

Small-sized optical modules



Overview

Mini SFF (Small Form Factor) transceivers offer a compact, reliable solution for high-density optical networking.

Key Takeaways

Small-sized optical modules are compact, hot-pluggable transceivers that convert electrical signals to optical signals and vice versa, enabling high-speed, space-efficient networking in data centers and telecom applications.

Small optical modules, such as SFP (Small Form-factor Pluggable), SFP+, and SFP28, are widely used in enterprise networks, data centers, and carrier-grade deployments. They provide modularity, allowing network devices to support different media types (fiber or copper) without replacing the host hardware, enhancing port density and deployment flexibility. These modules adhere to Multi-Source Agreements (MSAs), ensuring mechanical and electrical compatibility across vendors.

Types and Data Rates

- SFP (1–4 Gbps): Legacy Gigabit Ethernet and Fibre Channel applications.
- SFP+ (up to 10 Gbps): High-speed 10G Ethernet and Fibre Channel.
- SFP28 (25 Gbps): Single-lane 25G Ethernet for modern data centers.



- SFP56 and SFP112: Support 50–112 Gbps using PAM4 encoding for next-generation high-density networks . Modules can be single-mode (SMF) for long distances or multimode (MMF) for short-range connections, with common connectors like LC duplex and, less frequently, SC or RJ45 for copper links .

Key Components

- TOSA (Transmit Optical Subassembly): Converts electrical signals to optical signals.
- ROSA (Receive Optical Subassembly): Converts optical signals back to electrical signals.
- EEPROM & MCU: Store module information and support Digital Diagnostic Monitoring (DDM/DOM) for real-time monitoring of temperature, voltage, and optical power .

Power and Miniaturization

Modern small optical modules require compact, efficient power solutions. For example, Renesas offers RAA210040 and RAA210030 mini power modules with integrated inductors, capable of delivering 4A and 3A respectively, in a low-profile DFN package (~1.15mm height), suitable for space-constrained optical modules . These modules support fast transient response, low dropout voltage, and thermal efficiency, critical for high-speed data transmission.

Applications

- Data Centers: High-density server uplinks and interconnects.
- Telecom Networks: Metro, regional, and long-haul optical links.
- Specialized Modules: Mini RFoF modules like OZ10x for low size, weight, and power applications in antenna testing .

Design Considerations

- Thermal Management: Low power consumption and efficient heat dissipation are essential.
- Electrical Compatibility: Ensure host PHY and module support the same data rate and encoding.
- Optical Budget: Tx/Rx power and fiber losses must be calculated to maintain reliable links.
- Form Factor: Modules must fit the host cage while allowing hot-swappable operation .

Summary

Small-sized optical modules provide high-speed, modular, and space-efficient connectivity for modern networking. Their evolution from SFP to SFP112 and beyond allows higher data rates without increasing physical footprint, while integrated power solutions and diagnostic features ensure reliable operation in dense, high-performance environments .

Article Content

Smallest Thinnest Power Modules for Data Center Optical Modules

By operating from a single 2.7V to 5.5V input power rail and integrating the controller, gate driver, power inductor, and MOSFETs,

Compact SFF Optical Modules: Reliability, Density & Efficiency for ...

SFF (Small Form-Factor) transceivers represent a class of compact, reliable, and cost-effective optical modules

The Ultimate Guide to SFP Modules (2026): Types, Speeds

What is an SFP? SFP (Small Form-factor Pluggable) is a compact, hot-pluggable network interface module used to connect network

Optical Modules: Small Ultra-Low Phase Noise Oscillators | SiTime

SiTime MEMS differential oscillators are ideal for 100G to 800G optical modules. They offer breakthrough 70-fs jitter, the smallest

Optical module design resources | TI

Integrated circuits and reference designs help you create a smaller and faster optical module design used in high-bandwidth data

Mini SFF Transceivers | Compact Optical Modules for High-Density ...

Mini SFF (Small Form Factor) transceivers offer a compact, reliable solution for high-density optical networking. These space

Development of Small Receiver Module with Integrated Optical

The authors have successfully developed a small receiver module with an integrated optical demultiplexer. The module is compliant

Small Form-factor Pluggable

Small Form-factor Pluggable Small Form-factor Pluggable connected to a pair of fiber-optic cables Small Form-factor Pluggable

MCWDM Module (Micro CWDM) Small-sized Package Mini CWDM

MCWDM Module (Micro CWDM, Small-sized Mini CWDM), features miniature size, high optical performance, free-space structure,

TI DLP® System Design: Optical Module Specifications

The size of a DLP optical module primarily depends on the DMD size (see Figure 2-2), optical design, and illumination size. In

Fingertip-Size Optical Module, "Optical I/O Core", and ...

Special Section on Progress in Optical Device Technology for Increasing Data Transmission Capacity Fingertip-Size Optical Module,

Development of Chip-Scale Silicon Photonic Optical Transceiver ...

Abstract and Figures We have developed a highly-miniaturized Si photonic transceiver module named "Optical I/O

Compact SFF Optical Modules: Reliability, Density & Efficiency for ...

Discover how soldered SFF (Small Form-Factor) optical modules deliver high reliability, dense port integration and

OSFP Product Family » Acacia

Octal Small Form-factor Pluggable (OSFP) solution that fits into high-density switch and router client ports for optical interconnect links

Optical Module Market Size, Competitors & Forecast to 2032

The Optical Module Market, valued at USD 30.01B in 2026, is projected to reach USD 66.94B by 2032, growing at a 14.1% CAGR.

Understanding Optical Modules

Optical modules are the backbone of modern optical communication systems, enabling high-speed, reliable data transmission that

FIBER OPTIC MODULE FORM FACTORS

The related Small Form-Factor (SFF) transceiver is similar in size to the SFP, but is soldered to the host board as a pin through-hole

The Evolution of Optical Modules: Powering the Future of Data

Data centers, the beating hearts of this digital revolution, are tasked with processing and moving massive volumes of

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