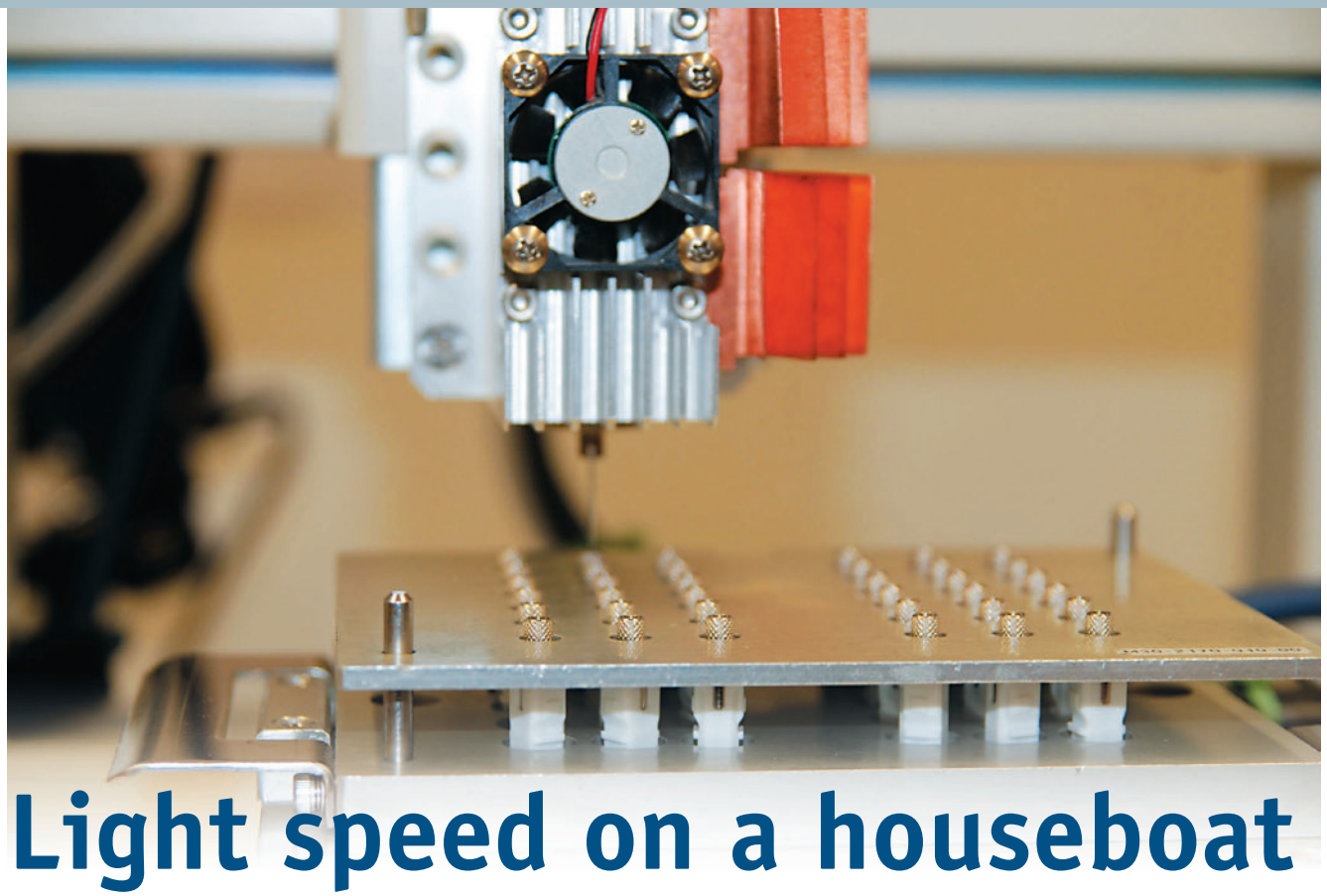


Light speed on a houseboat

›EXPANDED BEAM‹ TECHNOLOGY IS KEY TO PROVIDING HOUSEBOAT OWNERS IN AMSTERDAM WITH ACCESS TO THE GLASS FIBER NETWORK

The range of applications of optical fiber technology is demonstrated by the ›Fiber-to-the-Boat‹ project launched in Amsterdam back in 2007, with the goal of integrating houseboats into the local high-speed glass fiber network. The challenge had been to find a technology that can withstand the very adverse environmental conditions.

WILFRIED SCHNEIDER

It is not just in the workplace that the requirements for data, voice and image transmission are rapidly increasing. There is a huge demand in general for transmission media that can meet today's high performance requirements.

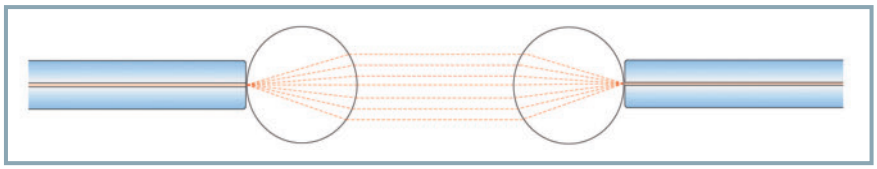
Glass fiber networks provide absolutely unlimited options – in theory at least. In real terms, critical situations occur if the network is not used in a dust-free server room but in a harsher location.

This is often the case in outdoor industrial plants and in the military – or even on houseboats tethered to the quayside. In these tough, harsh environment applications, the delicate optical connectors are the most sensitive part of the system and are thus the main focus of attention.

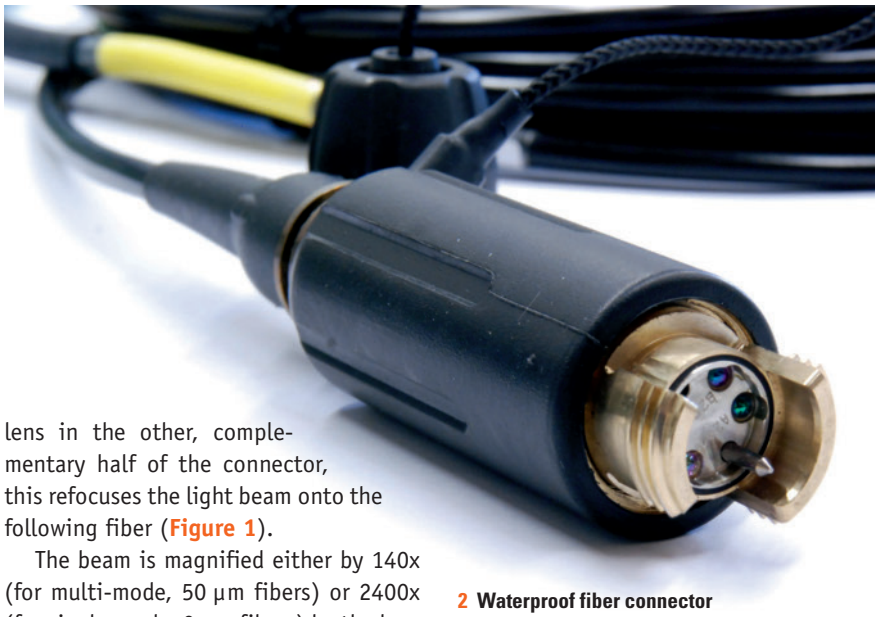
The physical glass fiber connectors currently available on the market are extremely sensitive to signal degradation caused by dirt and contamination. Even very tiny dirt particles are enough to interrupt or totally destroy the data transmission into or from the connector. To minimize this susceptibility, so-called ›expanded beam‹ connectors have been developed, and are used in conjunction with special cables for applications in harsh environments. They are far less sensitive to contamination or vibrations and are used wherever other components would quickly fail.

Connector principles

These connectors are based on an expanded beam approach to coupling. The light beam that exits at the end of a glass fiber cable is magnified and collimated using a spherical lens. When the expanded beam reaches a second spherical



1 Schematic illustration of the function of the expanded beam connector



2 **Waterproof fiber connector**

lens in the other, complementary half of the connector, this refocuses the light beam onto the following fiber (Figure 1).

The beam is magnified either by 140x (for multi-mode, 50 µm fibers) or 2400x (for single-mode, 9 µm fibers) by the lens in the connector. This expansion of the beam, avoiding physical contact of the end facets of the fibers, makes the connector far less sensitive to environmental influences such as contamination, dust, shock and vibration. Attenuation due to lateral displacement of the ferrules or damage to the fiber core caused by repeated reconnection (a frequent cause of problems with conventional plugs), are also eliminated.

Typical applications

This connector system is typically found wherever environmental or industrial conditions demand its use. It is of no surprise to learn that the technology is frequently used in the military sector, primarily in mobile applications such as field operation for high-speed usage conditions.

These connectors are also widely used for offshore applications, in underground and surface mining, and in outdoor rail and industrial plants. These plugs have also proved ideal for TV and radio transmissions, particularly live broadcasts. As requirements for data, voice and image transmission increase, the technology is becoming increasingly interesting for numerous new applications – particularly those faced with harsh environmental conditions, as in the case with internet access for houseboat owners.

High speed in local harbors

In 2007, the ›Fiber-to-the-Boat‹ project was launched in Amsterdam. Amsterdam has a total of 710 000 inhabitants, some of whom live on around 2500 houseboats moored on the banks of the city's canals.

Connecting these houseboats to the ›Glasvezelnet Amsterdam‹ (GNA) – the local high speed glass fiber network – brought particular demands in terms of the technical realization. On the one hand, the chosen components had to be completely resistant to seawater and additionally exhibit exceptional robustness, but, on the other hand, also needed to provide multiplexing capability. Many of the companies approached for a solution considered these problems to be insurmountable, as in addition to the minimum requirements in terms of quality and durability, the highest level of performance level was also required.

However, tde - trans data elektronik and its partner Draka has managed to develop a solution that precisely meets these requirements. An optimized, largely automated manufacturing process together with the use of high quality connectors and appropriate cables, enable maximum performance to be provided with a sophisticated salt water resistant system.

Utilized componentry

The Fiber-to-the-Boat project uses high quality HMA connectors and special MilTac cables. The HMA connectors used are completely resistant to salt water to a depth of two meters, are exceptionally shock resistant and have ten to twenty times the strength under tension of conventional connectors (Figure 2). The hermaphrodite connection means that connectors with one to four glass fiber channels, available in multi- and single-mode formats, can be used without adapters. Easy cleaning makes them particularly attractive for use in private households or on boats.

As the cables are also constantly exposed to the same harsh elements (dirt and seawater), tde opted for multi-fiber multi-mode MilTac cables with special, highly robust and virtually cut-resistant sheathing material. This is made of ▶

3 **Oliver Ax, owner of the first houseboat connected to the glass fiber network** (Image: Draka)

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an exceptionally strong polyurethane plastic, making the cable extremely resistant to tearing and also providing reliable protection against damage caused by chemicals. Originally developed for use in the military, with 20 times greater strength under tension than normal cables, the MilTac cables were perfect for use in Amsterdam. The implementation of optimized and largely automated manufacturing processes by tde means delivery of factory pre-assembled and 100 percent tested components, suitable for reliable on-site plug & play installation in next to no time.

Automation of the process, along with use of extremely high quality connectors and very robust glass fiber cables, has enabled tde and its partner Draka to offer maximum performance in this implementation of a salt water resistant system.

Summary: development continues

Technical development is continuing apace and every development opens up brand new application possibilities. tde is already working on a completely new, patented connector system featuring a modular construction. This goes beyond conventional lens connectors as utilized here, instead making use of miniaturized lens elements that allow integration into a huge variety of harsh environment connectors as well as in other connector types. This means that the expanded beam approach can also be implemented in multi-pole connectors.

For example, the lens elements can be used in hybrid connectors similar to the ›13W3‹ (Sub-D type) and in conjunction with copper contacts, offering an unprecedented level of flexibility. Self alignment of the ferrules in the lens modules and tde's optimized manufacturing process bring significant improvements in the attenuation figures of the lens elements, in the range well below 1 dB.

AUTHOR

WILFRIED SCHNEIDER is Chief Technology Officer (CTO) at tde in Bippen/Ohrte, Germany. As a member of the DKE/VDE standardization committee on ›Optical fiber connection technology and passive optical components‹, he is involved in drawing up international standards for IEC and CENELEC.

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