

**AT A GLANCE**

In practice both standardised and non-standard crimp profiles are being used. Common amongst all crimping systems is the requirement that the conductor, cable lug and crimping tools are engineered to work with each other ensuring a safe connection is achieved.

# Which method is correct?

## Crimp types at a glance

Initially the subject covering crimping profiles seems complicated; the electrical installer is confronted with a number of different cable types, each requiring different cable lugs or connectors and a professional crimping method. This combination depending on material, design and application requires the correct crimping profile to be used.

The following article will give a review of the most common crimp profiles the electrician should be familiar with (Review: see chart).

### For copper and aluminium: Hexagonal crimps

The most common type of crimp for cable lugs and connectors is the hexagonal crimp as this crimp profile is suitable for copper and aluminium conductors (Picture 1). The range of applications covering hexagonal crimps includes the crimping of conductors as per VDE-0295-categories 2, 5 and 6 and the processing of non-tension connections of aluminium cables per DIN 48201 part 1, and aluminium ropes per DIN EN 50182.

The advantage of a hexagonal crimp is the central force which is applied consistently from all directions and over a larger area during the crimping operation. During this crimping operation the individual strands of the conductor are being homogeneously compressed preventing any damage.

The result is a strong mechanical connection. Due to the even compression the hexagonal crimps are also suitable for application in medium and high voltage areas. However, these advantages are faced with some limitations.

The complete compression of wire strands using a hexagonal crimp and standard crimping dies is not possible. This means: Standard hexagonal crimps are not gas-tight (see gas-tight oval crimps at the end of this article). Therefore it should be observed that a professional hexagonal crimp requires the use of crimping dies which are matched exactly with material and dimensions.



**Incorrect cable lugs or the use of incorrect crimping tools can create serious safety defects in electrical installations and appliances**

### Hexagonal Crimps – DIN Type

Hexagonal crimps differ in two versions: One relates to the standard hexagonal crimp in accordance with DIN 48083 part 4 and the other to the manufacturers related hexagonal crimp. The standardized hexagonal crimp allows cable lugs and connectors according to DIN 46235 to be crimped with certified crimping dies per DIN 48083 part 4 (see Picture 2).

Marking on DIN cable lugs provide essential information as to manufacturer, dimensions and design of the cable lug. These markings indicate for instance which crimping tools and crimping dies need to be used to achieve a DIN compliant crimp. This designation is next to the manufacturers' marking. For instance "KL 18..."

stands for KL: manufacturer (in this case Klauke) and 18 for the die code.

The correct die code is a condition of a professional DIN crimp: Crimping dies used in the crimping tool need to comply with the die code shown on the cable lug. The mirror image of the die code can be seen on the surface of the crimping dies. After the crimping operation the die reference code can be seen on the barrel of cable lug as part of a visible and recordable quality control procedure.

The die code corresponds approximately to the tube diameter of the cable lug.

The range of copper lugs is approximately from 6 to 58 which correspond with the cross sections from 6 mm<sup>2</sup> to 1000 mm<sup>2</sup>.

Hexagonal crimping dies per DIN 48083 part 4 for aluminium lugs and connectors are described in accordance with the tube dimensions of lugs per DIN 46239 and connectors per DIN 46267 part 2.

### The alternative: Manufacturer specific hexagonal crimps

Apart from DIN standard hexagonal crimps the crimping of copper and particularly of cable types per VDE 0295 classification 2 also allows for a manufacturer related hexagonal crimp to be used. Prestigious manufacturers such as Klauke provide hexagonal crimping






CRIMPING PROFILES					
Crimping profiles	hexagonal-crimping	indent crimping	indent crimping solderless terminals	quad-point-indent crimping	oval-crimping
Symbol					

Chart: Crimping profiles at a glance



**Picture 1:** A hexagonal crimp is suitable for both copper and aluminium conductors. The advantage is the central force which is applied consistently from all directions.



**Picture 2:** The standardized hexagonal crimp allows cable lugs and connectors per DIN 46235 to be crimped with certified crimping dies per DIN 48083 part 4.



**Picture 3:** Indent (side indent) are always special application crimps which are primarily used for crimping fine stranded and compacted conductors to secure a permanent connection. The applied crimp profiles depend on the cross section of the conductor and type of cable lug.



**Picture 4:** The intensive indent crimp is only guaranteed when matched materials are used despite the large outside diameters a permanent and „deep acting“ connection will be achieved.

dies tested and approved to IEC 1238 for crimping standard copper cable lugs as per EN 13600. For commercial reasons such cable lugs are often used in control and switch cabinets. Despite offering cost benefits, there is no reduction in quality.

Important: The use of manufacturer related crimping dies and cable lugs are not controlled through the die codes.

Instead it depends more on the cross section of the cable being used indicated in mm<sup>2</sup>, the cable lug and the die reference. The square mm size is mirror printed on the crimping surface of the crimping dies.

Every manufacturer is responsible for the electrical and mechanical durability of connections crimped with their own tools.

As a safe and professional crimp is dependant on accurately matching suitable crimping dies to the cable lugs, Klauke always recommends using the manufacturers approved crimping tools.

### Proven and tested: Indent crimps

The indent crimp represents the oldest electrical crimp profile. This crimp profile is solely suitable for the processing of copper and is often used in control panels and switch cabinets operated within a range of 1000 V. The permissible cable range includes stranded conductors per VDE 0295 classification 2 and also fine stranded and compacted conductors per classification 5 and 6 up to 400 mm<sup>2</sup>. These conductors can be processed with R and F series tubular cable lugs.

Generally two different types of indent crimps are used: The W-profile for cross sections from 0.5 mm<sup>2</sup> up to 16 mm<sup>2</sup> and the classic single indent crimp for cross sections from 6 mm<sup>2</sup> up to 240 mm<sup>2</sup>.

Klauke crimping tools offer the possibility to indent crimp cross sections up to 400 mm<sup>2</sup>. The characteristics of both versions are identical: Indent crimps are always special crimping operations particularly required for fine stranded and compacted conductors to secure a permanent connection (Picture 3).

The real benefit of indent crimping is the simple operation and procedure for which normally hand operated

crimping tools can be used. The applied crimp profile depends on the cross section of cables, cable lugs and connectors to be used. Since the indent crimp does not represent a standardized crimp it is imperative to only use high quality materials and tools approved per IEC 1238 originating from one manufacturer. Only in this case the electrician is safeguarded utilizing cable lugs, connectors and tools which are matched to each other and which provide and guarantee a safe connection.

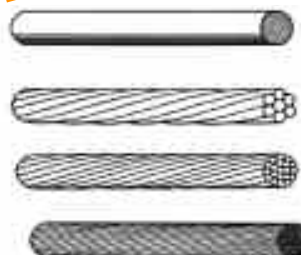
### For copper and insulated materials: Indent crimps

Indent crimps have been specifically developed for processing connections of cable lugs according to DIN 46234 and connectors per DIN 46341 part 1, form A+B, which in turn are suitable for conductors of VDE 0295 classification 2, 5 and 6. Cable lugs and connectors complying with these standards feature a particular large outside diameter which will accept all types of cables without any problem. The intense indent crimp ensures that despite of the large outside diameter a long lasting and „deep acting“ crimp is achieved (Picture 4).

The permitted cross sections range from 0.5 mm<sup>2</sup> up to 240 mm<sup>2</sup>. An indent crimp is also suitable for F-type cable lugs ranging from 10 mm<sup>2</sup> up to 300 mm<sup>2</sup>. F-type cable lugs feature a larger diameter; funnel shaped tube to accept fine stranded and compacted types of cables per VDE 0295 classification 5 and 6 without any splitting. An indent crimp is also suitable to crimp pre-insulated terminals in accordance with DIN 46234 where the crimp pierces the insulation.

To avoid that the insulation is damaged during the crimping operation it is imperative to only use cable lugs with

## CONDUCTOR TYPES



- round solid (re), conductors of classification 1 (described as solid conductors)
- round stranded (rm) conductors of classification 2
- fine stranded conductors of classification 5 (described as fine stranded conductors)
- compacted conductors of classification 6 (described as compacted conductors)

a high quality insulation and appropriate crimp profiles (Picture 5).

The indent and the side indent are also non-standard types of crimp but can also be used for standard cable lugs such as terminals per DIN 46234. For this reason here it is also important to use tools and materials from a single quality manufacturer. Materials incorrectly matched are disadvantaged further due to the extreme stresses applied during use. Once a single strand has been lost mechanical and electrical failures in the connection may become inevitable.

**No dies required:  
Quad point crimps**

The quad point crimp originates in the USA and is being used mainly in panels and switch cabinets up to 1000 V. These are also used in other electrical connections i.e. in drive systems for locomotives where this type of crimp offers the perfect solution. This crimp profile is suitable for cable lugs and connectors ranging from 10 mm<sup>2</sup> up to 300 mm<sup>2</sup> in combination with cables per VDE 0295 classification 2, 5 and 6 (Picture 6).

Attention: Application for use with pre-insulated cable lugs and connectors is not allowed.

The advantage over a simple indent crimp is the way the centric force is applied and that no crimping dies are needed. This means that with just one crimping tool all the above mentioned cross sections can be processed. The quality of the crimp depends solely on



**Picture 5: Cable lugs with a high quality insulation and appropriate crimp profiles ensures that the insulation does not become damaged during the crimping operation.**



**Picture 6: The quad point crimp is suitable for cable lugs and connectors with cross sections ranging from 10 mm<sup>2</sup> up to 300 mm<sup>2</sup> in combination with cable types per VDE 0295 classification 2, 5 and 6.**



**Picture 7: Gastight oval crimps provide for a permanent connection and good electrical conductivity. The ingress of fluid or a gaseous medium is not possible under normal atmospheric conditions. An oxidation of the individual crimped strands is prevented and an increase in resistance is avoided.**

the force and quality of the crimping tool used.

**Gastight: Oval crimps**

Gastight oval crimps are being used predominantly in the motor industry and in aggressive environments such as agricultural operations or chemical industries. A gastight connection means that both conductor and cable lug or connector is compacted together so tightly that no notable gap exists (Picture 7). This means that the ingress of fluid or a gaseous medium is not possible under normal atmospheric conditions. An oxidation of the individual crimped strands is prevented and an increase in resistance is avoided. For this reason gastight oval crimps provide for a permanent connection and good electrical conductivity.

A gastight connection can be tested by inspecting the polished cross section of the lug. There is no restriction to spe-

cific types of cables; therefore all types of conductors are suitable for gastight oval crimps. To meet the high technical requirements of gastight connections it is absolutely imperative to use only high quality branded crimping tools and connecting material.

**Outlook: Which crimp profile for the professional solution?**

To ensure that durable crimping connections are achieved, specific crimping operations are required.

In our next edition we will feature the various crimp profiles in detail and will explain what needs to be observed to obtain a professional high quality connections.

**IMPORTANT: SUITABLE TOOLS**

For all crimp profiles as a rule it is precondition to use professional tools, which do not over or under compress the connector. Incorrect crimps or the use of the wrong tools can result in an increase in joint resistance and may jeopardise

the installation causing fire. To exclude such consequences Klauke strongly recommends for crimping of their cable lugs the exclusive use of their appropriate crimping tools.

**MORE INFORMATION**

**Articles on this subject**

- Which cable lug suits which application? – de Special 1-2/2008
- Tubular cable lugs for special applications – de Special 8/2008
- Best practice for installation of Aluminium connectors – de 17/2008
- Professional processing of aluminium and copper, – de 22/2008

**Book on this subject**

Schmolke, Herbert: Selection and rating of cables and conductors, 2009, revised edition, 128 pages, paperback, with CD-ROM, 18 €, ISBN 978-3-8101-0285-0,