Test stand for measuring partial discharge
Long-term stability and a variety of application-specific designs are tested and optimized.

The challenge of developing and designing high-voltage resistant connectors lies in the mutual influence and necessary dielectric strength as well as an increasing demand for miniaturization. In smaller construction sizes, the distance between individual contacts decreases, thereby strengthening the electrical field. This also raises the risk of electrical breakdown and destruction of the insulator as well as the overall system.

06 PROFOUND EXPERTISE IN HIGH-VOLTAGE APPLICATIONS

For small connectors, it is indispensable to calculate and adhere to necessary clearance and creeping distances in order to reach consistently strong electrical current. It is equally important to avoid inhomogeneities in the product design such as sharp edges or corners, since under constant contact distance, these can intensify the electrical field many times over. Some material combinations can even promote this effect on the strength of the electrical field. ODU goes even further by taking into account yet another important parameter: the so-called partial discharge.

SPECIALIST KNOWLEDGE ABOUT PARTIAL DISCHARGE

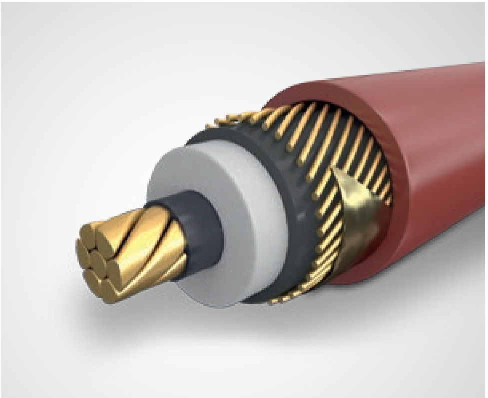
For connectors with a continuous high-voltage load, partial discharge is an important aspect to look for in addition to clearance and creepage distances. The issue of partial discharge can be observed, according to the IEC 60664 series of standards, starting with a continuously applied voltage of > 1 kV. For this reason, ODU considers all connectors > 1 kV as high-voltage connectors – even if they do not actually fall within the generally defined high-voltage range (60 kV to 110 kV). In this area, ODU has many years of expertise and experience regarding the physical effects of, and correct structural design for, connectors free of partial discharge.

Meeting the challenges

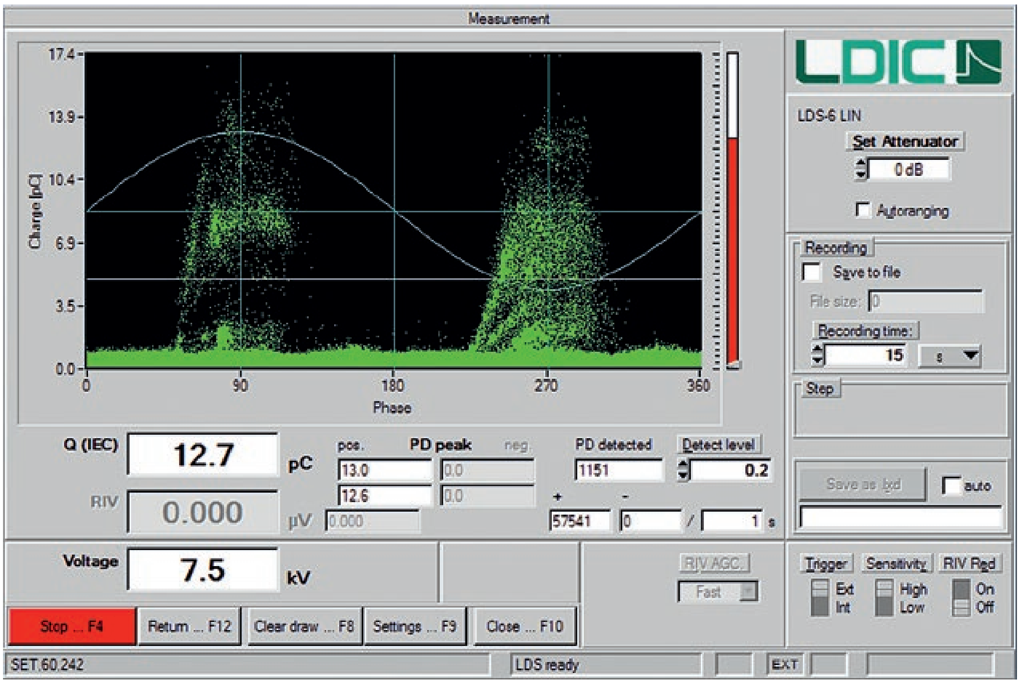
Even when taking into account clearance and creepage distances and their proper layout, inhomogeneities of the electrical field (such as through blowholes in the insulator) or contaminations in the assembly process could lead to the local exceedance of a system's dielectric strength.
If the operating voltage is applied for a longer period of time, the smallest of local discharges occur at the molecular level on these locally excessive field strengths. Over the course of the connector's service life, a "tree" can form as a result (misalignment from continuing local carbonizations). If the first partial discharge occurs on a field excess, the field excess will then be increased due to carbonization. This, in turn, can lead to an avalanche effect that, over the short or long term, can bring about a destructive electrical breakdown.

Experience shows that the connected cable is frequently a critical factor. For this reason, ODU selects an appropriate cable that enables improved field guidance in the case of applications where partial discharge is critical. In high-voltage applications, a grout is also frequently used in the cable connection area. This eliminates any remaining air in this area and a higher dielectric strength is achieved. The precise, high-quality processing of the grout, and the selection of the suitable grout, of course, is of particular importance. At ODU, this is completely covered.
The same is true for insulators. These materials demonstrate a kind of self-healing process, despite the occurrence of partial discharges. Due to their chemical structure, these materials either have no avalanche effect or only a very weak one. In some cases, field excesses can even be reduced.

Typical effects on the insulator in the case of an incorrect connector layout: so-called "trees".



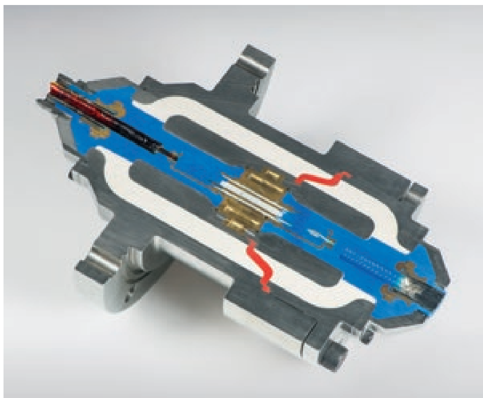
For optimized field guidance, the termination area is to be precisely adjusted to the specific high-voltage cable.



Partial discharge measurements at ODU

ODU possesses an in-house test stand for partial discharge measurements. It enables the long-term stability of high-voltage connectors to be tested, and various application-specific layouts to be tested and optimized. It also allows for the quick and effective comparison of various insulator materials in the context of partial discharge measurements.
A combination of this test stand and the necessary experience enabled ODU to bring a wide range of possibilities to the development of a connector for the international research project on the ITER fusion reactor. The connector in question is partial discharge-free up to the double-digit kilovolts range and is also suitable for ultra-high vacuum situations.

Visualization of partial discharges
Depending on the moment when inception voltages are exceeded in the phase diagram, conclusions can be drawn as to where they originate within the connector.



High-voltage feedthrough with connector for ITER – optimized and tested for freedom from partial discharge in all relevant areas.