



Fiber Optic Cable Types Used in Defense Platforms

Introduction

Modern defense platforms increasingly rely on high-speed, secure, and reliable communication networks to support mission-critical operations. Fiber optic technology has emerged as a typical enabler in these systems, providing **high-bandwidth data transfer, immunity to electromagnetic interference, and reduced signal attenuation** compared to traditional copper wiring. As defense applications become more complex, ranging from embedded aircraft systems to tactical field networks, the selection of fiber optic cables must balance performance, durability, and environmental resilience.

This whitepaper examines the essential fiber optic cable types used in defense platforms, highlighting distinctions between single-mode and multimode fibers, considerations for tactical versus embedded fiber, and the role of radiation-tolerant constructions in maintaining system reliability in extreme environments. Understanding these differences is essential for engineers, procurement specialists, and program managers tasked with designing robust and future-proof defense communication systems.

Fiber Optic Cable Comparisons

Fiber optic cables in defense platforms are distinguished by three primary factors:

1. Mode of light propagation (single-mode vs. multimode)
2. Deployment environment (tactical vs. embedded)
3. Resistance to environmental hazards (radiation-tolerant constructions)

Single-Mode vs. Multimode Fiber

Fiber optic cables are generally classified into **single-mode** and **multimode** fibers, each offering distinct advantages depending on application requirements.

- **Single-Mode Fiber (SMF):**

Single-mode fibers have a small core diameter, typically around 8–10 microns, which allows only one mode of light to propagate. This results in minimal modal dispersion, making SMF ideal for long-distance, high-bandwidth communications. In defense platforms, single-mode fibers are



often used in backbone networks, inter-satellite links, and high-speed avionics communications where low latency and signal integrity over long runs are critical.

- **Multimode Fiber (MMF):**

Multimode fibers have larger core diameters, allowing multiple light modes to propagate simultaneously. MMF provides lower-cost solutions for short-distance communication, typically within platforms such as vehicles, ships, or aircraft. Multimode fibers are more forgiving in terms of connector alignment and installation, making them suitable for rapid deployment scenarios.

Tactical vs. Embedded Fiber

Defense applications can also be categorized based on their deployment environment:

- **Tactical Fiber:**

Tactical fiber cables are designed for field operations, often exposed to harsh environments, high mechanical stress, and rapid redeployment. These cables are generally ruggedized with reinforced jackets, armoring, and bend-insensitive constructions. Typical applications include field communication networks, portable command posts, and rapidly deployable sensor arrays.

- **Embedded Fiber:**

Embedded fiber is integrated directly into the structure of the platform, such as aircraft, naval vessels, or ground vehicles. These cables must maintain high performance under extreme vibration, temperature cycling, and tight routing constraints. Embedded fiber solutions often employ lightweight, flame-retardant jackets and specialized coatings to promote long-term reliability without compromising system weight or space.

Radiation-Tolerant Fiber Constructions

Certain defense environments, particularly space, nuclear, and high-energy applications, require **radiation-tolerant fiber optic cables**. Radiation can induce darkening in the fiber core, increasing attenuation and degrading signal performance. To mitigate this:

- **Radiation-resistant glasses** and dopants are used in the fiber core to minimize radiation-induced attenuation.
- **Protective jacketing materials** are selected to withstand ionizing radiation without cracking or degrading.



These constructions are critical for satellites, high-altitude aircraft, nuclear command centers, and other platforms exposed to high-radiation environments.

By incorporating radiation-tolerant designs, defense platforms maintain mission-critical communications even in extreme operational conditions, establishing both reliability and longevity of fiber networks.

Conclusion

Fiber optic technology is a cornerstone of modern defense communication systems, providing unmatched bandwidth, immunity to electromagnetic interference, and adaptability for harsh operational environments. Choosing the appropriate fiber type—whether single-mode or multimode, tactical or embedded, or radiation-tolerant—is essential to meet the diverse demands of defense platforms.

By understanding the trade-offs in performance, durability, and environmental resilience, engineers and decision-makers can design fiber optic networks that are not only efficient and secure but also robust enough to support mission-critical operations under the most challenging conditions. The continued evolution of fiber optic technology promises to further enhance the capabilities and reliability of defense communications, making informed cable selection a strategic imperative.

Reference: Diagram Attached (Page 4)

