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Lightweight Tactical Single-Mode Fiber Optic Cable

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Abstract

A lightweight, tactical single-mode fiber optic cable was developed to meet specific optical and mechanical requirements for the battlefield environment. Several cable designs were tested to arrive at a 2.1 mm diameter cable using all-dielectric materials. The development of the present cable design was an iterative process using optical, mechanical, and environmental test results to arrive at the present cable design providing favorable mechanical performance without sacrificing optical performance. Mechanical tests such as tensile strength, impact, compressive load, and cyclic flexure were performed in accordance with DOD-STD-1678. The cables were temperature cycled in accordance with EIA-FOTP-72 to aid in material selection. This paper will present the development of the present cable design from the optical fiber selection to the jacket material and will include a summary of the cable designs tested, the testing performed, the development of manufacturing methods, and the selection rationale leading up to the present design.

Background

The goal was to develop a cable with the smallest diameter and weight to minimize the storage volume without sacrificing communication quality. Applications for the small cable range from point-to-point communication links to tethers for remotely controlled vehicles, where space is limited. Use of present communication cables are prohibited in these applications. The requirements for this cable included:

1. Lightweight
2. Small diameter
3. Tensile strength > 100 pounds
4. Reusable
5. Rugged construction
6. Low optical attenuation at 1300 and 1550 nm
7. Bending loss insensitive

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### Conclusion

Developing a cable which is small and lightweight is not as easy as downsizing a larger design to meet the small diameter requirements. Cables ranging from 1.2 mm to 2.5 mm were developed and tested to arrive at the present cable design. This design has a 2.1 mm diameter cable with polyurethane jacket and kevlar strength members weighing 5 kg/km. It has a tensile strength >100 pounds and average attenuation of 0.45 dB/km and 0.3 dB/km at 1310 and 1550 nm, respectively.

Also reflected in the cable design is the development of the manufacturing method such that the optical fiber was insensitive to the "shrink-back" that occurs in the cabling process. The kevlar strength members and optical fiber were pretensioned at different values to offset the "shrink-back" forces from the polyurethane jacket while it cooled from the extrusion line.

### Novelty/Advance in Technology

Optical fiber type, fiber coating and buffer material, strength members, and jacket materials had to be selected to meet the requirements of a tactical environment. To accept these materials, manufacturing processes and machinery had to be developed to fabricate the smaller sized cables. Special tensioning equipment for the kevlar strength members and optical fiber needed to be developed so that the "shrink-back" forces from the extruded jacket were offset resulting in a axially strain balanced cable.