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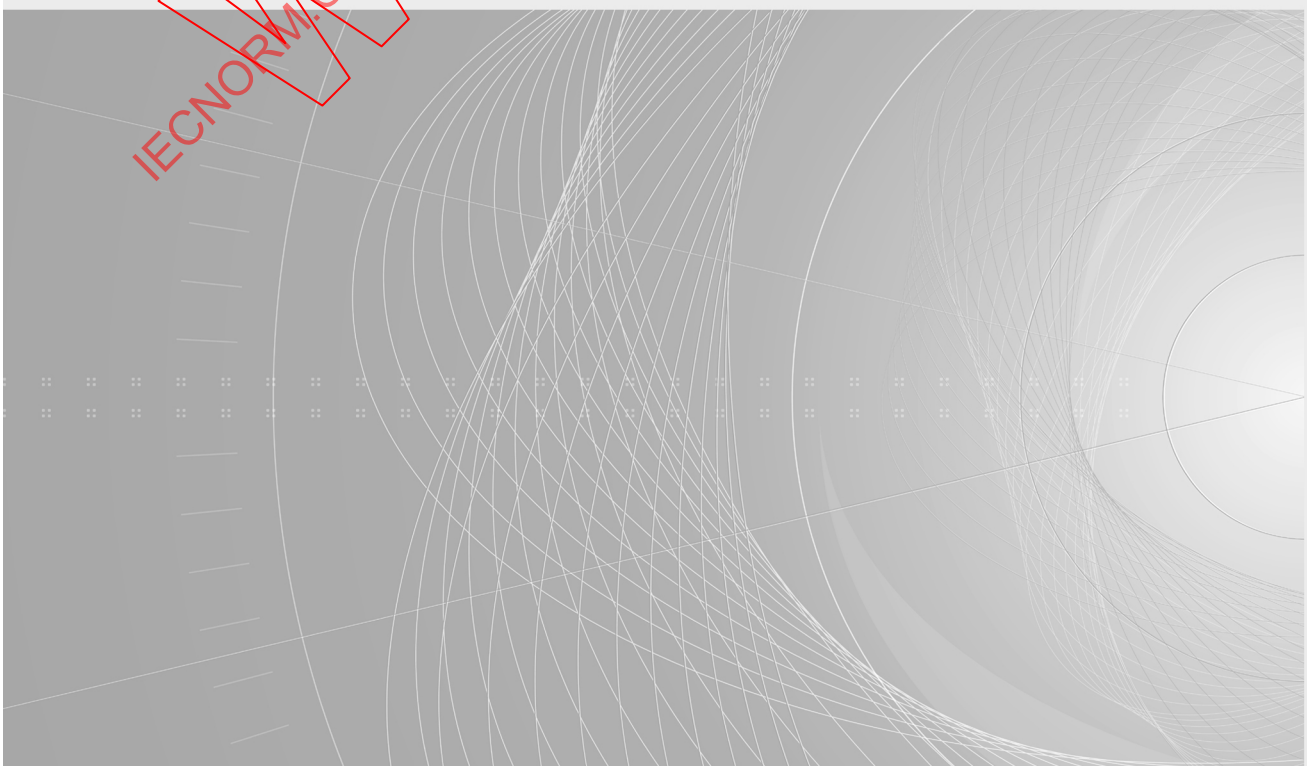
TECHNICAL REPORT

colour inside

Fibre optic interconnecting devices and passive components – Part 01: Fibre optic connector cleaning methods



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Fibre optic interconnecting devices and passive components – Part 01: Fibre optic connector cleaning methods

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Part 01: Fibre optic connector cleaning methods

FOREWORD

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IEC 62627, which is a technical report, has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86B/2902/DTR	86B/2940/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- replaced by a revised edition, or
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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Part 01: Fibre optic connector cleaning methods

1 Scope

This technical report is intended to emphasize the need for cleaning fibre optic connections as well as describing some of the current tools and methods available for proper cleaning. In addition, the report includes a definition of practices that are not recommended. This technical report explains the need to visually inspect plug endfaces but it does not address the inspection criteria, which are covered in another standard.

NOTE This technical report only covers single fibre plug-adaptor plug or plug-active device configurations, but the same principles apply to plug-socket configurations and multi-fibre ferrules.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
exposed plug endface
EPE
typically, a fibre optic plug that is held in the hand such as the end of a patchcord

NOTE The ferrule is exposed to the air and is not confined within an alignment sleeve of a bulkhead adaptor or device port. The endface of the plug is easy to access and can be brought into contact with the cleaning material.

2.2
port
open fibre optic alignment sleeve which contains a fibre optic plug endface to which a fibre optic plug may be mated

NOTE In the case of a bulkhead adaptor, it is the open side of the adaptor after a fibre optic plug has been inserted into one side. In the case of an optical device, it is the opening into which a user of the device will plug a patch cord. The mating side of a port can only be accessed through the alignment sleeve. Therefore the cleaning material must be brought to the endface through the alignment sleeve.

2.3
bulkhead adaptor
a component in which two or more plugs may be mated

NOTE It has one or more alignment sleeves in which two or more ferrules are aligned.

3 General

3.1 Need for cleaning of fibre optic connections

3.1.1 General

Contamination is the most common source of problems in optical networks. A single particle located on the core of a single mode fibre can cause significant back reflection, attenuation and fibre damage.

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 as well. Inspecting and cleaning every connection every time is the best assurance of a reliable optical network.

3.1.2 High power levels

High power levels may be experienced in transmission fibres, particularly where Raman amplifiers are used – pump power levels of one Watt (+30 dBm) or more may be present in the core of the fibre giving an energy density equivalent to 12,5 GW/m^2 for a single mode core with an effective area of 80 μm^2. Also high power levels may be used for information transmission in DWDM (Dense Wavelength Division Multiplexing) systems, where high power systems may have 100 mW to 1 W total signal power. When optical power of this magnitude is transmitted within a single mode fibre, any contamination on the endface of a fibre optic plug will be heated to extremely high temperatures resulting in possible vaporization of the contaminate and melting of the glass, thereby destroying the integrity of the connection and requiring a complete replacement of the connection components.

3.1.3 High data rates

With the onset of high data rate systems at gigabit data rates and above, cleaning multimode fibre optic plugs has become much more important. In the past, at slower data rates (10 Mb/s and 100 Mb/s), the use of LEDs as the light source and the larger size of the multimode core allowed for "some" contamination without noticeable network performance degradation. Equipment power budgets were typically in the range of 10 to 15 dB. Now with data rates at 1 Gb/s, 10 Gb/s and higher data rates the allowable channel insertion loss may be as low as 2,35 dB for example. Also, the use of VCSELs means that plug cleanliness is necessary to assure minimal back reflection thereby assuring system performance.

3.2 What is the source of contamination?

3.2.1 Mishandling

Mishandling of a plug endface is the most common source of contamination. Accidentally touching the endface will spread skin oil or hand lotion across the endface. Accidentally brushing the plug endface on clothing can leave skin oil or other oil previously absorbed by the fabric, lint generated from the material, particles held in the fabric or surfactants from previous cleaning of the garment. Leaving a fibre optic port or plug endface unprotected from the environment subjects the endface to environmental sources of contamination as discussed below.

Typical examples of contamination are shown in Figure 1.

IEC 1806/10

1a) Clean plug wiped on T-shirt

IEC 1807/10

1b) Clean plug wiped on jeans

Figure 1 – Typical examples of contamination

3.2.2 Environmental sources

Environmental sources of contamination are too numerous to catalogue completely. Building materials are a common contributor to fibre optic plug contamination; sawdust, sheet plaster dust and paint fumes are all potential contributors. Pollutants in the air can find their way onto plug endfaces. In dry climates airborne dust particles will find their way onto plug endfaces. In very damp humid areas, airborne contaminates can condense on the plug endface. Considering fibre optic applications exist in military, medical, oil and gas and manufacturing industries, the variety of potential contaminants becomes very large.

3.2.3 Contamination travels

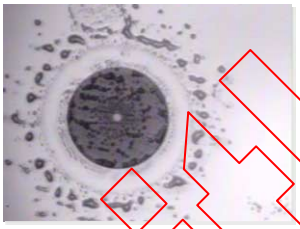
Contamination travels between plugs, as illustrated in the images in Figure 2. The insertion of a contaminated plug into a port will spread that contamination to the mated endface, which in turn will spread the contamination to the next plug that is plugged into the port. Below are pictures of the results of mating a clean plug with a contaminated plug.

IEC 1808/10

2a) Plug A before mating

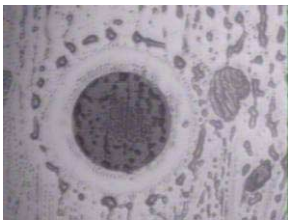
IEC 1809/10

2b) Plug B before mating



IEC 1810/10

2c) Plug A after mating



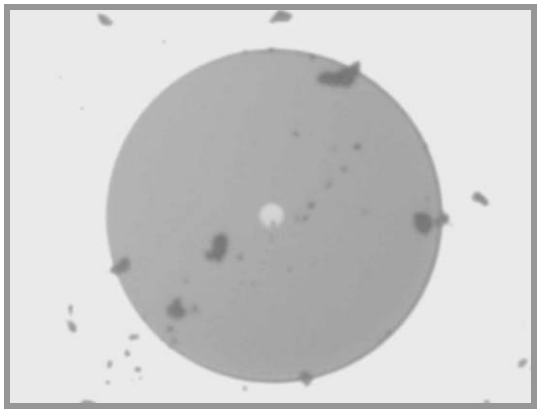
IEC 1811/10

2d) Plug B after mating

Figure 2 – Results of mating

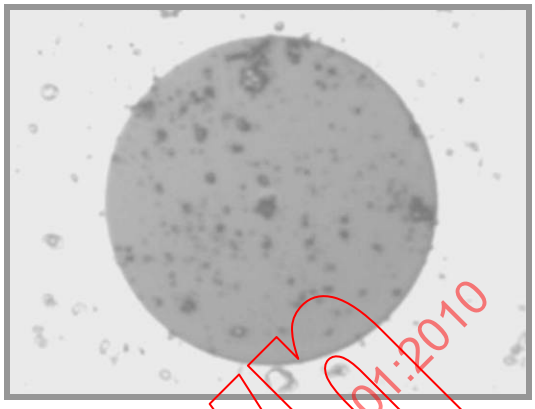
3.2.4 Contamination migration

Contamination can migrate toward the core, as shown in Figure 3. Initial contamination outside the core zone can be broken up by mating and travel toward or onto the fibre core.



IEC 1812/10

3a) Initial contamination



IEC 1813/10

3b) After 4th mating

Figure 3 – Contamination migration

3.3 What do I need to clean?

3.3.1 Fibre optic patch cord

If you are installing a fibre optic patchcord in your network, even a brand new one (right out of the package), the plug endfaces on both ends of the patch cord should be inspected and if necessary cleaned before mating. A new patch cord is not necessarily clean. It is most likely that it was clean when tested at the manufacturing plant but can become contaminated before you open the package to install the fibre optic cord.

3.3.2 Plug endfaces

If you are using a bulkhead adaptor to mate two plugs you should inspect and, if necessary, clean the plug endfaces on both sides and the inside of the sleeve of the adaptor before inserting them into the adaptor. If you cannot remove a plug from an adaptor to clean it, then the end-face shall be inspected and if necessary cleaned while it is in the alignment sleeve.

3.3.3 Testing or trouble shooting

If you are testing or troubleshooting your network, you will need to inspect and clean all plugs before mating. These connections include test equipment ports, adaptors, test cord plug endfaces and any ports into which you will be plugging the test cord. Every connection, every time, needs to be inspected and if necessary cleaned.

3.4 What are the effects of contamination?

3.4.1 Signal degradation

Example signal degradation (increased attenuation and back reflection) is shown in Figure 4.

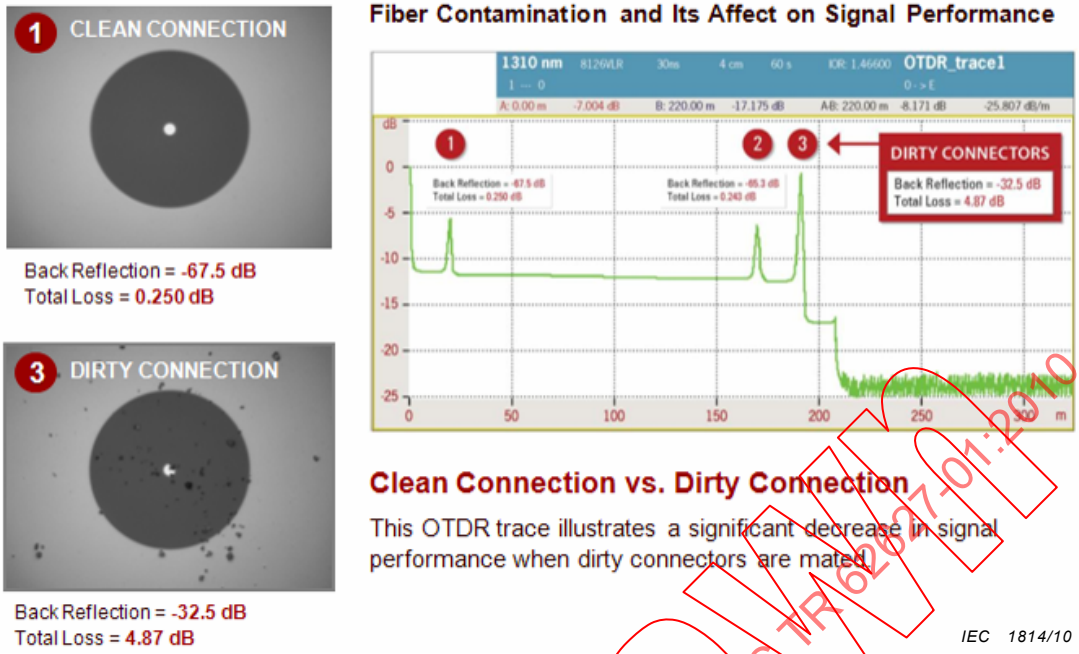


Figure 4 – Signal degradation due to contamination

3.4.2 Permanent damage

A dirty or contaminated plug can embed debris into the fibre. Once debris has been embedded into the fibre surface, cleaning might not remove it, as shown in Figure 5. If this occurs in the core zone, the plug has been permanently degraded.

5a) Dirty fibre prior to mating **5b) Fibre after cleaning** **5c) Embedded debris**

Figure 5 – Permanent damage due to contamination

3.5 When to clean the plug?

You need to inspect and if necessary clean both sides and the inside of the sleeve of every fibre optic connection before mating the pair; every connection, every time.

4 Apparatus

4.1 General

There are basically two types of cleaning that must be performed when cleaning plug endfaces. One type of cleaning is to clean an exposed plug endface (EPE). That is, you clean the plug endface while holding the plug in your hand, before you plug it into a port. The other type of cleaning you will encounter is cleaning a port. Cleaning a port requires cleaning a plug

endface that is within the confines of an alignment sleeve either within a bulkhead adaptor or within an optical device.

4.2 Apparatus to clean exposed plug endfaces

4.2.1 Dry wipes and cassettes

Use of fabric and/or composite material wipes provides combined mechanical action and absorbency to remove contamination. Wipes should be used with a resilient pad in order to avoid potential scratching of the plug endface and assist the cleaning material in conforming to the plug endface geometry. The wipe should be constructed of material that is lint free and non-debris-producing during the cleaning process. Please note that dry wipes have been shown to leave a static charge on the endface of the plug which can thereafter attract statically charged particles.

4.2.2 Using a solvent with dry wipes and cassettes

The use of a solvent with a dry wipe adds chemical action to the mechanical action of the wipe to increase the cleaning ability of the wipe. Also since dry wipes can produce a static charge, the use of a static dissipative solvent has been shown to eliminate the problem. Solvents should be compatible with the wiping material / cassettes they are used with (a solvent that dissolves any binding materials in the wipe or packaging materials of the cleaning device could become a source of contamination on the plug endface). Solvents should also be chosen based on several other criteria: safety of the user, effective cleaning, environmental impact, packaging (both ease of use and risk of contamination) and cost.

4.2.3 Summary

– Use of wipes is the lowest cost method to clean plug endfaces.
– Use of cassette cleaners is very convenient.
– Wipes should not be used on a hard surface (hand-held or on resilient pad).
– Only lint-free, non-debris-generating cleaning materials should be used for wipes or within cassette cleaners.
– All cleaning media shall be protected from contamination until used.

4.3 Apparatus to clean ports

4.3.1 Dry port cleaning devices

The use of purpose-built swabs or mechanical port cleaning devices provides mechanical action and absorbency to remove contamination. The cleaning end of the swab or cleaning material used in the port cleaning device should be lint-free, non-debris-generating material. If solvents are used, care shall be taken to avoid saturating the plug interface. In addition, the solvent shall be compatible with the cleaning swab or port cleaning device construction materials (a solvent that dissolves any adhesive materials in the cleaning stick or packaging materials of the port cleaning device could become a source of contamination on the plug endface). Solvents should also be chosen based on several other criteria: safety of the user, effective cleaning, environmental impact, packaging (both ease of use and risk of contamination) and cost.

4.3.2 Summary

– Different sizes/configurations are required to clean different plug styles.
– Use caution and moderation in applying solvents. A wet cleaning device will saturate the plug interface, allowing contamination to flow back into place at a later time.
– Mechanical port cleaning devices may not be able to wipe the entire plug endface.
– Mechanical port cleaning devices may provide more mechanical action (more surface area wiping) during cleaning than a single swab.

– Port cleaning devices including swabs should conform to plug endface geometry including APC.

4.4 Cleaning machines

4.4.1 General

A cleaning machine is a device that provides automated or semi-automated mechanical and/or chemical action to clean the plug endface. Any machine that is to be considered should be tested to verify its effectiveness and non-damaging functionality.

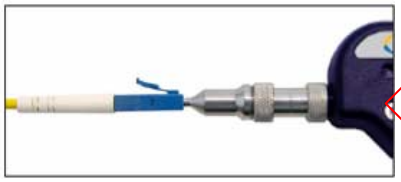
4.4.2 Summary

– May provide improved efficiency, consistency and cost effectiveness.

– Typically has higher initial cost.

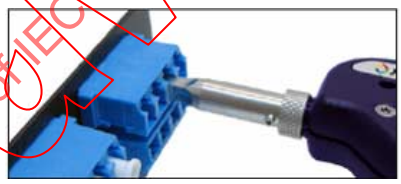
4.5 Inspection equipment

Video fibre microscopes display a magnified image of the plug endface on a screen. They can be used to inspect ferrule endfaces both for either a plug or port. Figure 6 shows an example of the typical FO plug inspection procedure.



IEC 1818/10

6a) Fibre microscope for a plug



IEC 1819/10

6b) Fibre microscope for port

Figure 6 – Patch-cord inspection and port inspection

5 Procedure

5.1 General

As shown in 4.3, it is necessary to inspect and clean both sides and the inside of the sleeve of a connection before they are mated. Figure 7 defines the basic flow to any optical inspection and cleaning process. The basic process is to inspect / clean / inspect again.

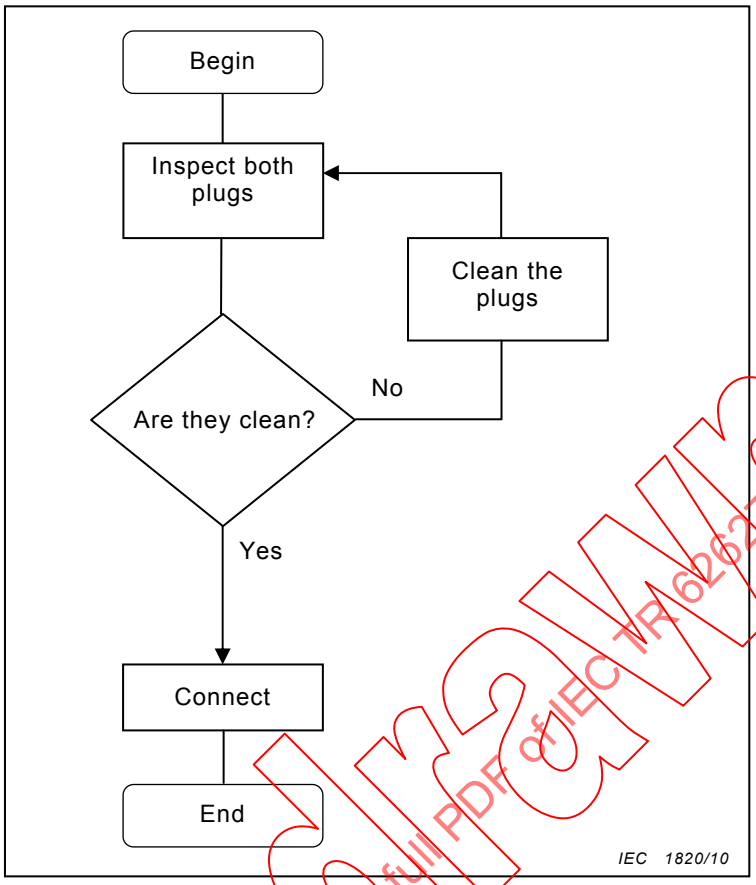


Figure 7 – Basic flow

5.2 Procedure to clean exposed plug endfaces

a) Before cleaning, inspect the plug

- If it is clean, do not clean it

b) First, try a dry cleaning method, shown in Figure 8

1) Use a designed-for-optics cleaner
2) Clean per the manufacturer's instructions
3) Inspect after every cleaning attempt
4) Repeat 2 or 3 times, if needed
5) If the debris remains it is bonded to the surface or mated-in (not removable)

IEC 1821/10

Figure 8 – Dry cleaning

c) Next, try a wet -to-dry cleaning method

1) Use a designed-for-optics solvent

2) Do not saturate the cloth or tape: damp is effective, soaking wet is not
3) Clean per the plug manufacturer's instructions
4) Wet cleaning shall be followed immediately by dry cleaning. Wet-dry can be one step (moving from damp to dry on a wipe) or two steps (damp wipe followed by dry wipe)
5) Inspect after every cleaning attempt
6) Repeat 2 or 3 times if needed
7) If the debris remains, it is mated-in (not removable)

d) Compare the plug endface to your pass/fail criteria

- Use or replace the plug

It is recommended to follow the plug manufacturer's instructions for cleaning fibre optic plugs. Do not clean against a hard surface. When using a wipe or cassette type cleaner, typically one or two 2,5 cm strokes of the cleaning material is sufficient. Enough pressure shall be applied so that the resilient/conforming material allows the wipe to conform to the endface geometry of the plug assuring the entire plug endface has been cleaned.

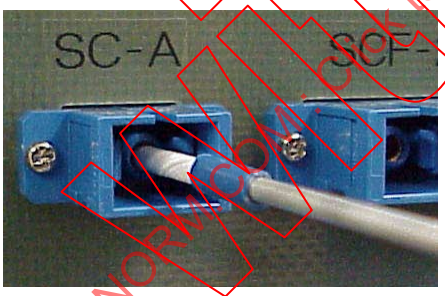
5.3 Procedure to clean ports

Plugs that can be removed from an adaptor for cleaning should be removed and cleaned.

a) Before cleaning, inspect the plug

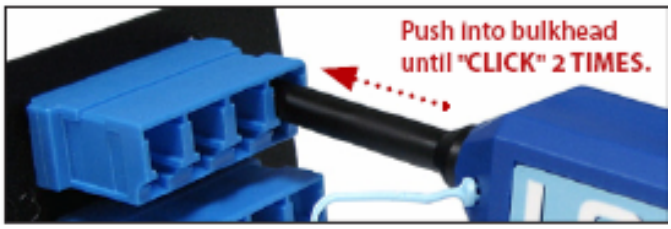
- If it is clean, do not clean it

b) First, try a dry cleaning method, shown in Figure 9
1) Select the designed-for-optics cleaner that corresponds to the plug type / ferrule size
2) Clean per the plug manufacturer's instructions
3) Inspect after every cleaning attempt
4) Repeat 2 or 3 times, if needed
5) If the debris remains, it is bonded to the surface or mated-in (not removable)



IEC 1822/10

9a) Dry cleaning for a port



IEC 1823/10

9b) Wet cleaning for a port

Figure 9 – Cleaning for ports

c) Next, try a wet -to-dry cleaning method
1) Apply a designed-for-optics solvent to a clean designed-for-optics cleaning wipe
2) Moisten the tip of the cleaning tool by touching it to the solvent spot on the cleaning wipe
3) Clean per the plug manufacturer's instructions
4) Wet cleaning shall be followed immediately by dry cleaning. Wet-dry can be one step (moving from damp to dry on a wipe) or two steps (damp wipe followed by dry wipe)
5) Inspect after every attempt
6) Repeat 2 or 3 times, if needed

7) If the debris remains, it is mated-in (not removable)

d) Compare the plug end face to your pass/fail criteria

- Use or replace the plug

Select a swab or port cleaning device that is manufactured for the size and type plug you are cleaning. Do not touch or contaminate the cleaning end of the swab or the port cleaning device. It is recommended that the user follow the manufacturer's instructions for use with all fibre optic cleaning devices.

Swab cleaning detail: Place the cleaning end of the swab into the port and rotate the swab while applying some pressure to the plug endface. Usually pushing so that the compression spring in the plug is slightly activated is ideal for 2,5 mm plugs. Rotating the swab several times is sufficient. The swab should only be used once and then discarded. If the user is cleaning angled polished plugs – APC (green plug housing or bulkhead adaptor) – then using a 1/4 turn back and forth rotation may help the swab end-face conform to the 8° angle.

Port device cleaning detail: Insert the device into the alignment sleeve and activate the cleaner to perform the mechanical clean either by pushing the device or by pressing on a button on the device. For wet-to-dry cleaning, an additional activation of the device assures that any excess solvent has been removed.

6 Other important points

a) IPA (isopropyl alcohol) will absorb moisture from its surroundings, including the air. Therefore, a container of IPA left open to the air can easily become diluted and contaminated. Contaminated IPA can leave a residue on the endface of the plug contributing to the reduced performance of the fibre optic link.

b) Not all materials are suitable for cleaning optical plugs. Materials not specifically designed for optical cleaning (e.g. cotton swabs, some types of foam) may contain contaminants that will remain on the fibre surface, or break down and leave material remnants on the plug.

c) Repackaging of wipes or swabs into your own containers may contaminate the cleaning products. Cleaning wipes or swabs removed from packaging and left "out" before use can pick-up contaminates from the air or handling.

d) If you are in doubt of the cleanliness/effectiveness of your fibre optic cleaning products, try the "Do no harm" test.

Take a clean plug (verified clean by inspection with a microscope)

1) Clean it with your cleaning materials

2) Re-inspect the endface with a microscope. Has the process damaged or added any contamination to the plug endface?

3) You may want to repeat the process several times

4) It is not unusual for cleaning products to occasionally leave some contamination on the endface

e) Use of canned air to directly clean the endface of a fibre optic plug or port is not recommended. Canned air can contain some oils, which are out-gassed by the main seal in the valve of the can. This is particularly true during the first few seconds of spraying after the can has not been used. The high velocity air could force some hard contaminates onto the plug surface potentially damaging it. Canned air is under pressure and cools as it leaves the confines of the container. Therefore, it can chill the optical component causing moisture in the air to condense on the surface, likely depositing contaminants.

f) All cleaning materials shall be packaged in a way that does not adversely affect the cleaning properties of the cleaning material.

1) Lint free wipes shall be packaged so that the wipe does not become contaminated in transport, storage or use.