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TECHNICAL REPORT

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

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

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

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FIBRE OPTIC ACTIVE COMPONENTS AND DEVICES – RELIABILITY STANDARDS –

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

FOREWORD

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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- withdrawn,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
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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-Gbps~~ 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 ~~type~~ optical transceivers are ~~required to be low cost and~~ 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 ~~require cleaning of~~, 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 ~~may~~ 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.

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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 ~~may~~ can be used as a guideline to prepare instruction manuals for the operators and maintenance staff of optical network systems.

2 Normative references

~~The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.~~

~~IEC/TR 62627-01, *Fibre optic interconnecting devices and passive components – Part 01: Fibre optic connector cleaning methods*~~

~~IEC/TR 62627-05, *Fibre optic interconnecting devices and passive components – Part 05: Investigation on impact of contamination and scratches on optical performance of single mode (SM) and multimode (MM) connectors*[2]~~

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

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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 ~~connecting~~ 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 (~~material of~~ 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 ~~having both the functions of~~ 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 ~~, in which~~ consisting of a cleaning cloth ~~is~~ rolled and ~~is~~ packed in a cassette box ~~,~~ and ~~with~~ a small window for cleaning

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

~~Note 1 to entry: It is sometimes called a swab type cleaner.~~

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

3.11
gas and vacuum type cleaning machine
optical connector end-face cleaning machine ~~in which~~ that injects and extracts volatile liquid solvent (gas) ~~is injected and extracted~~ from a nozzle

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3.12
air duster
canned air
cleaning tool ~~in which~~ that blows compressed air ~~is blown~~ from ~~a~~ the nozzle of a can

~~Note 1 to entry: It is sometimes called canned air.~~

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

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 ~~of~~ 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, ~~there is the possibility that~~ dust or condensation ~~may~~ 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 ~~10~~ 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 ~~may~~ might not achieve its designed optical performance (loss and return loss), ~~and may~~ 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 ~~on~~ of optical connector end-faces and optical performance (loss and return loss).

4.3 Transferring of contamination

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

4.4 Influence of contamination ~~on~~ of optical connector for optical transceivers

Contamination of the optical connector end-face of receptacle style optical transceivers ~~may~~ can impact optical performance in the same way that contamination of optical connector plugs

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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 ~~provided~~ 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 ~~preventing~~ to prevent contamination ~~to~~ 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 ~~distinguished~~ distinguishable, it should not be cleaned, or cleaned only by an air duster.

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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 ~~by~~ rubbing the end-face with a cloth. As rubbing ~~may~~ can produce a static electric charge, which ~~may~~ 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 ~~may~~ 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 ~~receptacle~~ 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. ~~As~~ Since the width of the cleaning cloth limits thecleaning area, only the centre of the end-face~~s~~ 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]);

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

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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 ~~distinguished~~ 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	~~Check individual transceiver type for compatibility~~ Consult transceiver manufacturer for recommended use.
Pen type	Applicable	Not applicable	~~Check individual transceiver type for compatibility~~ Consult transceiver manufacturer for recommended use.
Gas and vacuum cleaning machine	~~Check individual transceiver type for compatibility~~ Consult transceiver manufacturer for recommended use.	~~Check individual transceiver type for compatibility~~ Consult transceiver manufacturer for recommended use.	~~Check individual transceiver type for compatibility~~ Consult transceiver manufacturer for recommended use.
Air duster	~~Applicable, check for effectiveness~~ Consult transceiver manufacturer for recommended use.	~~Applicable; check for effectiveness~~ Consult transceiver manufacturer for recommended use.	~~Applicable; check for effectiveness~~ 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).

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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.

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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.

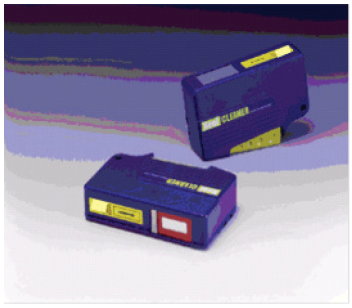

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Figure A.1 – Example of a reel type cleaner

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.

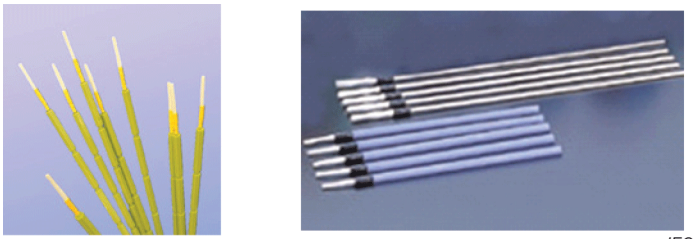

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Figure A.2 – Examples of stick type cleaners

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

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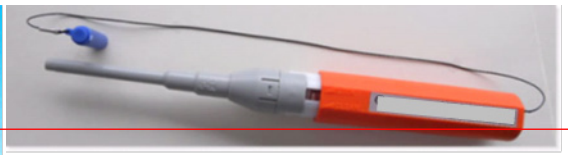
transceivers. Two kinds of single-fibre interface pen type cleaners for ϕ 1,25 mm diameter ferrules or ϕ 2,5 mm diameter ferrules are in the market. Care should be taken to use the cleaners conforming to the stub diameter of optical transceivers. There are two kinds of multifibre (MPO connector) interface 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).

~~Figure A.3a – Example 1~~



~~Figure A.3b – Example 2~~

~~Figure A.3 – Examples of pen type cleaners~~

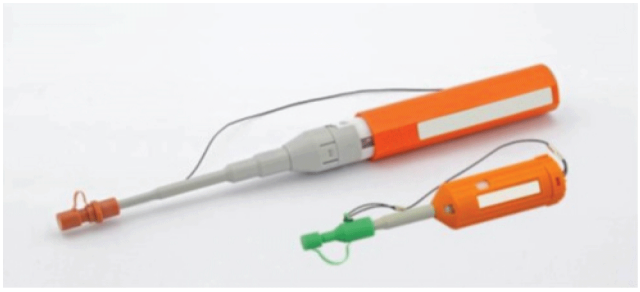


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Figure A.3 – Example of a single-fibre interface pen type cleaner

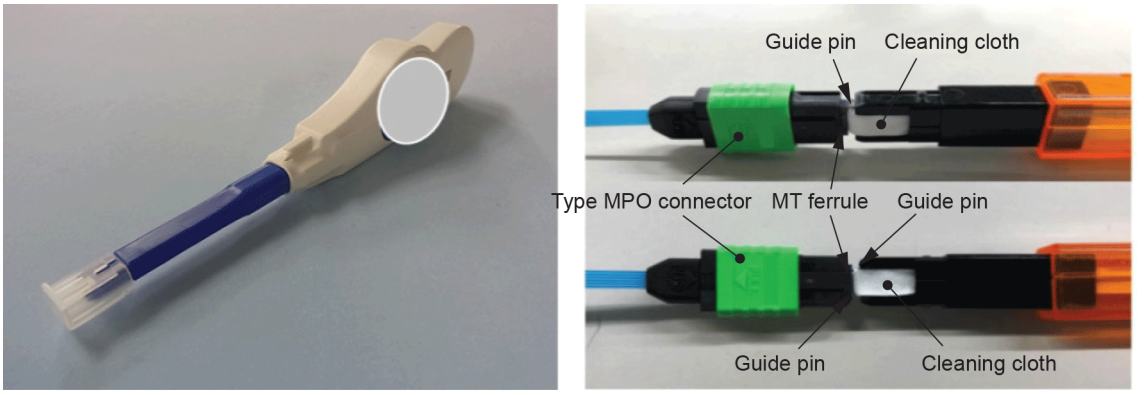

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Figure A.4 – Examples of a multifibre interface pen type cleaner

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.

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