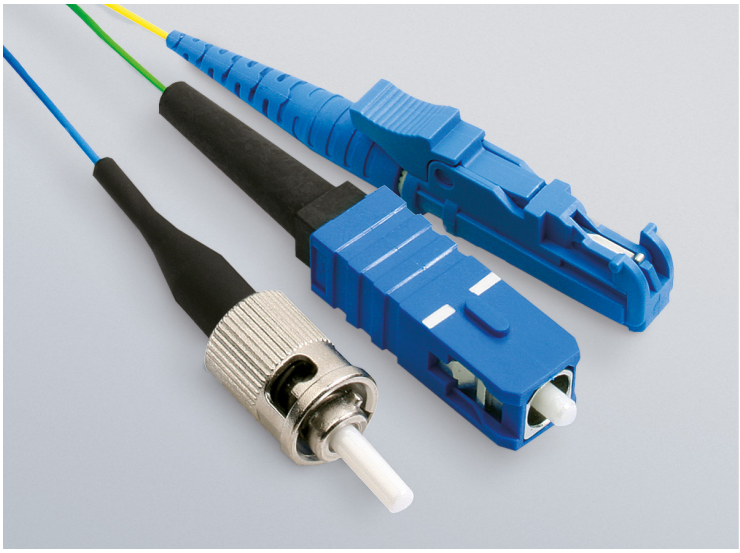
Telegärtner

QUALITY GRADES OF FIBER OPTIC CONNECTORS

With ever rising data rates, the demands on the cabling that transmits the data, rise as well. The higher the data rates become, the more important the quality of the cabling components becomes. Fiber optic connectors are of particular importance, as they show significant quality differences which cannot be seen by the eye. To determine the qulality of fiber optic connectors, they have to be tested and the test results have to meet determined levels. This special focuses on the internationally standardized quality grades of fiber optic connectors and explains the related technical background.

More and more data has to be transmitted further and faster still. Each day new devices, software apps and applications are brought to the market which produce even more data. For fast and faultless data transmission, a powerful cabling infrastructure is needed. Optical fibers have nearly unlimited transmission capacities, but they can only be reached in flawless transmission.



Connectors have always been critical components in a link. With a hand microscope one can easily check whether the surface of a connector's tip is clean. If not, it can be easily cleaned with the appropriate cleaning tools. Checking the optical quality of a connector, however, is something else. To examine the quality of a connector, an elaborate test site is necessary, and this is why factory assembled connectors are also tested in the factory.

FACTORS THAT DETERMINE THE QUALITY OF A FIBER OPTIC CONNECTOR

Assembling high-quality fiber optic connectors is demanding. This applies to assembling the connector on the fiber as well as to polishing the connector's end face.

During assembly the stripped and cleaned optical fiber is glued to a ferrule – a very precise sleeve made of metal or ceramics. The ferrule's hole that accepts the fiber is a little wider than the outer diameter of the fiber so that the glue-brushed fiber can be inserted. But as the hole is wider, the fiber can deviate a little bit and so the center of the fiber which guides the light is not exactly in the center of the ferrule. The drilling hole in the ferrule has some

very small tolerances. Also the fiber core that guides the light may not exactly be in the very middle of the fiber (so called core excentricity). Should the fiber be slighty bend inside of the ferrule, the light leaves the fiber in the connector tip at an angle.

Apart from the assembly, the polishing of the connectors have enormous influence on the quality of a connector:

- If the connector end face is not enough polished, the end face stays too rough.
- If the connector end face is polished too much, the fiber does not protude the ferrule enough. This is called undercut.
- If the connector end face is polished unevenly or at a wrong angle, the tip of the connector does not have the proper radius and the highest part of the end face is not the core of the fiber but lies somewhere else out of the ferrrule's center.

In any of the three cases, the connector will not have a good physical contact to the other connector in a connection. The very small air gap between the two connectors will cause unwanted reflections on the border of glass and air. The results: Insertion loss is too high and return loss is too low.

The problems listed above sum up, which is why small individual problems end up in a big overall problem.

STANDARDS TO DETERMINE THE QUALITY OF FIBER OPTIC CONNECTORS

Quality has to be measurable and verifiable based on generally accepted criteria. The international standard IEC 61753-1 specifies quality grades for fiber optic connectors based on insertion loss and return loss.
Insertion loss grades are identified by a letter, return loss grades by a number.
Basically any combination of letter and number is recognized by the standard, however not every one is sensible. To give an example: Grade B2 for singlemode connectors is a sensible thing, but B4 isn't. The standard specifies different values for singlemode and multimode connectors. At the time of writing, grades for field-installable singlemode connectors are still for further studies.

Signal losses in a fiber optic connection

When light leaves an optical fiber and enters another one, a little amount of the light is reflected. By this, less light reaches the receiver whereas the transmitter can be affected or even damaged by the reflection. Insertion loss is a measure of how much light is lost in the connections, return loss is the ratio of the originally transmitted amount of light to the unwanded reflection.
The receiver should receive as much light as possible and the refection should be as small as possible. This is why insertion loss should be as low as possible and return loss as high as possible (amount of light transmitted divided by the unwanted amount of reflected light).

Singlemode Connectors

Insertion loss	Insertion loss at 1310 nm, 1550 nm and 1625 nm
Grade A	ffs
Grade B	≤ 0.12 dB mean, ≤ 0.25 dB for ≥ 97% of the connections
Grade C	≤ 0.25 dB mean, ≤ 0.50 dB for ≥ 97% of the connections
Grade D	≤ 0.50 dB mean, ≤ 1.00 dB for ≥ 97% of the connections

Return loss	Return loss at 1310 nm, 1550 nm and 1625 nm
Grade 1	≥ 60 dB mated ≥ 55 dB unmated
Grade 2	≥ 45 dB
Grade 3	≥ 35 dB
Grade 4	≥ 26 dB

Insertion loss and return loss grades of singlemode connectors according to IEC 61753-1:2018+AMD1:2020 CSV

Multimode Connectors

Insertion loss	Insertion loss at 850 nm
Grade A_m	ffs
Grade B_m	≤ 0.3 dB mean, ≤ 0.6 dB for ≥ 97% of the connections
Grade C_m	≤ 0.5 dB mean, ≤ 1.0 dB for ≥ 97% of the connections
Grade D_m	ffs

Return loss	Return loss at 1310 nm, 1550 nm and 1625 nm
Grade 1_m	≥ 60 dB mated ≥ 55 dB unmated
Grade 2_m	≥ 45 dB

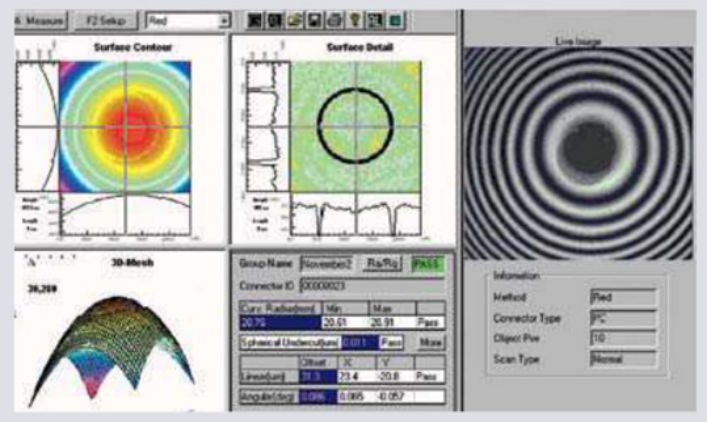
Insertion loss and return loss grades of multimode connectors according to IEC 61753-1:2018+AMD1:2020 CSV

REVIEW

IEC 61537-1 gives network designers, planners, installers and users generally accepted criteria to judge the quality of a fiber optic connector. The standard recognizes insertion loss and return loss a criteria to do so. However, the manufacturing processes, polishing and quality management of a manufacturer or assembly house also play an enormous role but cannot be easily specified by a standard. It is wise to ask manufacuturers and assembly houses about this. This includes possible contamination of the connectors after shipping.

Quality has a long tradition at Telegärtner

Telegärtner checks every single connector after assembly.
No exempts. Insertion loss of every connector is measured, and so is return loss of singlemode connectors.
When a polishing machine is set up for a new polishing series, every connector of the first group is measured with an interferometer to make sure the polishing process works perfectly.
On request, all connectors of an order can be measured with an interferometer, too.



Testing the connectors with an interferometer makes sure that the connector end face geometry passes particulaly high standards.

STANDARDS AND FURTHER READING

International standards (english):
IEC 61753-1:2018+AMD1:2020 CSV
(Consolidated Version)
Fibre optic interconnecting devices and passive components – Performance standard –
Part 1: General and guidance

European standards (local language):
EN IEC 61753-1:2019-10
Fibre optic interconnecting devices and passive components – Performance standard –
Part 1: General and guidance

Further reading:
Basic knowledge data / network technology;
Special topic brochure,
Telegärtner Karl Gärtner GmbH, Steinenbronn, Germany

Designation of multimode fibers; Special topic, Telegärtner Karl Gärtner GmbH, Steinenbronn

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