OM-Giga
A GI-POF for High Bandwidth Data Communication

1. Introduction

With the advancement of information technology, the concept of home network has become reality that enables remote control of entertainment and information systems as well as home appliances through the convergence of telecommunication and broadcasting. In a home network environment, real-time communication for video conferencing, online shopping, VOD (video-on-demand), EOD (education-OnDemand), medical consulting and security surveillance are possible. These various services are currently becoming more and more prevalent and are expanding into the field networks of various vehicles that include automotives, trains, airplanes and ships. Consequently, enormous amount of bi-directional data transmission occurs everywhere within homes and offices as well as in moving vehicles. Such high bandwidth data communication requires high-speed data transmission media for short distance (< 50 m) applications that are particularly appropriate for home and field networks. Polymer optical fiber (POF), especially Graded-Index polymer optical fiber (GI-POF), is such a medium that is capable of ultra-high bandwidth data communication.

The connection between service providers and end users starts from the long-distance Wide Area Network (WAN) and Access Network and then to the short-distance (typically within 50 meters) Local Area Network (e.g., home network). Subsequently, the final reach to the end users is mostly achieved by wireless connection. The long-distance WAN and Access Networks have implemented high bandwidth optical communication in mid-1980's using glass optical fibers (GOF), and the wireless connection to the end users is now achieved by high-speed Wi-Fi and 5G. The wireless and wired communication technologies are complementary to each other as the advancement of wireless technology requires the progress of wired communication technology. The short-distance communication for LAN, that covers the region between the long-distance WAN and the wireless connection to end users, is currently achieved by copper cables at 1 Gbps level. However, at the data transmission rate of 1 Gbps or higher, the electromagnetic interference (EMI) becomes a very serious issue. Thus, optical rather than electrical communication is considered to be more appropriate and practical thereby making the use of GI-POF more desirable for short-distance applications less than 50 meters. The short-distance applications include (1) home/office networks with the point-to-point connections less than 50 meters, (2) field networks less than 10 meters, and (3) the connections between PCs and peripherals and between (U)HD-TVs and set top boxes that are typically several meters (< 5m).

OM-Giga, that was introduced in 2004 by Optimedia, Inc. in Korea, is an MMA(methyl methacrylate)-based GI-POF for high-bandwidth applications. Since its introduction, more than 30 research labs and companies in Europe, USA and Japan have evaluated OM-Giga, and have proved its excellent characteristics and robust performance. OM-Giga is capable of data transmission at a rate greater than 3 Gbps within 50 meters, and greater than 10 Gbps within 10 meters that is well suited for all three short distance application areas mentioned above. Due to its flexibility and a large diameter, it is easy to handle and the cost for connection and installation is low. Furthermore, as it does not contain any dopant to create a gradient refractive index profile, it has excellent thermal as well as long-term stability.

2. Unique Features and Characteristics of OM-Giga

The GI-POF manufacturing technology of Optimedia is called CRPM (Continuous Reaction with Partial Mixing) process. In this unique process, preforms (or thick rods) with a gradually varying refractive index profile are fabricated by copolymerization of several acrylic monomers. Subsequently, the preforms are drawn into fibers of various diameters (typically smaller than 1 mm). Depending on a specific need (or application), this process can readily vary the numerical aperture (NA) of the fiber as well as the dimension of the preform and fiber.

When OM-Giga was first introduced in 2004, the primary target application was the home/office networks at 1 Gbps level, and the dimension of the fiber was 1 mm in diameter with the jacketed diameter of 2.2 mm (OM-Giga-DE100). This fiber/cable dimension was simply to match the dimension of the low bandwidth SI-POF that was prevalent at that time. Now that the application areas have evolved into much higher bandwidth than 1 Gbps with shorter application distances (<10m), Optimedia has also introduced new products that have been optimized for such applications. Besides the standard product, that is OM-Giga-DE100 (1 mm fiber made into 2.2 X 4.4 mm PE jacketed duplex cable), two different types of fibers

Attenuation spectra:

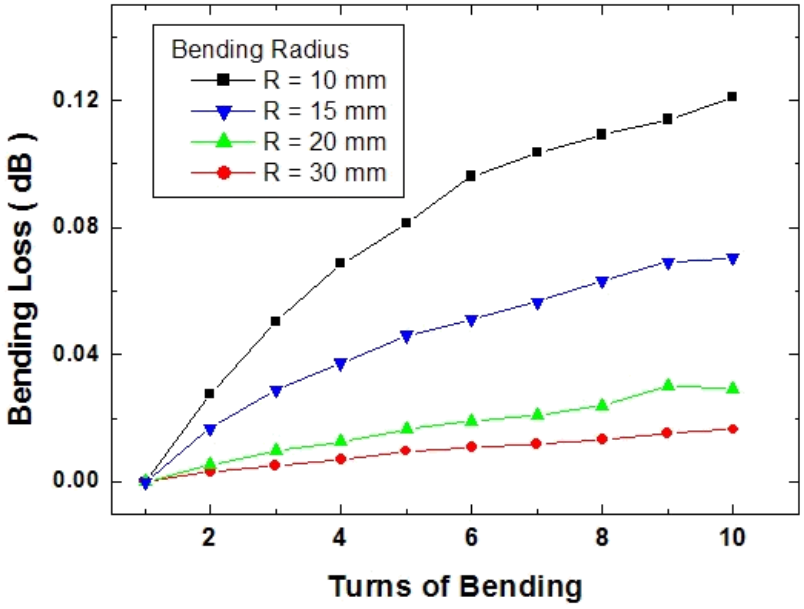
- Since we do not have a tunable light source, we cannot routinely measure the attenuation at variable wavelengths. Instead, we measure the attenuation of all products we produce (bare fibers as well as jacketed cables) at a fixed wavelength of 650 nm using an OTDR as a QC measure. The measurement by OTDR is non-destructive (unlike the cut-back method) and is very reliable.
- The attenuation spectra, that I provided to you many years ago, was measured by a customer in France and a university lab in Korea. All these measurements were on 1.0 mm fiber/cable (i.e., B100 or SE/DE 100). The importance of the spectral attenuation data to us is simply the fact that the minimum attenuation occurs near 650 nm.
- The attenuation increases slightly as the fiber diameter decreases. It is a structural effect that cannot be avoided. This diameter effect is the reason why the attenuation of B075 is ~220 dB/km (slightly larger than ~200 dB/km for B100), and ~240 dB/km for B040. All these values are based on hundreds of measurements conducted by ourselves using an OTDR as well as by the cut-back method.
- Once fiber is jacketed, the attenuation increases slightly due to a thermal effect. This thermal effect (or heat damage) is irreversible and should be minimized by optimizing the jacketing process. Jacketing of our fibers (1.0 and 0.75 mm fibers only) is done by us in our plant and our optimized jacketing process results in an increase in attenuation by ~20 dB/km.
- The reason why the attenuation measurements are always at 650 nm is obviously due to the fact that the attenuation is at its minimum at 650 nm, and the wavelength of the LED Tx for MMA-based POF (SI-POF like Eska, and OM-Giga) has been 650 nm. However, higher bandwidth transceivers are either LD or VCSEL and their wavelengths shifted slightly upward to 670~680 nm due to a thermal stability issue. The attenuation of OM-Giga at those wavelengths (i.e., at 670 or 680 nm), measured by our customers, turns out to be virtually same as that at 650 nm.
- **Attenuation at 850 nm**: As various applications for ultra-high bandwidth (> 10 Gbps), very short distance (< 1 m, or even 5 cm) have emerged, a couple of our customers measured the attenuation of OM-Giga B040 at 850 nm. The results were 3.5 dB/m (or 3500 dB/km), that closely matched the value given the attenuation spectra for 1.0 mm fiber. Based on this attenuation value, the eye diagrams at 850 nm as well as actual transmission of high resolution video image, it was concluded that OM-Giga B040 could use 850 nm VCSEL for ultra-high bandwidth applications if the transmission length is less than 2 meters.

Bending loss of OM-Giga B100 at 25°C:

Bobbin for bending loss measurement:

Height: 250 mm

Radius: 10, 15, 20, 30 mm



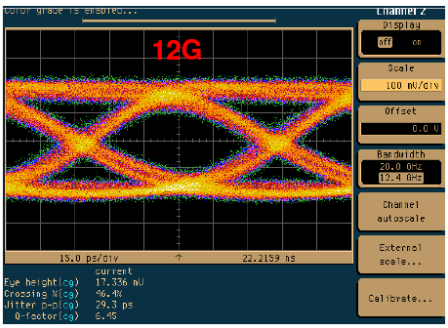
Temperature stability of OM-Giga SE100 (or DE100):

- When the fiber was kept **at 70°C for 700 hours** while monitoring the data transmission characteristics, the bandwidth did not change during the 700 hour testing period.
- When the temperature was increased to **85°C**, the bandwidth started to decline.
- These observations (or measurements) indicate that the temperature stability of OM-Giga at 70°C is excellent, and long-term stability is expected to be excellent as long as the fiber/cable is not exposed to a higher temperature near 85°C for an extended period.

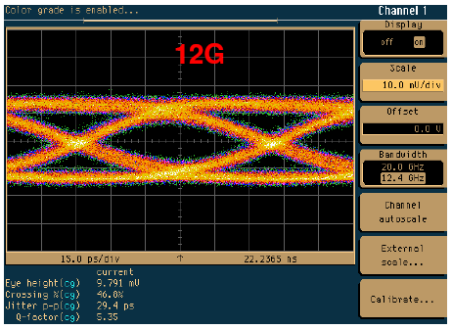
Eye Diagrams:

- As per your request, I am providing several eye diagrams that can be edited into your web pages. All these eye diagrams are for B040 and have been provided by our customers. Some data, when they were provided to us, were labeled as “confidential”. As such, I have been careful in releasing such information by not revealing the names of the data sources as well as the details about the measurement equipment and conditions, and I hope you will understand that.

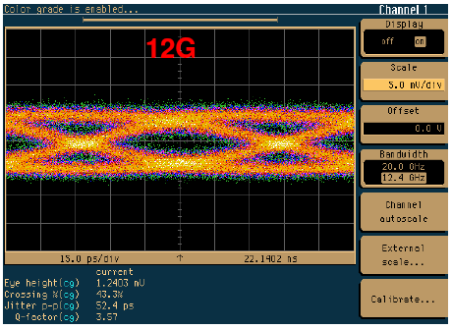
(1) Eye diagrams for OM-Giga B040 at **680 nm**



Base Line
(Optimized with Picometrix O/E)



3m OM-Giga B040
(direct connection from Tx to Rx)

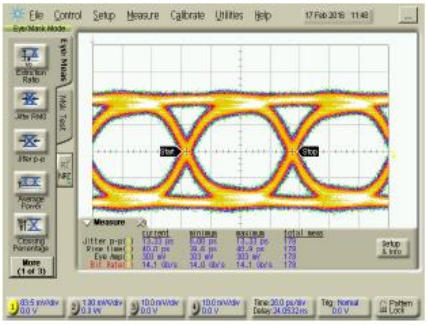


6m OM-Giga B040
(3m+3m using a coupler)

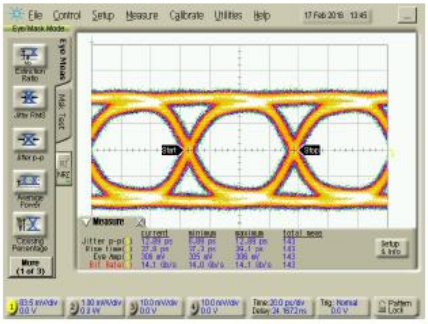
(2) Eye diagrams of multi-mode GOF & OM-Giga B040 at **850 nm**

- 1 meter-long fiber at 14 Gbps:

62.5um SI GOF 1m

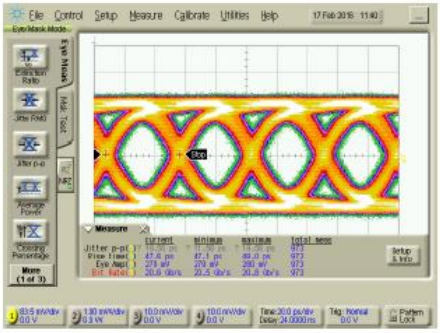


400um GI POF 1m

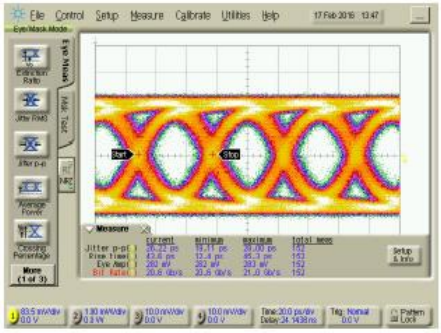


- 1 meter-long fiber at 21 Gbps:

62.5um SI GOF 1m

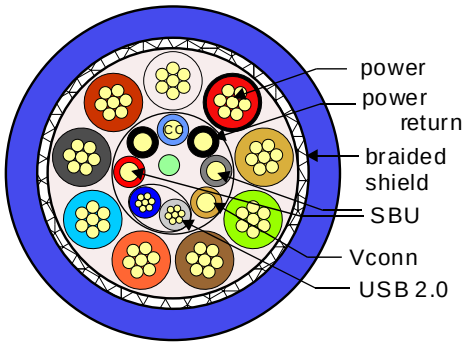


400um GI POF 1m



Schematic diagrams for USB 3.1 cables & hybrid cables:

USB 3.1 copper cable w/ DP (generation 2)



USB 3.1 copper cable w/o DP & hybrid cable w/o DP (generation 1)