IEC TR 62572-4

Edition 2.0 2020-09

TECHNICAL REPORT

colour inside

Fibre optic active components and devices – Reliability standards – Part 4: Guidelines for optical connector end-face cleaning methods for receptacle style optical transceivers

IEC TR 62572-4:2020-09(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC TR 62572-4

Edition 2.0 2020-09

TECHNICAL REPORT

colour inside

Fibre optic active components and devices – Reliability standards – Part 4: Guidelines for optical connector end-face cleaning methods for receptacle style optical transceivers

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 33.180.01

ISBN 978-2-8322-8780-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 7
4 Application of receptacle style optical transceivers and influence of contamination on optical connector end-face 9
4.1 Application of receptacle style optical transceivers 9
4.2 Influence of contamination on optical connector plugs 9
4.3 Transferring of contamination 9
4.4 Influence of contamination of optical connector for optical transceivers 9
5 Care in handling of receptacle style optical transceivers 9
5.1 General 9
5.2 Storage of receptacle style optical transceivers 9
5.3 Installation of receptacle style optical transceivers 10
5.4 Connection of optical connector plugs to receptacle style optical transceivers 10
5.5 Removing of receptacle style optical transceivers 10
5.6 Action in case of abnormality 10
6 Cleaning tools and machines 10
6.1 General 10
6.2 Cleaning tools and machines for optical receptacles 11
7 Internal structure of receptacle style optical transceivers and their applicable cleaning tools and machines 11
7.1 General 11
7.2 Single-fibre optical connector interface type 11
7.3 Multifibre optical connector interface type 12
Annex A (informative) Detail information of optical connector end-face cleaning tools and machines 14
A.1 Reel type cleaner 14
A.2 Stick type cleaner 14
A.3 Pen type cleaner 14
A.4 Gas and vacuum cleaning machine 15
A.5 Air duster 16
A.6 Wet clean 16
Annex B (informative) Detailed information on the internal structure of receptacle style optical transceivers and their applicable cleaning tools and machines 17
B.1 Internal structure of receptacle style optical transceivers 17
B.2 Example of the method to distinguish internal structure of receptacle style optical transceivers 17
B.3 Applicable cleaning tools and machines according to internal structure of receptacle style optical transceivers 18
B.3.1 General 18
B.3.2 Characteristics of stub type optical transceivers 18
B.3.3 Characteristics of lens type optical transceivers 18
B.3.4 Characteristics of plate contact type optical transceivers 19
Annex C (informative) Cleaning procedure of optical connector end-face of receptacle style optical transceivers 20

C.1 Basic cleaning procedure 20
C.2 Cleaning procedure of stick type cleaner 20
C.3 Cleaning procedure of pen type cleaner 21
C.4 Cleaning procedure of gas and vacuum type cleaning machine 21
C.5 Cleaning procedure of air duster 21
C.6 Other important points 21
Annex D (informative) Examples of inspection instruments for an optical connector receptacle end-face 23
Bibliography 24

Figure A.1 – Example of a reel type cleaner 14
Figure A.2 – Examples of stick type cleaners 14
Figure A.3 – Example of a single-fibre interface pen type cleaner 15
Figure A.4 – Examples of a multifibre interface pen type cleaner 15
Figure A.5 – Example of gas and vacuum cleaning machine 15
Figure A.6 – Example of air duster 16
Figure B.1 – Internal structures for connecting to optical connector plugs 17
Figure C.1 – Cleaning an optical transceiver receptacle end-face by a stick type cleaner 20
Figure C.2 – Cleaning optical transceiver receptacle end-face using a pen type cleaner 21
Figure D.1 – Examples of optical connector end-face visual inspection equipment 23

Table 1 – Typical optical connector receptacle cleaning tools and machines 11
Table 2 – Applicable cleaning tools and machines depending on the internal structure of single-fibre optical connector interface type optical transceivers 12
Table 3 – Applicable cleaning tools and machines depending on the internal structure of multifibre connector interface optical transceivers 13

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – RELIABILITY STANDARDS –

Part 4: Guidelines for optical connector end-face cleaning methods for receptacle style optical transceivers

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 62572-4, which is a Technical Report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

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

a) addition of terms and definitions on multifibre connector interface optical transceivers;
b) addition of cleaning methods for multifibre connector interface type optical transceivers;

c) updating URLs for reference websites.

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

Draft TR	Report on voting
86C/1661/DTR	86C/1681/RVDTR

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

A list of all parts in the IEC 62752 series, under the general title *Fibre optic active components and devices – Reliability standards*, 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 "http://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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

High speed internet communication systems and subscriber systems have spread rapidly owing to the increased capacity of data communication. In these systems, receptacle style optical transceivers such as SFP (small form factor pluggable) and XFP (10-Gbit/s small form factor pluggable), which can be mounted and removed during transmission systems operation, are widely used. Optical receptacles of optical transceivers are connected to optical connector plugs of optical patch cords, and optical signals are transmitted and received through these optical receptacles. Pluggable optical transceivers are typically of small size and low cost, and their designs are often simplified. Therefore, the internal structure, especially the receptacle structure, tends to vary between optical transceiver manufacturers.

Generally, to maintain high reliability of optical connections, the optical connector end-face needs to be cleaned. The Technical Report on cleaning of optical connector plugs and optical adaptors, IEC TR 62627-01 [1][1], proposed by Japan, was published in August 2010 and revised in January 2016.

There are, however, no standard cleaning methods for the optical receptacles of optical transceivers. It is a concern that the failure of optical transceivers due to damage and contamination of the optical receptacle end-face can lead to failure in optical network systems.

Multifibre connectors, like the multi-fibre push-on (MPO) connector – see IEC 61754-7 (all parts) [2] – have been widely used in data centres as fibre-to-fibre connections since the early 2010's. They are now also used as optical interfaces in optical transceivers, such as QSFP (quad small form factor pluggable) and CFP (C form factor pluggable) transceivers.

The physical structure of the optical interfaces in transceivers with MPO connectors is significantly different from that of transceivers with single fibre connectors, such as SC connectors (see IEC 61754-4 [3]) and LC connectors (see IEC 61754-20 [4]). Therefore, it was decided to revise this document by adding information on cleaning methods for MPO interface receptacle style optical transceivers.

IEC 62572-4:2013 was based on OITDA TP12/TP-2012, and this edition is based on OITDA TP12/AD-2019 [5].

[1] Numbers in square brackets refer to the Bibliography.

FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – RELIABILITY STANDARDS –

Part 4: Guidelines for optical connector end-face cleaning methods for receptacle style optical transceivers

1 Scope

This part of IEC 62572, which is a Technical Report, provides guidelines for optical connector end-face cleaning methods for receptacle style optical transceivers. It includes details about handling receptacle style optical transceivers, internal structures of optical transceivers, information on cleaning tools and machines, applicable cleaning methods, and cleaning procedures.

Receptacle style optical transceivers as well as optical fibre patch cords are handled by operators and maintenance staff of optical network systems. This document can be used as a guideline to prepare instruction manuals for the operators and maintenance staff of optical network systems.

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
stub
polished short ferrule, including optical fibre inside, mounted in a receptacle style optical transceiver

Note 1 to entry: The stub is connected to an optical connector plug of an optical patch cord.

3.2
stub type optical transceiver
receptacle style optical transceiver with a stub

3.3
lens type optical transceiver
receptacle style optical transceiver without a stub, optically coupling an optical semiconductor device to an optical connector plug of an optical patch cord with converging optical beams by a lens or lenses

3.4
plate contact type optical transceiver
receptacle style optical transceiver without a stub connected by contacting a flat or convex plate (glass or plastic) to an end-face of an optical connector plug of an optical patch cord

3.5
multifibre ferrule type optical transceiver
receptacle style optical transceiver with a multifibre ferrule connecting to a multifibre connector plug

EXAMPLE 1 MT multifibre ferrule (see IEC 61754-5 [6]).

EXAMPLE 2 MPO multifibre connector plug – see IEC 61754-7 (all parts) [2].

3.6
no ferrule type multifibre optical transceiver
receptacle style optical transceiver without a stub and a multifibre ferrule, optically coupling an optical semiconductor device to a multifibre connector plug of an optical patch cord

3.7
optical transceiver
optical module functioning as an optical transmitter and an optical receiver

Note 1 to entry: There are two types of optical interfaces: single-fibre connector and multifibre connector.

3.8
reel type cleaner
optical connector plug end-face cleaning tool consisting of a cleaning cloth rolled and packed in a cassette box and a small window for cleaning

3.9
stick type cleaner
swab type cleaner
optical connector receptacle and optical connector adaptor end-face cleaning tool consisting of a cleaning cloth attached to the top of a stick

3.10
pen type cleaner
optical connector receptacle and optical connector adaptor end-face cleaning tool consisting of a tape-shaped cleaning cloth on the top of a tool that moves and cleans

3.11
gas and vacuum type cleaning machine
optical connector end-face cleaning machine that injects and extracts volatile liquid solvent (gas) from a nozzle

3.12
air duster
canned air
cleaning tool that blows compressed air from the nozzle of a can

3.13
dust cap
protective cover or cap attached to an optical connector plug, optical connector adaptor, or optical receptacle when the optical connector is not connected

4 Application of receptacle style optical transceivers and influence of contamination on optical connector end-face

4.1 Application of receptacle style optical transceivers

Almost all optical receptacle style transceivers are a pluggable type. Pluggable optical transceivers are often attached to the front panels of optical network equipment. For installation and maintenance, pluggable optical transceivers (as well as patch cords) are mounted and removed from optical network equipment by operators and maintenance staff of optical network systems.

When optical components and modules with connector plugs are mounted in optical network equipment by equipment manufacturers, the environment (temperature, humidity and dust) in optical network equipment factories is generally well controlled, and precautions are taken to assure that components are kept clean. However, environments in which optical network systems operate, such as central office, data centres and computer rooms, are not generally as clean as those in the equipment factories. In these environments, dust or condensation can be introduced onto the optical connector end-faces of optical transceivers.

4.2 Influence of contamination on optical connector plugs

Optical signals propagate within or slightly outside of the core of optical fibres, the diameter of which is very small, typically from about 9 μm to around 50 μm. If a very small particle of dust of a few micrometres (μm) in size is deposited on an optical fibre core of an optical connector plug, the optical connector might not achieve its designed optical performance (loss and return loss), which can adversely impact the performance of the optical network system in which it is used. Cleaning of optical connector plugs is important and is described in IEC TR 62627-01 [1]. IEC TR 62627-05 [7] summarizes the relationship observed between contamination of optical connector end-faces and optical performance (loss and return loss).

4.3 Transferring of contamination

Optical connector plugs and optical connector receptacles can be mated many times, and they can also be mated to different connectors. When the end-face of an optical connector plug is contaminated, that contamination can be transferred to the optical receptacle to which it is mated. Moreover, that contamination can be transferred from the receptacle to another optical connector plug to which it is mated. Contamination can be spread from one component to another like an infection. Therefore, it is most important to prevent contamination of the optical connector end-face and to clean the end-face when contaminated.

4.4 Influence of contamination of optical connector for optical transceivers

Contamination of the optical connector end-face of receptacle style optical transceivers can impact optical performance in the same way that contamination of optical connector plugs impacts optical performance. The International Electronics Manufacturing Initiative (iNEMI) presented a paper at the Warsaw meeting of IEC/SC 86B in April 2012 that illustrates the impact of contamination on transmitter/receiver optical subassemblies (TOSA/ROSA) [8].

5 Care in handling of receptacle style optical transceivers

5.1 General

Clause 5 describes general care in handling of receptacle style optical transceivers. It is advisable to follow the manufacturer's operating manuals or instructions, where provided.

5.2 Storage of receptacle style optical transceivers

Receptacle style optical transceivers should be stored so as to protect the device from static electric discharge, dust, mechanical shock, and vibration and should also be kept within a

specified temperature and humidity range. During storage, dust caps should be placed on optical receptacles to prevent contamination.

5.3 Installation of receptacle style optical transceivers

Pluggable type receptacle style optical transceivers are used on the front panels of optical network equipment. When a pluggable type optical transceiver is mounted while network equipment is operating, the optical transceiver is driven by electrical power coming through the electrical pins of the transceiver. Dust caps should be put on optical receptacles when mounting on operating equipment to prevent eye damage to maintenance staff as well as to prevent contamination of the transceiver.

5.4 Connection of optical connector plugs to receptacle style optical transceivers

Optical connector plugs are connected to the optical receptacles of an optical transceiver after mounting on equipment. Dust caps should be removed just before the optical connector plugs are connected. Care should also be taken to prevent dust from entering the optical receptacle. Optical connector plug end-faces should be inspected and cleaned if contamination is observed. After optical connector plug end-faces are inspected and found to be in compliance with the specified visual inspection requirements, the optical connector plugs are connected to the optical receptacles of the transceivers. Optical receptacle end-faces are more difficult to clean than optical connector plug end-faces. Moreover, there are several different internal structures of optical receptacles of optical transceivers, and applicable cleaning methods will differ depending on these internal structures. To prevent transferring of contamination, as described previously, optical connector plugs should be inspected and cleaned as needed.

5.5 Removing of receptacle style optical transceivers

When optical transceivers are removed from equipment, optical connector plugs should be disconnected first, dust caps should then be placed on both the optical receptacles and the optical connector plugs, and only then should the optical transceivers be removed from the equipment.

5.6 Action in case of abnormality

When the performance of network equipment is degraded to the point at which it fails to function properly, and it is determined that failure has been caused by an optical transceiver, the optical transceiver should be removed and analysed. After removing the failed transceiver, the optical receptacle end-faces should be inspected. There is danger of eye damage if the end-faces are directly observed while still mounted to operating equipment and the transmitter is emitting optical radiation. Annex D shows examples of optical connector receptacle end-face visual inspection equipment. When contamination is observed on the end-faces of optical receptacles, it should be cleaned by appropriate cleaning methods depending on the internal structure of the receptacles. If the internal structure is not distinguishable, it should not be cleaned, or cleaned only by an air duster.

6 Cleaning tools and machines

6.1 General

It is well known that reel type cleaners work well for cleaning optical connector plug end-faces. However, it is more difficult to clean optical receptacle end-faces because the end-faces are located in the bottom of small diameter holes.

IEC TR 62627-01 gives general information on optical cleaning methods and cleaning tools and machines for optical connector plug end-faces. The typical cleaning method for connector plug end-faces is rubbing the end-face with a cloth. As rubbing can produce a static electric charge, which can hold contamination, it is recommended to use an optical connector cleaner with cloth that has been processed so that it will not create a static electric charge on the end-face. Lint-

free cloths or clothes woven from special fibres are also recommended to prevent contamination from the cleaning cloths themselves.

Sometimes, a solvent such as isopropyl alcohol is used with cleaning papers (normally used for cleaning optical elements) to clean end-faces. Care should be taken, as residue from the solvent can remain on the end-face after cleaning. After cleaning with solvents, dry cleaning should be performed to ensure that no residue is left.

6.2 Cleaning tools and machines for optical receptacles

Table 1 shows typical optical connector end-face cleaning tools and machines, especially applicable for receptacle end-face. Annex A also provides detailed information on optical connector end-face cleaning tools and machines.

Table 1 – Typical optical connector receptacle cleaning tools and machines

Cleaning tools and machines	Features
Stick type	Cleaning cloth is attached to the top of a stick. It is also called a "swab type cleaner". The stick-type cleaners for optical connector receptacle end-faces are sold in the market, and almost all cleaning cloth material is processed to prevent electro-static charge build-up.
Pen type	Cleaning cloth attached to the top of this type of pen type cleaner moves and cleans the end-face of optical connector receptacles. Pressing the top onto the end-faces causes the cleaning cloth to rotate. They are used for optical connector receptacle end-face cleaning. Since the width of the cleaning cloth limits the cleaning area, only the centre of the end-face is cleaned.
Gas and vacuum type cleaning machine	Volatile liquid solvent (gas) is injected and extracted by a nozzle to clean optical connector end-faces. This cleaning machine is available on the market.
Air duster	A propellant and compressed air are packed into a dispensing can; the compressed air is blown from a nozzle. It is widely used for removing dust from electronic and electrical equipment. The jet of compressed air from the air duster removes the dust from the end-face.
Wet cleaning	A solvent such as isopropyl alcohol and cleaning papers are used to clean the end-face. Using a solvent prevents the creation of a static electric charge on the end-face.

7 Internal structure of receptacle style optical transceivers and their applicable cleaning tools and machines

7.1 General

There are mainly two types of optical interfaces:

a) single-fibre optical connector plug such as an LC connector (IEC 61754-20 [4]);

b) multifibre optical connector plug such as an MPO connector – IEC 61754-7 (all parts) [2].

7.2 Single-fibre optical connector interface type

Optical emitting units and receiving units of a single-fibre optical connector interface type receptacle style optical transceivers are composed of optical units, called transmitter optical sub-assembly (TOSA) and receiver optical sub-assembly (ROSA). TOSA and ROSA are components that are connected to optical connector plugs of optical patch cords. Typical internal structures of TOSA and ROSA are of three types:

a) stub type;

b) lens type;

c) plate contacting type.

Table 2 shows the internal structures of single-fibre optical connector interface type receptacle style optical transceivers and their applicable cleaning tools and machines. When the internal structure is not distinguishable, only an air duster should be used for cleaning. The detail information of the internal structures of receptacle style optical transceivers and their applicable cleaning tools and machines, and the cleaning procedures are described in Annex B and Annex C, respectively.

Table 2 – Applicable cleaning tools and machines depending on the internal structure of single-fibre optical connector interface type optical transceivers

Cleaning tools and machines	Stub type optical transceivers	Lens type optical transceivers	Plate contacting type optical transceivers
Stick type	Applicable	Not applicable	Consult transceiver manufacturer for recommended use.
Pen type	Applicable	Not applicable	Consult transceiver manufacturer for recommended use.
Gas and vacuum cleaning machine	Consult transceiver manufacturer for recommended use.	Consult transceiver manufacturer for recommended use.	Consult transceiver manufacturer for recommended use.
Air duster	Consult transceiver manufacturer for recommended use.	Consult transceiver manufacturer for recommended use.	Consult transceiver manufacturer for recommended use.

7.3 Multifibre optical connector interface type

Receptacle style optical transceivers have several optical interfaces of 4 channels out of 8 channels for transmitters and another 4 channels for receivers; 10 channels of the 1st row for transmitters and 10 channels of the 2nd row for receivers, for example.

Receptacle style optical transceivers connecting with an unpinned MPO connector plug of QSFP, QSFP+, QSFP28 and so on have been standardized in the market by multi-source agreement (MSA).

The internal structures of optical interfaces of multifibre connector optical transceivers differ among manufacturers, similar to those for single-fibre connector optical transceivers, such as SFP, XFP, etc. An example of the internal structure of a two-guide-pinned MT ferrule inside and connecting to LDs and PDs by the short-length ribbon fibre is known. Other internal structures, such as a glass or metal plate with holes having two guide pins and optically coupled to LDs or PDs by optical beam either by lenses or directly, are assumed.

Table 3 shows the internal structures of multifibre optical connector interface type receptacle style optical transceivers and their applicable cleaning tools and machines. When the internal structure is not distinguishable, only an air duster should be used for cleaning. The internal structure of multifibre connector interface receptacle style optical transceivers is unknown and the appropriate cleaning methods are not clarified. However, in Annex B, the internal structure of single-fibre optical transceivers and the applicable cleaning methods can be referred. The cleaning procedure of pen type cleaning tools in Annex C described for single-fibre optical transceivers can be applicable for multifibre optical transceivers (refer to guidelines of the particular pen-type cleaning tool).

Table 3 – Applicable cleaning tools and machines depending on the internal structure of multifibre connector interface optical transceivers

Cleaning tools and machines	Multifibre ferrule type optical transceivers	No ferrule type multifibre optical transceivers
Stick type	Not applicable	Not applicable
Pen type	Applicable [a]	Not applicable
Gas and vacuum cleaning machine	Consult transceiver manufacturer for recommended use.	Consult transceiver manufacturer for recommended use.
Air duster	Consult transceiver manufacturer for recommended use.	Consult transceiver manufacturer for recommended use.

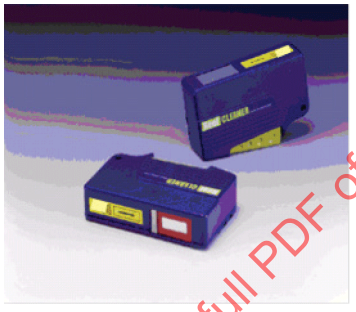
[a] Pen type cleaning tools designed for multifibre connectors should be used. Care should be taken in choice of 12-fibre designated or 16-fibre designated.

Annex A
(informative)

Detail information of optical connector end-face cleaning tools and machines

A.1 Reel type cleaner

A reel type cleaner is used for cleaning optical connector plug end-faces but is not suited for cleaning optical receptacles. The cleaning cloth is rolled and packed in a cassette. The cassette has a small window into which the plug end-face is inserted for cleaning. The optical connector plug end-face is pressed and rubbed on cleaning cloth to clean it. Figure A.1 shows an example of a reel type cleaner. It is recommended that the cleaning cloth be processed to prevent the creation of a static electric charge. The area of the cleaning cloth should be advanced before every cleaning to prevent contamination.



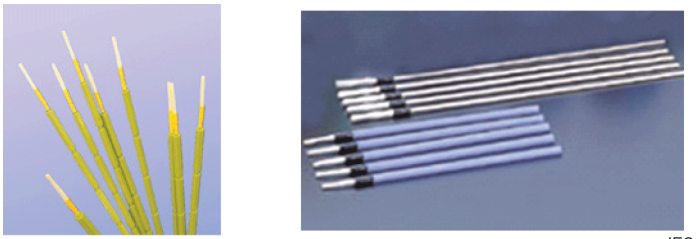
IEC

Figure A.1 – Example of a reel type cleaner

A.2 Stick type cleaner

A stick type cleaner has a cleaning cloth at the end of a stick. This cleaner is suitable for optical receptacles and optical adaptors. Figure A.2 shows examples of stick type cleaners.

The cleaning cloth material should be processed to prevent the creation of a static electric charge on the end-face. This cleaner is used only once. Two kinds of stick type cleaners for ϕ 1,25 mm diameter ferrules or ϕ 2,5 mm diameter ferrules are in the market. Care should be taken to use cleaners conforming to the stub diameter of optical transceivers.



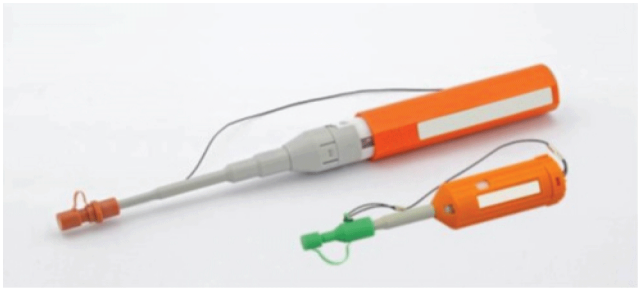
IEC

Figure A.2 – Examples of stick type cleaners

A.3 Pen type cleaner

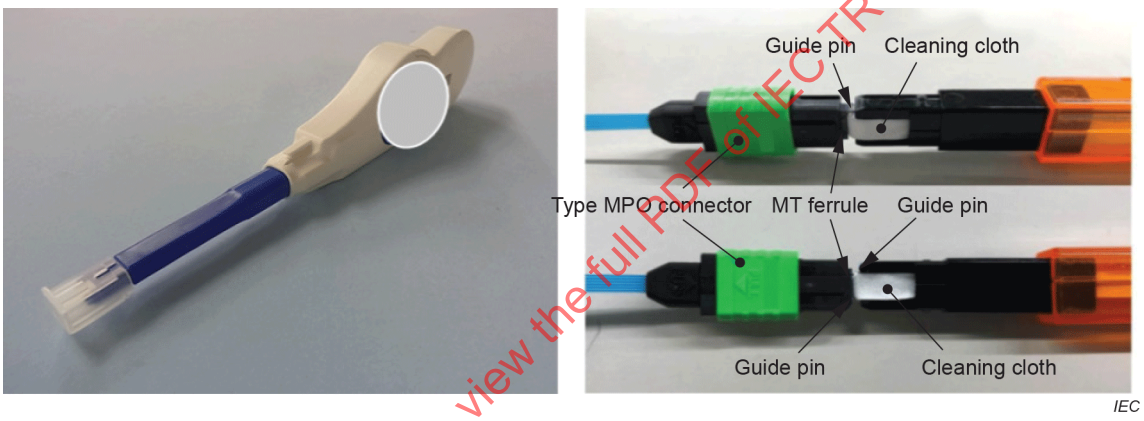
Pen type cleaners have a cleaning cloth at the end of the cleaner. The cleaning cloth moves when the top of the cleaner is pressed on the end-face of an optical receptacle and cleans the end-face. Figure A.3 shows examples of pen type cleaners for single-fibre interface optical

transceivers. Two kinds of single-fibre interface pen type cleaners for ϕ 1,25 mm diameter ferrules or ϕ 2,5 mm diameter ferrules are in the market. Care should be taken to use the cleaners conforming to the stub diameter of optical transceivers. There are two kinds of multifibre (MPO connector) interface pen type cleaners for 12-fibre and 16-fibre. Pen type cleaners that do not contact guide-pins during cleaning should be used (see Figure A.4).



IEC

Figure A.3 – Example of a single-fibre interface pen type cleaner



IEC

Figure A.4 – Examples of a multifibre interface pen type cleaner

A.4 Gas and vacuum cleaning machine

A volatile liquid solvent is injected and extracted from a nozzle. This cleaning machine is available on the market. Figure A.5 shows a picture of this cleaning machine. Contamination is removed by the solvent.

IEC

Figure A.5 – Example of gas and vacuum cleaning machine

A.5 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 include ifluoroethane (HFC-152a), trifluoroethane (HFC-143a), and tetrafluoroethane (HFC-134a). HFC-152a has a lower global warming potentials (GWP) index than HFC-143a, which is better for the environment. Care should be taken as the solvent can leak out when the contents are low or when the can is inverted. Figure A.6 shows an example of an air duster.

IEC

Figure A.6 – Example of air duster

A.6 Wet clean

The wet cleaning method uses a solvent such as isopropyl alcohol with cleaning papers for optical elements to clean the optical connector end-face. Care should be taken to ensure that no residue from the solvent remains after cleaning. Using a solvent prevents the creation of a static electric charge on the end-face and is sometimes effective for reducing stick contamination. Solvent cleaning should not be used with pen type cleaners. After wet cleaning, dry cleaning is recommended for removing residue from the solvent.

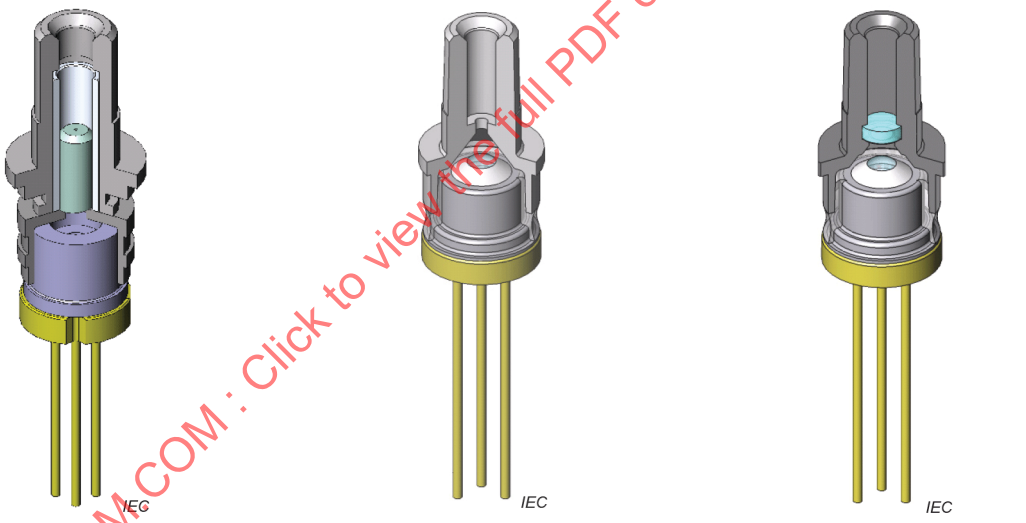
Annex B
(informative)

Detailed information on the internal structure of receptacle style optical transceivers and their applicable cleaning tools and machines

B.1 Internal structure of receptacle style optical transceivers

Receptacle style optical transceivers, especially pluggable optical transceivers, are uniquely designed by manufacturers with their own ideas of how to realize low cost and small size. Consequently, there are many different internal structures. One such typical receptacle style transceiver, SFP (small form factor pluggable), generally includes optical units of transmitter optical subassembly (TOSA) and receiver optical subassembly (ROSA) for optical transmitter and optical receiver components. TOSA and ROSA optically connect to optical connector plugs of optical patch cords. Figure B.1 shows typical internal structures of TOSA and ROSA.

Figure B.1 a), stub type, shows a stub contacting an optical connector plug. Figure B.1 b), lens type, optically connects an optical semiconductor device to an optical connector plug with converging optical beams by a lens or lenses. An optical connector plug stops at the small ring inside. In Figure B.1 c), plate-contacting type, a plate contacts an optical connector plug. The optically connecting mechanism is the same as the lens type.



a) – Stub type b) – Lens type c) – Plate contacting type

Figure B.1 – Internal structures for connecting to optical connector plugs

B.2 Example of the method to distinguish internal structure of receptacle style optical transceivers

It is well known that there are three types of internal structure for receptacle style optical transceivers, as described in Clause B.1. As mentioned, applicable cleaning tools and machines can vary for different internal structures. The internal structure cannot generally be distinguished by appearance. Clause B.2 provides an example of a method to distinguish the internal structure of receptacle style optical transceivers.

SFPs, one of the typical pluggable optical transceivers, generally mate to LC connector plugs (standardized by IEC 61754-20 [4]) and have the structure of an LC connector receptacle for the connector mating part. Standards of optical connectors define "mechanical reference plane" and "optical reference plane" for mating. For example, an optical connector plug of the type LC connector has a latching part in a lever, and the optical receptacle has a corresponding latching

part inside a connector housing. As the distance between the latching part and the optical reference plane is defined, the stub surface for a stub type receptacle (the stopper for lens type, or the surface of the plate for plate contacting type) can be observed by a microscope when adjusting the focus length to the optical reference plane. The stub surface (ferrule and optical fibre cladding and core) for the stub type can be observed; a dimly illuminated lens for lens type can be observed; and the surface of plane can also be observed. This is an example of how to distinguish the internal structures of receptacle style optical transceivers.

B.3 Applicable cleaning tools and machines according to internal structure of receptacle style optical transceivers

B.3.1 General

As explained in Clause B.1, there are typically three types of internal structures for receptacle style optical transceivers: stub type, lens type and plate contacting type. Clause B.3 explains how the characteristics of these different types of transceivers influence the choice of optical connector end-face cleaning methods.

B.3.2 Characteristics of stub type optical transceivers

For stub type optical transceivers, the stub surface contacts an optical connector plug end-face for connecting. This mechanism and the structure are the same as the combination of a first optical connector plug, optical adaptor, and a second optical connector plug combination. Contamination is generally attached to the stub surface and the inner surface of the split sleeve. Stick type cleaners and pen type cleaners are available to remove contamination. For a gas and vacuum cleaning machine, it should be verified that solvent is not trapped inside the optical transceivers prior to adoption. Generally, air dusters are not effective in cleaning receptacles. It is difficult to remove contamination with a compressed air blast because the structure of the optical receptacle has a small diameter bore of 1,25 mm (or 2,5 mm) which can be 10 mm deep. Larger contamination particles may effectively be removed by air injection.

B.3.3 Characteristics of lens type optical transceivers

Almost all lens type optical transceivers have a stopper inside, stopping the optical connector plug as shown in Figure B.1. Typically, an optical semiconductor device is contained in a lensed can behind the stopper. Contamination is sometimes attached to the surface of the lens or inner surface of the split sleeve. Generally, stick type cleaners and pen type cleaners should not be used for lens type optical transceivers. The size of the cleaning cloth on the top of stick type cleaners is slightly less than the diameter of the 1,25 mm (or 2,5 mm) of the inner diameter of the split sleeve of the optical adaptors. The small hole of the stopper of lens type optical transceivers is typically 0,5 mm to 1 mm in diameter, which is smaller than the size of the cleaning cloth of stick type cleaners. When the stick type cleaner is inserted into the receptacle, a part of the cleaning cloth can be caught by the hole of the stopper and remain after the stick cleaner is removed. The pen type cleaner is not effective for cleaning, as the cleaning cloth moves around the hole of the stopper. Moreover, the stick type cleaner and the pen type cleaner cannot reach as far as the lens surface, so neither can clean the lens surface. Lens type optical transceivers are designed with a converging optical beam focused at the stopper. If a small amount of contamination is on the surface of the lens, the effect on optical performance (optical output power and return loss) is considered to be small, because the beam diameter is relatively large at the lens' surface. For lens type optical transceivers, the gas and vacuum cleaning machine can be effective. However, depending on the internal structure of optical transceivers, the solvent might not be fully extracted and can remain inside the receptacle. Although the solvent used in the gas and vacuum cleaning machine is considered to be highly volatile, it should be determined that solvent is not trapped in the receptacle and that there is no impact on optical performance and reliability. It is difficult to remove contamination with a blast of compressed air because of the structure of the optical receptacle having a small diameter bore (1,25 mm or 2,5 mm) that is relatively deep. Larger sized contamination particles may effectively be removed by compressed air injection.

B.3.4 Characteristics of plate contact type optical transceivers

For plate contacting type optical transceivers, the optical connector plug contacts the surface of the plate when connected. For some optical transceivers, the optical connector plug rests slightly above the surface of the plate when connected. For this type of plate contacting optical transceiver, contamination is generally attached to the surface of the plate or inner surface of the split sleeve. For some optical transceivers, stick type cleaners and pen type cleaners can be used, depending on the internal structure of the optical transceiver. However, caution is advised when cleaning plate contact type transceivers. For the stub type optical transceiver, the stub (ferrule) is made of a relatively hard zirconia ceramic. In the plate type transceiver, the plate is not as hard because it is typically made from glass or plastic, depending on the optical transceiver design. When the plate is made of a plastic material, scratches can be created by cleaning if excess pressure is used. For some plate contacting type optical transceivers, a gas and vacuum cleaning machine can be effective. However, as already suggested, it should be verified that solvent is not trapped in the receptacle, which would adversely impact optical performance and reliability. Air dusters might not effectively clean the receptacle. It is difficult to remove contamination with a blast of compressed air because the structure of the optical receptacle has a small diameter bore (1,25 mm or 2,5 mm) that is relatively deep. Larger sized contamination particles may effectively be removed by compressed air injection.

Annex C
(informative)

Cleaning procedure of optical connector end-face of receptacle style optical transceivers

C.1 Basic cleaning procedure

The following describes the basic procedure for cleaning.

a) Inspect the optical connector end-face for contamination or damage before cleaning.

b) Dry clean the optical connector end-face if contamination, scratches or defects are found and the requirements for cleanliness are not met.

c) Inspect the optical connector end-face after every cleaning to determine if the contamination has been removed.

d) Repeat b) and c) several times if contamination remains; this might be due to contamination of the stick cleaner.

e) If contamination remains after dry cleaning several times, try wet cleaning using a solvent.

f) After wet cleaning, dry clean again.

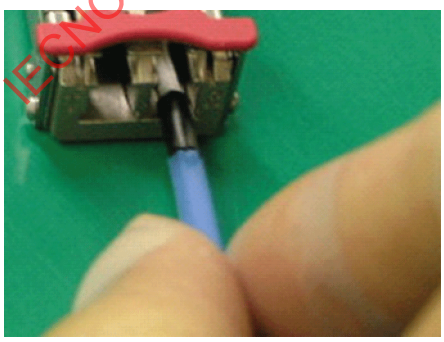
g) Inspect optical connector end-face after every cleaning, and judge according to the pass/fail criteria.

h) Repeat f) and g) several more times.

C.2 Cleaning procedure of stick type cleaner

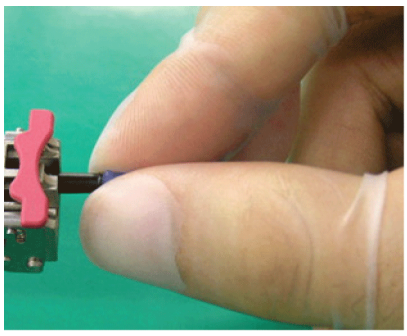
Insert stick type cleaner into the optical receptacle, press and rotate to clean. A light pressing force of a few Newton (N) magnitudes is recommended. Rotate several times. Rotate in the same direction to avoid re-contamination of the optical connector end-face. When using stick type cleaners, care should be taken to see that the cleaning cloth does not contact the housing of optical receptacles and contaminate the cleaning cloth before cleaning. Stick type cleaners can be used only once. Never use them a second time.

The size of the cleaning cloth is slightly smaller than the inner diameter of the split sleeve. When contamination is not in the centre, it can be more effective to insert the stick at an angle to reach the location of the contamination when rotating the stick. Figure C.1 a) shows a front view and Figure C.1b) a side view of cleaning with a stick type cleaner.



IEC

a) – Front view



IEC

b) – Side view

Figure C.1 – Cleaning an optical transceiver receptacle end-face by a stick type cleaner

C.3 Cleaning procedure of pen type cleaner

Insert the pen type cleaner into the optical receptacle and press to clean. Generally, for the pen type cleaner, the cleaning cloth on top of the cleaner moves when pressed. The width of the cleaning cloth is slightly smaller than that of stick type cleaners. Pen type cleaners might only clean the centre of the end-face. Follow the instruction manual provided by the cleaner supplier.

Figure C.2 shows a picture of cleaning using a pen type cleaner.

IEC

Figure C.2 – Cleaning optical transceiver receptacle end-face using a pen type cleaner

C.4 Cleaning procedure of gas and vacuum type cleaning machine

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

C.5 Cleaning procedure of air duster

The nozzle of the air duster is positioned at the proper distance (10 mm to several tens of mm) from the receptacle bore of an optical transceiver, and compressed air is directed into the transceiver bore for several seconds and then repeated. The proper distance for the nozzle can vary for different air dusters, because of differing velocities of the air jet. Care should be taken to see that propellant is not sprayed from the can, either because the can is nearly empty of compressed air or because it is being held in an inverted position.

C.6 Other important points

Clause C.6 describes general considerations for cleaning an optical connector end-face.

a) Optical connector cleaning tools or machines should be used. Cotton swabs are not typically lint-free and are not processed to prevent static electric creation. Some cotton swabs also use glue to attach the cotton material, which can be transferred to the optical connector end-face when cleaning. When a solvent such as alcohol is used with a cotton swab, the glue used to attach the cotton can dissolve and deposit an adhesive film on the optical connector end-face that is extremely difficult to remove.

b) Not all cleaning tools are effective for cleaning.

c) A lint-free cleaning cloth that has been processed to prevent creating a static electric charge should be used.

d) Alcohol can absorb water vapour from the air; care should be taken to store alcohol in a sealed container.

e) Solvents such as alcohol can leave a residue; therefore, dry cleaning after wet cleaning is recommended.

f) Cleaning tools, machines and cleaning cloths should be stored to prevent contamination from dirt.

g) Follow the gas and vacuum cleaning machine supplier's instruction manual for proper set-up, cleaning procedure, periodic maintenance, and storage.