Ultra-Compact MPO Connector with Excellent Handling and Bending Strength

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This paper describes a new ultra-compact multi-fiber push-on (MPO) connector for data centers that are increasing rapidly in number with the expansion of data traffic. In these data centers, many devices, such as switches, servers, and storage units, are connected with metal wires and optical fiber cables. For flexible cabling, the structured cabling system (SCS) has been introduced, and the MPO connector is the key device for a high-density and large-scale SCS. Our user-friendly round-cord-type MPO connector supports gender change and polarity change.

Keywords: data center, optical fiber cable network, structured cabling system, MPO connector

1. Introduction

With an increase in Internet traffic, multi fiber connectors capable of carrying distribution cables or cords at a high density and connecting them at the same time are increasingly used. Among various types of multi fiber optical cable connectors, multi-fiber push-on (MPO) connectors*1 are becoming the world's standard owing to their excellent cable connection reliability. Sumitomo Electric Industries, Ltd. is one of the makers that developed MPO connectors. The company designs and manufactures all MPO connector components (ferrules, housings, and optical fiber cables).

The company has developed a new MPO connector having a variety of new functions that are capable of meeting recent market needs. This paper details the construction, function, performance, and other features of the new MPO connector.

2. Problems with Conventional Connectors

Concerning conventional MPO connectors, users have raised the following problems and needs:

1) When MPO connectors are inserted or removed, the worker has to hold parts different from those of SC connectors or other single fiber connectors. This difference has caused the worker to occasionally leave MPO connectors without inserting them completely.
2) MPO connectors are difficult to insert/remove when they carry cables at a high density. Users need space-saving connectors with shorter overall length to prevent optical fiber cables from protruding out of the cable rack.
3) Users need connectors constructed of components that will not break even if a worker pulls an optical fiber cable by mistake during work.
4) Users want to insert/remove MPO connector guide pins and change polarity at cabling work sites.

3. Construction and Functions of New MPO Connector

The new MPO connector we have developed to solve the problems with conventional MPO is shown in Fig. 1. Similar to ordinarily used MPO connectors, the new MPO connector consists of a connector with pins and a connector without pins that are coupled to each other as a pair. The features of each connector component are described in Sections 3-1 through 3-3.

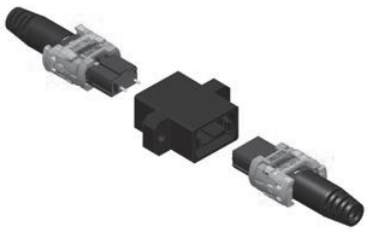

Fig. 1. Appearance of new MPO connector

3-1 Push-pull function

A worker holds the boot (upper left of Photo 1) when inserting a conventional MPO connector into an adapter, and holds the connector housing (outer housing) when removing the connector from the adapter (upper right of Photo 1).

In contrast, an SC connector, a popular single fiber connector, has been so designed that it can be inserted into or removed from the adapter when the worker holds and pushes or pulls the same component: connector housing (bottom of Photo 1).

Such a difference in insertion/removal methods between conventional MPO connectors and SC connectors is difficult for workers to picture instantly in mind. Workers unfamiliar with MPO connector insertion/removal have occasionally made mistakes by not inserting the connectors completely into the adapters.

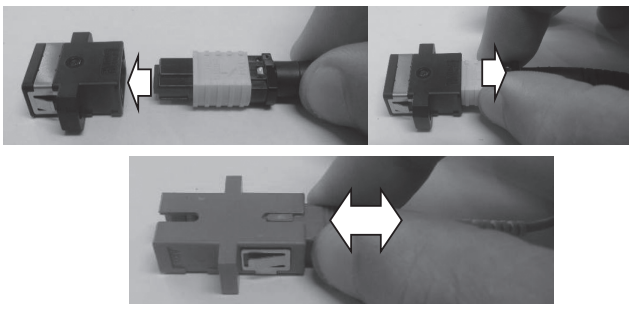

Photo 1. Insertion/Removal methods for conventional MPO connectors and SC connectors
(Upper left: Insertion of conventional MPO connector into adapter; Upper right: Removal of conventional MPO connector from adapter; Bottom: Insertion/Removal of SC connector into/from adapter)

The new MPO connector is provided with a push-pull function that allows the worker to insert/remove the connector into/from the adapter by holding and pushing/pulling the outer housing. The newly devised push/pull function provides the worker with the same handling feeling and insertion/removal efficiency as SC connectors.

A cross sectional view of an adapter into which the new MPO connector has been inserted by a mechanism different from that of conventional MPO connectors is shown in Fig. 2.

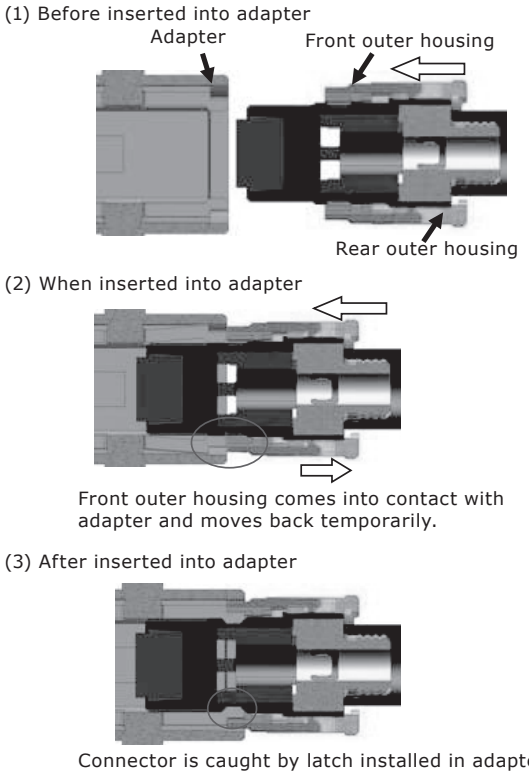

Fig. 2. Cross sectional view of new MPO connector being inserted into adapter

The outer housing of the new MPO connector consists of front and rear outer housings. When inserting the new MPO connector into the adapter, the worker holds the rear outer housing and pushes it into the adapter. Then the front outer housing moves backward with respect to the rear outer housing and ensures complete insertion into the adapter. When removing the new MPO connector from the adapter, the worker holds the rear outer housing and pulls it in the same manner as for conventional MPO connectors.

3-2 Development of connector with reduced length and enhanced bending strength

Conventional MPO connectors made by Sumitomo Electric were constructed of a 26 mm long connector and 33.2 mm long boot, as shown in Fig. 3. Meanwhile, Telcordia GR-1435-CORE issue 2, an international standard for optical connectors and related devices, requires that optical connectors shall resist to 90 deg. bending under a maximum load of 44 N (Proof (90 deg.), Objective). The requirement was established on the assumption that optical connectors may be subjected to the above load when installed or used. However, conventional MPO connectors could withstand only 33 N (Requirement). On the other hand, users' needs for shorter connectors have been increasing so as to make them easy to locate even in narrow spaces between the cable rack doors and servers or other equipment.

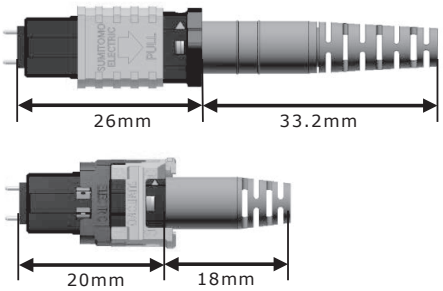

Fig. 3. Conventional MPO (upper side) and new MPO connector (lower side)

To realize a new connector that would satisfy both the above market needs for connectors of less than 40 mm in length and 44 N/90 deg. bending strength, as required by the Telcordia standard, we improved the construction of the boot and housing. To satisfy the bending strength required of connectors, we selected a new material and modified the construction of the slit. We also determined the overall length of the boot to be 18 mm after taking into account the space for the member that fixes a cable inside the boot.

For the connector, the portion to be inserted into the adapter has already been standardized (approx. 10.5 mm from connector edge). In addition, sufficient distance for sliding the outer housing should be provided inside the connector. To meet the above

conditions, the outer housing was partially notched to secure the distance that enables the outer housing to slide without interfering with the boot. As a result, the length of the connector could be reduced by 6 mm from that of conventional MPO connectors. In this way, we were confident that we would be able to reduce the overall length of the new MPO connector to 38 mm and thus to achieve the target length of 40 mm or less.

3-3 Other functions

The density of adapter arrangement in transmission equipment, cabling panels, and other systems in data centers has recently been increasing in order to enhance wiring efficiency. In association with the above trend, it has become more difficult for wiring workers to insert/remove connectors by hand. To alleviate the difficulty of manual insertion/removal of connectors, we have modified the connector construction so that a tab can be attached to the rear end of the connector plug after the connector is installed. After attaching a tab to the connector plug, the worker can push or pull the connector without being disturbed by nearby optical connectors.

The new connector construction facilitates high-density optical fiber cabling with multi fiber connectors and replacement of already-laid fiber cables. The procedures for attaching a tab to a connector plug are shown in Fig. 4.

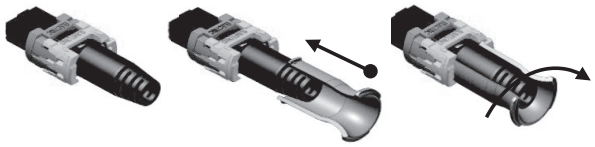

Fig. 4. Procedures for attaching push-pull tab to connector plug

An MPO connector consists of a male connector with guide pins and a female connector without guide pin both of which are coupled to each other through an adapter. Depending on the structure of a specific cabling system, cabling workers were required to use a female connector in place of male connector or vice versa in the field. To facilitate such replacement works, we have developed a guide pin retaining pin keeper that makes it possible to use a female connector in place of a male connector or vice versa using a wedge tool. Guide pins are usually fixed to the pin keeper. When the worker inserts the wedge tool into the connector housing, the wedge tool expands the pin keeper and reduces the guide pin retaining force, thereby making it easier for the worker to insert or remove the guide pins.

Since the size of guide pins is too small to insert by hand, we have also developed an insert tool that can assist manual insertion of guide pins. Combined use of the wedge tool and insert tool simplifies the insertion of guide pins. A guide pin insertion procedure is shown in Fig. 5.

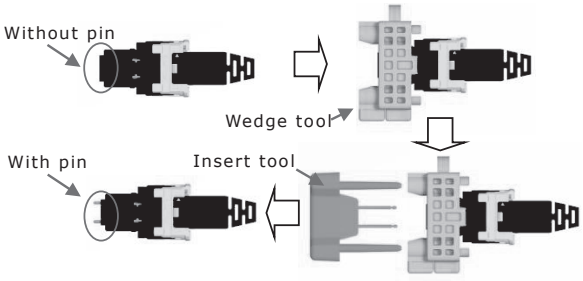

Fig. 5. Guide pin insertion procedure

An MPO connector is equipped with a key to distinguish between the front and rear faces. Two types of cabling methods (MPO polarity) are permitted: one orients the keys of both terminals in the same direction, while the other orients them in opposite directions. The purchasers of conventional MPO connectors were required to specify the polarity before issuing purchase orders. In contrast, the new MPO connector has been so constructed as to allow the users to change its polarity by disassembling the front housing containing an MPO key and the rear housing and reassembling them (latch shown on the right side of Fig. 6). The worker can change the polarity by releasing the coupling between the front and rear housings, turning the decoupled front housing 180 degrees, and then reassembling them (Fig. 7).

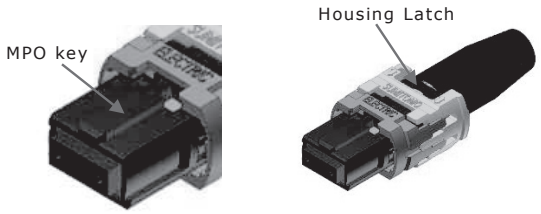

Fig. 6. Key and Latch of MPO Connector

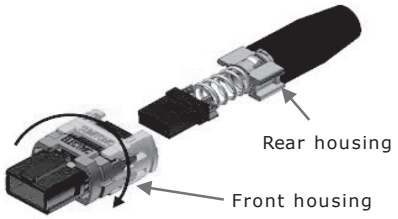

Fig. 7. Changing polarity of new MPO connector

4. Reliability Test Results

Using a new MPO connector mounting a 3 mm size 12 core round cord (SMF: ITU-T G.675.A1) as a test specimen, a reliability test was carried out in accordance with the requirements of Telcordia GR-1435-CORE issue

2. The test results are shown in Table 1. In particular, it was confirmed from this test that the maximum increase of loss in bending property of the new MPO connector after 90 deg. bending under 44 N (Proof (90 deg.), Objective) is 0.18 dB (measurement wavelength: 1.55 μm), which is less than the 0.2 dB that has been specified for high bending property by the Telcordia standard.

Table 1. List of reliability test results (wavelength: 1.55 μm)

Item		Test condition	Result ΔI.L.max.
Environmental	Thermal Aging	85°C, 7 days	0.03 dB
	Humidity Aging	95% at 75°C, 7 days	0.03 dB
	Thermal Cycling	-40°C to 75°C, 7 Days (21 Cycles)	0.15 dB
	Humidity Condensation Cycling	-10°C to 65°C, 90 to 100%, 7 Days (14 Cycles)	0.04 dB
	Dry-Out	75°C, 1 day	0.04 dB
Mechanical	Vibration	10 to 55 Hz 2 hours, 3 axis	0.06 dB
	Flex Test	8.9N, 100 cycles	0.11 dB
	Twist Test	13.0N, 10cycles	0.04 dB
	Proof (0°)	66.0N	0.07 dB
	Proof (90°)	44.0N	0.18 dB
	TWAL (0°)	33.0N	(During) 0.18 dB
			(After) 0.07dB
	TWAL (90°)	13.0N	(During) 0.27 dB
			(After) 0.05 dB
	Impact	1.5 m drop, 8 cycles	0.08 dB
	Durability	50cycles	0.18 dB

5. Conclusions

We have developed an extremely short multi-fiber push-on (MPO) connector. The easy-to-insert/remove feature and superior bending strength of the new MPO connector enhance the efficiency of optical cable connection works in data centers and other facilities.

Technical Term

∗1 Multi-fiber push-on (MPO) connector: A multi-optical-fiber connector utilizing PC connection technology. It can be connected to an adapter with a one-touch operation.

Reference

(1) S. Nagasawa, Y. Yokoyama, F. Ashiya, and T. Satake, "High-performance single-mode multifiber connector using oblique and direct endface contact between multiple fibers arranged in a plastic ferrule," IEEE Photon. Technol.Lett., vol.3,no.10, pp. 937-939 (1991)

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