

## Article

# POL-MUX System for Noncoherent Optical Networks

Radim Sifta <sup>\*</sup>, Michal Latal <sup>\*</sup>, Petr Munster <sup>\*</sup> and Tomas Horvath <sup>\*</sup>

Department of Telecommunication, Brno University of Technology, Technická 12, 616 00 Brno, Czech Republic; radim.sifta@gmail.com (R.S.); slatal08@vutbr.cz (M.L.); munster@fec.vutbr.cz (P.M.); horvath@fec.vutbr.cz (T.H.)

<sup>\*</sup> Correspondence: radim.sifta@gmail.com; Tel.: +420-736-625-794

† These authors contributed equally to this work.

**Abstract:** This paper is focused on applying a polarization multiplex to passive optical networks to double their transmission bandwidth without significant changes in the distribution network. Although polarization multiplexes are already employed for high-speed optical transport networks with digital signal processing and coherent detection, we propose a system that could be used in existing older optical networks using a dynamic polarization controller in combination with a wavelength division multiplex.

**Keywords:** WDM; polarization; PDM; POL-MUX; PON; crosstalk; BER; DPC



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## 1. Introduction

The demand for wider bandwidth in transport optical networks, as well as in optical access networks, increases every year. For this purpose, many multiplexing techniques have been developed, and some of them have been deployed for real data traffic. The most important multiplexing techniques in transport optical networks are the dense wavelength division multiplex (DWDM) and time division multiplex (TDM) [1]. The second generation of passive optical networks (PONs) uses both WDMs and TDMs [2]. Optical transport networks combine a DWDM with a polarization division multiplex (PDM) and coherent detection, thereby doubling the bandwidth. Although these systems are effective, it is not possible to use them for PONs due to digital coherent detection (DCD), which is the most expensive part. Nevertheless, there is a way to use a polarization multiplex without coherent detection.

Other multiplexing technologies have prospects for future deployment, but many of them are difficult to enforce because of the difficulty of implementation and necessity of intervention for the active components and distribution networks. This does not apply for polarization multiplexes, which can double the bandwidth without any intervention regarding the existing optical network, and in addition, such a multiplex is partially immune to polarization mode dispersion (PMD) [3]. The polarization multiplex (POL-MUX) is based on the transmission of two different optical signals in one optical fiber using polarization division. The optical beam in a single-mode fiber spreads in two polarization planes  $x$  and  $y$  that are orthogonal to each other. With a polarization beam splitter (PBS), it is possible to align independent optical signals into both polarization planes and transmit two different polarization-divided optical signals in one fiber.

The principle of polarization multiplexes can be compared with technologies used in radio systems, where radio signals are also transmitted in two orthogonal polarization planes and for receivers, two differently oriented antennas are used. Detection is possible only if the orthogonality of both signals is preserved. This is not possible in real optical fibers due to fiber imperfections (circular asymmetry of the fiber) and birefringence [4]. The basic scheme of the POL-MUX is shown in Figure 1.

# Noncoherent Optical Processing

**Ying-Ying Zheng**



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**Optical Processing** Francis T. S. Yu, Shizhuo Yin, 1992 **Linear Ray and Wave Optics in Phase Space** Amalia Torre, 2005-11-11 Ray wave and quantum concepts are central to diverse and seemingly incompatible models of light Each model particularizes a specific manifestation of light and then corresponds to adequate physical assumptions and formal approximations whose domains of applicability are well established Accordingly each model comprises its own set of geometric and dynamic postulates with the pertinent mathematical means At a basic level the book is a complete introduction to the Wigner optics which bridges between ray and wave optics offering the optical phase space as the ambience and the Wigner function based technique as the mathematical machinery to accommodate between the two opposite extremes of light representation the localized ray of geometrical optics and the unlocalized wave function of wave optics At a parallel level the analogies with other branches of both classical and quantum physics like classical and quantum mechanics quantum optics signal theory as well as magnetic optics are evidenced by pertinent comments and or rigorous

mathematics So the Lie algebra and group methods are introduced and explained through the elementary optical systems within both the ray and wave optics contexts the former being related to the symplectic group and the latter to the metaplectic group In a like manner the Wigner function is introduced by following the original issue to individualize a phase space representation of quantum mechanics which is mirrored by the issue to individualize a local frequency spectrum within the signal theory context The basic analogy with the optics of charged particles inherently underlying the ray optics picture in phase space is also evidenced within the wave optics picture in the Wigner phase space amalgamation of a great deal of contributions having witnessed the phase space picture of optics over the past 30 years introduces abstract concepts through concrete systems hosts of figures and logical diagrams to favour intuition and to introduce mathematics emphasis on the interrelations with quantum optics signal theory and magnetic optics feeds a feeling for genuine issues in higher mathematics and theoretical physics

**Introduction to Fourier Optics** Joseph W. Goodman, 2005 This textbook deals with fourier analysis applications in optics and in particular with its applications to diffraction imaging optical data processing holography and optical communications Fourier analysis is a universal tool that has found application within a wide range of areas in physics and engineering and this third edition has been written to help your students understand the complexity of a subject that can be challenging to grasp at times Chapters cover foundations of scalar diffraction theory Fresnel and Fraunhofer diffraction moving onto Wave Optics Analysis of Coherent Optical Systems and Wavefront Modulation Joseph Goodman s work in Electrical Engineering has been recognised by a variety of awards and honours so his text is able to guide students through a comprehensive introduction into Fourier Optics

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