Terahertz Analog-to-Digital Converter Employing Active-Controlled Spoofed Surface Plasmon Polariton Architecture

TECHNOLOGY NUMBER: 5809

OVERVIEW

High-bandwidth ADC using terahertz signals for improved speed and bandwidth

- Enhanced operational speed and bandwidth over traditional and optical ADC designs
- High-speed data acquisition, telecommunications, and advanced radar systems

BACKGROUND

Analog-to-digital converters (ADCs) are essential in converting continuous analog signals into digital data, a process critical in various high-speed applications like telecommunications and radar systems. Historically, ADC designs have relied on electrical sampling and quantization, which have reached a performance plateau due to large temporal jitter in sampling signals. Optical ADCs, which leverage the broad bandwidth of optical frequencies and ultra-stable sampling pulse trains from mode-locked lasers, were developed to address these limitations. However, they introduce new challenges, such as the mismatch between photonic devices and electronic circuits and limited utilization of optical bandwidth due to poor resonant conversion between photons and electrons. Additional bottlenecks include the limited modulation bandwidth of electro-optical modulator stages and the constrained repetition rate of mode-locked lasers, necessitating more advanced solutions to enhance ADC performance.

Technology ID

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Category

Hardware
Engineering & Physical Sciences
Semiconductors, MEMS, and Electronics

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INNOVATION

Researchers at the University of Michigan have developed an advanced ADC leveraging terahertz (THz) signals to address the inherent limitations of traditional and optical ADCs. This innovation utilizes THz frequencies, which can coherently interact with high-speed electronics, enabling next-generation high-speed integrated systems. The ADC design incorporates a spoofed-surface-plasmon-polariton (SSPP) waveguiding structure and a Mach-Zehnder interferometer (MZI) modulator, facilitated by a thin layer of doped GaAs. By adjusting the refractive index of GaAs, the phase of THz signals can be precisely controlled, creating a spatially shifted radiation pattern in the far field. This pattern is then digitized using a detector array arranged in a binary manner, achieving an operation rate of up to 50GS/s. The innovation allows applications in high-speed data acquisition, telecommunications, and advanced radar systems, providing significant improvements in speed and bandwidth for ADC technologies.

ADDITIONAL INFORMATION

US9341921 "Terahertz analog-to-digital converter employing active-controlled spoofed surface plasmon polariton architecture"