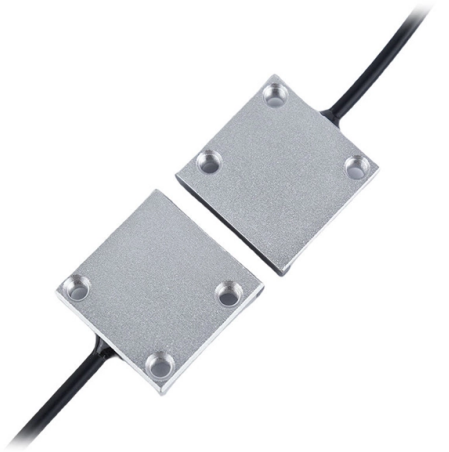
Which noise is dominant in an optical receiver



Overview

Optical systems can be subject to shot noise and optical noise, in addition to the standard thermal noise. These require somewhat different models and performance expressions.

Key Takeaways

The primary sources of noise in optical receivers include shot noise, thermal noise, dark current noise, relative intensity noise (RIN), and signal-spontaneous emission beat noise.

Shot Noise

Shot noise arises from the discrete nature of electric charge and occurs when electrons and holes cross a potential barrier, such as in a PN junction diode. It is particularly significant in low-light conditions and follows a Poisson distribution, causing random fluctuations in the photocurrent even when the optical signal is constant.

Thermal Noise

Thermal noise, also known as Johnson-Nyquist noise, is generated by the random motion of electrons in resistive components due to temperature. It is independent of the optical signal and depends only on the temperature and resistance of the circuit. Reducing thermal noise typically requires lowering the operating temperature or minimizing resistance values.

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Dark Current Noise

Dark current noise occurs when a small reverse leakage current flows through the photodetector even in the absence of light. This current fluctuates randomly, contributing to the total system noise and affecting the accuracy of low-light signal detection. Relative Intensity Noise (RIN)RIN represents the instability in the laser power output, causing fluctuations in the optical signal itself.

It is a multiplicative noise source, meaning its magnitude is proportional to the signal power, and it can degrade the signal-to-noise ratio in high-speed optical communication systems.

Signal-

Spontaneous Emission Beat Noise

This noise is generated by the mixing of the amplified optical signal with amplified spontaneous emission (ASE) noise in the photodiode. It is particularly relevant in systems using optical amplifiers, where ASE contributes additional fluctuations to the detected signal.

Additional Considerations

Other noise types, such as 1/f noise and excess noise in avalanche photodiodes (APDs), can also impact receiver performance. The overall signal-to-noise ratio (SNR) in an optical receiver is determined by the combined effect of these noise sources, and careful design of photodetectors, amplifiers, and filtering techniques is essential to minimize their impact. By understanding these noise mechanisms, engineers can optimize optical receiver design, improve sensitivity, and enhance the reliability of optical communication systems.

Article Content

Optical Noise

Optical systems can be subject to shot noise and optical noise, in addition to the standard thermal noise. These require somewhat different models and performance expressions. Receiver

Optical Fiber Receiver Noise Analysis | PDF | Amplifier

This document discusses noise sources in optical receivers, including shot noise, thermal noise, dark current noise, and 1/f noise. It examines these noise sources in PIN photodiodes and avalanche

Optical Fiber Receiver Noise Analysis

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Optical Fiber Receiver Noise Analysis This document discusses optical receivers and noise in fiber optic communication systems.

Lecture 15: Receiver Design

Electrical Shot Noise The shot noise generated in the photodetection process is physically due to the “quantum granularity” of the received (and photo converted) optical signal

Optical Receiver Sensitivity Evaluation in Presence of Noise in Digital ...

The optical receiver adds two types of noise namely thermal noise and shot noise. Since optical amplifiers are based on the principle of stimulated emission, its main contribution to noise is ASE noise.

Optical Receiver Noise

The shot noise and thermal noise are the two fundamental noise mechanisms responsible for current fluctuations in all optical receivers even when the incident optical power P in is constant.

Receiver noise

Noise introduced by the receiver is either signal dependent or signal independent. Signal dependent noise results from the random generation of electrons by the incident optical power. Signal

Analysis of Noise Propagation Mechanisms in Wireless Optical ...

From the perspective of signal propagation, wireless optical coherent communication systems can typically be analyzed by categorizing noise sources into three types based on their

Optical Receivers | part of Fiber-Optic Communication Systems

The design of an optical receiver depends on the modulation format used by the transmitter. The chapter deals with various noise sources that limit the signal-to-noise ratio in optical receivers, and also

Optical Transmitters, Receivers, and Noise

Further, high-performance optical receiver structures and their noise properties are outlined, both for the fiber channel and for the free-space channel. Basic receiver design rules as

OPTICAL RECEIVER NOISE MODEL COMPARISON ANALYSIS

RECEIVER MODEL In general, utilizing an optical amplifier as pre-amplifier is an effective method in optical fiber transmission to improve receiver sensitivity. However, this component also creates

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Noise Principles in Optical Fiber Communication

Abstract: This chapter contains sections titled: Introduction Receiver Thermal Noise Dark Shot Noise Signal Shot Noise Multiplication Shot Noise Optical Amplification and Beat Noises Optical Noise and

What are the noise sources known in Optical fiber network?

Active sources such as optical plugs, lasers, receivers, and amplifiers generate noise in the fiber link.

Optical Receiver Sensitivity Evaluation in Presence of Noise in Digital ...

Optical amplifiers can be used to improve the effective receiver sensitivity in optical systems. The optical amplifier works on the principle of stimulated emission . The optical amplifiers add noise to the

The Ultimate Guide to Optical Noise

Discover the causes of optical noise, its effects on signal quality, and practical methods to minimize its impact on optical communication systems.

NOISE IN FIBER OPTIC COMMUNICATION LINKS Robert Dahlgren Bob.Dahlgren@ieee

The physics of noise in optical communication links is of great interest in the design of fiber optic communication systems. In this report the role of noise in optical communications, and how it can

Pre-amp EDFA ASE noise minimization for optical receiver

This is the dominant noise element in pre-amp EDFAs. The optical noise elements of a pre-amp EDFA at different input power, output power, and different signal wavelengths and their

Noise Theory of Coherent Optical Receivers

Download Citation | Noise Theory of Coherent Optical Receivers | This chapter analyzes the noise components impairing the coherent optical detection, comparing two receiver architectures,

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