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Plastic Optical Fiber Applications

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INTRODUCTION

Nowadays cabling based on symmetrical copper cables is dominant in almost all telecom applications; glass fibers predominate in long-distance networks. Whereas just a few years ago l0-Mbit/s Ethernet (l0BaseT) had the main share of interfaces in star or tree structures, today's pure star networks are predominantly set up on the basis of 100-Mbit/s connections.

Plastic optical fiber (POF) is a promising candidate for optical cabling infrastructures due to its low price, large cross-section area, easy connection and coupling with optical sources, and simple use (Daum, Krauser, Zamzow, & Ziemann, 2002).

Connecting electronic devices to the electric circuit and through data networks with copper cables always produces loops that can act as antennas or even create undesired current paths. In commercial use, these problems should always be taken into consideration. Above all, the problem of induction, for example, caused by lightning striking, has to be solved by means of appropriate protective grounding. In such a case, POF would be an interesting alternative that could surely be used in special applications. Practical and proven solutions do exist for copper cables, too.

This article is developed in four sections. In the first section, POF technical details are exposed in order to introduce the reader to the main differences among the most popular glass fibers. In the next section, several standards and bodies are described. The reader should be aware about the standards and what specifications are included. Then, applications are exposed, and finally several POF research clubs all over the world are mentioned.

POF TECHNICAL BACKGROUND

POF is a promising optical fiber and in certain applications is superior to the most popular glass optical fibers. The advantages of POF are the following:

- **Large fiber cross-section area:** The core to cladding ratio is 980:1,000 ¼m. Due to the large fiber cross section, the positioning of POF at the transmitter or receiver presents no great technical problem, in contrast to glass optical fiber.
- **Relative immunity to dust:** Particularly in industrial environments, where dust is a main problem during construction, the large fiber diameter proves to be an advantage. If dust gets into the fiber end face, it affects the input and output optical power in every case. But with POF, minor contamination does not necessarily result in failure of the transmission route. For this reason, POF can readily be connected on site in an industrial environment.
- **Simple use (great resistance to mechanical damage):** The 1-mm thick optical fiber is easier to handle, resulting in less problematic handling during installation and applications. Bending is not a serious problem and flexibility is increased in contrast to glass fibers where bending tends to break glass and attenuation is considerably increased.

- **Low cost:** According to previous statements, the components for connection to transmitters and receivers are relatively economical. The uncomplicated processing of the end phases can be performed in an extremely cost-effective way, especially after assembling in the field.

There are, however, certain disadvantages, considering the most common applications of optical fibers.

- **Optical attenuation**: The attenuation of plastic components consisting of POF is extremely large, resulting in short-distance applications in telecommunications and industry (Daum, Brockmayer, & Goehlich, 1993).
- **Low supported data rate:** Due to the large core cross-section area, a lot of modes are supported during transmission, resulting in a considerable time dispersion. As a result, the data rate is considerably reduced (Gunther, Czepluch, Mader, & Zedler, 2000).
- **Low bandwidth-distance product:** Considerable data rates for telecommunications and industrial applications are achieved for short-distance connections (<500 m).

The plastic materials used in POF are polycarbonate core material (PC), polystyrene core material (PS), polymethylmetacrylate core material (PMMA), and fluropolymers for cladding materials. These materials have different optical windows for low-attenuation applications, according to Table 1.

STANDARDS

ATM Forum

In several documents of the ATM Forum (asynchronous transfer mode; ATM96a, ATM96b, ATM97, ATM99), the transmission medium for data transmission with 155 Mbit/s up to 50 m with POF or 100 m with HPCF (hard plastic-clad fiber) respectively is described. According to the last document from January 1999 (AF-PHY-0079.001, ATM99), the attenuation of a connection with POF should not be greater than 17 dB, of which 4 dB represents the connector loss. With HPCF connections, the maximum attenuation amounts to 6.5 dB, of which 4.5 dB contains the plug attenuation. The polymer optical fiber with a diameter of 1,000 ¼m has a step-index profile as specified in IEC 61793-2 Section 4 cat A4d. The HPCF is a 225-¼m multimode, step-index hard polymer-clad fiber as specified in IEC 61793-2 Section 3 cat A3D. The minimum bandwidth, because of mode dispersion, amounts to 10 MHz/km measured at 650 nm in accordance with 61793-1-C2A or IEC 61793-1-C2B.

IEEE 1394b

In the document P1394b, the characteristics of POF and HPCF cables for data rates up to 125 Mbit/s (S100) and 250 Mbit/s (S200) at transmission wavelengths of 650 nm are specified. By using these transmission media, the goal is to provide economical point-to-point connections between IEEE 1394 components for 50 m (POF) or 100 m (HPCF) respectively.

Table 1. Optical window for different materials

Material	Refractive core index n	Optical attenuation
PMMA	1.49	70-100 dB/km at 570 nm 125-150 dB/km at 650 nm
PC	1.58	700 dB/km at 580 nm 600 dB/km at 765 nm
PS	1.59	90 dB/km at 580 nm 70 dB/km at 670 nm