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Technical Paper

Plastic Optical Fiber Distribution System for Customer premises

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FOREWORD

This is a technical paper (TP) on the standardization published by Optoelectronic Industry and Technology Development Association (OITDA). TP is published to announce the proposed standards, provide technical materials on standardization, or to supplement the standards.

Currently, there are various network connections for the use of broadband service that include LAN, FTTx, xDSL, CATV, Wireless LAN, and mobile. The services provided by the network have also diversified such as the Triple Play service and a video distribution service in addition to data communications and phone services. Particularly, as FTTx using an optical distribution system can do the broadband transmission and is scalable to the Triple Play service and other various services in the future, its demand has increased in the access network.

For the optical distribution in FTTx, a telecommunication provider installs a silica-glass optical fiber to a building and a house, and the telecommunication provider or a user installs silica-glass optical fibers, LAN cables, and coaxial cables within the premise as necessary. However, as a LAN cable and a coaxial cable tend to be affected by noises generated by an electric facility within the premise, and thus, it is likely the performance is not sufficient to provide a service that requires broadband network such as video distribution.
As a Plastic Optical Fiber (POF) can provide sufficient performance that can replace a LAN cable and a coaxial cable within a premise, apartment houses and hospitals have started to adopt it. It is also expected to be used as an optical distribution item between rooms within a dwelling unit.

This technical paper describes an optical cabling configuration and a cabling method of POF within a premise as well as cabling items and parts in a systematic manner. We expect that this technical paper can be a guideline for developers, designers, and constructors who intend to introduce an optical distribution system of POF in a premise, as well as promote the dissemination of optical distribution facilities.

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* Position of this TP

- This TP is updated from time to time to meet the technical advancement in plastic optical distribution system.
- Please send your opinions and information to the following contact:

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Plastic Optical Fiber Distribution System for Customer Premises

Introduction

Although a Plastic Optical Fiber (hereinafter referred to as "POF") has a shorter transmissible distance compared with a silica-glass optical fiber that is widely used for the telecommunication purposes, it has a larger diameter, is easy to be processed and handled, and is less damageable due to bending. Thanks to the above advantages, POF is mainly used for equipment general users have many chances to touch an optical fiber such as a digital audio equipment, factory automation, and data transmission in a mobile environment such as in a car. Furthermore, the above characteristics, its easy-to-processing nature, and safety of plastics, POF is sometimes used for cabling item for premise network.

This TP describes technical information when POF is used for optical distribution system for customer premises.

1. Scope

The TP mainly defines the facility structure, laying, connection, and test methods of POF about the optical distribution system for customer premises (hereinafter referred to as "optical distribution for customer premises") using POF. We assume that major users of the TP are designers/users, and constructors of customer premises. The former uses the TP for collecting information on the optical distribution for customer premises using POF and designing houses based on such information, and the latter uses the execution of optical distribution work for customer premises using POF. There are two types of POF; an acrylic resin-type and a fluoropolymer-type. The purpose of use for each item is different.

1.1 Characteristics and Purpose of Use of Acrylic Resin-Type POF

Although an acrylic resin-type POF has a wider diameter and a shorter transmission distance of 50 m compared with a silica-glass-type optical fiber, it can be easily handled in terms of end face treatment. Additionally, its transmission loss is the same level (18 dB/100m @100 MHz) as that of UTP CAT5e cable (≦22 dB/100 m @100 MHz) and CAT 6 cable (≦19.8 dB/100 m @100 MHz) both of which are widely used and under the TIA/EIA-568-B standard. It also has less restriction on execution, as the cable is thin and can be installed at the same time when an electric line is installed. Currently, the acrylic resin-type POF is used to replace existing UTP cables within a house. Its major light source wave length is within a visible area of 650 mm and an optical connector specific to POF such as SMI shape or F 07 (PN) shape is used (please refer to 5 of 4.2.1).

Product specifications of POF that meet the TP are as follows:

a) Outer diameter of 1000 μm, step index (SI)

1) Fiber standard: JIS C 6837 PSI-980/1000-B (IEC standard: 60793-2-40 A4d)

2) Cord standard: JIS C 6836 OFC2.2 - # - PSI-980/1000-B

("#" is an alphabet indicating a buffer material)

b) Outer diameter of 750 μm, graded index (GI)

1) Fiber standard: JIS C 6837 PGI-500/750 (IEC standard: 60793-2-40 A4e)

2) Cable standard: JIS C 6836 OFC2.2 - # - PGI-500/750

("#" is an alphabet indicating a buffer material)

1.2 Characteristics and Purpose of Use of Fluoropolymer-Type POF

Although the diameter of fluoropolymer-type POF is smaller than that of acrylic resin-type POF, its transmission loss is smaller and thus, used

for a backbone cable for buildings. It can use the same light source wave length (850 nm and 1310 nm) and same optical connectors (SC, LC, etc.) as those of a silica-glass optical fiber.

Product specifications of POF that meet the TP are as follows:

a) Outer diameter of 490 μm, GI

1) Fiber standard: JIS C 6837 PGI-120/490 (IEC standard: 60793-2-40 A4g)

2) Cable standard: not applicable

We can now see some products on the market of which core dimension is 55μm or 80 μm, that can be used for the transmission of 10 Gbps for up to 100 m, and of which bending loss is significantly improved.

1.3 Scope of Each POF

The scope of the TP is in-house cabling from ONU within a generic cabling box in each dwelling unit to an information terminal located in each room in the case of acrylic resin-type POF. Regarding the introduction of optical cable to a house, please refer to the "Optical Distribution System for Detached Houses in FTTH".

Regarding a fluoropolymer-type POF, the scope is cabling from MDF to each dwelling unit. For the introduction of optical cable to a MDF room, please refer to the "Optical Distribution System for Detached Houses in FTTH".

2. Definitions and Abbreviations

2.1 Definitions

1) Cable

It is a product that is composed by one or more cable units in the same type and category within a sheath. It can house several telecommunication lines and has a structure to be capable of cabling work and cabling distribution environment.

2) Optical fiber cable (optical cable)

It means a cable consisting of more than one optical cable element.

3) Optical cable with optical connector

It means an optical cable that has an optical connector in either end or both ends.

4) Optical cord with optical connector

It means an optical cord that has an optical connect in either end of both ends.

5) Backbone cable (vertical)

It is a cable that is installed in a vertical direction of the customer premise and connects between a self-PT board and a PD board. It can also be used for the connection between PD boards within a premise.

6) Self PT Board

It means a distributor from which the main cable starts. It has a patch panel with optical connectors and a facility demarcation point of an optical cable from a telecommunication service provider. It is usually placed in a MDF room. It is also called as a user termination cabinet or an optical termination box.

7) PD board

It means a distributor that connects the main cable with a horizontal cable. It is usually placed in an EPS in a common space of residential premise. It is also called as a branching distributor or an optical connection box.

8) Horizontal cable (horizontal)

It means a cable connecting the PD board with an in-house generic cabling box or a telecommunication outlet. On the floor where the PD board

is not installed, it is allowed to directly connect the telecommunication outlet with a self PT board.

9) Optical Network Unit (ONU)

It means equipment to connect an optical cable with a LAN cable such as UTP and to mutually convert optical signals to/from the electric signals in FTTH.

10) Generic cabling box

It means a distributor that centralizes the input and output information cabling from outside of the house (telephone, broadcasting, and telecommunications, etc.). It houses not only the cabling but also a terminal component of cables, transmission equipment, and a splitter, and can be used for checking, maintenance, update, and mutual switching of information and telecommunication facilities.

11) Router

It means equipment that relays and switches the packets in accordance with the protocol definition of the network layer.

12) Information outlet

It means cabling equipment that centralizes telecommunication and broadcasting systems and a power supply.

13) HUB

It means integration equipment to mutually connect LAN equipment.

14) Media converter

It means equipment to connect different transmission media and mutually convert signals received by media. In this TP, it is equipment to connect a LAN cable such as UTP and POF and convert the optical signal to/from the electric signal.

15) Plastic optical fiber

It means an optical fiber of which core and clad materials are made of plastic.

16) Plastic optical fiber cord

It means a plastic optical fiber with tensile strength of which plastic optical fiber is buffered by resin. It is also called as a POF cord.

17) Telecommunication outlet

It means a optical outlet embedded within a wall of the house.

18) Optical outlet

It means an interface to connect an optical drop cable or an optical indoor cable introduced to a house with an in-house optical distribution cord. In this TP, the telecommunication outlet and the optical jack are collectively referred to as an optical outlet which is used for POF cabling from ONU to each dwelling unit as well as a connection with a POF cord within room.

19) Optical jack

It means an optical outlet exposed within a house.

20) Plug

It means a male-type optical connector part where an optical fiber is attached and jointed through an adopter.

21) Termination

It means a condition that the end of cable can be connected to a distributor.

2.2 Abbreviations

EPS	Electric Pipe Shaft
GI	Graded Index
IEC	International Electrotechnical Commission
LAN	Local Area Network
LC	Type LC optical connector

M/C	Media Converter
MDF	Main Distributing Frame
ONU	Optical Network Unit
PD	Premise Distributor
PE	Polyethylene
PN	Type F07(PN) optical connector
POF	Plastic Optical Fiber
PVC	Polyvinyl Chloride
SC	Type SC optical connector
SMI	Type SMI optical connector
UTP	Unshielded Twisted Pair

3. Reference Standards

The following standards constitute part of the provisions in this TP by referring to them in the TP. Among these standards, only the version of the year that is clearly indicated constitutes the provisions of the TP, and their revised or supplemented versions do not apply.

(Regarding the reference standards that have no description of year version, the latest version (including the supplementary ones) shall apply)

JIS C 6824 Test methods for bandwidth of multimode optical fibers

JIS C 6836-1999* All Plastic Multimode Optical Fiber Cords

JIS C 6837-2008 All plastic multimode optical fibers

JIS C 6861-1999 Test methods for mechanical characteristics of all plastic multimode optical fibers and cords

JIS C 6862-1991** Test methods for structural parameters of all plastic multimode optical fibers

JIS C 6863-1990*** Test methods for attenuation of all plastic multimode optical fibers

JIS C 5976-2001 F07 Type connectors for optical fiber cables

IEC 60794-2-40 Ed.2.0 (2008) Optical fibre cables - Part 2-40: Indoor optical fibre cables - Family specification for A4 fibre cables

IEC 60794-2-41 Ed.1.0 (2008) Optical fibre cables - Part 2-41: Indoor cables – Product specification for simplex and duplex buffered A4 fibres

IEC 60794-2-42 Ed.1.0 (2008) Optical fibre cables - Part 2-42: Indoor optical fibre cables - Product specification for simplex and duplex cables with A4 fibres

IEC 61754-21 Ed.1.0 (2005) Fiber optic connector interfaces - Part 21: Type smi connector family for plastic optical fiber

*As the current version does not have a description on GI POF, it is planned to be revised to a new version to be consistent with the IEC standards.

**It has been superseded by JIS C 6822, test methods for structural parameters of optical fibers.

***It has been superseded by JIS C 6823, measuring methods for attenuation of optical fibers.

4. Basic Configuration of POF Optical Distribution System

4.1 Summary

As the diameter of POF is large, it cannot directly be connected with a silica-glass optical fiber for FTTH. Therefore, the configuration is to convert a signal to an electronic signal at ONU and to convert it again to an optical signal at a media converter to send it through POF. The number of core fibers in an optical fiber is generally two for upstream and downstream. As the transmission distance is different; 50 m for an

acrylic resin-type POF and 200 m for a fluoropolymer-type POF, the application of these two types of POF is significantly different in a premise. The following describes the optical distribution system and facility conditions using each type of POF.

4.1.1 Optical Distribution Configuration of Acrylic Resin-Type POF for Detached Houses

Although Acrylic resin-type POF has a shorter transmission distance, as its transmission speed reaches 1 Gbit/s, it is used for cabling from a place where ONU is placed to each room in a house. We can provide a video distribution service if we use POF rather than a LAN cable or a coaxial cable.

In the cabling to each room, a CD tube or a PF tube that is embedded on a wall is used for newly constructed houses. For existing houses, an exposed cabling with Cable protectors is popular taking advantages of characteristics of POF cable such as thinness and flexibility.

The following are examples of cabling configuration for newly constructed houses and existing houses:

a) Newly constructed houses

Figure 1 shows an example of cabling configuration of acrylic resin-type POF for newly constructed houses.

In this optical distribution system, a generic cabling box that concentrates ONU, a router, HUB and a media converter is placed near the introduction point of optical drop cable, and POF is distributed from a media converter within the generic cabling box to a telecommunication outlet in each room using a pre-installed conduit. The advantages of this configuration are that cabling and equipment installation can easily be changed at the generic cabling box, which means that the system can be changed flexibly in response to the change of purpose of each room, and that it has large scalability. Disadvantages include that it is expensive, as this configuration requires placing conduits and a generic cabling box when a house is constructed.

The following shows major components used for newly constructed detached houses and apartment houses:

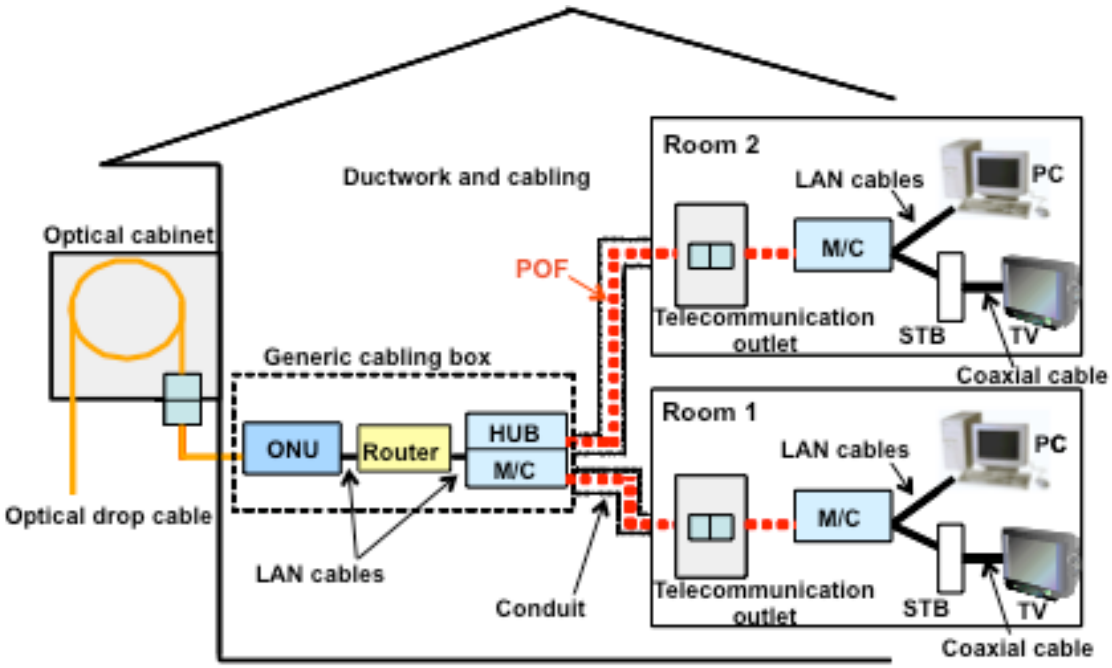


Figure 1: An example of cabling configuration of acrylic resin-type POF for newly constructed houses

Major components

• Generic cabling box

• Conduit

• HUB

• POF cable and optical connector

• Telecommunication outlet

• Media converter

b) Existing houses

Figure 2 shows an example of cabling configuration of acrylic resin-type POF for existing houses.

If it is difficult to install a generic cabling box in an existing house, an optical drop cable is introduced to a house and connected to ONU through an optical outlet. After that, POF is distributed in an exposed form from HUB and a media converter to an optical jack in each room through a router. Such configuration is easy to be introduced to existing houses that have various housing environment and facility conditions, and the cost for facilities is inexpensive. On the other hand, exterior beauty should be considered when adopting exposed cabling. If it is possible to use existing tubes, the configuration shown in Figure 1 can be used except for a generic cabling box.

The following shows major components used for existing detached houses and apartment houses:

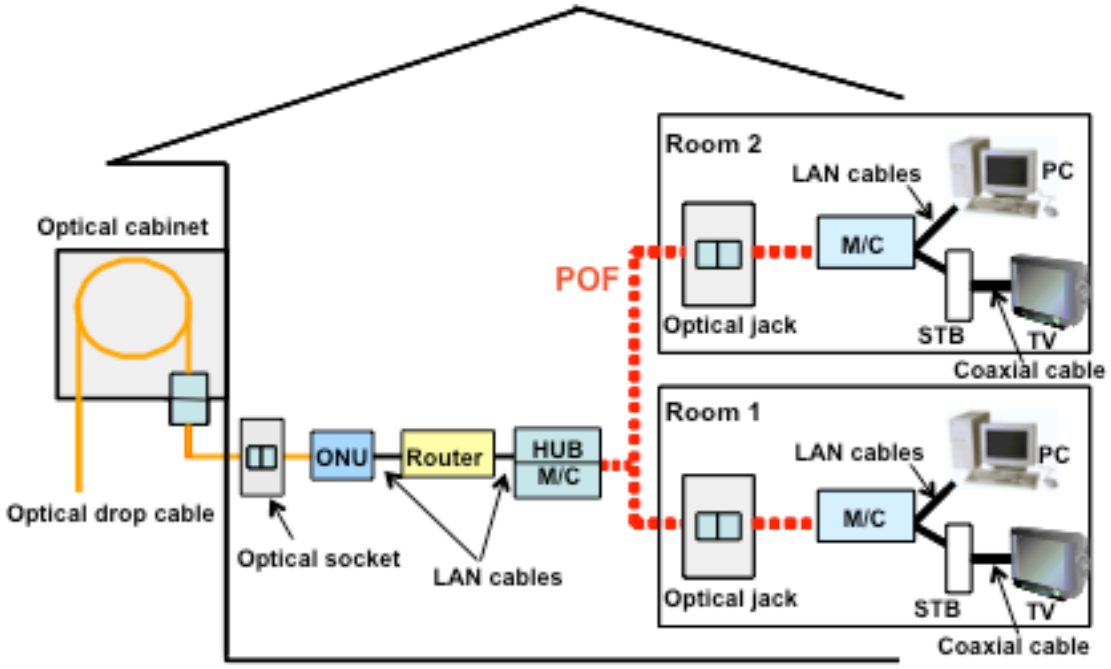


Figure 2: An example of cabling configuration of acrylic resin-type POF for existing houses

Major components

• HUB

• POF cable and optical connector

• Optical jack

• Media converter

• Cable protectors

4.1.2 Facility conditions for Acrylic Resin-Type POF

a) Newly constructed houses

1) There is a sufficient space to install ONU and a media converter in a generic cabling box, or there is a sufficient space to install a generic cabling box where ONU and a media converter can be placed.

2) There is an electric power supply near the generic cabling box in order to operate ONU, a router, and a media converter.

3) There is an electric power supply near the optical outlet in order to operate a media converter.

4) There is star-shaped tubing for POF from the generic cabling box to an optical outlet of each room. The diameter of the tube is generally 22 mm or16 mm.

b) Existing houses

1) There is an electric power supply near the place where ONU is placed to operate ONU, a router, and a media converter.

2) There is an electric power supply near the optical jack in order to operate a media converter.

4.1.3 Basic Optical Distribution Configuration of Fluoropolymer-Type POF for Apartment Houses

Figure 3 shows an example of basic configuration of fluoropolymer-type POF for apartment houses.

The optical distribution system of fluoropolymer-type POF consists of a MDF room, a backbone cable, a horizontal cable, each area (space) of dwelling unit, and distribution equipment such as a self PT board, a PD board, optical cables, and optical outlets placed in each area (space). A media converter is installed in the MDF room and each dwelling unit, and an optical cable is installed between them.

In the FTTH cabling using the distribution method of optical fiber direct connection, a fluoropolymer-type POFs with several cores is installed from the MDF room to each dwelling unit in accordance with the following rules:

1) One-to-one connection between the self PT board and an optical outlet of each dwelling unit;

2) It is allowed to install a connector connection as necessary between a self PT board and an optical outlet of each dwelling unit.

3) In the case where branching or amplification of optical signal, or separation of wave length of optical signal is required, such functional element should be implemented in the upper cascade of the self PT board (in the primary side/telecommunication provider side), or the lower side of the optical outlet (in the secondary side) or after. It is not allowed to install any functional element other than the connection point between the self PT board and the optical outlet of each dwelling unit.

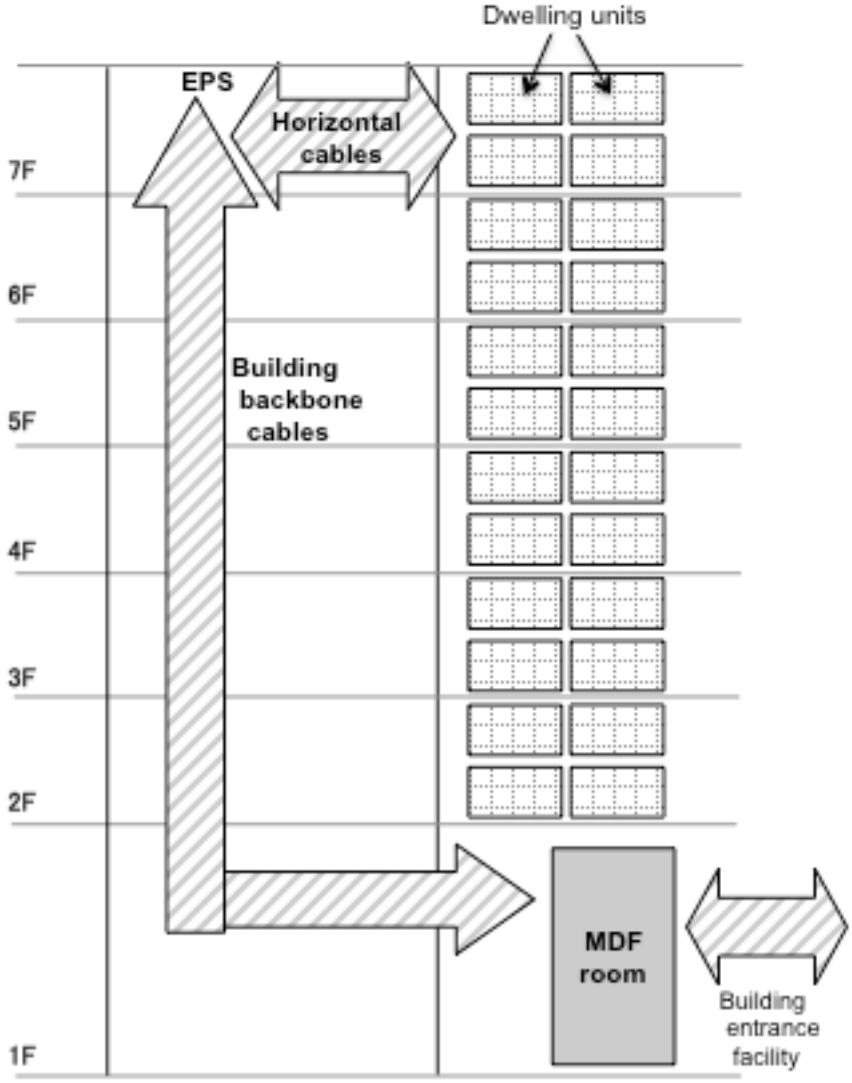


Figure 3: An example of basic configuration of Fluoropolymer-type POF for apartment houses

The following shows major components of optical distribution system using fluoropolymer-type POF for apartment houses:

Major components

- Optical cable and optical connector
- Optical jack
- Media converter
- Cable rack
- Self PT board
- PD board

4.2 Summary of Cabling Parts and Items Consisting of Optical Distribution System

4.2.1 Optical Distribution Items and Parts of Acrylic Resin-Type POF for Detached Houses

The following items and parts are used for optical distribution of acrylic resin-type POF for detached houses.

1) Optical cord and optical cable

It is general to use a single cord or duplex zip cord, both of which are POFs directly buffered by resin. A duplex zip cord or a duplex cable consisting of two single-core cords buffered by resin is also used depending on the purpose of use.

The permissible tension of the duplex zip cord shown in Figure 4 (a) is from 90 N to 140 N depending on the type of products, and the permissible tension of duplex cable shown in Figure 4 (b) is 195 N.

a) Duplex zip cord (2.2 x 4.4 mm) **b) Duplex cable (4.0 x 5.5 mm)**

Figure 4: Examples of acrylic resin-type duplex POF cord and cable [1]

2) Generic cabling box

A generic cabling box is a cabling box that mainly concentrates an optical network line introduced from a transmission facility of telecommunication service provider, a telephone line, and TV line from a receiving antenna, and distributes them through a star-shaped cabling to each room.

Within the generic cabling box, telecommunication equipment such as ONU, a router, and SW-HUB and TV receiving equipment such as a booster and a splitter are placed, and a media converter and POF cable for POF distribution are also placed and connected. An example of generic cabling box is shown in Figure 5. In this example, ONU and a router are placed in a free space. A generic cabling box is placed by residents and it is desirable that the box is installed in a place where maintenance staff can check the box easily. If there is no specific place for installing a generic cabling box, it can be placed, for example, on a wall of the corridor, in a ceiling space, on a wall of the stairs, or within a shoe cupboard.

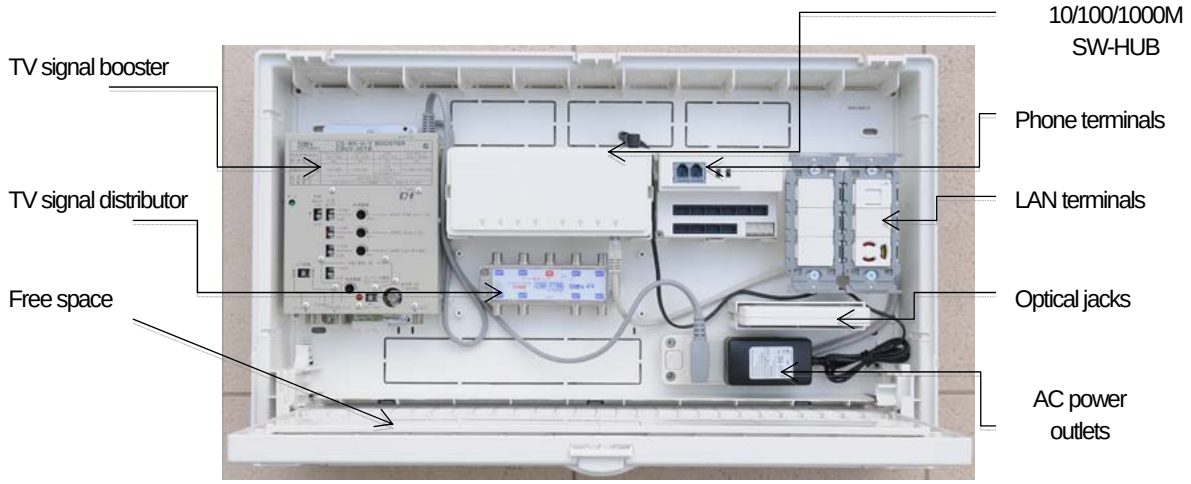


Figure 5: An example of generic cabling box [2]

3) In-house ductwork

Tubes are installed within a wall in a house, within which a POF cable, a LAN cable, and a coaxial cable for TV are introduced. It is generally a combined duct using a flexible CD tube. An inside diameter of the tube is generally 16 mm or 22 mm. The external appearance of CD tube is

shown in Figure 6.

While it is difficult to install tubes in an existing house, if tubes are placed to each room at the time of constructing a house, it not only enables to flexibly respond to any change due to the change of the purpose of room use, reform of the house, or re-installation of cables, but also does not damage external beauty of the room by avoiding exposed cabling.

If there are many bending points in the tube, it is difficult to insert cables in the tube. Thus, the maximum right-angle bending points in one section should be three or less, and a box should be installed if the number of right-angle bending points exceeds three. It is recommended that the radius of curvature should be six times or larger of the inside diameter of the tube.

<Reference>

There are two types of combined duct; a PF (Plastic Flexible Conduit) tube and a CD tube. While a PF tube has burning resistance (self-extinction ability), a CD does not have burning resistance (no self-extinction ability). To distinguish the type of tubes, a CD tube is usually painted with orange.

Figure 6: Examples of CD tubes [3]

4) Cable protector

A Cable protector is used for protecting and covering exposed fibers within a house. It consists of a base part fixed by an adhesive tape or a screw, and a cover part, and has three types for wall, floor, and baseboard. In the case of duplex zip cord shown in Figure 4, it can be housed in the thinnest No. 0 lace.

Figure 7: An example of cable protector for wall surface wiring

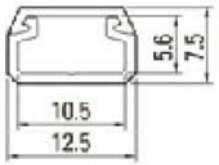
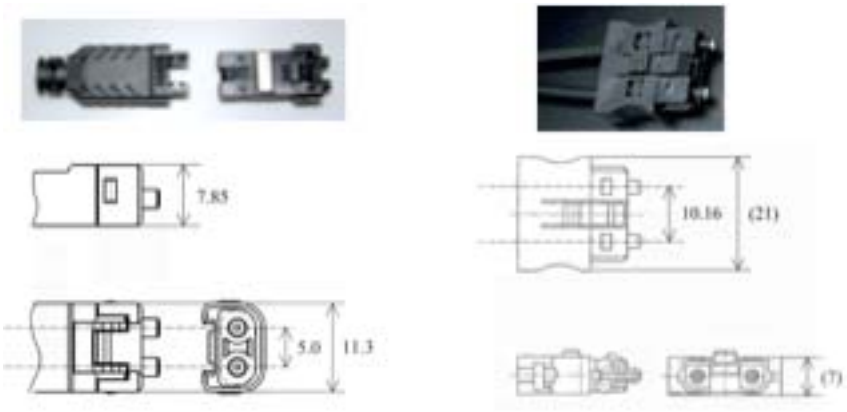


Figure 8: Cross section of a cable protector [4]

5) Optical connector

Optical connectors used for acrylic resin-type POFs require less dimensional accuracy than those for silica-glass optical fibers, most of the connectors are made of resin with combined ferrule and housing. Such structure enables to complete terminal processing and connection (between optical fibers and with equipment) easier and with a shorter time. Either type SMI or type PN optical connector is generally used for duplex zip cord and duplex cable.



(a) Type SMI optical plug **(b) Type F07 (PN) optical plug**

Figure 9: Optical plugs for acrylic resin-type POFs (unit: mm) [1]

6) Telecommunication outlet

A telecommunication outlet is embedded on a wall of a room like an electric outlet. A POF cord or a POF cable distributed within the wall are introduced to a telecommunication outlet, and is connected and terminated at the backside of the telecommunication outlet. This telecommunication outlet enables to connect the POF cord or the POF cable distributed within the wall with an in-house POF cord with connector in a one step. Figure 10 shows an example of telecommunication outlet for acrylic resin-type POF.

Figure 10: An example of telecommunication outlet for acrylic resin-type POF [5]

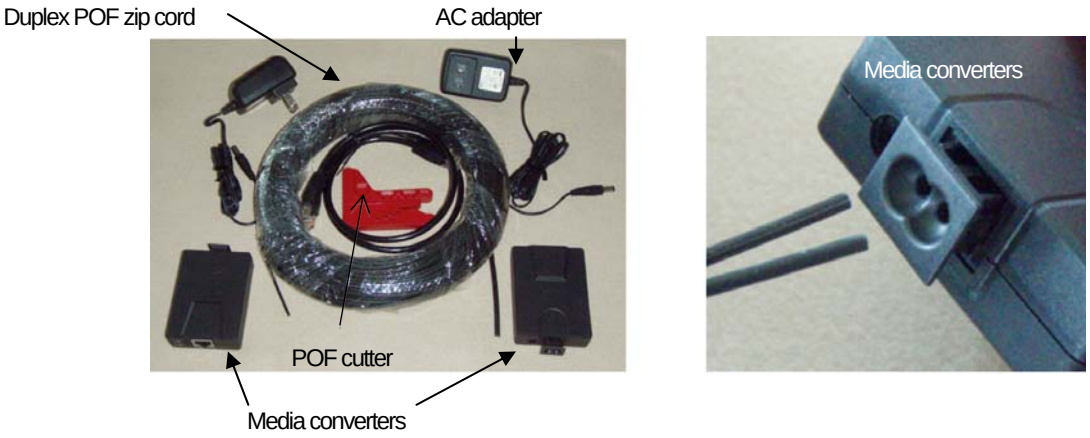
7) Media converter

A media converter is used for connecting a LAN cable such as UTP from ONU with POF, and connecting POF with a LAN terminal of an information terminal. Figure 11 shows an example of media converter for acrylic resin-type POF.

(a) Example 1 [5] (b) Example 2 [6] (c) Example 3 [7]

Figure 11: Media converters for acrylic resin-type POF

Additionally, as shown in Figure 12, media converter DIY kits for plug-less connection are available on the market that enables to connect POF cord to the converter by cutting the cord with a small cutter



(a) DIY kit of media converter for plug-less connection **(b) Plug-less connection**

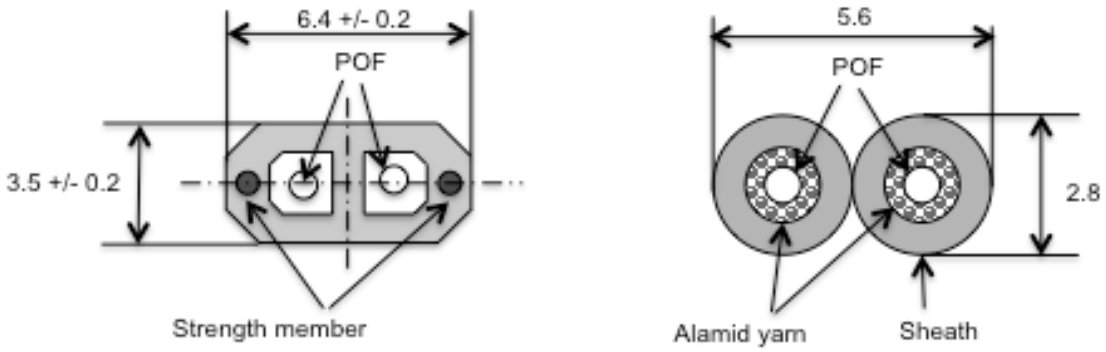
Figure 12: An example of POF media converter DIY kit [8]

4.2.2 Optical Distribution Items and Parts of Fluoropolymer-Type POF for Apartment Houses

Optical distribution of fluoropolymer-type POF for apartment houses includes the following items and parts.

1) Optical cable

Generally, a duplex loose cable (flat type) with tension lines, or a duplex cable with aramid fiber is used. The permissible tension is 220 N and 200 N, respectively.



(a) Loose duplex flat cable **(b) Loose duplex zip cable**

Figure 13: Cross sections of typical duplex cables for of fluoropolymer-type POFs (unit: mm) [8]

2) Cable rack

Please refer to Chapter 6 "Installation of Optical Cables and Distributor Equipment" of TS C 0017 "Optical Distribution System for Customer Premise".

3) Optical connector

Optical connectors generally used for fluoropolymer-type POFs are type SC and LC that are the same as those for silica-class optical fibers.

Figure 14: An example of duplex luoropolymer-type POF cable with Optical connectors Type SC and type LC [9]

4) Telecommunication outlet

Figure 15 shows an example of telecommunication outlet for a duplex connector.

Figure 15: An example of telecommunication outlet for duplex fluoropolymer-type POF [9]

5) Media converter

Figure 16 shows an example of media converter for fluoropolymer-type POF placed in a MDF room and each dwelling unit.

Figure 16: An example of media converter for fluoropolymer-type POF [10]

5. Cabling and Connection

5.1 Optical Distribution Works and Connection of Acrylic Resin POF for Detached Houses

5.1.1 Distribution of Optical Cords and Cables

a) Newly constructed houses

An optical cord or cable is usually distributed from a generic cabling box to an optical outlet of each room through star-shaped in-house tubes. When putting a cable in a tube, the tension should be lower than the tensile strength described in the specifications of optical cord or cable.

b) Existing houses

The standard is an exposed cabling using Cable protectors.

Figure 17 shows an example of distribution works for the actual premise distribution.

(a) An example of premises distribution **(b) Installation of an optical jack**

Figure 17: Examples of optical distribution works of acrylic resin POF for existing houses

5.1.2 Setting of Optical Connector and Termination

Figure 18 shows an example of works to set an optical plug to an acrylic resin-type POF cord and cable. An acrylic resin-type POF cord and cable has a tight buffer structure and a primary cover is usually fixed on the plug with a latch.

(a) Separate zip cord, and strip the buffer **(b) Insert a plug cover** **(c) Fix the plug, and pre-cut excess length of POFs**

Figure 18: An example of setting and termination process of a POF connector [11]

The hot-plate processing is mainly used for terminating the end of an acrylic resin-type POF. In this method, the end of optical fiber is soften by pressing it on a heated mirror board to transcript a mirror to the end of POF (Please refer to Figure 19). The polish processing that is used for a silica-glass optical fiber is also used (Please refer to Figure 20).

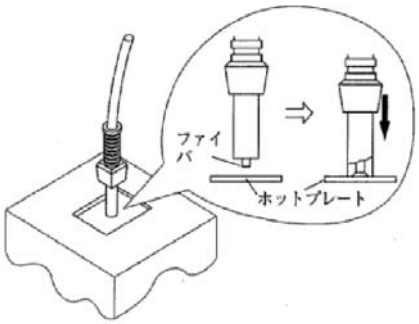


Figure 19: Hot-plate termination [11]

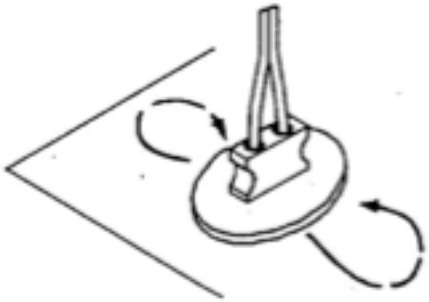


Figure 20: Termination by polishing with a simple polishing disk [11]

5.1.3 Extra Length Treatment

a) Summary

When connecting a POF cable with an optical outlet, 0.5 to 1 meter of extra length is required for terminal processing. Thus, the connection items such as an optical outlet should have a function not only to fix the connection point but also properly houses the extra length.

b) Extra length housing method

Figure 20 shows an example method of housing an extra length in the backside of the telecommunication outlet. A coiling item that can maintain the proper bend radius is installed in the wall side of the telecommunication outlet around which the extra length of the cable installed in the telecommunication outlet is coiled after the termination processing.

In the case that a telecommunication outlet is not used or the extra length of the cable is housed in a pull box, the extra length should be bundled with a radius that is larger than the minimum bend radius designated on the specifications of the POF cord or cable.

c) Notes

1) Be careful not to nip a cable in the lid of housing equipment.

2) Be careful not to twist a cable when coiling it.

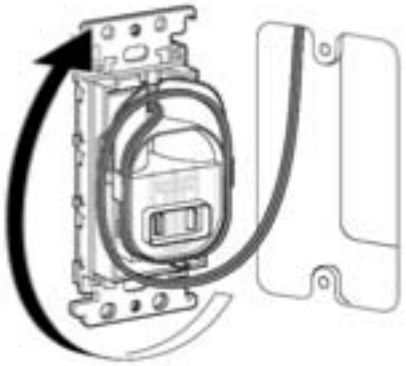
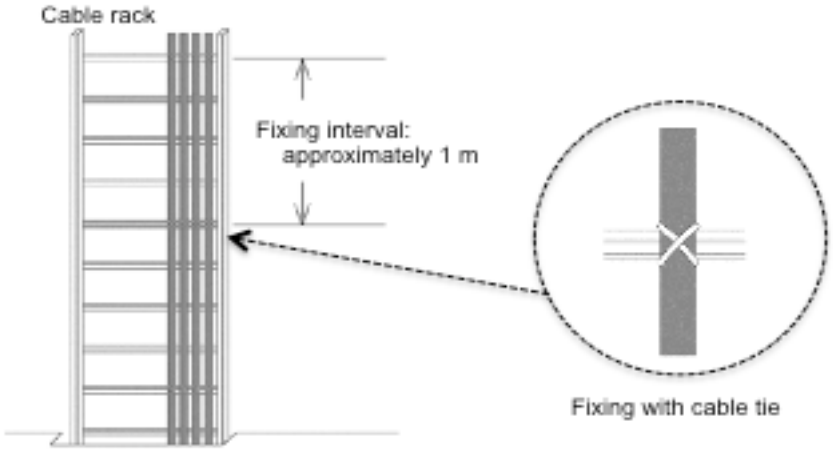


Figure 21: An example of extra length housing in the backside of the telecommunication outlet [12]

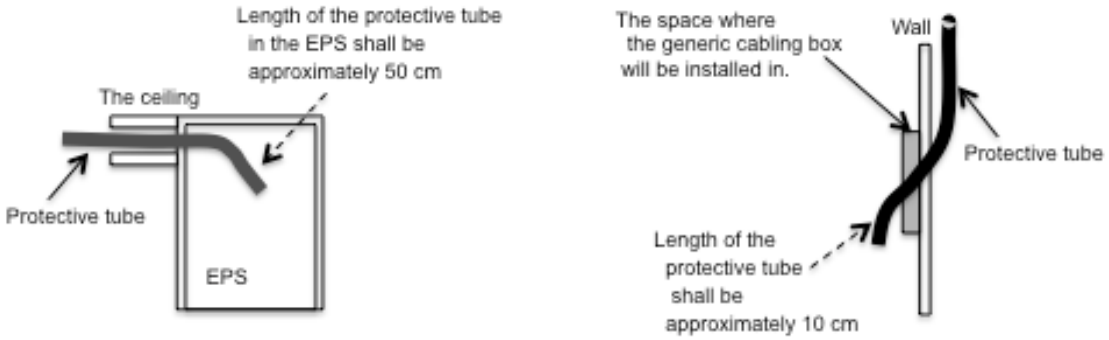
5.2 Optical Distribution Works and Connection of Fluoropolymer-Type POF for Apartment Houses

5.2.1 Optical Cable Distribution

When distributing fluoropolymer-type POF, the cable is distributed in a premise with the protection by a tube, distributed using a metal duct, or installed in a cable rack. When using a tube, it is desirable to choose a tube with an inner diameter of 22 mm to consider the bend radius of optical cable and future additions. Figure 21 shows an example of introduction works using a cable rack and EPS.



(a) Wiring with cable rack **(b) Fixing with cable tie**



(c) Introducing into EPS (d) Wiring to the generic cabling box

Figure 22: An example of optical distribution works of fluoropolymer-Type POF [9]

5.2.2 Setting of Optical Connector and Termination Treatment

The polishing method is used for terminating the end of the optical connector for fluoropolymer-type POF. Figure 23 shows an example of termination works.

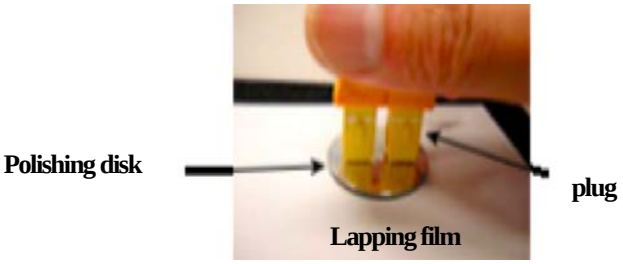


Figure 23: Termination by polishing with a simple [9]

5.2.3 Extra Length Treatment

An extra length of fluoropolymer-type POF within a distributor should be processed pursuant to Section 7.3 of TS C 0017 "Optical Distribution System for Customer Premise". The extra length treatment in the case of connecting to a telecommunication outlet should be done in accordance with Section 5.1.3 of this TP.

6. Maintenance and Management

The following should be noted when distributing cables in a premise:

1) Do not touch the connecter terminal of optical outlet by hands;

2) Be careful not to damage (cut) optical cables due to stamping when moving furniture and other items in a house;

3) When distributing an optical cable in a tube, pulling the cable with less than the permissible tension.

7. Test and Performance Standards

The optical fiber transmission test is conducted to measure the optical loss in a testing distance using an optical power meter after installing an optical cable and completing the termination treatment.

In this method, the value measured is a total of loss from the optical fiber itself and that from the optical connector. In the performance standards, it should be provided that the measured loss is less than the performance standard value.

The testing procedures (simple method) are as follows:

1) Turning on the light source and maintaining it for approximately 10 minutes for warming up to stabilize the output power.

2) After the light source is stabilized, connecting a launching optical fiber to the light source;

3) Connecting the outgoing tail of launching optical fiber to the optical power meter to measure the standard value of incident wave (Pin);

4) Plugging off the outgoing tail of the launching optical fiber from the optical power mater and connecting it to the end of the measured optical fiber;

5) The outgoing tail of the measured optical fiber to the optical power meter to measure the outgoing wave strength (Pout);

6) Calculating the loss value in accordance with the formula below:

$$\text{Loss (dB)} = \textit{Pin}\,\text{(dBm)} - \textit{Pout}\,\text{(dBm)}$$

where

Pin is the input optical power to the cable under test;

Pout is the output optical power of the cable under test.

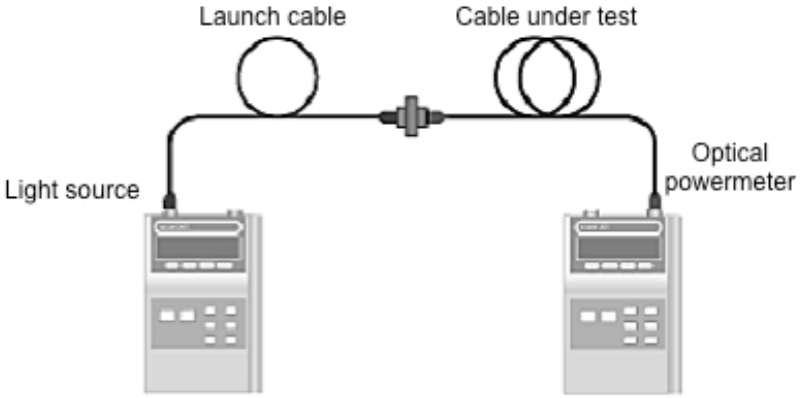


Figure 24: Procedure of optical loss measurement

The testing method and the performance standards are different depending on the system configuration and individual transmission standards.

Reference

(1)"Basic Execution Specifications for In-house Information-Communication Distribution (version 2)" by In-house information-communication/broadcasting advancement forum:

(2) Sekisui Chemical Co., Ltd "Hybrid Cabling System"
http://www.hybrid-system.jp/ (2009.3.25)

(3) Furukawa Electric Co., Ltd. "Electric Facility Material Guide: 2008 - 2009":
http://www.furukawa.co.jp/tukuru/pdf/densetu/densetu_index.htm (2009.3.25)

(4) Masaru Industries Ltd. "General Catalogue of Telecommunication and Electric Facility Items and Parts: 2008 – 2009":
http://www.masarukk.jp/catalog/ (2009.3.25)

(5) Sekisui Chemical Co., Ltd. "Plastic Optical Fiber System for Apartment Houses":
http://g-dive.jp/about/tech.html (2009.3.25)

(6) R&M Product Catalogue (The Year 2008 version)

(7) Firecomms Ltd. "MCE300T Product Material" (2008)

(8) Aisan Electric Co., Ltd. "Product information/optical telecommunication products" on its website
http://www.aisan.co.jp/products/index-products-main.html

(9) Asahi Glass Co., Ltd. Supplementary Materials for "Lucina -Simplified SC Connector" (2007)

(10) Telegärtner Japan Limited "Palm Type Media Converter":
http://www.telegaertner.co.jp/seihin/D02-01/D02-01-01.htm (2009.3.25)

(11) Mitsubishi Rayon Co., Ltd. "Optical Fiber and Information Transmission Products":
http://www.pofeska.com/pofeska.htm (2009.3.25)

(12) Panasonic Electric Works Co., Ltd. Supplementary Materials for Embedded Optical Outlet (2007)

Annex A Classification and major characteristics of POFs

JIS classification	Structure			Characeristics		IEC category
	Cladding diameter (μm)	Core diameter (μm)	NA[*1]	Attenuation (dB/100 m)	Bandwidth (MHz @100 m)	
PSI-980/1000 - A	1,000	See Note 1	0.50	≤ 30[*2]	≥ 10	A4a
PSI-735/750	750	See Note 1	0.50	≤ 30[*2]	≥ 10	A4b
PSI-485/500	500	See Note 1	0.50	≤ 30[*2]	≥ 10	A4c
PSI-980/1000 - B	1,000	See Note 1	0.30	≤ 18[*3]	≥ 100[*3]	A4d
PGI-500/750	750	≥ 500	0.25	≤ 18[*3]	≥ 200[*3]	A4e
PGI-200/490	490	200	0.19	≤ 4[*4]	1,500 to 4,000[*4]	A4f
PGI-120/490	490	120	0.19	≤ 3.3[*4]	1,880 to 5,000[*4]	A4g
PGI-62.5/245	245	62.5	0.19	≤ 3.3[*4]	1,880 to 5,000[*4]	A4h

Note 1: Typically 15 μm to 35 μm smaller than the cladding diameter

*1: Theoretical NA for PSI-XX, effective NA for PGI-XX

*2: At 650 nm, under equilibrium mode launch condition

*3: At 650 nm, launch NA = 0.3

*4: At 850 nm

Annex B　Blank details of duplex POF zip cord for premises wiring

1.　Structure and dimension

Attributes	Specification	Test conditions
Core diameter	μm	Refer to JIS C 6837
Cladding diameter	mm	Refer to JIS C 6837
Cable structure	Duplex zip cord	Refer to JIS C 6836
Dimension	mm	Refer to JIS C 6836
Weight	g/m	
Buffer color		
Length	m	

2.　Characteristics

Attributes	Specification	Test conditions
Attenuation	_ dB/km	Refer to JIS C 6863
Bandwidth	_ MHz over 100m	Refer to JIS C 6824
NA		Refer to JIS C 6862
Buffer strip force	_ N	
Tearing force	_ N min, _ N max.	
Minimum bend radius (temporaly)	_ mm	Duration: 10 seconds, Maximum residual loss increment: _ dB
Minimum bend radius (permanent)	_ mm	Duration: 5 minutes, Maximum residual loss increment: _ dB
Kink		Refer to JIS C 6851
Permissible tensile strength (temporaly)	_ N	Duration: 10 seconds, Maximum residual loss increment: _ dB
Permissible tensile strength (permanent)	_ N	Duration: 5 minutes, Maximum residual loss increment: _ dB
Torsion		Refer to JIS C 6861
Crush	_ N/100mm	Refer to JIS C 6861
Impact	_ J	Refer to JIS C 6861
Operating temperature		
Storage temperature		
Fire performance		

Annex C　Blank details of duplex POF cable for premises wiring

1. Structure and dimension

Attributes	Specification	Reference
Core diameter	μm	Refer to JIS C 6837
Cladding diameter	mm	Refer to JIS C 6837
Cable structure	Duplex cable	
Dimension	mm	
Weight	g/m	
Sheath color		
Length	m	

2. Characteristics

Attributes	Specification	Test conditions
Attenuation	_ dB/km	Refer to JIS C 6863
Bandwidth	_ MHz over 100m	Refer to JIS C 6824
NA		Refer to JIS C 6862
Buffer strip force	_ N	
Tearing force (in the case zip cord is used)	_ N min, _ N max.	
Minimum bend radius (temporaly)	_ mm	Duration: 10 seconds, Maximum residual loss increment: _ dB
Minimum bend radius (permanent)	_ mm	Duration: 5 minutes, Maximum residual loss increment: _ dB
Kink		Refer to JIS C 6851
Permissible tensile strength (temporaly)	_ N	Duration: 10 seconds, Maximum residual loss increment: _ dB
Permissible tensile strength (permanent)	_ N	Duration: 5 minutes, Maximum residual loss increment: _ dB
Torsion		Refer to JIS C 6861
Crush	_ N/100mm	Refer to JIS C 6861
Impact	_ J	Refer to JIS C 6861
Operating temperature		
Storage temperature		
Fire performance		

Annex D Blank details of fluoropolymer-type POF loose duplex flat cable for premises wiring

1. Structure and dimension

Attributes	Specification	Reference
Core diameter	μm	Refer to JIS C 6837
Cladding diameter	mm	Refer to JIS C 6837
Cable structure	Duplex cable	
Dimension	mm	
Weight	g/m	
Sheath color		
Length	m	

2. Characteristics

Attributes	Specification	Test conditions
Attenuation	_ dB/km	Refer to JIS C 6863
Bandwidth	_ MHz over 100m	Refer to JIS C 6824
NA		Refer to JIS C 6862
Buffer strip force	_ N	
Tearing force (in the case zip cord is used)	_ N min, _ N max.	
Minimum bend radius (temporaly)	_ mm	Duration: 10 seconds, Maximum residual loss increment: dB
Minimum bend radius (permanent)	_ mm	Duration: 5 minutes, Maximum residual loss increment: dB
Kink		Refer to JIS C 6851
Permissible tensile strength (temporaly)	_ N	Duration: 10 seconds, Maximum residual loss increment: dB
Permissible tensile strength (permanent)	_ N	Duration: 5 minutes, Maximum residual loss increment: dB
Torsion		Refer to JIS C 6861
Crush	_ N/100mm	Refer to JIS C 6861
Impact	_ J	Refer to JIS C 6861
Operating temperature		

Description of Plastic Optical Fiber (POF) Distribution System for Customer Premises

This description is to explain matters that are described in the body text and Annex and other relevant matters, and not a part of the technical paper (TP).

I. History

Although a plastic optical fiber (hereinafter referred to as "POF") has a shorter transmissible distance compared with a silica-glass optical fiber, it has a larger diameter, is flexible, and easy to be processed and handled. Due to the above advantages, POF is mainly used for digital audio interface, factory automation, and data transmission in a mobile environment such as in a train and a car.

Currently, the broadband access network has sharply developed and new houses have started installing an in-house network. As POF has various characteristics such as easy terminal processing and safer handling even if a fiber is exposed due to a broken cable, we have heard some cases that it is used in hospitals, large apartment houses, small- and middle-sized apartment houses, and detached houses.

Sub-committee on In-house optical fiber distribution system under Fiber Optics Standardization Committee of Optoelectronic Industry and Technology Development Association (JAPAN) started the investigation of detached house structure, examination of silica glass/plastic optical fiber and peripheral technology, collection of execution example of optical cabling, and identification of problems in FYE 2004.

In FYE 2005, for the purpose of preparing the guideline for promoting the optical fiber introduction to detached houses, the sub-committee examined the current condition and the latest technical trend, and discussed about the summary of guideline.

In FYE 2006 and 2006, the sub-committee prepared the technical paper entitled "Plastic Optical Fiber Distribution System for Customer Premise" and published the first version of "Plastic Optical Fiber Distribution System for Customer Premises".

In FYE 2009, the sub-committee revised the first version based on opinions given to the first version, and published the second version after changing the following points:

a) A document structure is changed to be consistent with other technical papers.

b) Regarding the optical distribution system for detached houses, the description was divided into the case of newly constructed houses and that of existing houses.

c) Blank specifications of duplex POF cord and cable are added.

Additionally, based on opinions obtained from domestic POF makers and in response to the changes of products available on the market after the release of the second edition, we started the preparation of the third edition in FY ended March 2011.

The major changes on the third edition are the descriptions of product specifications and connectors for fluoropolymer-type POF. Particularly, the product specifications of fluoropolymer-type POF are significantly different from that in the second edition. Additionally, as our description in the second edition does not conform to the POF product specifications in the current JIS and IEC, we will carefully check the market movement and the revision of product specifications in the future, and appropriately reflect such changes and revisions on this technical paper.

II. Description of Major Items

1. Scope

The scope of this technical paper is in-house distribution in detached houses and apartment houses using POF from ONU of generic cabling box in each house to an information terminal of each room.

For the introduction of optical cable to a detached house, please refer to the TP entitled "Optical Fiber Distribution System for Detached Houses in FTTH".

2. Definitions and Abbreviations

The terminologies of major components for optical distribution system such as distributor, generic cabling box, optical cable, and optical network unit are defined.

3. Referenced Standards

This TP indicates the standards of product specifications and testing methods for POF and POF connectors.

4. Basic Configuration of Optical Distribution System

The basic configuration of POF optical distribution system is from ONU of generic cabling box in each house to an information terminal of each room. The number of core wires of the optical fiber is two. As the form of cable and execution method are different between an acrylic resin-type POF and a fluoropolymer-type POF, the cabling configuration and cabling items and parts are described for each type of POF.

In any cabling configuration, the optical signal is converted into the electric signal in ONU which is connected to a router or SW-HUB through a LAN cable such as UTP. For the distribution to each room, the signal is currently converted into optical signal again by a media converter for POF and distributed to an optical outlet of each room through a star-shaped cabling. Within a room, the optical signal from the optical outlet is converted into the electric signal by the media converter for POF and sent to an information terminal connected using a LAN cable.

5. Termination of Cable, Extra Length Treatment, Maintenance and Management, Testing and Performance Standards

The current examples are shown about the termination, extra length treatment, maintenance and management, and test of POF cables. In the case of POF, as there may be a case that a constructor or a user conducts the termination, a summary of connector types, the termination methods, and the extra length treatment methods are described.

III. Standardization Progress of In-house POF Optical Distribution in Foreign Countries and Other Domestic Organizations

Regarding the standardization of distribution in premises, the international standardization process is in progress at ISO/IEC JTC 1/SC 25/WG, and ISO/IEC 11801 "Generic Cabling for Customer Premises" was established in 2002. Regarding the POF distribution system, ISO/IEC 24702 "Generic cabling Industrial premises"(2006), IEC 61158 "Fieldbus specifications" (2007) and IEC 61918 "Installation of communication networks in industrial premises" (2007) have some descriptions as an industrial distribution standards.

However, as no information on cabling and execution works is included, these are not sufficient to use a reference for in-house optical distribution. Especially, the standards of in-house distribution using POF which is a major subject of this TP has not been sufficiently developed both domestically and overseas.

In ISO/IEC JTC 1/SC 25/WG3 mentioned above, ISO/IEC 24702 "Generic cabling -- Industrial premises" is now under the revising process, and in conjunction with the above revision, IEC SC86A/WG1 had a discussion and add a new category about POF on IEC 60793-2-40 Ed.3.0 as fragmentation of existing categories. This revision is expected to be reflected on JIS.

IV. Reference

In addition to the reference set forth in the TP, the following is also used as a reference.

(1) "Ubiquitous Technology Home Network and Information Electric Appliances" supervised by Yasuo Ni, edited by In-house information-communication/broadcasting advancement forum, published by Ohmsha, Ltd. (on September 25, 2004)

V. Draft Preparation Committee

The draft of this technical paper (TP) was prepared by Sub-committee on In-house optical fiber distribution system of Fiber Optics Standardization Committee at the end of FYE 2009. The members participated in preparing the draft are as follows:

Chairman	Toshihiko Sekiguchi	Nippon Telegraph and Telephone Corporation
Member	Shin-ichi Furukawa	Yazaki Corporation
Member	Katsuyuki Ishibashi	Kinden Corporation
Member	Daisuke Iwakura	Furukawa Electric Co., Ltd. (from June 2008)
Member	Yukitoshi Kudo	Furukawa Electric Co., Ltd. (from April 2011)
Member	Akihiro Kimura	Nippon Comsys Corporation
Member	Hideo Kikuchi	Fujikura Ltd. (from April 2010)
Member	Taku Yoshida	Fujikura Ltd. (from April 2010)
Member	Yoko Nakamura	Japan Standards Association (from May 2010)
Member	Teruo Koyama	Mitsubishi Cable Industries Ltd.
Member	Satoshi Takahashi	Japan Science and Technology Agency
Member	Teruyuki Taniguchi	Sekisui Chemical Co., Ltd.
Member	Koji Yoshida	Kyowa Exeo Corporation
Member	Toshiaki Takahashi	Sumitomo Electric Industries Ltd.
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Member	Kazuhiko Tana-ami	Urban Renaissance Agency (until March 2011)
Member	Shoichi Saito	Urban Renaissance Agency (from April 2011)
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Member	Shigeyasu Hatsuyama	Industrial Science and Technology Policy and Environment Bureau, Ministry of Economy, Trade and Industry (from April 2011)
Observer	Takeo Masuda	OITDA
Secretariat	Takashi Inada	OITDA
Secretariat	Tomoyuki Miyamoto	OITDA (from April 2011)