Fiber Loop Mirror Sensors Interrogated and Multiplexed by OTDR

8 Author(s) Maria Thereza Miranda Rocco Giraldi ; Cindy Stella Fernandes ; Marta S. … View All Authors

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Abstract:
In this paper, two techniques for interrogation and multiplexing of fiber loop mirror (FLM) intensity sensors based on optical time domain reflectometer (OTDR) are proposed. These configurations enable series and parallel FLM sensor interrogation. A fiber taper characterized as a displacement sensor was used as the intensity sensor. The OTDR parameters were optimized in order to obtain the best results. The optimized parameters were 100-ns pulse width and 10-dB input signal attenuation which permitted to attain ~18 dB dynamic range in the operating wavelength of 1550 nm. The results show a linear behavior for both configurations with similar slope, -15.3 dB/mm, in the normalized displacement range of 0.2 to 0.7 mm. It was also achieved a displacement resolution of 0.027 and 0.093 mm, for the series and parallel configurations, respectively. Sensors multiplexing are demonstrated for both configurations and the systems do not present crosstalk. Based on the experimental results, the best configuration is the parallel one. The proposed approach is a viable alternative for multiplexing and interrogation of remote fiber sensors.

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Contents

I. Introduction

Optical time domain reflectometer (OTDR) is the most utilized equipment to measure distributed losses in optical fibers. It uses Rayleigh scattered light to determine the attenuation of optical fiber links. OTDR is also useful to localize events, breaks and to evaluate splices and connectors [1]. Due to these advantages and since OTDR is a simple, easy and ready to be used tool, it has also been the starting point of distribution sensing techniques [1]. As interrogation system, OTDR has been utilized in different configurations. One of the most common is to use fiber Bragg grating (FBG) and/or long period grating (LPG) with OTDR [2]– [4]. Recently, it was proposed a multi-point strain measurement system based on OTDR for FBG sensors [2], [3]. Another approach employs OTDR to interrogate Fabry–Perot cavities sensors [5], [6]. Finally, a significant function of the OTDR is to enable multiplexing [7]–[9] and remote sensing [8]–[10] interrogation. OTDR trace loss [8], [11] –[13] or reflection peak variation [7] , [10] are the most attractive techniques for interrogation when OTDR is used. In the case of the OTDR trace loss and considering multiplexing and remote sensing, there is a compromise between the number of sensors to be multiplexed and the distance between sensors since the loss introduced by the sensors will be a serious limitation to the system. OTDR reflection peak variation does not present such limitation.