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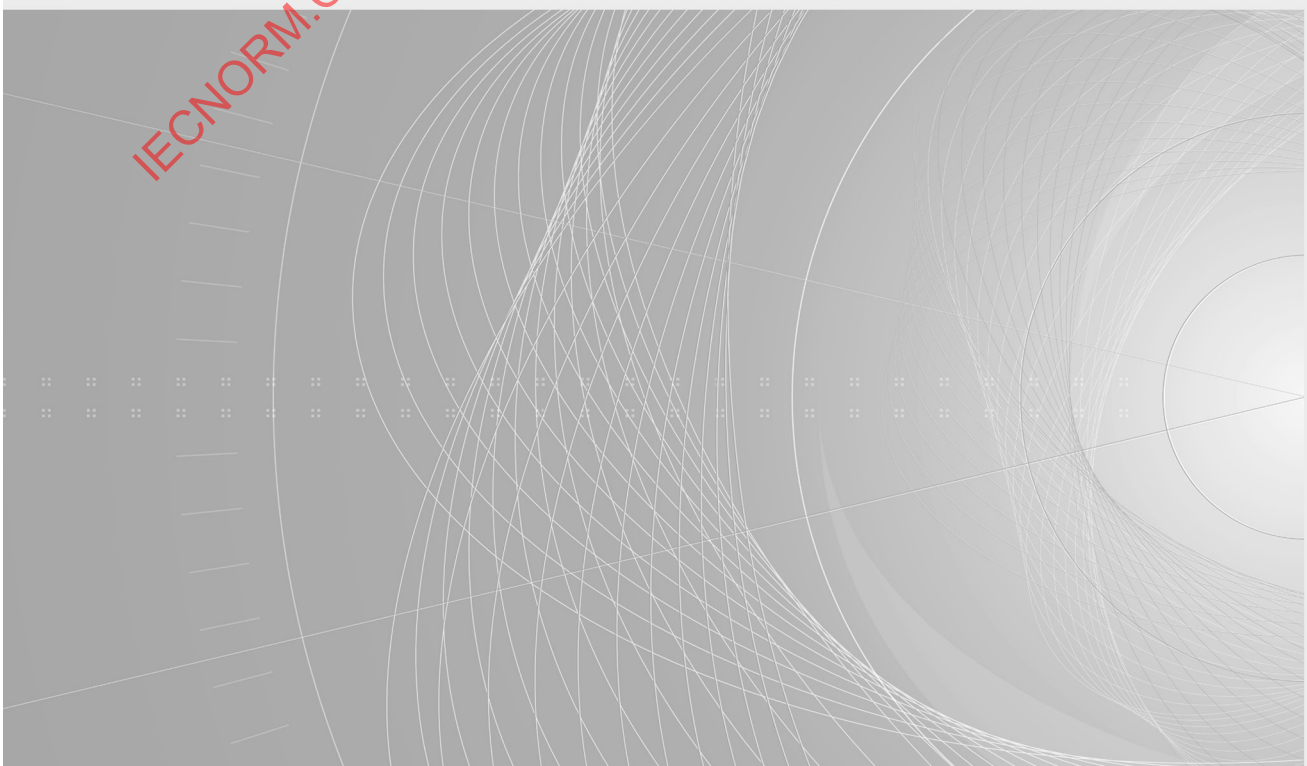
Edition 3.0 2023-01

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Part 01: Fibre optic connector cleaning methods

FOREWORD

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IEC TR 62627-01 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics. It is a Technical Report.

This third edition cancels and replaces the second edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) addition of cleaning tools for adhesive pad type and adhesive pen type in terms and definitions (Clause 3), in information (7.5 and 7.6), in fibre optic connectors and their applicable cleaning tools (Table 1 and Clause 8) and procedures (9.5, 9.6 and 9.7);
b) addition of classification of cleaning tools and machines (Figure 1).

The text of this Technical Report is based on the following documents:

Draft	Report on voting
86B/4625/DTR	86B/4647/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62627 series, published under the general title *Fibre optic interconnecting devices and passive components*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Part 01: Fibre optic connector cleaning methods

1 Scope

This part of IEC 62627, which is a Technical Report, details cleaning methods for fibre optic connectors. It includes typical cleaning tools and machines, and cleaning procedures. Other cleaning methods exist. The impact of contamination and the reasons for connector visual inspection and cleaning are described in Annex B. This document does not address the visual inspection procedures, which are covered in IEC 61300-3-35.

Optical fibre patch cords are handled by the operators and maintenance staff of optical network systems. This document is useful as a guideline to prepare instruction manuals for those involved in optical system maintenance and operation.

This document covers fibre optic connector plugs, optical adaptors, optical receptacles (excluding optical transceivers) and dust caps. Guidelines for fibre optic connector end-face cleaning methods for receptacle style optical transceivers are covered in IEC TR 62572-4.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Cleaners

3.1.1
adhesive backed stick type cleaner
cleaning tool for end-faces of fibre optic connector plugs, fibre optic connector receptacles and fibre optic connector adaptors using a soft adhesive backing at the end of a stick

3.1.2
adhesive pad type cleaner
cleaning tool for end-faces of fibre optic connector plugs using a pad style with soft adhesive surface

3.1.3
adhesive pen type cleaner
cleaning tool for end-faces of fibre optic connector plugs, fibre optic connector receptacles and fibre optic connector adaptors using a pen style with a soft adhesive tape at the top of the tool

3.1.4
air duster
canned air
cleaning tool where compressed air is blown from a nozzle of a can

3.1.5
gas and vacuum type cleaning machine
fibre optic connector end-face cleaning machine in which volatile liquid solvent (gas) is injected and extracted from a nozzle

3.1.6
pen type cleaner
probe type cleaner
cleaning tool for fibre optic connector end-faces, receptacles and fibre optic connector adaptors where a tape cleaning cloth at the top of the tool moves and cleans

3.1.7
reel type cleaner
cassette type cleaner
fibre optic connector plug end-face cleaning tool, in which a cleaning cloth roll is packed in a cassette box, with a small window for cleaning

3.1.8
stick type cleaner
swab type cleaner
fibre optic connector receptacle and fibre optic connector adaptor end-face cleaning tool in which a cleaning cloth is attached to the top of a stick

3.2 Fibre optic connector parts

3.2.1
bulkhead adaptor
adaptor mounted in a panel

Note 1 to entry: A bulkhead adaptor has one or more alignment sleeves in which two or more ferrules are aligned.

3.2.2
dust cap
cover or cap which is attached to a fibre optic connector plug, a fibre optic connector adaptor or an optical receptacle when the fibre optic connector is not connected to protect it from contamination

3.2.3
exposed plug end-face
EPE
fibre optic plug without any fixed optical end-face protection that can be held in the hand

EXAMPLE End of a patch cord.

Note 1 to entry: The ferrule is exposed to the air and is not confined within an alignment sleeve of a bulkhead adaptor or device port. The end-face of the plug is easy to access and can be brought into contact with cleaning material.

3.2.4
port
open fibre optic alignment sleeve which contains a fibre optic plug end-face to which a fibre optic plug can be mated

Note 1 to entry: 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 is brought to the end-face through the alignment sleeve.

3.2.5
power blocking shuttered adaptor
optical adaptor that has a shutter to block optical power emitted from a fibre optic connector plug

Note 1 to entry: An optical adaptor with shutter is a structure that, when two fibre optic connector plugs are interfaced and the fibre optic connector plug is removed at the shuttered side, the shutter automatically moves to block emitted optical power. There are two types of optical adaptors with shutter that have already been commercialized: one focuses on blocking the optical power and the other focuses on dust-proofness. Generally, power blocking shuttered adaptors that focus on blocking power often have a metal shutter within the optical adaptor.

Note 2 to entry: Refer IEC TR 62627-08.

4 Application of fibre optic connectors

4.1 General

Fibre optic connectors consist of several parts: connector plugs, receptacles, adaptors, dust caps, etc.

Optical communication network equipment generally has optical adaptors on the front panel or the back-plane to interface with other equipment or transmission lines. An optical patch cord, which has fibre optic connector plugs on both ends of an optical fibre cord, is generally used for optical connection between equipment.

4.2 Influence of contamination of fibre optic connector end-faces

Optical network equipment is located in the central offices, data centres, computer rooms, etc. The environment of these locations is not necessarily clean, and it is possible that dust or condensation is introduced onto the fibre optic connector end-faces, which can affect their optical performances (see Annex B).

5 Guidelines for handling fibre optic connectors

5.1 Guidelines for careful handling fibre optic connectors

Clause 5 describes guidelines for handling fibre optic connectors.

5.2 Storage of fibre optic connectors

Unused ports on optical network equipment, and unused fibre optic connector plugs on optical patch cords are covered or capped by clean dust caps. It is advisable adusted cap does not enter into contact with a fibre end-face when fitted. Optical patch cords are stored in clean closed and sealed boxes or bags. Used dust caps are cleaned before storage. Dust caps are stored in clean closed and sealed boxes or bags. Storage boxes or bags are ESD (electric static discharged) processed.

5.3 Connection of fibre optic connector plugs to ports on optical network equipment

For safety reasons, before connection, optical power is off. Dust caps are removed just before the optical connection is made. Before the optical connection, both the fibre optic connector end-faces to be mated are inspected, and cleaned if necessary, unless otherwise recommended by the manufacturer. Annex C shows an example of fibre optic connector end-face visual inspection equipment. It is advisable the applicable cleaning tools and machines are appropriate for fibre optic connector plugs and optical adaptors.

Clean fibre optic connector plugs are inserted in ports and mated securely.

5.4 Disconnection of fibre optic connector plugs to ports

Before disconnection, optical power is off.

Immediately after the disconnection, clean dust caps are fitted to fibre optic connector plugs and ports.

6 Dust caps

Many shapes and materials of dust caps are available in the market. Appropriate dust caps are fitted. For fibre optic connector plugs, there are typically two types of dust caps: covering the top of the ferrule, or covering part of the plug housing. It is advisable dust caps have a structure so that their inner surfaces do not come into contact with the ferrule end-face when dust caps are fitted. Dust caps are processed to prevent the creation of a static electric charge. Dust caps are cleaned using an air duster.

7 Cleaning tools and machines

7.1 General

Clause 7 describes cleaning tools and machines for fibre optic connectors.

Cleaning tools and machines are classified as shown in Figure 1.

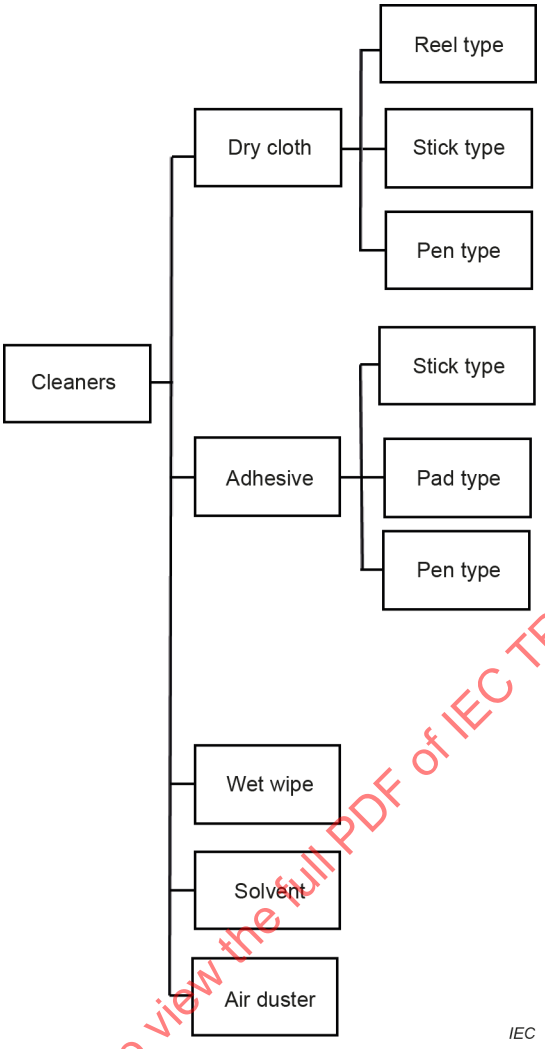


Figure 1 – Classification of cleaning tools and machines

Fibre optic connector cleaning tools or machines should be used.

Fibre optic connector plugs are easier to clean than optical receptacles or optical adaptors. A typical cleaning method for fibre optic connector plugs is to wipe the ferrule end-face with a cloth. As rubbing is possible to produce a static electric charge, which can attract contamination, it is advisable to use a fibre optic connector cleaner with cloth that has been processed so that it will not create a static electric charge. Lint-free cloths are also usually used.

Other than a cloth type, adhesive cleaning tools are available. Adhesive cleaning tools do not produce a static electric charge.

NOTE An ionizer can be useful to neutralize the electrostatic charge which can develop from the cleaning process.

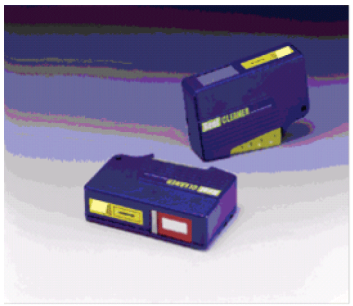
Typical cleaning tools and machines are described in 7.2 to 7.10. This list is not exhaustive.

7.2 Reel type cleaner

A reel type cleaner is used for cleaning fibre optic connector plug end-faces, but is not suited for cleaning optical receptacles. The cleaning cloth in the reel type cleaner is rolled and packed in a cassette which has a small window into which the plug end-face is inserted for cleaning. Figure 2 shows an example of a reel type cleaner. The cleaning process of connector end-faces with reel type cleaner can result in an electrostatic charge (ESC) effect. Therefore, the cleaning cloth is processed to prevent the creation of a static electric charge. The fibre optic connector

plug end-face to be cleaned is pressed into then wiped along the cleaning cloth. The cleaning cloth is advanced before every cleaning to prevent contamination.

For the IEC 61754-7 series, type MPO connector plugs with guide-pins, dedicated reel type cleaners are available in the market.



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Source: OPTIPOP©, fibre optic connector cleaner, reproduced with the permission of NTT-AT.

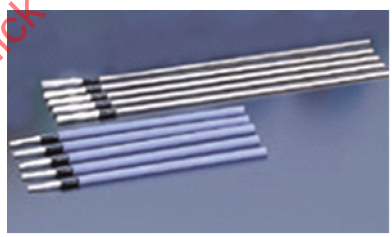
Figure 2 – Example of a reel type cleaner

7.3 Stick type cleaner

A stick type cleaner has cleaning cloth on the top of a stick. It is sometimes called a "swab type cleaner". This cleaner is suitable for optical receptacles and optical adaptors. Figure 3 shows an example of stick type cleaners.

Lint-free cloths are generally used. Cleaning material are processed to prevent the creation of a static electric charge on the end-face. This type of cleaner is used once only.

There are several thicknesses of stick type cleaners available, depending on the ferrule diameter.



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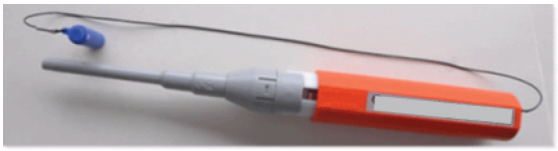
Source: CLETOP©, fibre optic connector cleaner, reproduced with the permission of NTT-AT.

Figure 3 – Example of stick type cleaners

7.4 Pen type cleaner

Pen type cleaners have a cleaning cloth on the top of the cleaner. The cleaning cloth rotates when the top of the cleaner is pressed on the end-face of an optical receptacle, and cleans the end-face. For some cleaners, as the width of the cleaning cloth limits the area of cleaning, only the centre of end-faces can be cleaned. The cleaning cloth is processed to prevent the creation of a static electric charge. The cleaning cloth is lint-free. It is sometimes called a "probe type cleaner". Figure 4 shows an example of a pen type cleaner.



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Source: NEOCLEAN©, fibre optic connector cleaner, NEOCLEAN R-E pen type, reproducted with the permission of NTT-AT.

Figure 4 – Example of a pen type cleaner

7.5 Adhesive backed stick type cleaner

Adhesive backed stick cleaners have a soft adhesive backing at the top of the cleaner. The adhesive backed stick cleaner is briefly pressed into and removed from the end-face of an fibre optic connector, receptacle or fibre optic connector adaptor whereby the soft adhesive backing removes dust and other particulates. Figure 5 shows an example of an adhesive backed stick type cleaner.

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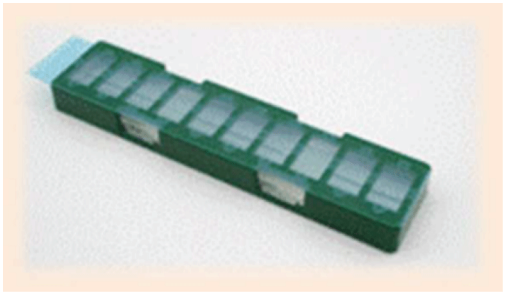
Source: Optres™ , optical plug assembly cleaner, OPTO LEAF, reproduced with the permission of Tomoegawa CO. LTD.

Figure 5 – Example of an adhesive backed stick type cleaner

7.6 Adhesive pad type cleaner

Adhesive pad type cleaners have a soft adhesive thin sheet filled in a lattice box. A fibre optic connector plug can be cleaned (removing dusts and other particles) by pressed briefly on a soft adhesive thin sheet and removed. A soft adhesive thin sheet is contacted the top surface of the end-face of a fibre optic connector. An adhesive pad type cleaner is available for pinned MPO connector plugs as the thin sheet is deformed. Figure 6 shows an example of an adhesive pad type cleaner.



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Source: Optres™, optical plug assembly cleaner, OPTO LEAF, reproduced with the permission of Tomoegawa CO.

Figure 6 – Example of an adhesive pad type cleaner

7.7 Adhesive pen type cleaner

Adhesive pen type cleaners have a soft adhesive tape at the top of the cleaner. After the soft adhesive tape is rotated and fresh tape part is placed at the top of the cleaner, the adhesive pen type cleaner is briefly pressed into and removed from the end-face of an fibre optic connector plug, fibre optic connector receptacle or fibre optic connector adaptor whereby the soft adhesive tape removes dust and other particulates, and cleans the end-face. An adhesive pen type cleaner is available for pinned MPO connector plugs as the tape is deformed. Figure 7 shows an example of an adhesive pen type cleaner.

Source: Optres™ , optical plug assembly cleaner, OPTO LEAF, reproduced with the permission of Tomoegawa CO.

Figure 7 – Example of an adhesive pen type cleaner

7.8 Gas and vacuum cleaning machine

A volatile liquid solvent is injected and extracted from a nozzle. Contamination is removed by the solvent. It is advisable liquid does not enter the cable elements or other parts of a connector where it cannot be removed. Figure 8 shows an example of a gas and vacuum cleaning machine.

Source: CleanBlastPRO™, reproduced with the permission of Viavi solutions.

Figure 8 – Example of a gas and vacuum cleaning machine

7.9 Air duster

An air duster is widely used for cleaning electronic and electric equipment. Compressed air is blown from the nozzle of a can. It is sometimes called "canned air". Examples of materials are difluoroethane (HFC-152a), trifluoroethane (HFC-143a) or tetrafluoroethane (HFC-134a). HFC-152a has a lower global warming potentials (GWP) index than HFC-143a, which is better for the environment. Figure 9 shows an example of an air duster.

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Source: MicroCare™, reproduced with the permission of MicroCare.

Figure 9 – Example of an air duster

7.10 Wipe and solvent – Wet cleaning

The wet cleaning method uses a solvent, such as isopropyl alcohol, with cleaning wipes for optical elements to clean the fibre optic connector end-face. No residue from the solvent usually remains after cleaning. Using a solvent prevents the creation of a static electric charge on the end-face and is sometimes effective for removing sticky contamination. After wet cleaning, dry cleaning is performed to remove solvent residue. The cleaning wipes are lint-free.

8 Fibre optic connectors and their corresponding cleaning tools and machines

Table 1 shows typical fibre optic connectors and their corresponding cleaning tools and machines. For power blocking shuttered adaptors, stick type tools cannot be used as the cleaning cloth on top of the stick can be caught by the shutter plate.

Table 1 – Cleaning tools and machines for typical fibre optic connector parts

Tools and machines	Plugs	Adaptors/ receptacles with connected plugs on back side	Power blocking shuttered adaptors with connected plugs on back side	Dust caps
Reel type	Most common	N/a	N/a	N/a
Stick type	N/a	Most common	N/a	N/a
Pen type	Alternative	Most common	Most common	N/a
Adhesive backed stick type	Alternative	Most comon	Most common	N/a
Adhesive pad type	Most common	N/a	N/a	N/a
Adhesive pen type	Alternative	Most common	Most common	N/a
Gas and vacuum	Alternative	Alternative	N/a	N/a
Air duster	N/a	N/a	N/a	Alternative
Wipe and solvent	Alternative	N/a	N/a	N/a

For dust caps, an alternate method to an air duster, which is suitable for one single dust cap, is to clean multiple caps at one time using an ultrasonic cleaner filled with a suitable solvent. Attention is drawn to the fact that liquid cleaning can leave a residue.

9 Procedures

9.1 General

As described in 5.3, it can be necessary to inspect and clean both sides and the inside of the sleeve of a connection before they are mated unless otherwise recommended by the manufacturer. Precautions for the cleaning process is described in Annex A.

9.2 Basic procedure of cleaning

Unless otherwise recommended by the manufacturer, the basic procedure of cleaning is as follows.

a) Inspect the fibre optic connector end-face for contamination or damage before cleaning.
b) Dry clean the fibre optic connector end-face if contamination, scratches or defects are found.
c) Inspect the fibre optic connector end-face after every cleaning to determine if contamination has been removed.
d) Repeat b) and c) several times. If contamination still remains, it can be due to contamination of the cleaning tools.
e) If contamination remains after dry cleaning several times, try wet cleaning using a solvent.
f) After wet cleaning, dry clean again.
g) Inspect the fibre optic connector end-face after every cleaning, and judge according to the pass/fail criteria.
h) Repeat f) and g) several more times, if needed.

9.3 Procedure to clean exposed plug end-faces with a reel type cleaner

The procedure to clean exposed plug end-faces with a reel type cleaner is as follows.

a) Before cleaning, inspect the plug. If it is clean, do not clean it.
b) First, try a dry cleaning method, as shown in Figure 10:
   1) use a designed-for-optics cleaner;
   2) clean as 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).

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Figure 10 – Cleaning with a reel type cleaner

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 as 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 end-face with the pass/fail criteria in IEC 61300-3-35 and decide to either use or test the plug against its optical performance specification (typically attenuation and/or return loss).

The plug manufacturer's instructions are followed for cleaning fibre optic plugs. Do not clean against a hard surface. When using a wipe or reel type cleaner, typically one or two 25 mm strokes of the cleaning material is sufficient. Enough pressure is applied so that the resilient/conforming material allows the wipe to conform to the end-face geometry of the plug ensuring the entire plug end-face has been cleaned.

9.4 Procedure for port cleaning using a stick type or a pen type cleaner

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

a) Before cleaning, inspect the plug: if it is clean, do not clean it.
b) First, try a dry cleaning method, as shown in Figure 11 and Figure 12:
   1) select the designed-for-optics cleaner that corresponds to the plug type/ferrule size;
   2) clean as 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).

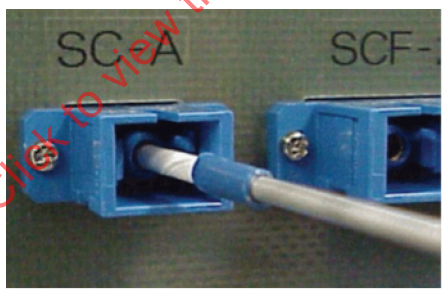

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Figure 11 – Cleaning ports using a stick type cleaner

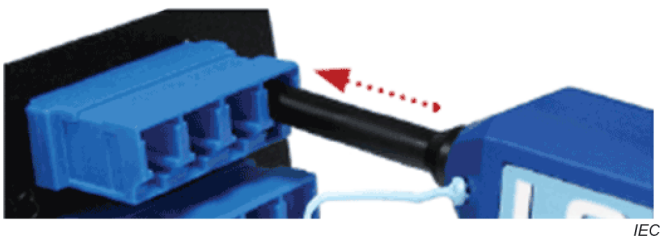

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Figure 12 – Cleaning ports using a pen type cleaner

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 as per the plug manufacturer's instructions;

4) wet cleaning is 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 with the pass/fail criteria in IEC 61300-3-35 and decide to either use or test the plug against its optical performance specification (typically attenuation and/or return loss).

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

Stick type cleaning detail: place the cleaning end of the swab into the port and rotate the swab while applying appropriate pressure to the plug end-face. 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 is only used once and then discarded. If the user is cleaning angled polished plugs – angled physical contact (APC) which are typically marked green plug housing or bulkhead adaptor –, then using a 1/4 turn back and forth rotation can help the swab end-face conform to the 8° angle.

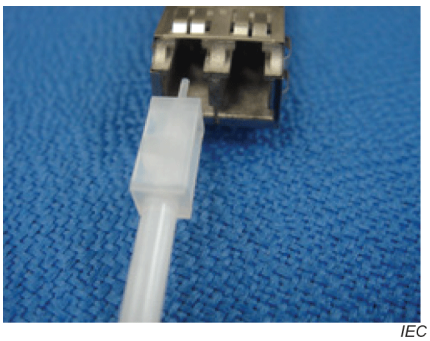
Pen type cleaning detail: insert the device into the alignment sleeve and activate the cleaner to perform the mechanical clean either by pushing the device or by pressing on a button on the device. For wet-to-dry cleaning, an additional activation of the device assures that any excess solvent has been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

9.5 Procedure for port cleaning using an adhesive backed stick type cleaner

Adhesive backed stick type cleaner detail: insert the cleaning end of the stick into the port of the fibre optic connector, receptacle or fibre optic connector adaptor and apply some pressure briefly, then remove (see Figure 13).

Depending on manufacturer guidelines, repeat the process of inserting the stick into the port, pressing briefly and removing a number of times. Typically, this process can be repeated about 3 times.

Depending on the manufacturer's guidelines, the same adhesive backed stick cleaner can be used on multiple ports before being discarded.



IEC

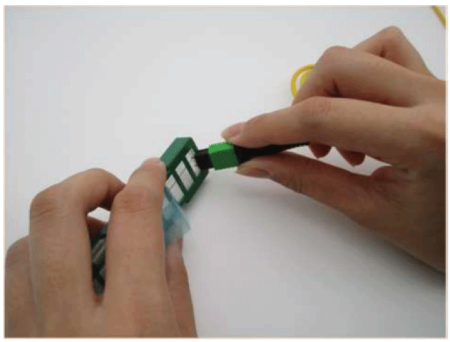
Figure 13 – Cleaning ports using an adhesive stick type cleaner

9.6 Procedure for plug cleaning using an adhesive pad type cleaner

Adhesive pad type cleaner detail: press an fibre optic connector plug onto a surface of adhesive thin sheet in a pad type cleaner briefly, then remove (see Figure 14).

For pinned MPO connector plugs, press the surface of adhesive thin sheet until attach to the end-face.

It is important to use fresh surface of adhesive thin sheet for every single cleaning process, and follow the manufacturer's instructions for use.



IEC

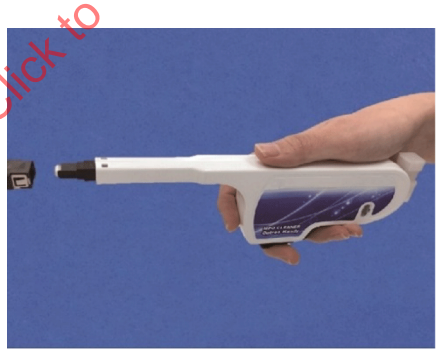
Figure 14 – Cleaning with a pad type cleaner

9.7 Procedure for port cleaning using an adhesive pen type cleaner

Adhesive pen type cleaner detail: after the adhesive tape is rotated, briefly press the top of the cleaner on the end-face of a fibre optic connector plug, fibre optic connector receptacle or fibre optic connector adaptor, then remove (see Figure 15).

For pinned MPO connector plugs, press the surface of adhesive tape until attach to the end-face.

It is important to use fresh part of adhesive tape for every single cleaning process, and follow the manufacturer's instructions for use.



IEC

Figure 15 – Cleaning with an adhesive pen type cleaner

9.8 Cleaning procedure using a gas and vacuum type cleaning machine

Insert the nozzle into the receptacle of an optical adaptor to clean the optical end-face. The cleaning machine injects a volatile solvent into the receptacle to dislodge contamination and then extracts the solvent to remove the contamination. For operating details, it is important the instruction manual provided with the machine by the supplier is thoroughly reviewed before use.

Annex A
(informative)

Precautions for the cleaning process

A.1 Material to be cleaned

A.1.1 Plug connector

Unless otherwise recommended by the manufacturer, plug end-faces are inspected first, cleaned if necessary, then mated. This applies to plugs with a single fibre cylindrical ferrule and a multi-fibre rectangular ferrule.

A.1.2 Plug connector inside adaptors

Unless otherwise recommended by the manufacturer, ferrule end-faces inside of connector plugs inside ports and receptacles are also inspected first, cleaned if necessary, then inserted into the plugs. The receptacle connectors are widely used as interface in communication equipment, measuring instruments, transceivers, etc.

A.1.3 Adaptor for a cylindrical ferrule plug

An adaptor for a cylindrical ferrule plug usually contains an alignment sleeve. Although there is no end-face in the adaptor, the inside of the sleeve is cleaned. Contamination inside the sleeve can spread onto the plug end-face during mating. Therefore, the cleaning of the inside of the sleeve is important to maintain the cleanliness of plug end-faces.

A.1.4 Timing of the cleaning

There is a possibility that contamination adheres to the end-face at any time. Therefore, before every connection, unless otherwise recommended by the manufacturer, inspection and if necessary cleaning of the plug end-face is performed. After every cleaning, an inspection of the plug end-face is performed to ensure a clean end-face.

If installing a fibre optic patch cord in a network, even a brand new one (right out of the package), the plug end-faces on both ends of the patch cord are cleaned, unless otherwise recommended by the manufacturer, before mating if no inspection has been carried out. It is probable that it was clean when tested at the manufacturing plant but it could become contaminated before the package is opened to install the fibre optic cord.

A.2 Additional information

a) Isopropyl alcohol (IPA) and some liquid cleaners will absorb moisture from its surroundings, including 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 end-face of the plug contributing to the reduced performance of the fibre optic link. IPA with a volume fraction of 95 % or higher is used.

b) Not all materials are suitable for cleaning optical plugs. Materials not specifically designed for optical cleaning (e.g. cotton swabs, some types of wipe, some types of foam) can 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 one's own containers can 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 in doubt about the cleanliness/effectiveness of the fibre optic cleaning products, try the "do no harm" test. Take a clean plug (verified by inspection with a microscope).

1) Clean it with the appropriate cleaning materials.
2) Re-inspect the end-face with a microscope. Has the process damaged or added any contamination to the plug end-face?
3) The process can be repeated several times.
4) It is not unusual for cleaning products to occasionally leave some contamination on the end-face.

e) Use of canned air to directly clean the end-face of a fibre optic plug or port is not advisable. 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 are packaged in a way that does not adversely affect the cleaning properties of the cleaning material.
1) Lint free wipes are packaged so that the wipe does not become contaminated in transport, storage or use.
2) Liquid cleaners are packaged so that they cannot be contaminated.
- Hermetically sealed containers that dispense solvents only when being used are best.
- Propellants in aerosols usually do not contribute to the contamination problem.

g) Opened containers of IPA will absorb moisture from the air along with any airborne contaminates dissolved in that moisture in the air and leave a residue on the end-face.

h) Unless otherwise recommended by the manufacturer, inspect both plugs before making the connection. This is the only way to ensure the devices are clean and safe to connect.

Annex B
(informative)

General information on contamination

B.1 Impact of contamination

B.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. IEC TR 62627-05 contains an investigation on the impact of contamination on the optical performance of fibre optic connectors.

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 the adaptor sleeve are inspected unless otherwise recommended by the manufacturer, and if necessary, cleaned before making the connection. This applies to test equipment and test cords as well as network components. New plugs are inspected unless otherwise recommended by the manufacturer, and if necessary, cleaned. Inspecting and cleaning every connection every time is the best assurance of a reliable optical network.

B.1.2 High power levels

High power levels can be experienced in transmission fibres, particularly where Raman amplifiers are used – pump power levels of one watt (+30 dBm) or more can 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. High power levels can also be used for information transmission in dense wavelength division multiplexing (DWDM) systems, where high power systems can 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 end-face 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.

B.1.3 High data rates

With the onset of high data rate systems at 1 Gbit/s and above, cleaning multimode fibre optic plugs has become much more important. In the past, at slower data rates (10 Mbit/s and 100 Mbit/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 dB to 15 dB. Now with data rates at 1 Gbit/s, 10 Gbit/s and higher data rates, the allowable channel insertion loss can be as low as 2,35 dB for example. Also, the use of VCSELs means that plug cleanliness is necessary to ensure minimal back reflection thereby ensuring system performance.

B.2 Source of contamination

B.2.1 Mishandling

Mishandling of a plug end-face is the most common source of contamination. Accidentally touching the end-face will spread skin oil or hand lotion across the end-face. Accidentally brushing the plug end-face 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 end-face unprotected from the environment subjects the end-face to environmental sources of contamination as discussed below.

Typical examples of contamination are shown in Figure B.1.

a) Clean plug wiped on a T-shirt

b) Clean plug wiped on jeans

Figure B.1 – Typical examples of contamination

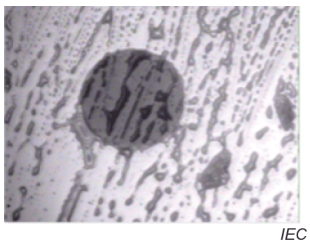
B.2.2 Environmental sources

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 end-faces. In dry climates, airborne dust particles will find their way onto plug end-faces. In very damp humid areas, airborne contaminates can condense on the plug end-face. Considering fibre optic applications exist in military, medical, oil and gas and manufacturing industries, the variety of potential contaminants becomes very large.

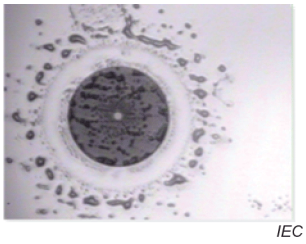
B.2.3 Contamination travels

Contamination travels between plugs, as illustrated in the images in Figure B.2. The insertion of a contaminated plug into a port will spread that contamination to the mated end-face, 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.

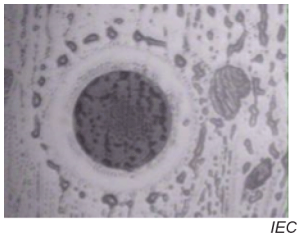
a) Plug A before mating



b) Plug B before mating



c) Plug A after mating



d) Plug B after mating

Figure B.2 – Results of mating