



Next Gen NETWORKS

Effective Integration of
**Reduced Bend Radius
Fiber into the Network**



Introduction

Bending of singlemode fiber has everyone talking these days. The idea that you can bend a fiber around a pencil without a dramatic increase in attenuation is a concept that has everyone considering new fiber applications and design possibilities.

Today, industry standards for traditional single mode fiber typically specify a minimum bend radius of ten times the outside diameter of the jacketed cable or 1.5" (38 mm), whichever is greater. This new breed of flexible singlemode optical fiber has the potential to significantly reduce these minimum bend radius requirements to values as low as 0.6" (15 mm), depending on the cable configuration, without increasing attenuation.

There are many names for optical fiber that can endure a tighter bend radius—"bend insensitive," "bend resistant" and "bend optimized" are several that come to mind. However, some of these terms can be somewhat misleading. Designers and installers may believe reduced bend radius optical fiber is impervious to all of the forces that can increase attenuation and cause failure on an optical fiber link. Staff and contract technicians can make false assumptions on its durability and performance capabilities as well. Such beliefs can have a serious impact on network performance.

For purposes of accuracy, ADC KRONE uses the term "reduced bend radius," because this title best describes what the product actually delivers. This paper will discuss the proper usage for this product and the considerations that must be kept in mind when deploying it.

What is Reduced Bend Radius Optical Fiber?

As mentioned above, reduced bend radius fiber is able to withstand tighter bends within frames, panels and pathways. To understand how this is achieved, it is important to understand that all fiber types rely on principles of Total Internal Reflection, which allows a light signal to travel from one end of the fiber to another (see Figure 1). By improving the bend radius of optical fiber, light entering the core is effectively reflected by the cladding back into the core. Instead of using a matched clad profile, some constructions of reduced bend radius optical fiber use a depressed clad profile with a lower index of refraction than the core, causing light to stay within this core.

To achieve tighter bend radii, some constructions change the Mode Field Diameter (MFD)—the area across the core of the fiber that fills with light. Typical MFD for standard singlemode optical fiber is about 10.4µm; reduced bend radius optical fiber may exhibit MFD of between 8.9µm and 10.3µm.

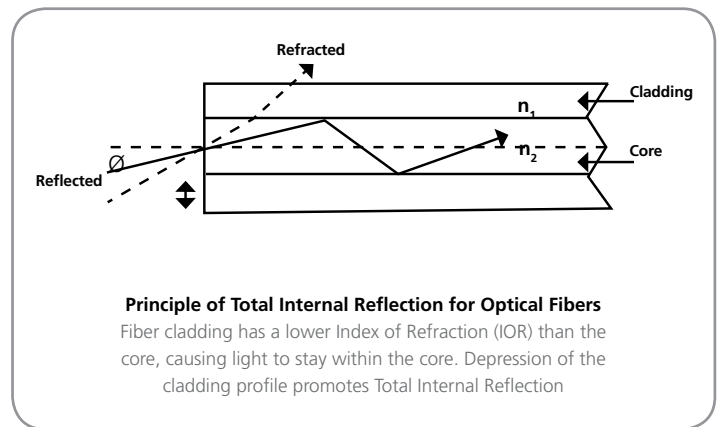


Figure 1

Regardless of the type of construction, all reduced bend radius fiber products do one thing very well—they can perform under a tighter bend radius where macrobends occur. Examples include a CO application, where fiber exits from a panel into a vertical cable route; or in an FTTX deployment, within the confines of an optical network terminal (ONT).

The fiber's performance is definitely impressive. For example, in ADC KRONE tests a standard singlemode optical fiber with one turn around a 1.2" (32 mm) diameter mandrel shows induced attenuation of less than 0.50 dB at 1550 nm. This same test on a reduced bend radius singlemode 1550 nm optical fiber shows less than 0.02 dB of attenuation.

In general, reduced bend radius optical fiber is designed to perform with low loss across the spectrum of wavelengths, from 1285 nm to 1650 nm, using all the channels available on those wavelengths to maximise bandwidth. Current designs include low water peak or zero water peak so that high attenuation is avoided at 1383 nm. Many reduced bend radius optical fiber products meet ITU-T Recommendation G.657, meaning they work well at 1550 nm for long distance and voice applications and at 1625 nm for video applications.

Does it Improve Performance?

Despite the improved bend radius, the reality of this fiber is that bend radius protection is still a concern – just not to the extent of regular fiber. There is still a mechanical limit on how tightly any optical fiber can be routed before the structural integrity of the glass is violated.

The assumptions about improved performance are not accurate either, at least beyond the exceptional bend radius performance. In reality, the performance of reduced bend radius optical fiber—or any optical fiber—depends upon many factors, not just bend radius properties.

By itself, reduced bend radius optical fiber does not offer improvements in attenuation. True, it bends more tightly without causing additional attenuation. Yet laid out on a long, straight run next to a standard optical fiber, there is no difference in performance that can be attributed to the cables' construction. It is inaccurate to believe that reduced bend radius optical fiber is the end-all solution when, in fact, there are many other factors that determine optical fiber link performance.

Durability

Reduced bend radius optical fiber offers the same crush resistance and tensile strength as the same cable with standard singlemode fiber. As with standard optical fiber, excessive weight will crush reduced bend radius optical fiber and excessive pulling tension will damage the cable, both of which affect attenuation.

Connector pull-off resistance

Cable assemblies and connectors must meet Telcordia® (GR326) requirements for strength of the fiber termination connector. Reduced bend radius optical fiber does not improve connector pull-off resistance. Connectors that are easily loosened or disconnected increase attenuation and cause failures.

Connector performance

When it comes to connector performance, endface characteristics determines loss from the connector. Reduced bend radius optical fiber does not impact insertion loss from connectors, making termination and quality of connectors an important consideration in link performance.

Bend Radius Protection – Just One Component of Proper Cable Management

When it comes to an optical fiber network, success may be measured in one or many ways—maximum system uptime, minimum operational and material costs, no lost revenue due to outages. Achieving these goals requires a complete cable management system that includes cable routing paths, cable and connector access, physical protection and, of course, bend radius protection.

Bend radius protection

Reduced bend radius optical fiber and patch cords that protect against macrobends are a good start—but only a start. First, there is a limit on the bend radius; it is smaller, but it still exists. Second, reduced bend radius optical fiber is still subject to microbends, which can permanently damage

cable. Proper slack storage is still required to ensure optical fiber and patch cords neither exceed bend radius limits nor encounter sharp edges on frames and throughout pathways.

Cable routing paths

It is essential to be proactive when it comes to cable handling. Vague routing paths create congestion that reduces density, confuses the next technician and strands capacity with haphazard use of precious space. Clear, intuitive cable routing paths are essential for management of fibers in cabinets, racks, raceways and panels.

Connector and cable access

Front and rear connector access is essential for service turn-up, rearrangements and troubleshooting. All connectors need to be accessible without disturbing adjacent fibers and all connections must be easily identified to prevent pulling the wrong termination. There is a physical limit to density. When connectors cannot be properly removed or seated, service can be affected. When a configuration is so dense, chassis port can become inaccessible and are not fully utilised.

Physical protection

Once optical fibers are installed, they should be protected throughout the network from accidental damage by technicians and equipment. Fibers routed between pieces of equipment without proper protection are susceptible to damage, which can critically impact network reliability. Robust cable management ensures that every fiber is well-protected and designed to withstand daily wear and tear.

Proper Applications for Reduced Bend Radius Optical Fiber

Singlemode reduced bend radius optical fiber offers benefits for applications that including the central office, FTTX deployments, the data center and OEM solutions. Singlemode reduced bend radius optical fiber is best suited for environments where little or no bend radius protection is available. It is also ideal for applications where space is an issue. Specific applications that make sense for this type of fiber are described below:

Space is tight

For drop cable or termination of pigtails in multiple dwelling unit (MDU) and optical network terminal (ONT) boxes for FTTX deployments—where there is no space and often no cable management—reduced bend radius optical fiber offers less chance of increased attenuation during field installation and maintenance.

No fiber management is available

The front of frames and routers—where moves/adds/changes occur—is ideal for use of reduced bend radius patch cords and multifiber breakout assemblies. Many OEM active components do not have bend radius limiters or protection on the front of the equipment.

Space is at a premium

Patch cords and multifiber breakout assemblies that can bend more tightly enable increasing density of active equipment in racks and cabinets without sacrificing access. For manufacturers of active equipment, reduced bend radius optical fiber can help reduce size of electronics, improving density and airflow. However, in these applications, even more consideration must be paid to the elements of proper cable management.

Tighter bend radius also offers OEMs the chance to increase the functionality of active equipment by utilizing less chassis space.

Of course, a key advantage of reduced bend radius optical fiber is use in high bandwidth applications. For standard optical fiber, the 1625 nm to 1550 nm wavelengths are the first to go when the cable is wrapped around a mandrel. Preserving these wavelengths around tighter bends offers benefits for OEMs seeking to improve functionality of network equipment or network managers looking for the efficiency of having all wavelengths available on a given optical link.

Conclusion

Singlemode reduced bend radius optical fiber has generated quite a buzz, and is a great step forward in optical fiber construction. It makes the much-handled patch cords and multifiber assemblies less susceptible to macrobends that affect attenuation and limit bandwidth of optical fiber links.

It is crucial for the health and performance of your network to be aware that reduced bend radius fiber does not, in any case, mean that the fundamentals of proper fiber management are to be ignored. In fact, as this fiber is used in higher density applications, factors such as connector access and cable routing paths become even more crucial. Reduced bend radius optical fiber is just one aspect of a complete strategy for efficient, future-proofed network management.



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