PAM4 Selection Guide for Backbone Network-Grade Optical Transceiver Modules

Overview

The Marvell® PAM4 optical DSP portfolio, including Spica™ and Nova™ DSPs, addresses the critical the need for high-bandwidth optical interconnects to power AI infrastructure.

Key Takeaways

Selecting PAM4 optical transceivers for backbone networks requires balancing data rate, reach, power efficiency, and modulation technology to meet high-bandwidth, low-latency requirements. Understanding PAM4 TechnologyPAM4 (4-level Pulse Amplitude Modulation) encodes two bits per symbol using four distinct amplitude levels, effectively doubling the data rate compared to NRZ (2-level) modulation at the same baud rate. This improves spectral efficiency and reduces the number of lanes required for high-speed transmission, making it ideal for 100G, 400G, 800G, and 1.

6T backbone networks. PAM4 is widely adopted in IEEE 802. 3 standards for 50GE, 200GE, and 400GE interfaces.

Key Selection Criteria

Data Rate and Form FactorChoose transceivers based on required line rates: 100G, 200G, 400G, 800G, or 1. 6T. Common form factors include QSFP28 (100G), QSFP112/OSFP (400G), and OSFP twin-port modules for 800G links.

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For ultra-high-speed links, 1. 6T modules powered by DSPs like Marvell Ara or Nova are suitable for AI and cloud data centers. Reach and Fiber TypeShort-reach (SR) modules use multimode fiber for distances up to 100 meters, ideal for intra-rack or data center interconnects.

Long-reach (LR/DR) modules use single-mode fiber for metro or backbone networks, supporting distances from 2 km to 80 km or more.

DWD

M PAM4 modules combine PAM4 with wavelength-division multiplexing to maximize spectral efficiency over long distances.

DS

P and Power EfficiencyDSPs handle signal equalization, pre-emphasis, and error correction, critical for PAM4's higher sensitivity to noise.

Vendor DS

Ps like Broadcom Centenario, Jesko, and Marvell Spica or Ara provide low-power, high-performance solutions for hyperscale and AI networks. Consider power per lane and total module power to ensure thermal compatibility with network switches and servers.

Compatibility and Protocol Support

Ensure modules support required protocols: Ethernet, InfiniBand, or proprietary AI interconnects. Check backward compatibility with existing NRZ or lower-speed PAM4 links if network upgrades are incremental. Latency and ReliabilityLow-latency DSPs and retimers are essential for AI/ML workloads and high-performance computing.

Twin-port OSF

P modules can provide flexible link aggregation while maintaining low latency for 800G or 2x400G configurations.

Practical Recommendations

For data center interconnects (DCI): 100G PAM4 DWDM modules in QSFP28 form factor offer high spectral efficiency and long-reach capability. For hyperscale AI networks: 400G to 1. 6T PAM4 modules with advanced DSPs (Marvell Ara, Broadcom Gemera) provide high bandwidth, low power, and low latency.

For short-reach, high-density links: 2xSR4 or SR8 twin-port OSFP modules are cost-effective and minimize latency for intra-rack connections. Evaluate vendor ecosystem for support, firmware updates, and interoperability with existing network infrastructure.

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Conclusion

Selecting PAM4 optical transceivers for backbone networks involves evaluating data rate, reach, DSP capabilities, power efficiency, and protocol support.

High-performance DS

Ps and PAM4 modulation enable doubling of data throughput per lane, making them essential for modern AI, cloud, and telecom backbone networks. Combining PAM4 with DWDM or twin-port architectures further optimizes spectral efficiency and link flexibility, ensuring scalable, low-latency, and cost-effective network deployments.

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400G PAM4 QSFP-DD DR4/DR4+ Transceiver

The optical transceiver supports a full QSFP-DD-compliant set of control, alarm, and monitoring features through a standard I2C management interface, as well as low speed control pins which support

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Marvell Ara PAM4 Optical DSP

The Marvell Ara PAM4 DSP is a next generation solution for GenAI and cloud datacenter interconnects utilizing pluggable transceivers. Ara features eight 200Gbps/channel PAM4 host electrical interfaces,

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Selection Guide for Carrier Backbone Network Grade SFP Optical Modules QSFP28 A practical, engineer-friendly guide to choosing the right transceiver form factor by speed, port density, power,

400G Optical Selection Guide: QSFP-DD vs QSFP28 vs

Profile: A mid-sized financial institution updating a legacy 100G network containing 200 active QSFP28 modules. Requirement: Boost backbone

Comprehensive Guide to QSFP – MapYourTech

The Quad Small Form-Factor Pluggable (QSFP) family represents a critical evolution in high-speed optical transceiver technology for data centers, telecommunications networks, and

RoCEv2 Network Solutions: Transceiver & Cable Deployment Guide

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To preserve signal integrity over these high-frequency lanes, modern optical transceivers require sophisticated, high-performance Digital Signal Processors (DSPs), which cause module power ...

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The single-mode optics are then shifted to the backbone, where wave-multiplexed or parallel single-mode transceivers handle the longer Leaf-to-Spine links—spanning from 50 meters up

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