Optical Receiver Demultiplexing

Overview

In this chapter we have studied a Y-shaped photonic demultiplexer based on two different configurations.

Key Takeaways

Optical receiver demultiplexing separates multiplexed optical signals into individual channels, using polarization, wavelength, or high-speed analog techniques to enable efficient detection and processing.

Polarization Demultiplexing

Polarization demultiplexing is used in polarization-division multiplexed (PDM) systems, where two orthogonal polarization states carry independent data streams. Coherent optical receivers can perform electronic polarization demultiplexing using high-speed digital signal processing (DSP) to separate the signals in the electrical domain. Optimal designs often employ maximum-likelihood estimation for joint symbol detection, which outperforms conventional zero-forcing demultiplexers unless the channel is ideal and noise is uniform across polarizations.

Coherent detection also allows compensation for polarization mode dispersion (PMD) and polarization-dependent loss (PDL), ensuring robust performance in dynamic fiber networks.

Wavelength Demultiplexing

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Wavelength demultiplexing separates signals in wavelength-division multiplexed (WDM) systems. Modern implementations include silicon photonic (SiPh) devices that exploit birefringence to achieve polarization-independent operation, splitting multiple wavelengths into separate channels with low insertion loss and minimal crosstalk. Integration with photodiodes is possible on InP or SiPh platforms, though SiPh devices often require polarization diversity schemes to handle arbitrary states of polarization (SOP) due to structural birefringence.

High-

Speed Analog Demultiplexing

For ultra-high-speed optical signals, analog demultiplexing converts a high-baudrate optical input into multiple lower-rate electrical signals, enabling the use of slower ADCs. For example, a 128-GBd optical receiver can use a traveling-wave transimpedance amplifier (TIA) and a current-mode sampling analog demultiplexer to split the signal into two half-rate outputs, supporting NRZ and PAM4 formats over tens of kilometers without DSP. This approach simplifies ADC design and allows scalable high-speed receiver architectures.

Reconfigurable and Multi-

Format Receivers

Advanced optical receivers can combine demultiplexing and demodulation using cascaded optical filters, supporting multiple modulation formats such as OOK, FSK, PPM, and hybrid schemes. These reconfigurable receivers enhance flexibility, reduce losses, and allow retuning for different wavelength and format combinations, making them suitable for high-capacity, multi-format optical networks.

Testing and Performance Considerations

Polarization demultiplexing performance is evaluated using SOP tracking, PMD tolerance, and PDL compensation. Coherent receivers rely on DSP algorithms to track and correct polarization impairments dynamically, ensuring reliable operation at data rates of 100 Gb/s and beyond. Testing involves varying polarization rates and measuring recovery times, orthogonality, and tolerance ranges to validate system robustness.

Summary

Optical receiver demultiplexing is a critical function in modern fiber-optic communication systems. It can be achieved through: Polarization demultiplexing using coherent detection and DSP for PDM signals. Wavelength demultiplexing using integrated photonic devices for WDM systems.

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Analog demultiplexing for ultra-high-speed signals to reduce ADC requirements. Reconfigurable multi-format receivers for flexible, scalable optical networks. These techniques ensure efficient separation of multiplexed signals, maintain signal integrity, and support high-capacity optical communication.

Article Content

Analog Demultiplexing 128-GBd Optical Receiver Integrating a

This paper presents an analog demultiplexing optical receiver capable of converting a high-baudrate optical input into two half-rate output signals, facilitating the use of lower-speed analog-to-digital

Demultiplexing

In this chapter we have studied a Y-shaped photonic demultiplexer based on two different configurations. The first demultiplexer is based on a cross structure; in this case we used the EIT

Constrained polarization demultiplexing for coherent optical receivers

A rudimentary intradyne receiver with the proposed polarization demultiplexer can be used in order to theoretically estimate the tolerance of uncompensated coherent optical communications systems to

Proper polarization demultiplexing in coherent optical receiver using ...

Abstract: Constant modulus algorithm (CMA) with the training mode is demonstrated for accurate polarization demultiplexing and equalization in a digital coherent optical receiver.

Optimal Polarization Demultiplexing for Coherent Optical

The primary goal of this paper is the optimal design, using the maximum-likeli-hood criterion, of polarization-diversity coherent optical receivers for polarization-multiplexed optical signals, in the

Demultiplexing

Demultiplexing refers to the process of separating multiple data-carrying optical beams, such as orbital angular momentum (OAM) beams, into individual beams using techniques like spatial light

Analog Demultiplexing 128-GBd Optical Receiver ...

We describe and compare two different receiver DSP architectures for reduction of these interferences and evaluate their performances in electrical and optical back-to-back experiments.

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Wavelength-division multiplexing

Optical receivers, in contrast to laser sources, tend to be wideband devices. Therefore, the demultiplexer must provide the wavelength selectivity of the

Forward error correction with optical and electrical transponder

U.S. Patent Application US20180076925A1 for a test instrument or host device can apply inverse transmitter and receiver functions to data transmitted or received by an electrical and optical

Fiber-optic communication

Modern fiber-optic communication systems generally include optical transmitters that convert electrical signals into optical signals, optical fiber cables to carry the

Multiplexing

A reverse process, known as demultiplexing, extracts the original channels on the receiver end. A device that performs the multiplexing is called a multiplexer (MUX), and a device that performs the reverse

Real time low-complexity adaptive channel equalization for coherent ...

Abstract: In this paper, a novel low-complexity adaptive channel equalization (ACE) algorithm for digital coherent optical systems is proposed and experimentally demonstrated. We divide the ...

Roadmap on optical communications

The optical communications area has become increasingly diverse, covering research in fundamental physics and materials science, high-speed electronics and photonics, signal processing

Reliable equalization aided long-distance OFDM-FSO performance

Receiver background noise in the IM/DD FSO is modelled as the superposition of signal- dependent shot noise and signal—independent thermal noise. The detected photo current included

Orthogonal frequency-division multiplexing

In telecommunications, orthogonal frequency-division multiplexing (OFDM) is a type of digital transmission used in digital modulation for encoding digital (binary) data

(PDF) Optical Multiplexing and Demultiplexing

PDF | Optical multiplexing is a technique used in optical fiber communication systems for enhancing the capacity of point-to-point links, as well as for... | Find, read and cite all the research ...

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Demultiplexing

Optical filtering may then be used to select out the demultiplexed channel. As we discussed in the section on demultiplexing, whatever specific all-optical switching technique is employed, we need to

Multiplexed orbital angular momentum beams demultiplexing ...

Optical beams carrying orbital angular momentum (OAM) are promising candidates for free-space optical communication. The authors devise a hybrid optical-electronic convolutional

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