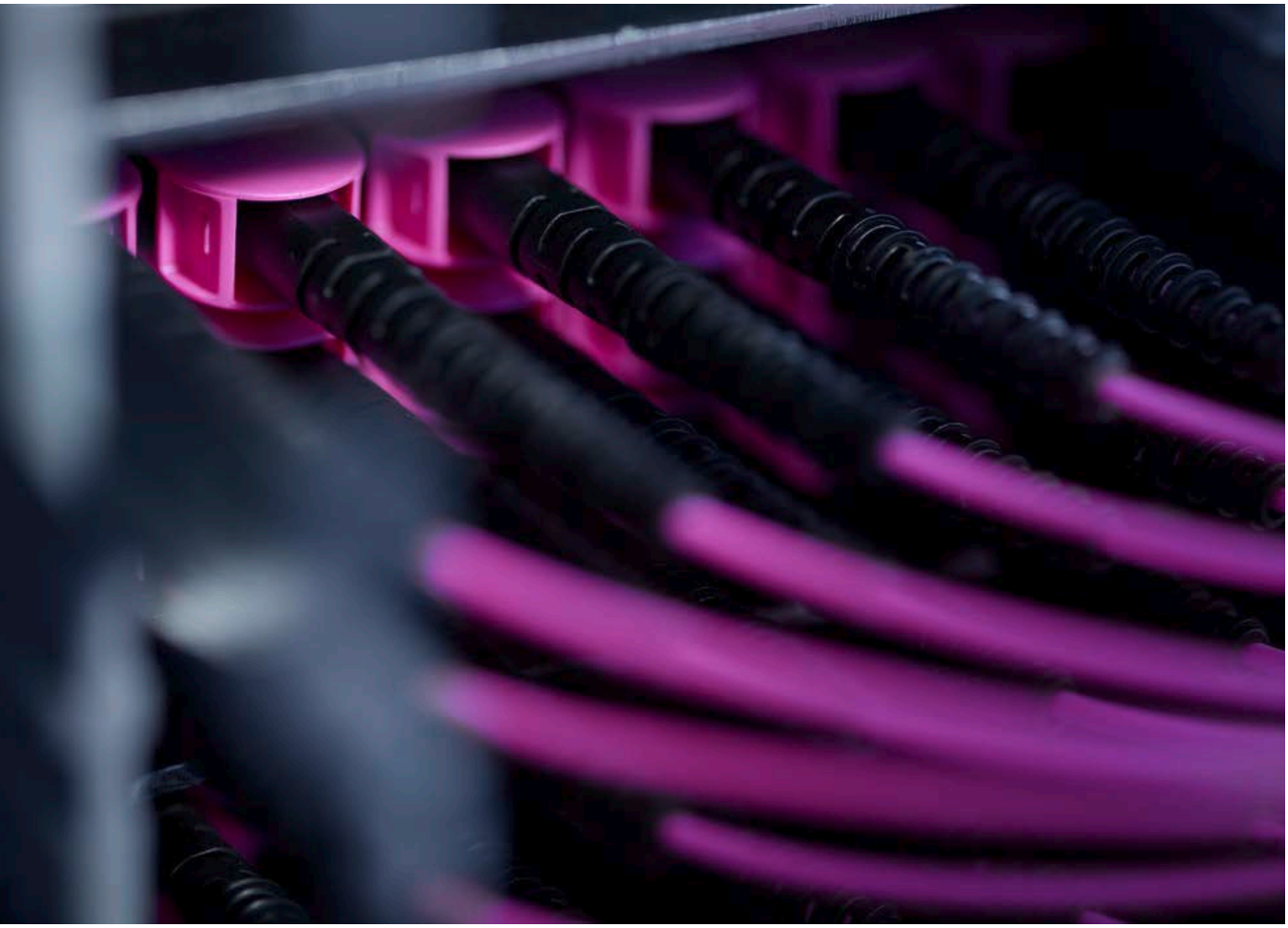
White Paper



Fiber optic connections: check and clean first, then connect!

How installers ensure the quality of their work

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How installers ensure the quality of their work

CONTENTS

Only a clean connector delivers full performance

With the latest advances in optical high-performance networks, connectors are becoming ever more crucial components in the passive fiber optic infrastructure. High-quality connectors ensure optimum transmission rates and constant network availability in all areas, from WAN to metropolitan area and campus networks, as well as backbone networks and subscriber connections. However, only clean connections achieve the values guaranteed by standards and manufacturers. It is therefore vital that installers possess sound knowledge of the correct way to install and clean these components. This white paper contains information on the currently applicable standards and discusses the relevance of properly cleaned fiber optic connectors.

Application:	Fiber optic cabling
Technology:	Fiber optic connectors
Format:	White Paper
Subjects:	Cleaning optical connectors – when and how?
Objective:	Provide information on surface properties and set out a practical approach. Ensure the quality of installations.
Target group:	Installers, network managers, users of fiber optic cabling
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1. When to clean?

The performance of a fiber optic system depends heavily on how clean the interfaces are. Small particles of dirt, grease, dust etc. can negatively impact transmission characteristics and even destroy a fiber optic connection depending on the circumstances.

The perpetual increase of data rates in particular is making transmission quality more sensitive to dirty connections. This is why it is becoming increasingly important to test all connectors and adapters, and, if necessary, to clean them before they are mated. In this case, both sides of a connection including the guide sleeve should be cleaned, as recommended in IEC 62627-01/TR for example. This applies to devices and test cables, as well as for network components.

New connectors should also be tested and, if necessary, cleaned. This is the best guarantee for a reliable optical network. In fact, various studies have shown that up to 85% of local faults are caused by connectors that either have not been cleaned carefully or have not been cleaned at all.

However, it is a popular misconception that every connector should always be cleaned before being plugged in. Most connectors actually arrive at their place of deployment in the pristine state in which they left the production facility. In such cases, the installer can actually only make the quality worse by cleaning the connector. The rule should be not “always clean before you plug in” but in fact “always check before you clean”. Figure 1 shows the procedure in full.

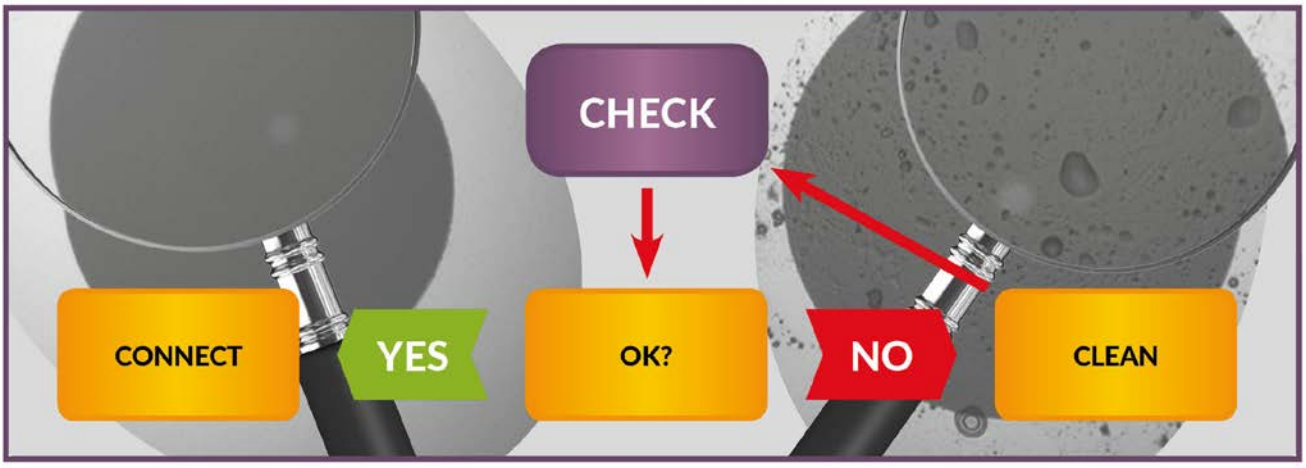


Figure 1: Procedure for checking a connector

2. Checking surfaces

Although the manufacturer will conduct a test using an interferometer, it is still necessary to perform a visual inspection on site using a microscope or another suitable tool. Here, the surfaces of the fiber ends are checked for scratches, cavities, adhesive residue and dirt. In order to achieve the defined optical properties of the connector, all four zones of the end surface of the fiber (as shown in Figure 2) must be completely free of dirt. Otherwise, the following criteria apply:

- **Zone A:** No scratches or pits permitted. 25 µm is three times the core diameter. Therefore, the zone must be checked especially carefully.
- **Zone B to C:** Small scratches and cavities may be permitted. Here, too, absolutely no dirt must be present.
- **Zone D:** Although this is already the ferrule region, this zone must still be checked as it is also part of the transmission area due to the contact stress on the connector. The interferometry test also registers a diameter of 250 µm.

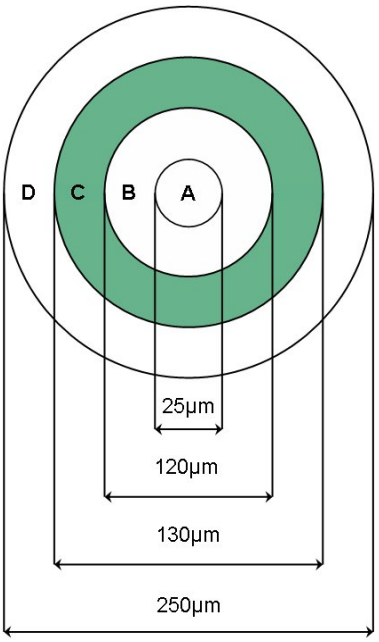


Figure 2: Surface zones on the end of the fiber (SM)

The detailed pass/fail criteria are standardized in IEC 61300-3-35. However, the primary focus of this white paper is the topic of cleaning.

A minimum 200-fold enlargement is required for the visual surface test. Use a lower resolution for a simple dirt check in the field. However, at least 100-fold enlargement is recommended here too.

Scratches through zone “B”

Possible causes:

- Manufacturing defect
- A dirt particle on the cleaning device has scratched the ferrules

➔ As the scratches are clearly < 3µm, the connector can be used (IEC 61300-3-35)

➔ If the problem reoccurs, use a new cleaning cloth

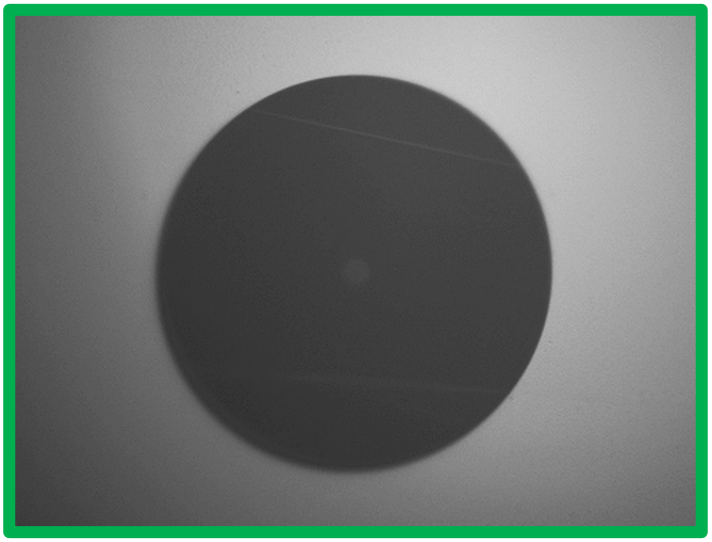


Figure 3

Scratches through zone “A”

Possible causes:

- Manufacturing defect
- A dirt particle on the cleaning device has scratched the ferrules

➔ Replace the connector (IEC 61300-3-35) or regrind it if possible

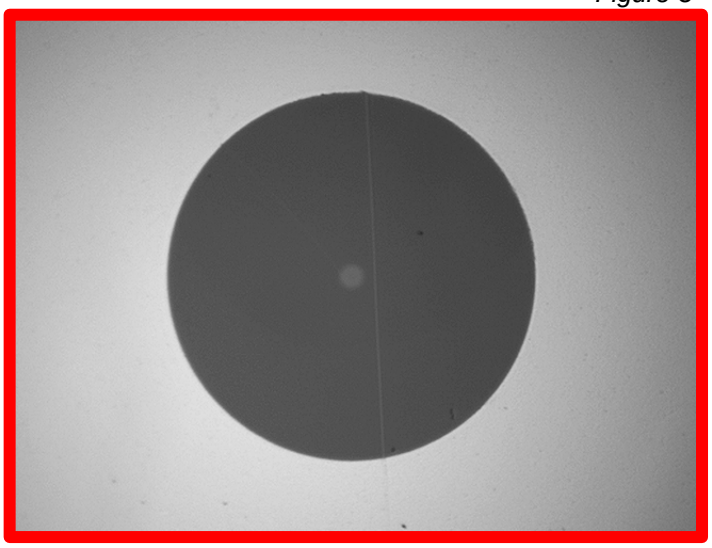


Figure4

Alcohol

Possible causes:

- Connector was cleaned but too much alcohol was used or the connector was not wiped on a dry cloth
- It is also possible that there is alcohol in the adapter (or microscope!) or on the opposing connector

➔ Clean the endface of the connector

➔ If necessary, clean the adapter/microscope

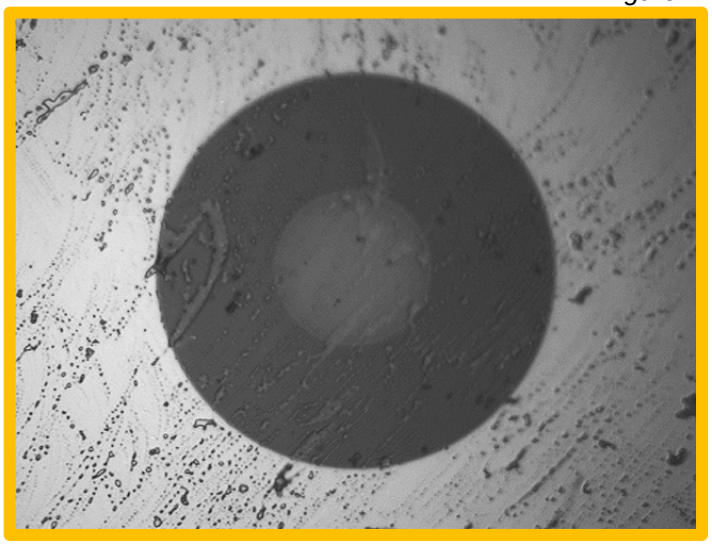


Figure5

Grease

Possible causes:

- Connector endface has come into contact with skin
- Dirty dust caps
- Dirty microscope

➔ Clean the connector endface AND the ferrule mantle
➔ If the connector is not plugged in immediately, use new dust caps
➔ Clean the microscope if necessary

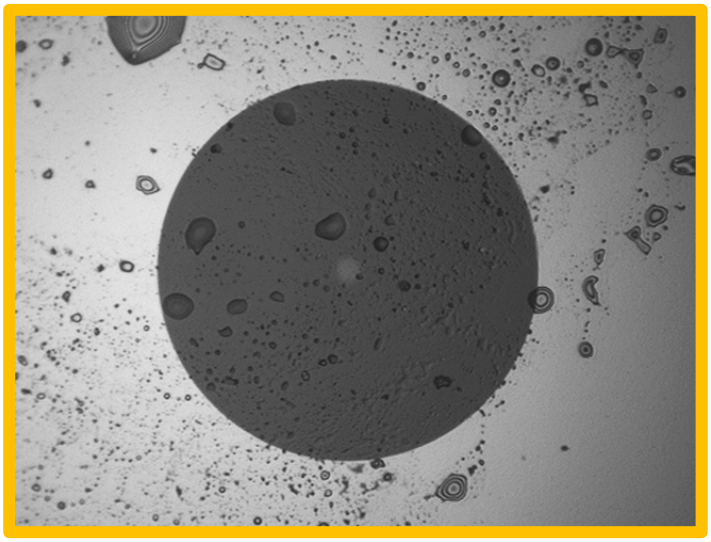


Figure 6

Oil

Possible causes:

- Unsuitable cleaning agent
- Dirty dust caps
- Dirty microscope

➔ Clean the connector endface AND the ferrule mantle
➔ If the connector is not plugged in immediately, use new dust caps
➔ Clean the microscope if necessary

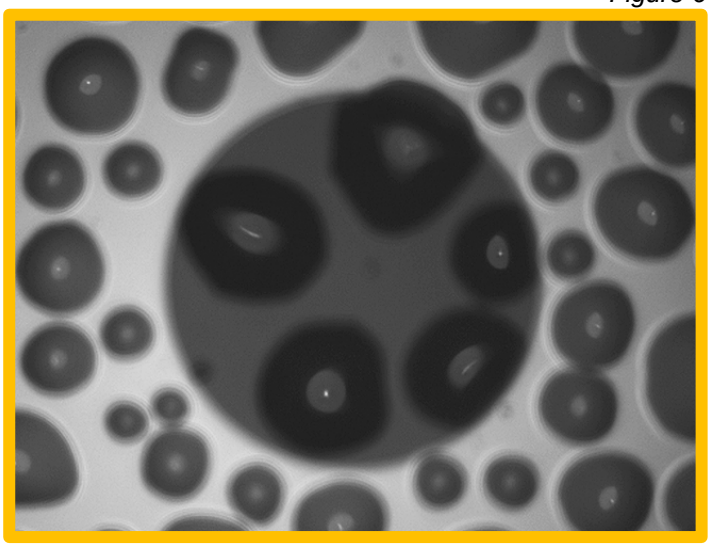


Figure7

Dirt particles

Possible causes:

- Connector has no dust cap
- Dirty dust caps
- Dirty microscope

➔ Clean the connector endface AND the ferrule mantle
➔ If the connector is not plugged in immediately, use new dust caps

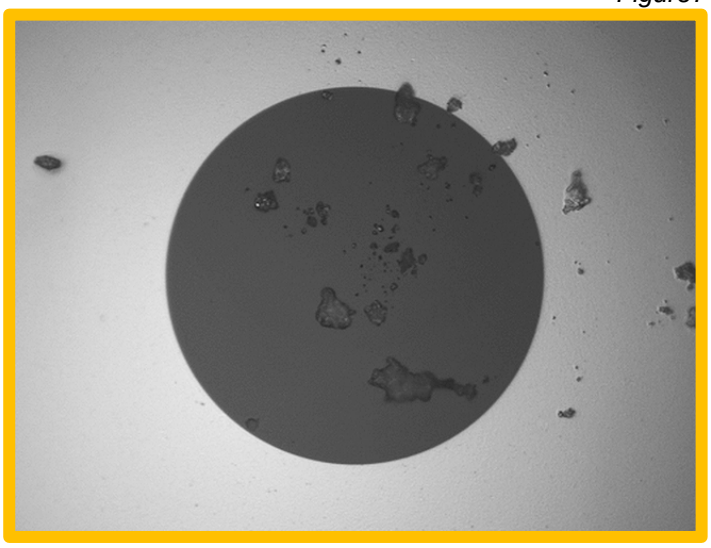


Figure8

Water

Possible causes:

- Unsuitable cleaning agent
- Dirty dust caps
- Dirty microscope

➔ Clean the connector endface AND the ferrule cladding

➔ If the connector is not plugged in immediately, use new dust caps

Figure9

Water (after plugging in once)

Possible causes:

- Dirty connector plugged in
- Dirty adapter
- Dirty mating connector

➔ Clean the connector endface and ferrule mantle on both connectors and the adapter

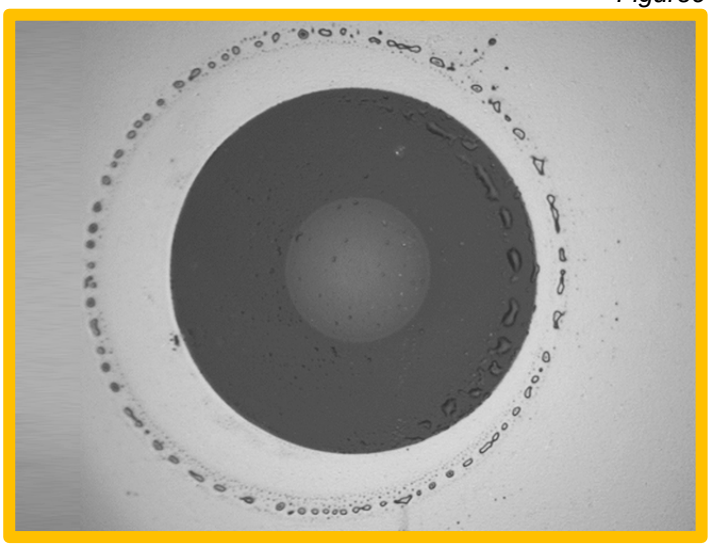


Figure10

PASS

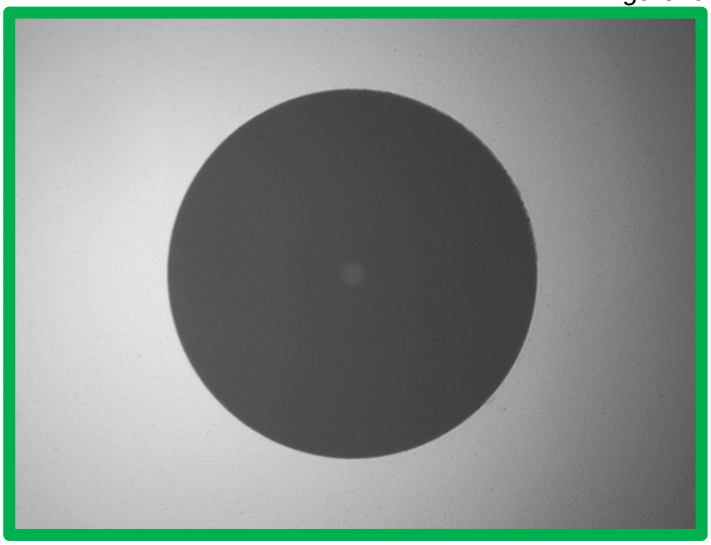


Figure11

3. How to clean?

The following tools are recommended for cleaning:

- lint-free cloths
- isopropyl alcohol
- lint-free cotton buds
- dry cleaning tape

Instructions:

- Wet a lint-free cloth with a few drops of isopropyl alcohol.
- Clean the ferrule cladding with the wet part of the cloth. The first 3 to 5 mm are the most important here, as this part is fed into the guide sleeve depending on the connector type.
- Lay the cloth out on a table or flat surface. The surface should not be too hard. Several cloths placed on top of one another can be used here. This makes a small cushion.
- Pull the connector in a straight line across the wet part of the cloth. Do this very gently. Pull the connector from the wet part of the cloth over to the dry part. The alcohol dissolves dirt and oil residues and is removed when the connector is pulled across the dry part of the cloth.

Various cleaning devices are available on the market. With most of these, the connector does not move across the cloth, but instead the cloth moves under the connector. However, in principle, the procedure is the same as described above.

4. Standards and dependencies

4.1. IEC 62627-01/TR

The procedure for inspecting and cleaning optical connections is described precisely in *Annex B* of IEC 62627-01/TR/Ed2 – *Fibre optic interconnecting devices and passive components – Technical Report – Fibre optic connector cleaning methods*. This technical report stresses how important it is to use the correct procedure. It states that:

With increased data rates, it has become increasingly important to ensure that all plugs and adaptors are inspected and if necessary cleaned before mating. This means that both sides of a connection and the inside of adaptor sleeve should be inspected and if necessary cleaned before making the connection. This applies to test equipment and test cords as well as network components. New plugs shall be inspected and if necessary cleaned. Inspecting and cleaning every connection every time is the best assurance of a reliable optical network.

In short, never connect without first inspecting – and cleaning if necessary. And this must happen on site. Although providers of optical components and systems such as R&M guarantee that their products leave their premises in perfect condition, they have no influence over the human and environmental factors that arise during transport and storage. Therefore, in order to guarantee the performance of an optical network, all connections must be checked – including the test cables, the outer patch cords and, above all, the permanent connections inside the patch panels and cabinets.

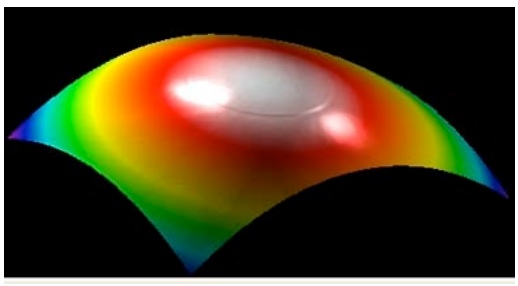
IEC 62627-01/TR comprehensively describes the cleaning methods for fiber endfaces. Furthermore, all suppliers of optical components and systems provide cleaning instructions for their products that are specifically tailored to the material properties, design features etc.

The instructions from R&M, which are delivered with every product, reflect the recommendations of IEC 62627-01/TR so that all installers can apply these methods. They also comply with the inspection criteria of IEC 61300-3-35 – *Interconnecting devices and passive components – Basic test and measurement procedures – Examinations and measurements – Visual inspection of fiber optic connectors and fiber-stub transceivers.* The criteria of IEC 61300-3-35 can be used to make clear decisions on whether the condition of a connector is good or bad.

Users can avoid faults in the optical network, signal problems, excessive insertion loss, poor return loss or even permanent fiber damage simply by following R&M's instructions.

4.2. Surface geometry

The surface quality of the fiber end plays a crucial role in determining the transmission properties and service life of a connector. Dirt can and will permanently damage the surface and often causes changes in the connector geometry. If one considers that connectors in the region of 250 µm are elastically deformed by the contact stress (see also Hertzian contact stress), it is clear that a dirt particle will generate enormous forces at specific points and is capable of permanently damaging the optical fiber and/or the bonding gap.



4.3. Return loss

Dirt, along with damage such as scratches and cavities, is one of the main causes of problems with the return loss. Dirt causes

- a change in the refractive index
- a pathway to the air
- and thus backscattering of the modes or photons.

Any kind of impurity leads to significant impairment of the return loss

4.4. Insertion loss

The effects of dirt on the insertion loss are slightly less serious. Water residue, dust or other residues are typically pushed to the outside by the convex shape of the connector endface. It is therefore unlikely that larger particles will remain in the core area. At the edges, they can only deflect a small portion of the light. Even slightly deflected modes can still be coupled into the next fiber.

Dirty surfaces have an impact on the insertion loss, but there needs to be a high level of contamination before measurable changes in the loss can occur.

5. Additional information

In addition to this white paper, we recommend:

- White paper “Modal noise in fiber links”
- White paper “Manufacturer-Neutral Quality Grades for Fibre-Optic Connectors”

Download from www.rdm.com

You will also find further information about R&M’s products and solutions here.