

Demultiplexing function of optical receiver



Overview

Abstract—Spectrally-efficient optical communications systems employ polarization division multiplexing (PDM) as a practical solution, in order to double the capacity of a fiber link.

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

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.

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

Demultiplexing

Demultiplexing is defined as the process of making a data stream wider by splitting it into multiple parallel paths, thereby reducing the continuous throughput rate to achieve a data rate compatible

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

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

Optimal Polarization Demultiplexing for Coherent Optical

Abstract—Spectrally-efficient optical communications systems employ polarization division multiplexing (PDM) as a practical solution, in order to double the capacity of a fiber link. Polar-ization

OPTICAL DEMULTIPLEXERS

The main function of an optical demultiplexer is to receive from a fiber a beam consisting of multiple optical frequencies and separate it into its frequency components, which are coupled in as many

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

Optical Based Demultiplexing: A Comprehensive Overview

Optical demultiplexing plays a crucial role in this process, enabling the separation of multiple data streams that have been combined onto a single optical carrier.

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 by independent component analysis in coherent optical ...

A real-time coherent optical receiver using Digital Signal Processing (DSP) enables the transmission system to perform dispersion compensation, carrier phase estimation, polarization de

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

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

Optical receiver and optical reception method compatible with ...

The present invention relates to an optical receiver and an optical reception method, for demodulating a signal light subjected to the differential quadrature phase shift keying, and in particular, to a

Ultrashort pulse all-optical wavelength conversion for WDM-OTDM

These results confirm that the ultrashort mode-locked-pulse-driven all-optical wavelength converter enables high-fidelity information replication and transmission in free-space optical communication

Optical signal demultiplexing device and optical signal demultiplexing ...

When demultiplexing the multiplexed optical signal, multiplexed light is demultiplexed at a timing assigned beforehand. By multiplexing and demultiplexing the optical signals directly in the state of

Hardware-Efficient and Reliable Coherent DSCM Systems

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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

Multiplexing – Definition – Types of Multiplexing: FDM, WDM, TDM

Wavelength division multiplexing is also known as WDM. A demultiplexer at the receiver end separates the optical signal wavelengths or colors. In this technique, the bandwidth of the communication

Wavelength-division multiplexing

In fiber-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single

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