Design and Performance of SFP module cleaner

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IEC, 86C, WG4
Mar 3, 2012
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1. Introduction

- Currently there are no commercially available cleaners for MM SFP modules designed with a small diameter hole (<0.5 mm) and a spherical lens located behind the hole [1] [2].
- Module makers and EMSs find it very difficult to clean the contaminated lenses during the manufacturing process.
- Since the modules include optics and electronics parts, no solvents are allowed in the optical subassembly behind the small hole.
- Since the MM SFP module is used up to 10Gbps and expensive, the economical benefits of cleaning contaminated modules is significant.
- The authors propose a new type of cleaner with coated filament yarn (CFY) to wipe off contaminations on the spherical lens through the small hole in the module.

2. SFP module structure and cleaning requirements

• Figure 1 shows an SFP module (Supplied by courtesy of Oplink).

• Figure 2 shows the LC ferrule coupling OSA and de-assembled parts. Both the LD and PD OSAs have the same coupling structure through spherical lens to optical fiber as shown in Fig. 2.

• Figure 3 shows the internal structure of the PD module.
2. SFP module structure and cleaning requirements

• We believe the only possible contamination is sand dust and dry filaments from paper. The small hole prevents skin oil from contaminating the lens.

• The target product for cleaning is MM SFP modules with a 0.5 mm hole. Possible contamination to be cleaned.
  – Dry dust like Arizona Road Dust.
  – Dry filament from paper or textile.

• We have assumed that only dry cleaning is allowed to avoid secondary contamination by solvents and possible damage to electronics.
2. SFP module structure and cleaning requirements

• In our initial experiments, we used a specific module design. The OSA structure is shown in Figure 4. The initial lens condition observed through x100 power microscope shown in Figure 5.

• For cleaning no use of any chemical solutions is allowed. Only mechanical wiping method is considered to be developed.

![Diagram of targeted OSA structure](image1.png)

**Fig. 4** Targeted OSA structure of SFP module for cleaner development

![Initial condition (x100)](image2.png)

**Fig. 5** Initial condition (x100)
3. Cleaner design (Cleaning material)

- In order to clean contaminations in the MM SFP modules the new cleaner idea is proposed as shown in Figure 6-1 and Figure 6-2.
- This cleaner uses a coated filament yarn (CFY) of < 0.5 mm diameter as shown in Figure 6-1, and a pipe with ID of 0.5 mm and OD of ~1.24 mm which is close in size to the connector ferrule outside diameter.
- The filaments yarn consisted of 300 thin polyester filaments of 14.3 um diameter held within a plastic coating. The outside diameter of the coating is less than 0.5 mm.

![Fig. 6-1 Coated Filament Yarn (CFY)](image1)

![Fig. 6-2 CFY inserted pipe](image2)
3. Cleaner design (Prototype Tool)

- Prototype of SFP cleaner

Pipe of OD=1.24 mm

Stripped Filament Yarn

Coated Filament Yarn

Pipe slide range = 4 mm

Mechanical pencil tool

Fig. 7 Stripped Filament Yarn

Fig. 8 Prototype tool
4. Cleaner mechanism (Tool and operation-1)

- The following figures show cleaning tool and operation.

![Diagram](image)

**Fig. 9-1** Coated filament yarn (CFY) is pushed out for 4 mm

![Diagram](image)

**Fig. 9-2** The top of CFY coating is removed for 3 mm by a wire stripper
4. Cleaner mechanism (Tool and operation-2)

Cleaning operation continue.

Pipe (OD 1.23 mm, ID 0.5 mm)
Slide part
Sliding interval
Mechanical pencil part
Coating removed yarn is straightly aligned in the pipe
Three nail Chuck
Knock head

Fig. 9-3 The coating removed part is aligned in the pipe.

Glass ball lens assembly module (Type A)
Device
Glass lens
Hole diameter ~0.5 mm

Applicator

Fig. 9-4 The top of tool is inserted into the module hole.
4. Cleaner mechanism (Tool and operation-3)

Cleaning operation continue.

After cleaning, the used filaments are cut by a wire stripper and new fresh filaments are prepared by pushing out the CFY as shown in Figure 9-1.

**Fig. 9-5 The top of applicator is inserted into the module hole.**

Coated part of CFY can come in the small diameter hole of 0.5 mm

Filaments touches on the lens and wipe off contaminations by rotation.

Rotate several times

Push
5. Cleaning experiment

Figure 10-1 shows that the initial photo has some scratched on the lens but no contamination. Figure 10-2 shows the dust applied lens surface. Figure 10-3 shows the lens surface after cleaning with filament yarn. The dust is cleaned and cannot be seen within 500 um diameter area observed through the 500 um hole.

From this result, the prototype cleaner works nicely.
5. Cleaning experiment

• After cleaning it was observed that the dust transferred to the filaments.

Fig. 11 Dust wiped off of the lens was attached to the filaments
6. Conclusion

• We proposed a new style MM SFP module cleaner with filament yarn.
• The prototype cleaner demonstrated good performance in wiping dust from the lens.
• The soft filaments were pushed on the lens while being supported by the coating on the yarn.
• We will investigate additional filaments to optimize cleaning efficiency.

Acknowledgement

• We would like to acknowledge Mr. Glenn Victor for his support by supplying SFP modules and useful suggestions.
• We also thank Dr. Tatiana Berdinskikh for her encouragement and discussions.
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