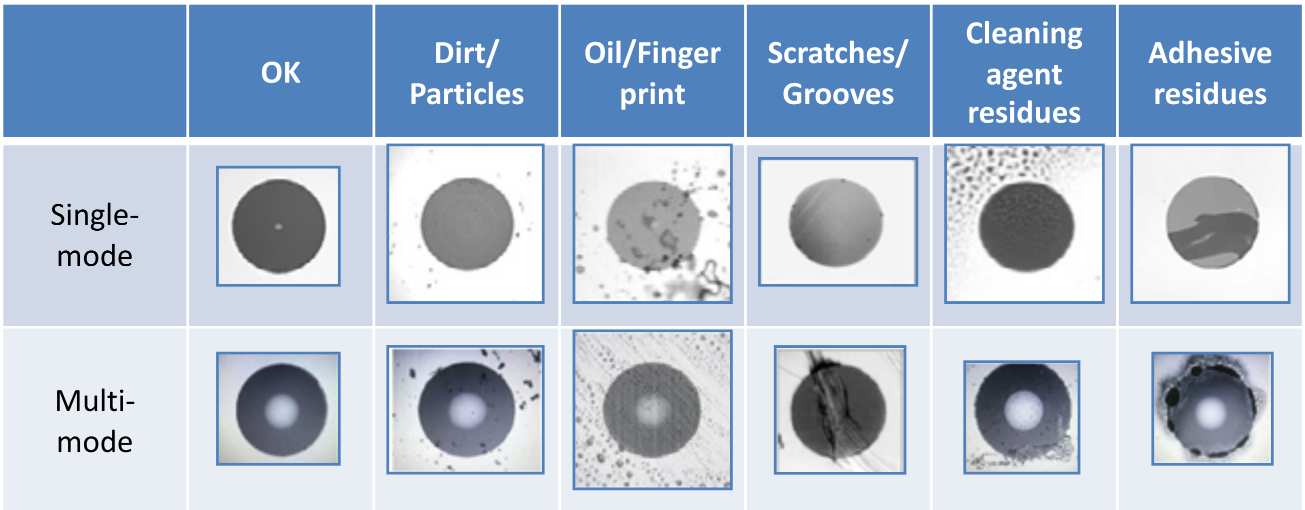
Clean or not clean?

FiberXpert

WireXpert 4500

IT Networks

Figure 1: Microscopic images of fiber end faces in various conditions



What does "clean" mean?

Automated assessment of fiber end faces in fiber optic connections guarantees consistent quality and functionality.

In the world of data transmission via fiber optic cable, it is widely known that defects such as scratches or chipping and, above all, contamination on the fiber end faces of connectors are the principal cause of faults and the deterioration of transmission quality on the transmission paths. From a metrological point of view, impairments of this kind lead to increased reflections, which manifest themselves in reduced return loss at connector transitions and an increase in insertion loss along the entire path. Scratching or even destruction of the fiber end faces of other connectors during patching procedures are possible mechanical consequences.

In light of ever-growing bandwidth requirements and increasing use of fiber optic cables in networks, contaminated and damaged connectors are impairing network performance more and more often and can even lead to the failure of whole transmission paths.

Therefore, it is imperative that fiber end faces are always inspected for cleanliness before establishing a connection. This applies to all phases in a system's life cycle, starting at assembly or installation, continuing through regular operation and regular maintenance work, up to fault tracing when malfunctions occur.

But when is a fiber end face deemed to be "clean" and ready for operation? As this concerns areas in which faces with diameters within a narrow micrometer range are pertinent, a simple visual inspection will by no means be sufficient. Every technician who works with fiber optic cables should at least carry with them a simple manual hand-held microscope, which is designed specifically for inspecting fiber end faces. Of course, this is in addition to appropriate cleaning equipment for removing any contamination that may have been detected before connecting for the first time (see fig. 1).

Standardized cleanliness

A standard devised by the International Electrotechnical Commission (IEC) provides a definition of "clean" and operational readiness. The standard's designation is IEC 61300-3-35. This standard defines general requirements regarding the quality of fiber end faces in order to guarantee optimum insertion loss and return loss. It contains pass/fail criteria for testing and analyzing the end faces of optical connectors. As part of this, separate requirements are specified for various types of connections, e.g. SM-PC, SM-UPC, SM-APC and MM and multifiber connectors. Compliance with the required limit values guarantees a consistent level of performance from the optical connector.

Because the suitability of technicians is variable and cannot be verified and due to inconsistent light conditions and display quality, inspection and analysis with a purely manual fiber microscope is, however, not a reliable or reproducible method for guaranteeing compliance with the IEC standard. In addition, no test report is generated during manual inspection and therefore, it is not possible to document the quality of the fiber end faces directly on site.

As compliance with the IEC standard is the only way to fulfill the performance potential of modern fiber optic cable networks with their numerous connectors, it is suggested that the process of fiber end face testing be automated.

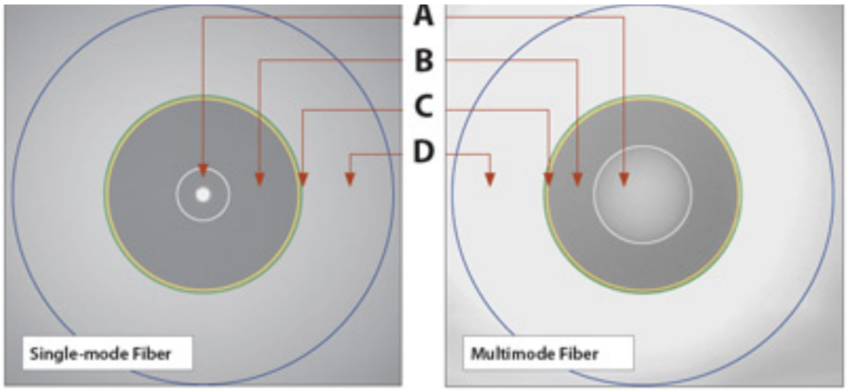
Automated assessment guarantees quality

A fiber microscope is used for this, which takes the pass/fail criteria of the IEC standard as a basis for an assessment, in conjunction with a piece of analysis software.
The automation of this inspection with a system of this kind removes the uncertainties associated with manual testing, produces a documented quality certificate at the place where the fiber end face is installed and ensures that the process is replicable and reliable. These benefits make automatic inspection of fiber end faces the most effective way of guaranteeing and verifying compliance with the IEC standard during the whole life cycle of the fiber optic cable and of fulfilling the performance potential of next-generation networks.

The fiber end faces to be assessed are divided into various zones, radially around the center of the connector. 4 different zones are identified around the center of the connector (see fig. 2). The various fault criteria for damage and contamination are specified for each individual zone according to number, size and position in relation to the fiber core.

Of course, it only makes sense to inspect the fiber end faces as part of a larger procedure, which involves alternating cleaning and inspection measures. The IEC standard also features an appropriate flowchart for this, so as to clearly define good and bad connectors. Consistent compliance with this workflow ensures that the inspection is carried out correctly each time and that the fiber end faces are clean before the connection is established. This prevents contaminated or damaged fiberglass from being connected to the network, along with the problems that presents.

Figure 2: Assessment zones for multi-mode and single-mode fiber end faces



Zones	Description	Radius at	Radius at
		SM	MM
A	Fiber core zone	0 µm to 25 µm	0 µm to 65 µm
B	Cladding glass zone	25 µm to 120 µm	65 µm to 120 µm
C	Adhesive zone	120 µm to 130 µm 120 µm to 130 µm	
D	Ferrule or contact zone	130 µm to 250 µm	130 µm to 250 µm

Video microscopes for practical application

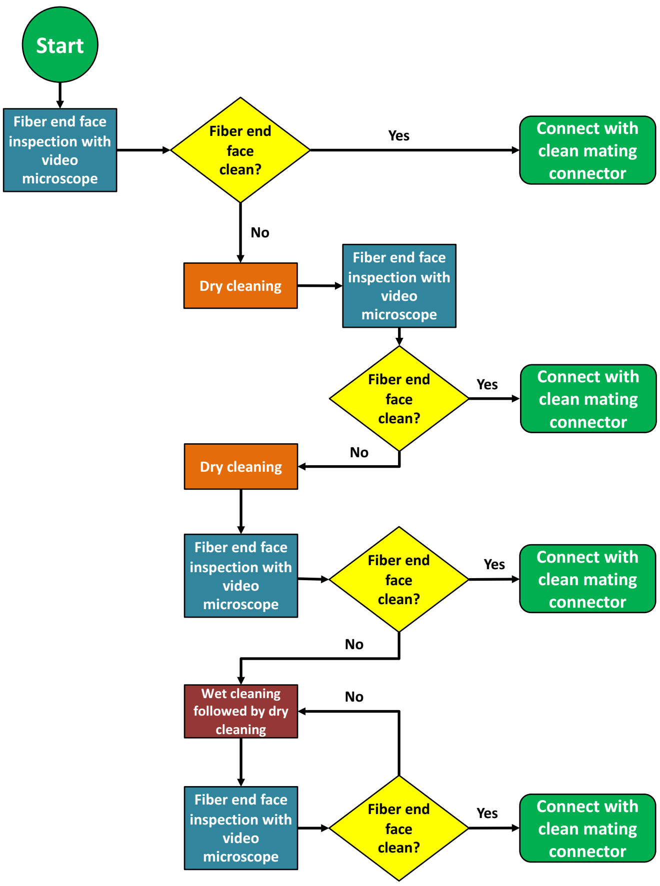
This process usually falls due for the first time in the life cycle of a fiber optic system during assembly or installation of the cables if the purpose is to determine the optical properties such as attenuation or reflection behavior in order to document either proper assembly or correct installation.

Essentially, a distinction is made between two levels when measuring fiber optic cables. Level 1 describes only attenuation measurements which are usually carried out with standalone attenuation measuring stations or auxiliary modules on certification devices for copper cabling. This involves comparing readings for transmission to fixed limit values which are either calculated from the permissible properties of the associated individual components or devised from the requirements of an application standard.

Level 2 supplements the attenuation descriptors regarding reflectance curves for visualizing occurrences on the fiber optic cables and at the same time, it also requires that only the fiber end faces of the relevant cables be documented.

For both types of measurement and before a measurement cable, delay line or follow-up line is connected, inspection and cleaning cycles should always be carried out in accordance with the procedure described below (see fig. 3), so that smooth operation of a system can be guaranteed.

Figure 3: Flowchart for inspection/cleaning of fiber end faces



Softing manufactures devices for both measurement levels onto each of which a video microscope can be connected via the USB port and for which the assessment in accordance with IEC 61300-3-35 can be carried out internally. In each case, the results are presented in the form of a graph and can be distributed as a separate document or together with the relevant associated measurement results or archived for the purposes of verification at a later date.

For measuring in accordance with Level 1, the WireXpert 4500, the flagship certifier, is fitted with fiber optic cable measurement adapters rather than copper cabling measurement adapters. As well as the classic single and multi-mode adaptors for the optical windows of 850/1300 nm and 1310/1550 nm, it also has modules capable of assessing multifiber connectors, so-called MPO connectors, in a measurement cycle using up to 12 multimode fibers. These multifiber systems are also already included in the IEC 61300-3-35 standard. Only the external zones C and D are not included in it.

The FiberXpert device is available for measurements in accordance with Level 2. A classic OTDR (optical reflectometer) in two designs, one a purely multimode device for the optical window of 850/1300 nm and the other a quad device which can be used for both multimode and single-mode systems and covers all four of the most common optical windows (see fig. 4)

Figure 4: Softing FiberXpert OTDR with connected video microscope for inspection of fiber end faces (example image)

Conclusion

All of the benefits of automatized assessment listed above ensure that automatic fiber end face testing is currently the most effective method of certifying compliance with the IEC standard throughout a fiber optic system's life cycle and of ensuring that the potential of next-generation networks is fulfilled.

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Sources:
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by VIAVI / Matt Brown

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Lichtwellenleiter - Verbindungselemente und passive Bauteile - Grundlegende Prüf- und Messverfahren *[Fiber optic cables - Connecting elements and passive components - Basic testing and measurement procedures]*- Part 3-35: Inspections and measurements - Visual inspection of fiber optic cable connectors and fiber stub transceivers

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About Softing IT Networks

Softing IT Networks, formerly Psiber Data, a sister company of Psiber Data Systems Inc. USA, was founded in 2003 and has been part of Softing AG since 2014. Softing IT Networks provides high-end electronic test equipment for the qualification, certification and documentation of complex IT cabling systems.

Softing AG is a listed German company that develops and manufactures hardware and software for industrial automation and vehicle electronics. The company was founded in 1979 with headquarters in Haar near Munich. In the financial year 2016, the company generated a turnover of 80.4 million euros with a total of 430 employees.

The competencies of Softing IT Networks are complemented by the expertise in networking industry of the Industrial division and the expertise in functional evaluation of electronic vehicle components from Softing Automotive.

Competences & Specializations.

Softing IT Networks is a specialist in measuring technology for qualification, certification and documentation of the performance of cabling in IT systems based on worldwide technological standards.

Whether for telecommunications, data bases, mainframes or industrial automation plant engineering, with Softing IT Networks' professional measurement technology you can optimize the performance of your data communications with faster and more secure connections throughout the network lifecycle.

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