Reference MPO Connectors with Pre-Angled MT ferrules and measurements of fiber core position

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Abstract: This paper describes the single mode 12-fiber reference MPO connector with insertion loss of no more than 0.15dB and core eccentricity of no more than 0.45µm.

OCIS codes: (060.2340) Fiber optics components; (060.2430) Fibers, single-mode

1. Introduction

Multi-fiber connectors can easily connect high fiber count cables used in access networks and densely populated fiber optic switching equipment used in core networks. One such common connector is the multi-fiber MPO.

Technological advancements have improved the quality of MT ferrules resulting in the emergence of low loss MPO connectors. This brought about the need for a solution that can accurately measure the insertion loss of the low loss MPO connectors. As the accuracy of insertion loss is highly dependent on the reference MPO connector used, a high quality reference MPO connector is needed.

This paper describes a single mode 12-fiber reference MPO connector with insertion loss of no more than 0.15dB and core eccentricity of no more than 0.45µm.

2. Features

Fig. 1 shows the structure of Single mode reference MPO connectors. Single mode MPO connectors often have an eight degree angle in order to minimize reflections resulting in return loss. These overall dimensions match the international industry standards for MPO connectors.

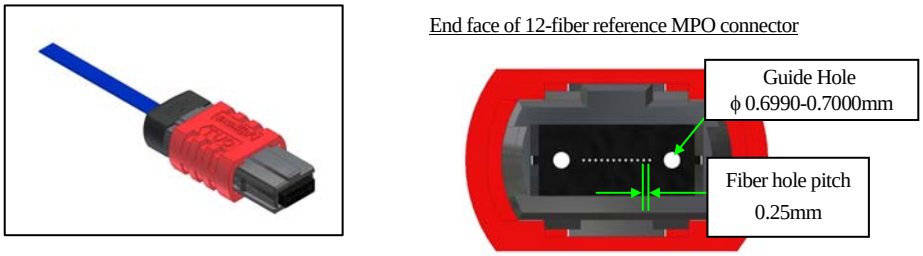

Fig.1 Structure of single mode reference MPO connector

Table.1 shows the MPO reference connector specifications that we have developed. As we have established a method to measure the core eccentricity of an MPO connector having an eight degree angle end face (Fig.2), we can specify the actual fiber core locations of the finished reference assembly.

Table. 1 Specification of reference MPO connector

No.	Item	Criteria
1	Insertion Loss	≤ 0.15dB
2	Return Loss	≥ 55dB
3	Core Eccentricity	≤ 0.45µm
4	Guide Hole Diameter	ϕ 0.6990 – 0.7000mm
5	Guide Hole Pitch	4.6mm ± 1µm

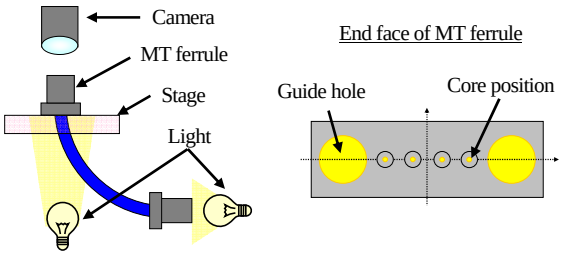

Fig. 2 Measuring method of core position

Calculation of insertion loss is given by equation (1) [1]. When core eccentricity is no more than 0.45μm, insertion loss obtained is no more than 0.15dB.

$$L = 4.34(R/w)^2 \qquad (1)$$

L : Calculation of insertion loss
R : Core eccentricity
w : Mode field radius

Based on the Japan Industrial Standard (JIS C 5982), a reference MPO connector is specified as a group of three connectors with a maximum round robin insertion loss of no more than 0.3dB (Fig.3). However, as fiber core position is unknown from this method, selection of three connectors that meet the JIS requirement is very time consuming (Fig.4). With the establishment of a method that can measure fiber core position, a reference MPO connector can be produced by specifying the core eccentricity, hence eliminating this tedious selection process.

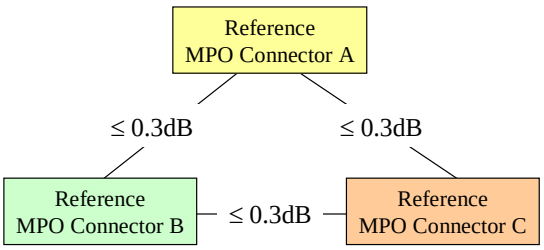

Fig. 3 Round robin style of Japan industrial standard

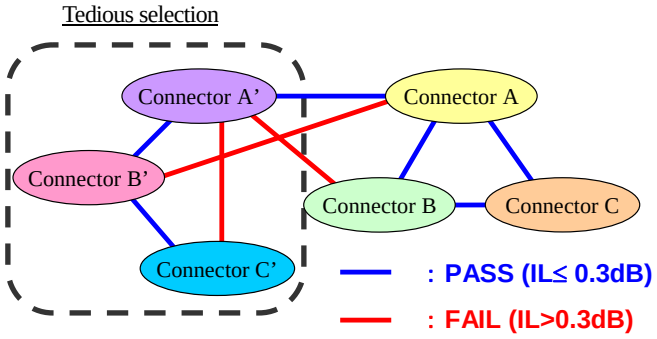

Fig. 4 Selection method of three connectors

3. Production Technology

It is necessary to minimize core eccentricity in order to obtain insertion loss of no more than 0.15dB. We used Pre-angled MT ferrules (Fig.5) [2] to obtain accurate fiber core positions. Unlike standard MT ferrules, Pre-angled MT ferrules have a molded 8 degree angle, rather than polished onto the end face.

One of the connector attributes that affects finished assembly fiber core locations is the tilt of the raw ferrule fiber holes. The actual core eccentricity after polishing deviates from the expected core eccentricity based on the raw ferrule fiber hole eccentricity. As more ferrule material is removed during polishing, the core eccentricity increases as a function of the fiber angle. By using Pre-Angled MT ferrules to minimize material removal during polishing, the core eccentricity after polishing is optimized (Fig.6). Table.2 shows the Pre-Angled MT ferrule specifications for reference MPO connectors that we have developed.

4. Characteristics

Insertion loss and return loss were measured without index matching fluid by random connection at a wavelength of 1310nm. Since fiber tolerances also impact core location and insertion loss, precise fibers were selected for the assemblies. The connector samples in this study were 12 fiber MPO connectors. Alignment pins with a diameter of 698.5μm were used.

The average insertion loss was 0.08dB, the maximum insertion loss was 0.15dB (Fig.7), and the minimum return loss was 59.4dB (Fig.7).

The average core eccentricity was 0.27μm with a maximum eccentricity of 0.45μm (Fig.7).

5. Conclusion

We have established a 12-fiber MPO reference connector with insertion loss of no more than 0.15dB and core eccentricity of no more than 0.45μm. We have established a means to pre-determine the core position of terminated MPO connectors having an eight degree angle end face. This approach provides a means to specify fiber core eccentricity resulting in a methodology to effectively produce high quality reference MPO connector assemblies.

Similarly, we plan to develop 24-fiber MPO reference connectors with maximum insertion loss of 0.15dB and eccentricity of no more than 0.45μm.

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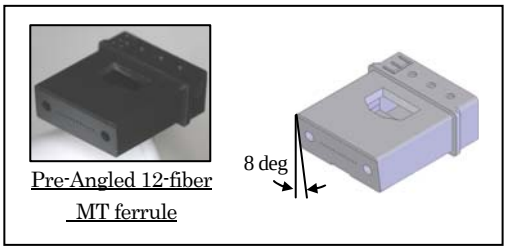

Fig.5 Pre-Angled MT ferrule

Table2 Specification of Pre-Angled MT ferrule for reference MPO connector

No.	Item	Criteria
1	Fiber Hole Eccentricity	≤ 0.3μm
2	Guide Hole Diameter	ϕ 0.6990 – 0.7000mm
3	Guide Hole Pitch	4.6mm ± 1μm

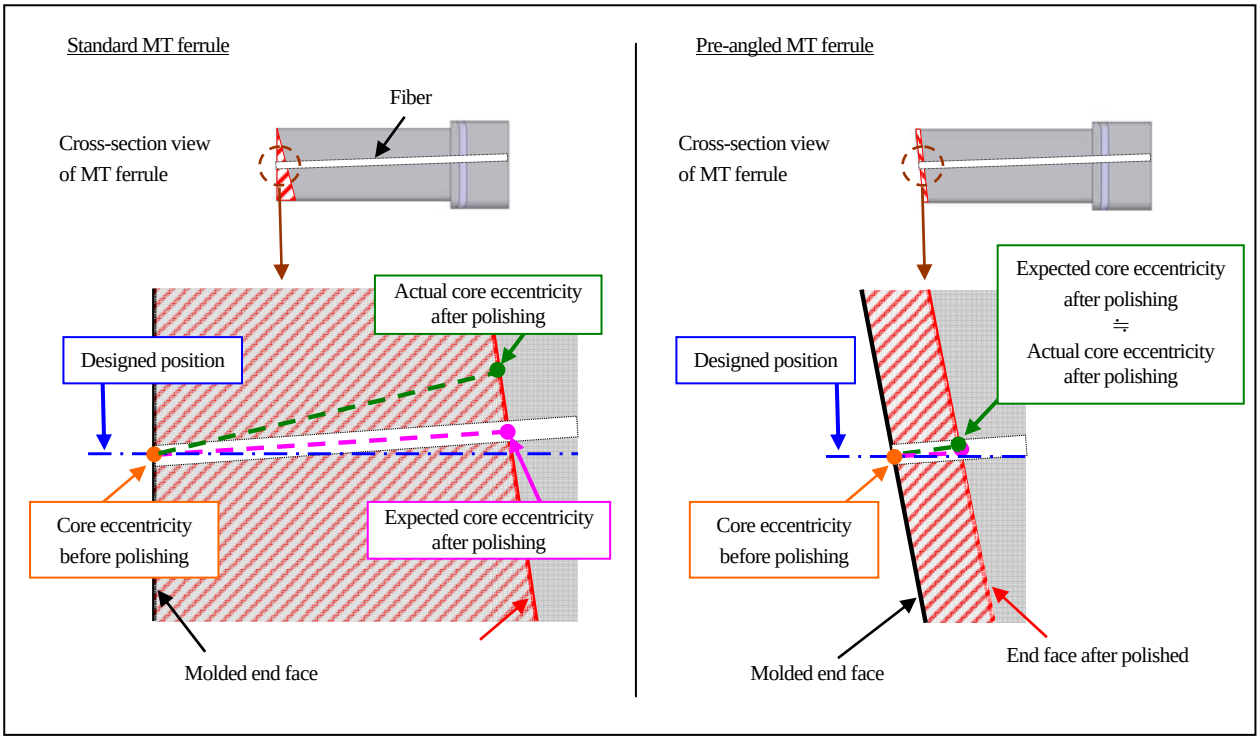

Fig.6 Core eccentricity after polishing comparison between Standard MT Ferrule and Pre-Angled MT ferrule

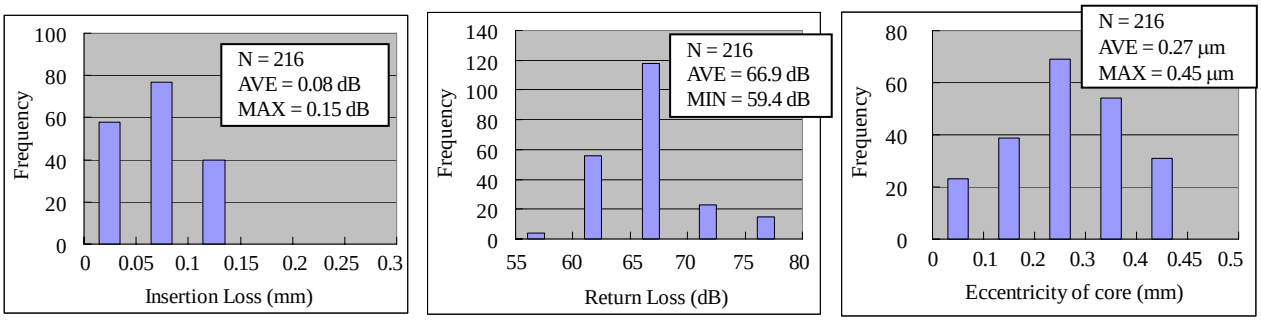

Fig.7 Insertion loss, return loss and core eccentricity of 12-fiber reference MPO connector

6. References

[1] T.Satake et al, "Single -Mode Multifiber Connector Design and Performance," ECTC, (1996)
[2] S.Kato et al, "Development of a Multiple Row Pre-Angled MT Low Loss Connector," OFC/NFOEC2008, JWA116