GORE® Aerospace Cables
For Civil & Defense Aircraft

AIRCRAFT WEIGHT SAVINGS

Through Innovative Materials Science & Unique Cable Designs

Technical Paper

Together, improving life

Weight savings is an important design and modernization consideration for civil and defense aircraft to increase payload, fuel efficiency, range, and time on station. Gore offers a variety of solutions that reduce the size and weight of microwave/RF cable assemblies, and high-speed copper and fiber optic cables.

Saving Operating Cost without Compromising Performance

Aircraft that use microwave/RF cable assemblies benefit from lightweight, durable solutions that drive improvements in fuel efficiency and long-term operating costs. Gore's cable technologies significantly decrease weight without sacrificing durability or signal quality.

Airframe cable assemblies are exposed to extreme conditions that can compromise their performance. Beginning with the challenges of installation and continuing through demanding flight conditions, cable assemblies are exposed to rapid temperature and pressure changes and potential contamination from fuels, oils, and other fluids. Maintaining signal integrity in these challenging environments is essential to ensuring the reliability of the sophisticated electronic systems in the aircraft.

GORE-FLIGHT® Microwave Assemblies, 6 Series, are lightweight, rugged cable solutions that deliver the lowest insertion loss before and after installation, ensuring reliable performance for the life of the system (Figure 1). The robust construction of these assemblies reduces total costs by withstanding the challenges of installation, reducing costly production delays, field service frequency, and the need for purchasing replacement assemblies. Also, the low weight of the 6 Series improves fuel efficiency and increases payload. Gore's cable can save up to 62.5 pounds of weight on a medium rotary-wing platform compared to an alternative supplier cable assembly (Figure 2).

The 6 Series is qualified to the most stringent specifications for airframe assemblies. Gore controls the entire manufacturing process from purchasing raw materials, and creating and applying the proprietary dielectric material, through testing and shipping the final cable assembly. This unsurpassed vertical integration allows Gore the complete control necessary to consistently achieve tight specifications. This process includes testing 100% of the assemblies for vapor leakage, dielectric withstanding voltage, VSWR, insertion loss, impedance, and velocity of propagation — ensuring that every assembly will deliver the highest-quality performance and lightest weight required for today's civil and defense aircraft.

Figure 1: Low-Weight Construction of GORE-FLIGHT® Microwave Assemblies, 6 Series

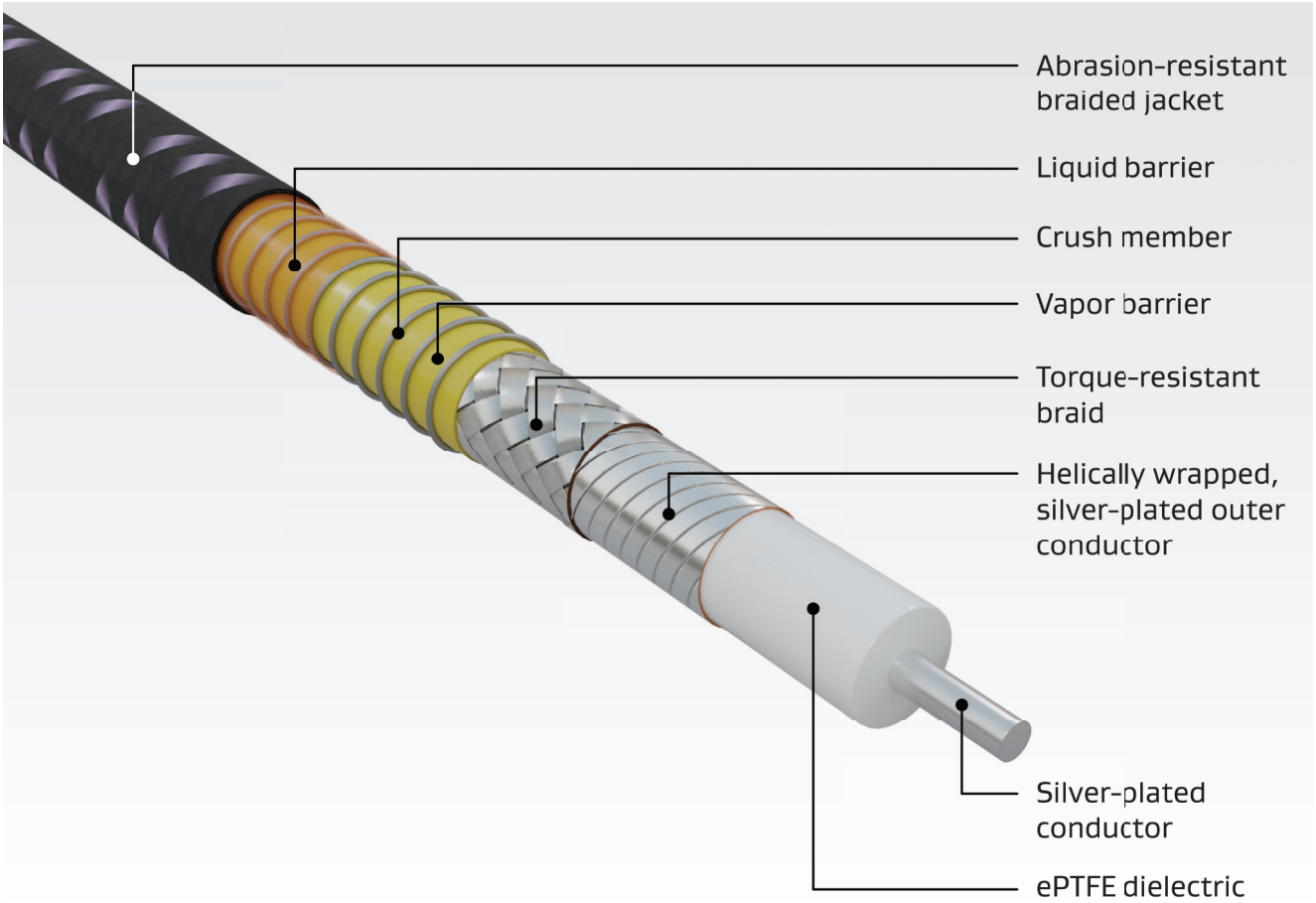
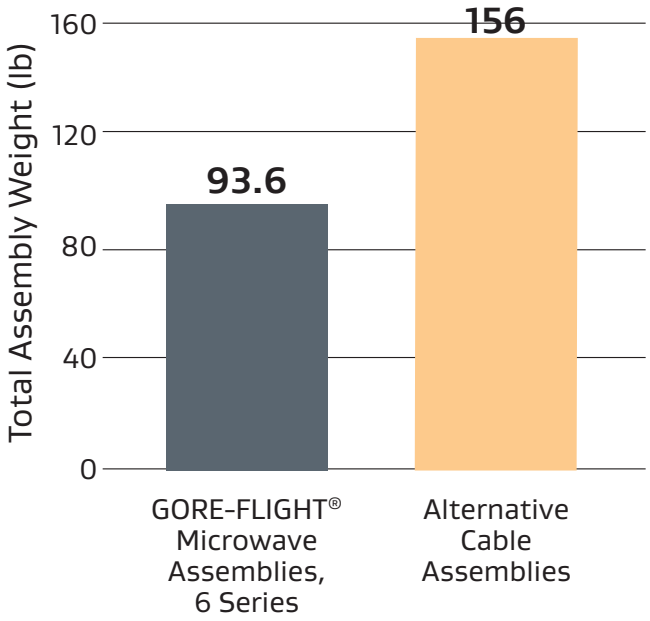


Figure 2: Weight Comparison for Medium Rotary-Wing Helicopter



Gore's 6 Series can save up to 62.5 lb of weight on a medium rotary-wing platform.

Increasing Data Rates without Adding Cable Weight

The aerospace industry continues to demand higher data rates in modern aircraft, which often means more cables. However, copper cables are inherently heavy. Fiber optic cables are significantly lighter and should be considered a viable option. They are immune to electromagnetic interference (EMI), radio frequency interference (RFI), and crosstalk when transmitting signals.

Historically, fiber optic cables have not been widely considered by system designers. However, advances in expanded beam termini have allowed for more serviceability and forgiveness in fiber optic connections, making fiber optic cables an increasingly viable option for modern aircraft applications. Expanded beam connectors are designed to provide optimal performance where resiliency to dust and dirt are imperative, resulting in reliable high-speed system performance and minimal maintenance downtime. These connectors also provide reduced sensitivity to dust and dirt contamination and reduce the need for cleaning in harsh environments.

The lens in an expanded beam fiber optic connector collimates the light from the optical fiber. The collimated light is transmitted to the mating connector through an air gap. The light is focused onto the second fiber by a second lens (Figure 3). For 50/125 multi-mode fiber, the collimated light beam is significantly larger than the core of the optical fiber. Where a speck of dirt could completely block the light path of a standard fiber optic connection, an expanded beam connection can remain unaffected.

The advances in termini do not mean that all fiber optic cables are the same. One of the most important aspects of good cable design is crush resistance that is crucial for survivability during initial installation and for resistance to over tight tie wraps and lacing.

Early fiber optic designs often suffered from crushing and breakage during handling, installation, and operations. Therefore, new designs often required thicker jackets with an overall diameter of 2.8 millimeters to increase durability. However, these designs added weight, required more space in wire bundles, and delivered a much larger bend radius. More rugged designs were developed in the market to overcome the vulnerabilities of some fiber optic cables that can resist crushing and breakage during handling, routing, and operation.

GORE® Fiber Optic Cables, 1.8 mm Simplex, is proven to have a higher level of crush resistance compared to alternative 1.8 mm cables available on the market today. This version is also proven to have a high weight impact resistance of 3.7 lb. Gore's 1.8 mm Simplex is qualified according to ARINC 802-2 and BMS13-71 requirements, plus exceeds new stringent EN3745-513 and JN1177 requirements for added durability and protection. Watch a video of Gore demonstrating the high weight impact resistance of the 1.8 mm Simplex at **youtube.com/watch?v=8e5fWJd2W6w**.

Gore's 1.8 mm Simplex also has a smaller, lighter weight and more flexible design (Figure 4). This version weighs 2.6 lb per 1000 feet compared to alternative rugged fiber optic cable designs that weigh 6.7 lb per 1000 ft. Gore's fiber optic cable translates to 60% weight savings on aircraft (Figure 5).

Likewise, Gore's fiber optic cable weighs 2.6 lb per 1000 ft when compared to commercially available Ethernet copper cables that weigh 55 lb per 1000 ft. (Figure 6). In other words, switching to fiber optic cables translates to 95% weight savings compared to copper cables. Fiber optic cables can also carry data rates up to 100 gigabits per second (Gb/s) compared to Ethernet cables that can carry up to 10 Gb/s.

All of this translates to significantly lighter fiber optic cables that can achieve higher data rates at longer distances. For example, replacing multiple copper cables with a single Gore fiber optic cable directly multiplies the weight savings in aircraft.

Figure 3: Diagram of Expanded Beam Interface

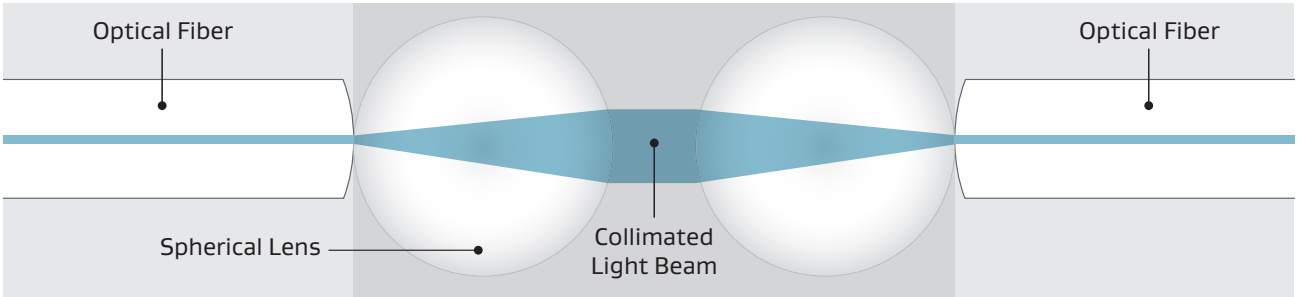


Figure 4: Compact Design of GORE® Fiber Optic Cables, 1.8 mm Simplex

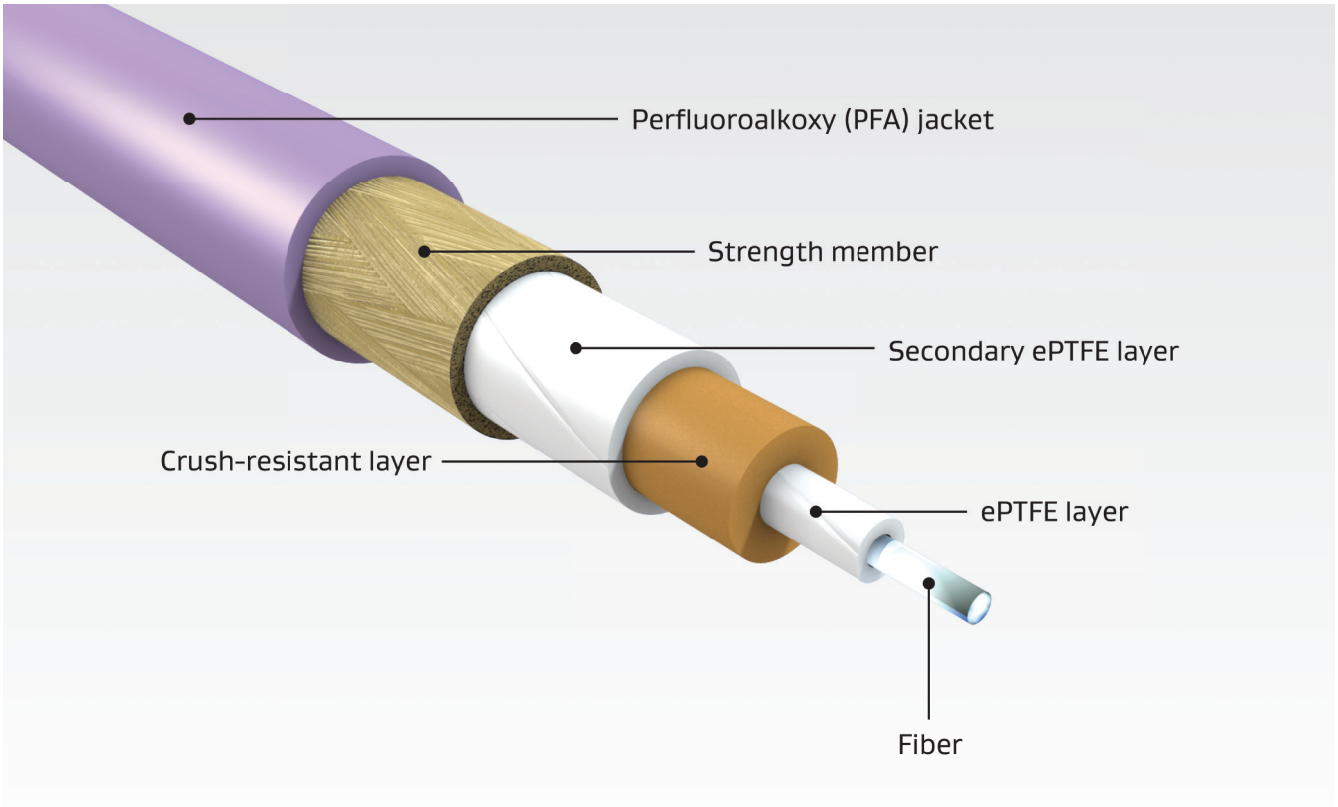


Figure 5: Weight Comparison of Fiber Optic Cables

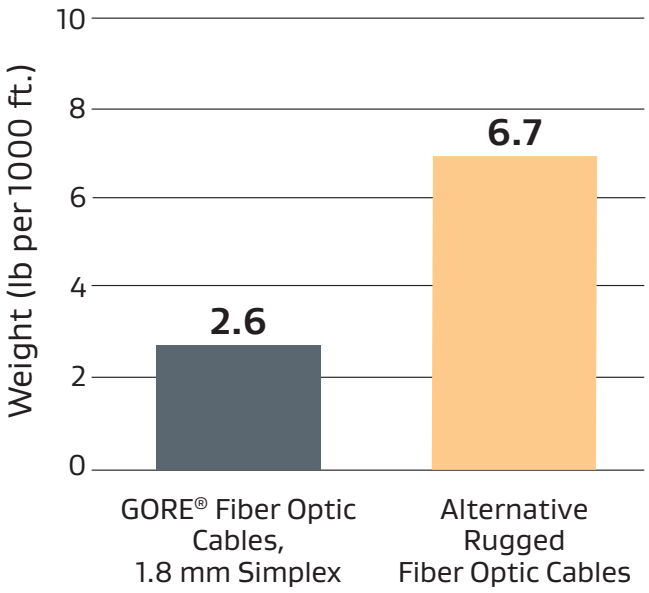
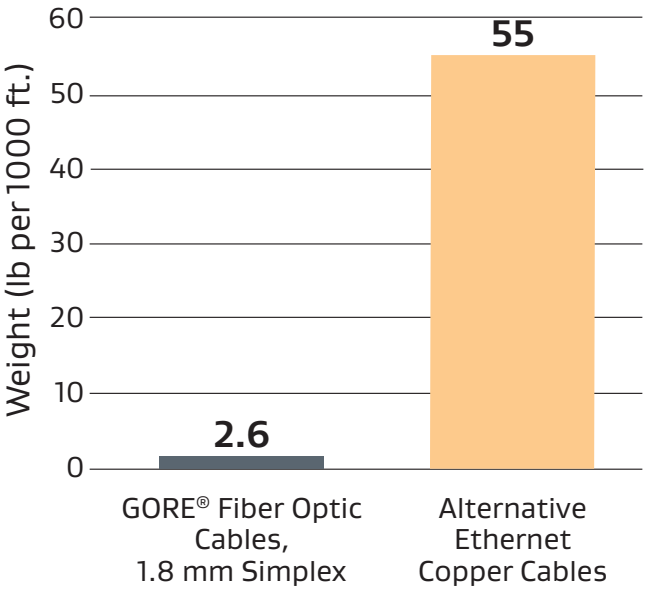


Figure 6: Weight Comparison of Fiber Optic Cables vs. Copper Cables



GORE® Fiber Optic Cables, 1.8 mm Simplex, weighs 2.6 lb per 1000 ft. and translates to 60% weight savings on aircraft compared to alternative rugged fiber optic cables.

When a fiber optic cable is not an option in aircraft system design, GORE® Ethernet Cables for Cat6a protocol are an ideal solution to substantially reduce weight without sacrificing durability or signal quality (Figure 7).

This version is built with high-density materials that are inherently lighter weight resulting in smaller diameters. The cable's unique design is 24% smaller and 25% lighter than alternative designs. The reduced cable diameter also allows for greater flexibility and a tighter bend radius, which makes routing easier and faster for maintainers.

Furthermore, Gore's Cat6a version exceeds electrical requirements and delivers excellent signal integrity with sufficient margin for high-speed data transmission up to 10 Gb/s at lengths up to 262 ft. Using Gore's Ethernet Cat6a cables can save long-term lifecycle costs for improved sustainability and maintainability.

In addition, Gore conducted testing to compare the weight savings of several GORE® Aerospace High Speed Data Cables versus leading alternative cables on a heavy rotary-wing helicopter. Results indicated that Gore's cables reduced weight by 25 lb, which saves 27% of space on aircraft (Figures 8 and 9).

Figure 7: Lighter Weight Materials of GORE® Ethernet Cables, Cat6a Version

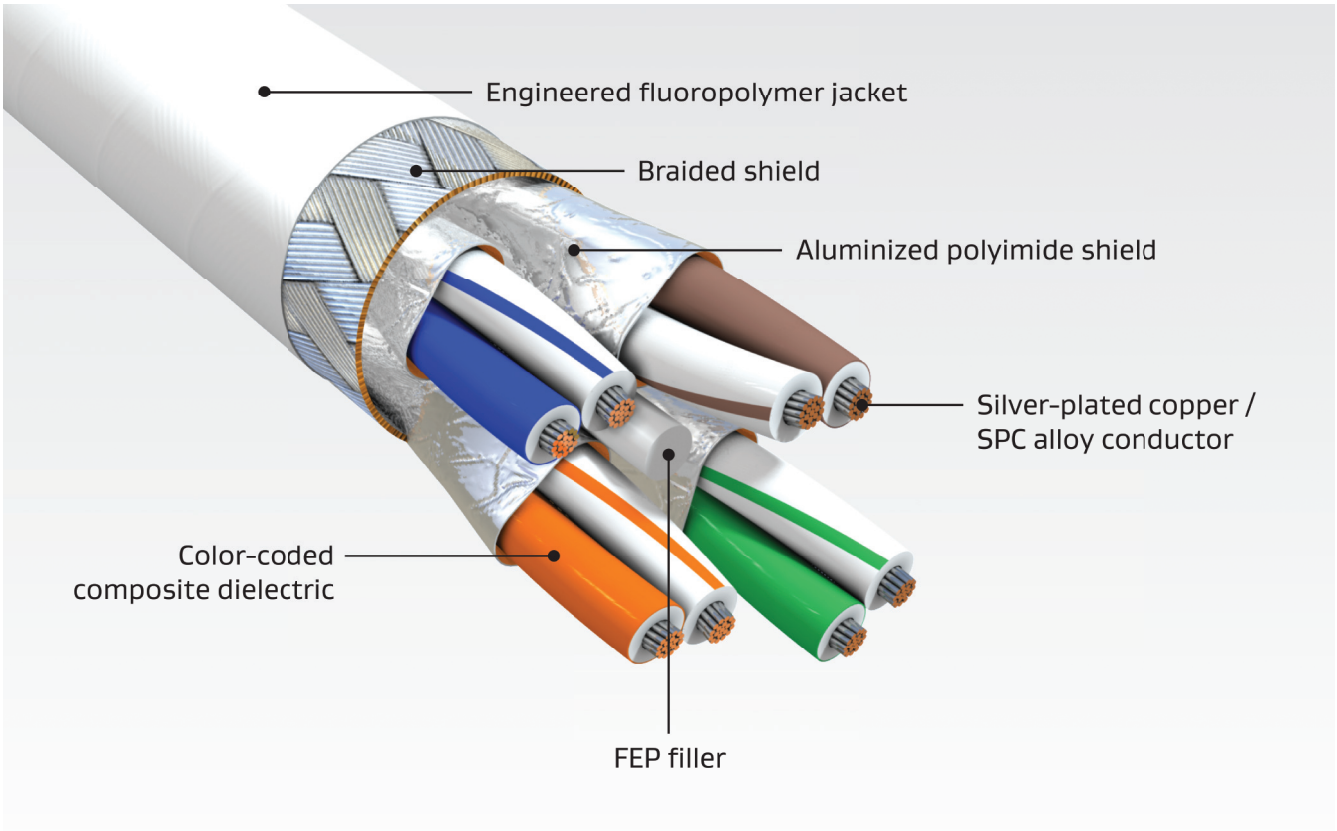


Figure 8: Weight Comparison of High-Speed Data Cables

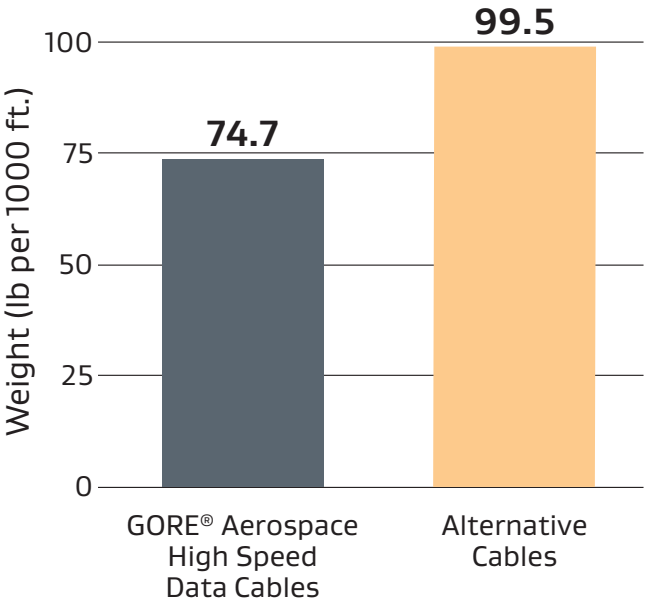
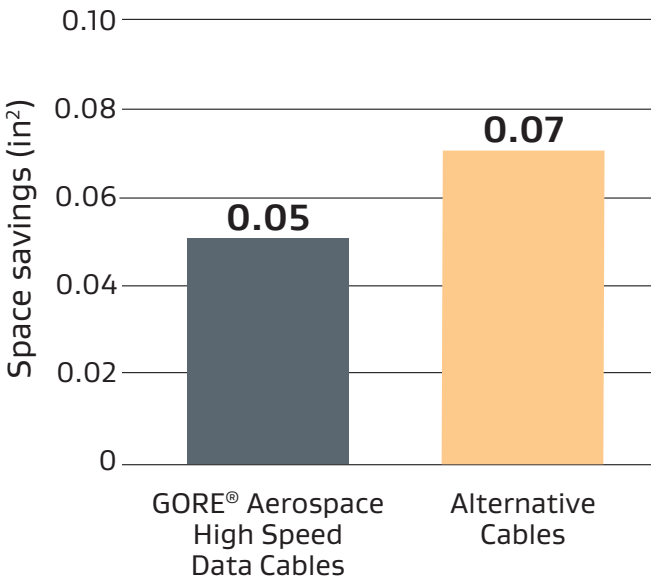


Figure 9: Space Savings Comparison of High-Speed Data Cables



Conclusion

Ultimately, there are many choices in the aerospace industry when choosing microwave/RF cable assemblies, and high-speed data copper and fiber optic cables, depending on specific application needs and requirements. However, Gore offers system designers an extensive portfolio of lightweight products with proven unmatched signal integrity for high-speed data transmission up to 100 Gb/s, while meeting and exceeding stringent industry requirements.

Furthermore, comparative testing against leading alternative supplier cables proved that GORE-FLIGHT® Microwave Assemblies, 6 Series, can save up to 62.5 lb of weight on a medium rotary-wing platform. Also, the 1.8 mm Simplex of GORE® Fiber Optic Cables can save 60% of weight on aircraft. Finally, installing GORE® High Speed Data Cables can save 27% of space on aircraft.

GORE® High Speed Data Cables reduce weight by 25 lb, which saves 27% of space on aircraft.

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