Opt Quant Electron (2013) 45:1229–1235
DOI 10.1007/s11082-013-9743-8

Use of copper-coated fiber as a tunable optical time-delay line in precise timing systems

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Received: 8 March 2013 / Accepted: 16 July 2013 / Published online: 31 July 2013

Abstract In this paper we present a novel, time-delay approach using a copper-coated fiber. Piezo optical-fiber stretchers and temperature-controlled fiber spools are normally used for a conventional time-delay lines. A copper-coated fiber preserves the performance of a standard single-mode optical fiber, while at the same time acting as an electrical wire, which can be effectively heated by applying an electrical current. As a result of the significant temperature change, the signal (group) delay can be properly adjusted and controlled. Compared to piezo optical-fiber stretchers and temperature-controlled fiber spools, much shorter lengths of fiber are required and a faster response time can be achieved. This paper also proposes a simple, lumped thermal model and thus a copper-coated fiber can be included in the heat-transfer and response-time calculations of a realistic system that involves surrounding elements (e.g., heatsinks).

Keywords Metal-coated fibers · Copper-coated fibers · Optical delay line · Thermal constants

1 Introduction

All optical-timing systems with a high timing precision require the appropriate stabilization of an optical link to compensate for the temperature changes and vibrations induced along the fiber path. Such systems are needed to synchronize particle accelerators and phased-array radio telescopes or they are used for accurate time and frequency transfer and distributed high-speed synchronous sampling (Batagelj et al 2011). Several stabilization methods and techniques using laser-wavelength tuning, opto-mechanical delay lines, heated/cooled fiber

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