Performance of AI Data Centers Using Multimode Fiber and APC Polishing

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The era of Artificial Intelligence is increasingly demanding improvements in data center infrastructure, and as a result, technologies such as multimode APC (Angled Physical Contact) connectors are gaining more space, especially the 16-fiber MPO.

Difference Between APC and UPC Polishing

The difference between APC (Angled Physical Contact) and UPC (Ultra Physical Contact) connectors lies in the type of polishing applied to the end of the optical connector. In UPC connectors, the polish is convex/flat and extremely smooth, and since there is no angle, the optical signal that is not perfectly coupled may be reflected directly back into the fiber core, generating return loss.
In APC connectors, the polish has an 8° angle, making the reflection controlled. Thus, instead of the reflected signal returning directly to the source, it is deflected in another direction, significantly minimizing interference caused by reflection.

When analyzing data centers dedicated to AI processing, such as those using NVIDIA DGX SuperPOD networks, the scenario of technological improvement becomes even more evident. These environments require transmission capabilities beyond those of conventional data centers, positioning optical interconnections as critical components to meet these demands, which brings a series of challenges to the fiber optic market.

Challenges of Multimode Optical Fiber

Multimode optical fiber (MMF) OM5, was developed to increase efficiency and bandwidth. Its design supports multiple wavelengths and includes features that help improve differential mode delay (DMD) compared to other multimode fibers, such as OM4. The main challenges of this technology include:
Differential Mode Delay (DMD): Refers to the variation in propagation time of different light modes in a multimode fiber, resulting from fiber geometry and material refractive index. This variation can cause signal dispersion and limit effective bandwidth.
Return Loss (RL): Refers to the signal that is reflected to the source due to imperfections or mismatches in connectors. Excessive reflections can compromise signal quality, increase error rates, and restrict transmission distance.
Insertion Loss: Refers to signal attenuation occurring when passing through a connector. Significant losses can reduce the received signal power, impacting receiver sensitivity.

Advantages of Choosing the Appropriate Polishing

To improve connections and meet new demands, the use of APC polishing in multimode optical fiber can offer many advantages.
Significant reduction in return reflection: The 8-degree APC polishing angle directs reflected light out of the fiber core, drastically minimizing signal return to the source. This results in superior return loss (RL) compared to current UPC polishing.
Signal integrity: With reduced return reflection, there is an improvement in optical signal integrity, enabling higher transmission rates and, in some cases, longer distances without significant performance degradation.
Tolerance to imperfections: APC polishing “tolerates” small imperfections and defects on the connector surface, providing greater reliability.

Practical Application Example

Based on the understanding of APC polishing use in MMF, a practical example can be observed in the Ethernet 400G-SR8 standard, defined by the IEEE (Institute of Electrical and Electronics Engineers), which uses MPO-APC connectors with 16 optical fibers. In this context, the application involves

transceiver-to-transceiver communication, highlighting the use of MPO16F-APC in MMF for high-speed transmission with the 400G-SR8 protocol.
This same concept can be extended to environments such as DGX SuperPOD networks, where multimode MPO16F-APC contributes to a balanced set of performance combined with cost-effectiveness. This includes greater signal stability, reduced reflection, and mitigation of DMD effects.
In AI-oriented computing scenarios, which combine high-performance hardware, scalable architecture, and optimized software, solutions with these characteristics are essential to meet demands for efficiency, reliability, and stability. Critical factors for effective training and operation of artificial intelligence models.

Conclusion

The combination of OM5 MMF with MPO 16F APC connectors represents a robust solution capable of sustaining years of operation without the need for network infrastructure upgrades. Although current applications operate around 400 Gbit/s, the potential for evolution is significant, reaching up to 1.6 Tbit/s by leveraging WDM in OM5 fibers. Therefore, it is an investment with strong return potential. Additionally, well-designed connectivity ensures high signal quality, reduces optical losses, and contributes to greater data transmission efficiency.