

Energy-efficient optical receivers for the Internet of Things



AI Overview

Energy-efficient optical receivers for IoT leverage low-power transimpedance amplifiers, advanced equalization, and optimized modulation schemes to achieve high sensitivity with minimal energy per bit.

Key Design Techniques

Transimpedance Amplifiers (TIA): Low-power TIAs are central to energy-efficient optical receivers. Designs often use shunt-feedback (SF) or transadmittance-stage topologies to reduce thermal noise and maintain linearity while minimizing power consumption. Multi-stage TIAs can improve sensitivity without increasing silicon area or power.

Equalization Methods: Sensitivity enhancement is achieved using continuous-time linear equalizers (CTLE), feed-forward equalizers (FFE), and decision feedback equalizers (DFE). These techniques mitigate inter-symbol interference (ISI) and improve data recovery, allowing receivers to operate efficiently at higher data rates.

Modulation Schemes: For IoT and short-reach applications, NRZ, PAM-4, and duobinary sampling are commonly used. Duobinary sampling, in particular, improves sensitivity and energy efficiency by leveraging controlled ISI rather than canceling it, enabling higher data rates with lower power. PAM-4 receivers can achieve high data throughput while maintaining low energy per bit, e.g., 1.28 pJ/bit at 48 Gb/s.

Integration and Fabrication

CMOS and 3D Integration: Fabrication in advanced CMOS nodes (28 nm, 12 nm) allows for ultra-low-power operation and high bandwidth density. 3D integration with co-designed optical devices further reduces power consumption and improves sensitivity, achieving sub-100 fJ/bit efficiency in state-of-the-art designs. Wire-bonded photodetectors and micro-ring resonators are also used to bridge optical and electrical domains efficiently.

DSP-Free Architectures: To reduce power, some designs eliminate digital signal processing (DSP) at the receiver...

Article Content

Energy Efficient IoT Virtualisation with Passive Optical Access

Abstract— In this paper, the energy efficiency of edge computing platforms for IoT networks connected to a passive optical network (PON) is investigated. We have developed a mixed integer linear

Ultra-Low Power Receivers for IoT Applications: A Review

To address the power and performance tradeoffs in standard compatible receivers, two design approaches are presented in sections III and IV. The first is a BLE compatible back-channel receiver

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Energy efficient optical receivers for next generation non-terrestrial ...

Abstract Conventional free-space optical receivers carry out the beam tracking and symbol detection functions in two separate units inside the receiver. This leads to a more complex receiver

Design of Energy-Efficient Optical Transceivers

This dissertation presents three designs focusing on power-efficient short-reach optical communication up to hundreds of meters, including one wire-bonded optical receiver and two 3D

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Design of Energy Efficient Receiver and Transmitter for Optical ...

In this paper, the main aim of the author is to design an energy efficient [11-14] transceiver for wireless optical communication. Figure 1 represents the different modes of communication.

This compact, low-power receiver could give a boost to

Traditionally, IoT receivers operate on fixed frequencies and suppress interference using a single narrow-band filter, which is simple and

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A wideband low power RF Receiver Front-End for Internet-of-Things ...

Owing to the commendable attributes of low power consumption and wideband characteristics inherent in the Radio Frequency (RF) front-end circuit, it emerges as highly suitable

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A wideband low power RF Receiver Front-End for Internet-of-Things ...

The RF receiver front-end circuit comprises a I and Q doublebalanced quadrature passive mixers and an 25% duty-cycle LO generator. The circuit's broadband characteristics enable it to

Fostering Advanced Optical Wireless Communication: Approaches for ...

Optical wireless solutions can be highly beneficial for Internet of Things (IoT) deployments, offering unique advantages in terms of data communication, energy efficiency, and

Receivers for energy efficient optical interconnects | IDEALS

The recent exponential increase in internet traffic has created the need for more powerful data centers in which thousands of servers are connected with high bandwidth interconnects. Optical

Low-Power Wake-Up Receivers for Resilient Cellular

Smart Cities leverage large networks of wirelessly connected nodes embedded with sensors and/or actuators. Cellular IoT, such as NB-IoT and 5G

Ultra Low-Power Receivers for IoT Applications

We'll examine how these receivers are pushing the boundaries of energy efficiency while maintaining reliable communication in diverse IoT scenarios.

IEEE INTERNET OF THINGS JOURNAL A High Efficiency, Simple

A High Efficiency, Simple-Structure, Compact Wideband Microwave Energy Harvester for Wirelessly-Powered IoT Receivers Jiupei Shi, Student Member, IEEE, Chaoyun Song ...

Energy efficient optical receivers for next generation non-terrestrial ...

In this chapter, a detector array receiver is proposed that integrates the beam tracking and symbol detection functions in one single unit. This not only simplifies the receiver architecture but also leads

Ultra-Low Power Receivers for IoT Applications: A Review

I. INTRODUCTION With the coming of age of the Internet of Things (IoT), demand on ultra-low power (ULP) receivers will continue to boost tremendously. Innovations in both the system architecture and

Ultra-low power, high-data rate, fully on-chip radio frequency on-off ...

Here, we present an energy-efficient, ultra-low power, higher data rate supporting, completely on-chip radio-frequency receiver frontend for on-off keying modulated signals in the 2.4

Integrated Electronics for Energy-efficient Coherent Optical

A component to this vision is the realization of low-power, broadband optical receivers for quadrature phase shift keying (QPSK) or higher-order coherent waveforms. Improvements in energy efficiency

Maximum efficiency at minimum power consumption: New options for ...

The particularly energy-efficient technology combines ultra-low energy consumption with extremely fast response times – a

This compact, low-power receiver could give a boost to

MIT researchers have designed a compact, low-power, low-cost receiver that would be ideal for battery-powered Internet of Things (IoT) devices

A Monolithic O-Band Coherent Optical Receiver for Energy-Efficient ...

The coherent optical receiver (CORX) leverages a monolithic 45-nm CMOS SOI photonic-enabled process to realize an energy-efficient quadrature phase shift keying (QPSK) demodulation. Co

Optical Transceiver Market Size, Share, Analysis 2030

The global Optical Transceiver Market size in terms of revenue was estimated to be worth \$13.6 billion in 2024 and is poised to reach \$25.0 billion by 2029, growing

AI-powered LED system delivers stable wireless power

With the rapid development of Internet of Things (IoT), the demand for efficient and flexible power solutions is also increasing. Traditional power

AquaE-lite Hybrid-Solar-Cell Receiver-Modality for Energy

Our goal is to develop an energy-autonomous solar cell receiver that can be integrated with a variety of smart devices to implement the Internet of Things in next-generation applications.

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Ultra-low power, high-data rate, fully on-chip radio frequency on-off ...

Aasish Boora and colleagues implement low-power on-chip radio frequency receiver for high data rate Internet of Things applications. Their device can be reconfigurable to adjust power

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