Automated crimping technique: Large series are assembled along highly automated assembly lines.
ODU has the relevant expertise for developing and manufacturing reliable solutions that are stable for the long term even for critical, performance-limiting termination areas. To achieve this, ODU mainly uses three termination types: screw, solder and crimp. Solder and crimp terminations are most widely used on the cable side, and crimping is used particularly in highly critical applications. Therefore, the more detailed focus here will be on crimp termination.

09

THE TERMINATION FOR A PERFECT CONNECTION

The termination of the connector is often underrated regarding its impact on the performance and functioning of the overall connector system. The transition from the connector to the cable is a critical area when it comes to the flow of current and heat. An incorrect layout may limit the system’s overall performance. This is true for high-voltage and high-speed applications as well as for high-current and high-temperature applications. When extreme requirements are added to this, such as temperature fluctuations or vibration and shock, it means the termination area is under permanent stress.
The ideal crimp connection constitutes a non-detachable, gas-tight, permanently corrosion-free and contact-reliable connection between the connection cable and the contact. It is highly stable against vibration and applied force, as well as resistant against environmental conditions such as high temperature, thermal shock and humidity.

The crimp connection is created by means of the exact crimping of the conductor and contact material. This process involves the contact-welding of the metals at the pressing point, thereby leading to a gas-tight connection. Neither liquid nor gaseous media are able to penetrate the crimp under normal atmospheric conditions, which prevents oxidation between the crimped single wires, among other things. The mechanical and electrical requirements for such connections are defined in the IEC 60352-2 standard.

In addition to parameters such as the material properties, the structure of the cable or single conductors, and the current and thermal load, the right crimp geometry in particular must be determined and established for fault-free crimping. This is decisive for the quality and long-term stability of the crimp connection.

The layout of the application-specific geometry of a crimping involves experience and the use of the ODU crimp database, which has grown over the years. The development process is naturally supported by ongoing FEM calculations and measurements that accompany the development, such as the current-carrying capacity. Each new strand-contact combination is precisely aligned at ODU, and the quality of the crimp connection is confirmed by means of comprehensive laboratory tests. This is also when the parameters to be checked during manufacturing are defined.

The right layout:
An extensive database makes it possible to create a reliable forecast map of crimp processes by means of FEM simulation. In addition to making visible the quality of the pressing operation of the wires (lll. left), it also makes it possible to reliably recognize critical stress conditions in the case of over-crimping of the material. To the right, an optimally crimped layout.
Flexible connection technology:
1. In the upper part, a high-quality solder termination. Below this, a socket contact with the adjustable hex crimp developed by ODU crimped on a fine-wire strand.
2. The FEM simulation shows the stress within the material. The adjustable crimp profile results in a highly balanced stress distribution in the crimp barrel.
3. The micrograph of the transverse section shows a flawless pressing of the cable strands; the crimp barrel has no cracks.
PUTTING TERMINATION TECHNOLOGY TO THE TEST

In order to ensure the long-term stability of crimp connections, comprehensive test scenarios are sometimes required. Only through the detailed knowledge and understanding of the connector’s future application area can the tests be precisely and specifically coordinated.

Comprehensive tests and consistent checking

The entire crimp qualification is specified at ODU in the PB 1120 in-house standard.

- The visual inspection of the crimping by means of microscopy. In this part of the test, particular attention is paid to material cracks or scratches on the surface.
- The crimping height is measured by means of a micrometer screw – for process control in later serial production. The measurement of the crimp height shows perfect compression around the contact’s conductor.
- Determination of contact resistance via the 4-wire measuring method. The electrical resistance is decisive for the capability of the connection to conduct electricity. An excessively high electrical resistance is an indication of an insufficiently broken-up oxidation layer of the single wires.
- Assessment of the polished sections using the metallographic microscope as well as documentation regarding the compression level and thus the quality of the crimp connection. The formation of the originally round single wires into irregular rectangles provides information about gas-tightness. The crimp barrel must also show a slight deformation on its inner surfaces and exhibit no gaps.
- Tensile tests regarding the draw-out strength of the connection cable and a comparison of the standard specifications. This test also determines existing damage to strands or incorrectly set crimp tools.
- Environmental and aging tests are performed on the crimp connection in an application-specific manner.
- Following series release, the contact resistances, crimp heights and draw-out strengths of the strands are inspected and documented during production prior to each production batch.

Metallographic examination:

Highly polished test pieces are evaluated under a high-resolution light microscope. Electroplatings are measured and the grain structure of the basic materials is examined using a chemical etching procedure for contrasting.
1. Grinding and polishing machine:
Embedded test pieces are prepared for a later microstructure evaluation under the light microscope in a 6-stage grinding and polishing process.

2. Electrical stress test:
Subjected to a high level of climatic stress, current is cyclically applied to the test pieces. These extreme requirements can only be met through the use of an optimally designed crimp connection and suitable material pairings.

3. Conductor draw-out strength:
The draw-out strength of the conductor from the contact is, in addition to other electrical and mechanical criteria, a measurement of the quality of a crimp connection. In ODU’s T²C test laboratory, testing facilities exist with a tensile force of up to 30 kN.