High-speed ADC for high-speed optical modules

Overview

Today, one of the most important objectives concerned with integrated optical circuits is to realize all-optical networks.

Key Takeaways

High-speed ADCs and DACs, combined with optical interconnections, enable ultra-fast data conversion and transmission for applications ranging from optical coherent transceivers to satellite communications and data center networks.High-Speed ADCs and DACs

High-speed ADCs convert analog signals directly into digital form at very high sampling rates, often exceeding several gigasamples per second (GSPS). For example, the ADC12DJ3200 can sample at 6.4 GSPS, supporting RF-sampling architectures that bypass traditional super-heterodyne designs, enabling direct conversion of RF signals to digital for radar, wireless, and industrial applications . High-speed DACs perform the reverse operation, converting digital signals into analog form with high fidelity and bandwidth. Modern DACs, such as those from Analog Devices, support wideband RF, intermediate frequency, and baseband applications, with sampling rates of 30 MSPS and above, enabling high-bandwidth signal generation for communication and instrumentation systems .

Optical Modules and Interconnections

Integrating ADCs and DACs with optical modules addresses the challenge of transmitting and routing massive amounts of data. Electro-optic modules can include 8-bit, 2 GSa/s ADCs and 12-bit, 2 GSa/s DACs connected via parallel fiber-optic links using VCSELs and GaAs PIN photodiodes. These links can achieve aggregate data rates of 25 Gbps per channel, supporting advanced digital processing architectures such as beamforming and multi-channel satellite payloads . In optical coherent transceivers, high-speed DACs and ADCs are essential for modulating and demodulating optical signals. Coherent detection relies on DSP to compensate for chromatic dispersion and other impairments, enabling multi-rate 100 Gb/s DWDM systems and even 200 Gb/s per carrier. The evolution of CMOS technology from 130-nm to 28-nm has allowed a 20-fold increase in throughput and gate count, supporting higher symbol rates and forward error correction (FEC) for reliable transmission .

Applications in Data Centers and Short-Range Optical Links

High-speed ADC/DAC modules are also critical for short-range optical communication, such as data centers and optical access networks. Research focuses on ultra-broadband electrical components (DACs, ADCs, drivers) and optical components (DML, VCSEL, EML) combined with advanced signal processing techniques like DMT, OFDM, MIMO, and pre-distortion. These innovations target data rates exceeding 1 Tbit/s and bandwidths beyond 100 GHz, enabling next-generation 400G and 1T Ethernet links .

Summary

High-speed ADCs and DACs, when integrated with optical interconnections, provide:

• Ultra-fast data conversion for RF, optical, and baseband signals

• High-bandwidth transmission for satellite, coherent optical, and data center networks

• Support for advanced DSP for signal compensation, beamforming, and multi-channel processing

• Scalability to meet future high-throughput requirements in both long-haul and short-range optical systems These technologies are central to modern high-speed communication systems, enabling efficient spectrum utilization, high data rates, and flexible digital processing architectures.

Article Content

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High-speed ADC-to-FPGA communication bandwidth optimization

These systems rely on high-speed analog-to-digital converters (ADCs), fast optical links, and field programmable gate

Designing a Module for High-Speed Optical Communication

The ultimate goal for all-optical connectivity with an ultra-high F5G bandwidth is to increase transmission rates. Optical modules —

High-speed ADC and DAC modules with fibre optic interconnections

In this perspective, we have undertaken to assess the benefits and constraints of optical interconnections as a

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High-speed digital-to-analog converters (DACs) and DSP were introduced into optical transmission in 2005 with the

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High-speed optical hold module in optical assisted ADC

An optical hold module (OHM) is proposed, theoretically analyzed, numerically simulated and experimentally

High Performance Analog Interface Products

A logical “1” corresponds to the transmission of an optical pulse and a logical “0” corresponds to the omission of an optical pulse.

High-speed ADC and DAC modules with fibre optic interconnections

ADC and DAC modules with optical interconnections is an attractive option as it can solve easily the transmission and routing of the

Optical and High Speed Networking

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The next generation commercial optical communication requires ADCs with more than 50GS/s and at least 5 ENOB. For this ultra

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