Cisco MDS 9124V 64-Gbps 24-Port Fibre Channel Switch

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Cisco MDS 9124V 64-Gbps 24-Port Fibre Channel switch brings the latest high-performance, low-latency Fibre Channel Storage Area Network (SAN) technology to market. Along with the higher bandwidth, the Cisco MDS 9124V switch supports ease of configuration and management, detailed and in-depth performance insights, and automation capabilities.

Figure 1.
Cisco 9124V 64-Gbps 24 Port Fibre Channel Switch

Product overview

The next-generation Cisco MDS 9124V 64-Gbps 24-Port Fibre Channel Switch (Figure 1) provides high-speed Fibre Channel connectivity for all-flash arrays and high-performance hosts. This switch offers state-of-the-art analytics and telemetry capabilities built into its next-generation Application-Specific Integrated Circuit (ASIC) chipset. This switch allows seamless transition to Fibre Channel Non-Volatile Memory Express (NVMe/FC) workloads whenever available without any hardware upgrade in the SAN. It empowers small, midsize, and large enterprises that are rapidly deploying cloud-scale applications using extremely dense virtualized servers, providing the benefits of greater bandwidth, scale, and consolidation. Some of the main benefits for a small-scale Storage Area Network (SAN) are automatic zoning, nonblocking forwarding and a single port group of 24 ports. Benefits for a mid- to large-size SAN include higher scale for Fibre Channel control-plane functions, Virtual SANs, fabric login (FLOGI), device alias and name server scale, 24 ports of 64-Gbps non-oversubscribed line-rate ports, bidirectional airflow, and a fixed-form NVMe/FC-ready SAN switch with enhanced Buffer-to-Buffer (B2B) credits and capable of hardware-assisted Fibre Channel link encryption. Large-scale SAN architectures built with SAN core directors can expand 64-Gbps connectivity to the server rack using these switches configured in either switch mode or Network Port Virtualization (NPV) mode. Additionally, the switch supports enhanced diagnostic features such as Inter-Switch Link (ISL) and Host-Bus-Adapter (HBA) diagnostics, remote SFP (Read Diagnostic Parameter) diagnostics, remote port beaconing (Link Cable Beaconing) and advanced reliability features such as link level Forward Error Correction (FEC) with HBA ports.

Main features and benefits

The main features of the Cisco MDS 9124V 64-Gbps 24-Port Fibre Channel Switch include:

- **High performance:** MDS 9124V architecture, with nonblocking arbitration, provides consistent 64-Gbps low-latency performance across all traffic conditions for every Fibre Channel port on the switch.
- **Fully integrated SAN Analytics:** This feature-rich switch also offers state-of-the-art data traffic analytics and telemetry capabilities that have been built into this next-generation hardware platform. This new state-of-the-art technology couples the next-generation port ASIC with a fully dedicated Network Processing Unit (NPU). Information is extracted by the port ASIC from passing line rate traffic and used by the NPU to calculate performance data on board the switch in real time. Using an industry-leading open telemetry format, the data can be streamed to any analytics visualization platform.
- **Cisco Dynamic Ingress Rate Limiting (DIRL):** MDS 9124V supports the dynamic ingress rate limiting feature. Using DIRL, the MDS SAN can automatically detect any symptoms of congestion and then dynamically rate limits the congested and slow-drain devices so that adverse effects are not spread to other devices. DIRL dynamically adapts the rate-limiting to suit the traffic profile of the congestion or slow-drain device.
- **Capital Expenditures (CapEx) savings:** The 64-Gbps ports allow users to deploy them with existing 32- or 16-Gbps transceivers providing investment protection, with an option to upgrade to 64-Gbps transceivers and adapters whenever needed.
- **High availability:** MDS 9124V switch is designed to provide 99.999% availability. The MDS 9124V switches provides such outstanding availability and reliability by providing redundancy on all major components, such as the power supply and cooling subsystems. Dual power supplies also facilitate redundant power grids.
- **Reliability:** As part of the standard 64-Gbps Fibre Channel specification, Cisco provides FEC between switch ports and HBA ports on all 64-Gbps Fibre Channel fixed switches. This feature helps ensure any error introduced in flight gets corrected at the receive side of the link. In addition, Cisco extends Buffer-to-Buffer State Change Notification (BBSCN) and buffer-to-buffer credit recovery, which is supported on all Cisco switches between ISL ports, to the fabric ports attached to any end device. Over time, the corruption of receiver-ready messages, known as R_RDY primitives, can lead to a loss of credits, which can eventually cause a link to stop transmitting in one direction. Buffer-to-buffer credit recovery provides for two attached ports to detect and correct this situation.
- **Next-generation ASIC:** The MDS 9124V Fibre Channel switch is powered by Cisco developed next- generation high-performance 64G ASIC.
- **Higher scalability:** Increased fabric scalability provides more flexibility for a variety of SAN architectures.
- **Telemetry**[1]**:** Fibre Channel and Small Computer System Interface (SCSI) or NVMe headers can be inspected without the need for any external taps or appliances. The resulting metrics can be analyzed on the switch and can additionally be exported using a dedicated 1Gbps Small Form-Factor Pluggable Plus (SFP+) port for telemetry and analytics purposes.

[1] Analytics is supported on Cisco MDS 9124V in MDS NX-OS 9.4(1) and later releases.

- **Intelligent services:** Auto-zone, Smart Zoning, slow-drain detection and isolation, Virtual SAN (VSAN) and Inter-VSAN Routing (IVR), and fabric-wide Quality of Service (QoS) enable migration from SAN islands to enterprise-wide storage networks. Traffic encryption is available to meet stringent security requirements.
- **Sophisticated diagnostics:** The MDS 9124V provides intelligent diagnostics tools such as ISL diagnostics, HBA diagnostics, remote SFP-error collection, Switched Port Analyzer (SPAN), integrated Cisco Call Home capability, Slow Drain Monitoring and an Online Health Management System for greater reliability, faster problem resolution, and reduced service costs.
- **Virtual-machine awareness:** The MDS 9124V provides visibility into all virtual machines that are accessing storage LUNs or namespaces in the fabric. This feature is available through HBAs capable of priority tagging the Virtual Machine Identifier (VMID) on every Fibre Channel frame. Virtual-machine awareness can be extended to intelligent fabric services such as analytics to visualize performance of every flow originating from each virtual machine in the fabric.
- **Programmable fabric:** The MDS 9124V provides Cisco NX-API, a powerful RPC-style HTTP/HTTPS API to enable flexible and rapid programming of utilities for the SAN. This can be coupled with specific modules for Ansible and Python.
- **Secure-boot and anti-counterfeiting technology:** The MDS 9124V uses onboard hardware that protects the entire system from malicious attacks by securing access to critical components such as the bootloader, system image loader, and Joint Test Action Group (JTAG) interface.

SAN architecture benefits

The new 64-Gbps fabric switches address the requirement for highly scalable, virtualized, intelligent SAN infrastructure in current-generation data center environments. The industry is already poised to transition to 64-Gbps fixed switches with the availability of 64-Gbps HBAs and storage arrays from vendors. Additionally, as low-latency flash arrays and extremely dense virtualization deployments become more pervasive, fixed switches will be expected to provide 64-Gbps connectivity to the SAN core.

This solution offers several important benefits:

- **Server port consolidation:** The demand for 64-Gbps fabric switches will increase as hyperscale virtualization doubles the virtual machine density per rack, increasing the need for higher bandwidth HBA ports per rack of blade or standalone servers. Soon 64-Gbps HBA ports will consolidate the current 16-Gbps HBA installed base, with the need to increase the server capacity in the same rack. Hence, the MDS 9124V, with 24-port in a 1RU form factor, provides an excellent solution.
- **Simplification:** Through consolidation, the SAN administrator can reduce complexity and simplify management. With an MDS 9124V 64-Gbps 24-Port switch in N_Port ID Virtualization (NPIV) core mode and Fibre Channel switches connecting to it in N_Port Virtualization (NPV) mode, device ports can scale very cost-effectively over time without adding the burden of managing the NPV switches. Auto-zoning facilitates zero-touch automatic zoning without any need for configuring zoning on the 64-Gbps fixed switches that are deployed in SANs with single switch topology.

- **Multiprotocol convergence:** 64-Gbps links benefit from lower latency when compared to lower bandwidth links, bringing better network throughput to your storage array workloads. Greater bandwidth also helps ensure less ISL congestion for the newer storage protocols that are expected to be available on externally attached storage arrays: for instance, NVMe over Fibre channel can coexist on the same link as existing SCSI workloads.
- **Scale and performance:** This fixed form-factor switch supports the performance and scale required to deploy a dedicated and standalone Fibre Channel SAN connecting both initiators and targets without requiring any other switching infrastructure.

VSAN

VSANs are ideal for efficient, secure SAN consolidation, enabling more efficient storage network utilization by creating hardware-based isolated environments with a single physical SAN fabric or switch. Each VSAN can be zoned as a typical SAN and maintains its own fabric services for added scalability and resilience. VSANs allow the cost of SAN infrastructure to be shared among more users, while helping ensure complete segregation of traffic and retaining independent control of configuration on a VSAN-by-VSAN basis.

IVR

In another step toward deploying efficient, cost effective, consolidated storage networks, the Cisco MDS 9124V supports IVR, the industry's first routing function for Fibre Channel. IVR allows selective transfer of data between initiators and targets on different VSANs while maintaining isolation of control plane traffic within each VSAN. With IVR, data can transit VSAN boundaries while maintaining control plane isolation, thereby maintaining fabric stability and availability. IVR is one of the feature enhancements requiring a license and eliminates the need for external routing appliances, greatly increasing routing scalability while delivering line rate routing performance, simplifying management, and eliminating the challenges associated with maintaining separate systems. Under the right circumstances, deploying IVR means lower total cost of SAN ownership.

Comprehensive solution for Robust Network Security

To address the need for enhanced security in storage networks, the Cisco MDS 9124V includes as standard an extensive security framework to protect highly sensitive data crossing today's enterprise networks:

- **Smart Zoning:** When the Smart Zoning feature is enabled, Cisco MDS 9000 Family fabrics provision the hardware access control entries specified by the zone set more efficiently, avoiding the superfluous entries that would allow servers (initiators) to communicate to other servers, or allow storage devices (targets) to communicate to other storage devices. This feature makes larger zones with multiple initiators and multiple targets feasible without excessive consumption of hardware resources. Thus, smart zones can correspond to applications, application clusters, hypervisor clusters, or other data center entities, saving the time that administrators previously spent creating many small zones, and enabling the automation of zoning tasks.
- Intelligent packet inspection is provided at the port level, including the application of ACLs for hardware enforcement of zones, VSANs, and advanced port security features.
- Switch-to-switch and host-to-switch authentication helps eliminate disruptions that may occur because of unauthorized devices connecting to a large enterprise fabric.
- FC-SP ESP payload encryption, which supports encrypted data to flow through the switch, is supported.

- Port security locks down the mapping of an entity to a switch port to help ensure that SAN security is not compromised by the connection of unauthorized devices to a switch port.
- VSAN-based access control allows customers to define roles in which the scope of the roles is limited to certain VSANs.
- FC-SP provides switch-switch and host-switch Diffie-Hellman Challenge Handshake Authentication Protocol (DH-CHAP) authentication, supporting RADIUS and TACACS+, to help ensure that only authorized devices access protected storage networks.
- Digital certificates are issued by a trusted third party and are used as electronic passports to prove the identity of certificate owners.

Ease of management

To meet the needs of all users, the Cisco MDS 9124V provides three principal modes of management: the Cisco MDS 9000 Family CLI and integration with third-party storage management tools.

The Cisco MDS 9124V presents a consistent, logical CLI. Adhering to the syntax of the widely known Cisco NX-OS® Software CLI, the Cisco MDS 9000 Family CLI is easy to learn and delivers broad management capabilities. The Cisco MDS 9000 Family CLI is an extremely efficient and direct interface designed to provide optimal capabilities to administrators in enterprise environments.

Cisco MDS Smart Licensing

The Cisco MDS 9124V supports the Cisco Smart Licensing Using Policy (SLP) licensing model. With this licensing model, it is easier to buy, use, and manage Cisco MDS software and port expansion licenses for MDS 9124V. The licenses are in digital form and, once ordered on Cisco Commerce, are credited instantly to the customer's Cisco Smart Account or partner holding account. The software licenses are not tied to a serial number, so a customer can allocate the software licenses on different switches of the same model as required. Through the Cisco Smart Account on Cisco Smart Software Manager (CSSM), a customer can easily manage all its Cisco licenses from one single place.

Cisco MDS 9124V implements a simplified licensing model with two subscription software licenses – Premier and Advantage – available with 1-, 3-, 5-, and 7-year options for direct sale and for sale to OSM partners. The Premier subscription license includes Enterprise, NDFC and SAN Analytics licenses, and the Advantage subscription license incudes Enterprise and NDFC licenses. Customers can buy the subscription licenses as required, so they pay as they use.

Table 1. Software subscription licenses

Subscription Software Licenses	Included or Optional
Cisco MDS Premier Subscription License	Optional
Cisco MDS Advantage Subscription License	Optional

Product specifications

Table 2. Product specifications

Feature	Description
Product compatibility	Cisco MDS 9000 Family
Software compatibility	Cisco MDS 9000 NX-OS Release 9.3(1) or later
Protocols	• Fibre Channel standards • FC-PI-6 (INCITS 512-2015) • FC-PI-7 (INCITS 543-2019) • FC-FS-4 (INCITS 488-2016) • FC-FS-5 (INCITS 545-2019) • FC-GS-7 (INCITS 510-2017) • FC-GS-8 (INCITS 548-2020) • FC-LS-3 (INCITS 487-2018) • FC-LS-4 (INCITS 553-2020) • FC-SW-6 (INCITS 511-2016) • FC-SW-7 (INCITS 547-2020) • NVMe/FC (INCITS 540-2018) • NVMe/FC-2 (INCITS 556-2020) • FC-PH, Revision 4.3 (ANSI INCITS 230-1994) • FC-PH, Amendment 1 (ANSI INCITS 230-1994/AM1-1996) • FC-PH, Amendment 2 (ANSI INCITS 230-1994/AM2-1999) • FC-PH-2, Revision 7.4 (ANSI INCITS 297-1997) • FC-PH-3, Revision 9.4 (ANSI INCITS 303-1998) • FC-PI, Revision 13 (ANSI INCITS 352-2002) • FC-PI-2, Revision 10 (ANSI INCITS 404-2006) • FC-PI-3, Revision 4 (ANSI INCITS 460-2011) • FC-PI-4, Revision 8 (ANSI INCITS 450-2008) • FC-PI-5, Revision 6 (ANSI INCITS 479-2011) • FC-FS, Revision 1.9 (ANSI INCITS 373-2003) • FC-FS-2, Revision 1.01 (ANSI INCITS 424-2007) • FC-FS-2, Amendment 1 (ANSI INCITS 424-2007/AM1-2007)

Feature	Description
	• FC-FS-3, Revision 1.11 (ANSI INCITS 470-2011) • FC-FS-4 • F-LS, Revision 1.62 (ANSI INCITS 433-2007) • FC-LS-2, Revision 2.21 (ANSI INCITS 477-2011) • FC-LS-3, Includes revision 3.53 • FC-SW-2, Revision 5.3 (ANSI INCITS 355-2001) • FC-SW-3, Revision 6.6 (ANSI INCITS 384-2004) • FC-SW-4, Revision 7.5 (ANSI INCITS 418-2006) • FC-SW-5, Revision 8.5 (ANSI INCITS 461-2010) • FC-SW-6 • FC-GS-3, Revision 7.01 (ANSI INCITS 348-2001) • FC-GS-4, Revision 7.91 (ANSI INCITS 387-2004) • FC-GS-5, Revision 8.51 (ANSI INCITS 427-2007) • FC-GS-6, Revision 9.4 (ANSI INCITS 463-2010) • FC-GS-7, Includes revision 10.8 • FCP, Revision 12 (ANSI INCITS 269-1996) • FCP-2, Revision 8 (ANSI INCITS 350-2003) • FCP-3, Revision 4 (ANSI INCITS 416-2006) • FCP-4, Revision 2b (ANSI INCITS 481-2011) • FC-SB-2, Revision 2.1 (ANSI INCITS 349-2001) • FC-SB-3, Revision 1.6 (ANSI INCITS 374-2003) • FC-SB-3, Amendment 1 (ANSI INCITS 374-2003/AM1-2007) • FC-SB-4, Revision 3.0 (ANSI INCITS 466-2011) • FC-SB-5, Revision 2.00 (ANSI INCITS 485-2014) • FC-BB-2, Revision 6.0 (ANSI INCITS 372-2003) • FC-BB-3, Revision 6.8 (ANSI INCITS 414-2006) • FC-BB-4, Revision 2.7 (ANSI INCITS 419-2008) • FC-BB-5, Revision 2.0 (ANSI INCITS 462-2010) • FC-BB-6, Revision 2.00 (ANSI INCITS 509-2014) • FC-VI, Revision 1.84 (ANSI INCITS 357-2002) • FC-SP, Revision 1.8 (ANSI INCITS 426-2007) • FC-SP-2, Revision 2.71 (ANSI INCITS 496-2012)

Feature	Description
	• FAIS, Revision 1.03 (ANSI INCITS 432-2007) • FAIS-2, Revision 2.23 (ANSI INCITS 449-2008) • FC-IFR, Revision 1.06 (ANSI INCITS 475-2011) • FC-FLA, Revision 2.7 (INCITS TR-20-1998) • FC-PLDA, Revision 2.1 (INCITS TR-19-1998) • FC-Tape, Revision 1.17 (INCITS TR-24-1999) • FC-MI, Revision 1.92 (INCITS TR-30-2002) • FC-MI-2, Revision 2.6 (INCITS TR-39-2005) • FC-MI-3, Revision 1.03 (INCITS TR-48-2012) • FC-DA, Revision 3.1 (INCITS TR-36-2004) • FC-DA-2, Revision 1.06 (INCITS TR-49-2012) • FC-MSQS, Revision 3.2 (INCITS TR-46-2011) • Fibre Channel classes of service: Class 2, Class 3, and Class F • Fibre Channel standard port types: E and F • Fibre Channel enhanced port types: SD, ST, NP and TE • NVMe/FC • In-band management using IP over Fibre Channel (RFC 2625) • IPv6, IPv4, and Address Resolution Protocol (ARP) over Fibre Channel (RFC 4338) • Extensive IETF-standards based TCP/IP, SNMPv3, and remote monitoring (RMON) MIBs
Fibre Channel ports	• Fixed-switch form factor with 24 SFP+ ports base
Security	• VSAN fabric isolation • Intelligent packet inspection at port level • Hardware zoning by Access Control Lists (ACLs) • Fibre Channel Security Protocol (FC-SP) switch-to-switch authentication • FC-SP host-to-switch authentication • Role-Based Access Control (RBAC) using RADIUS, TACACS+, or Lightweight Directory Access Protocol (LDAP) authentication, authorization, and accounting (AAA) functions • Secure FTP (SFTP) • Secure Shell Protocol Version 2 (SSHv2) • Simple Network Management Protocol Version 3 (SNMPv3) implementing Advanced Encryption Standard (AES) • Control-plane security

Feature	Description
	• Cisco TrustSec® payload encryption • Secure Boot and Anti-counterfeit technology
Performance	• Port speed: 8-, 16-, 32 and 64-Gbps autosensing with 64 Gbps of dedicated bandwidth per port • Aggregate bandwidth of 1.5-Tbps end-to-end full duplex • Buffer credits: Up to 24,000 for a group of 24 ports, with a default of 1000 buffer credits per port and a maximum of 16,000 buffer credits for a single port in the group • Port groups: 1 port group of 24 ports • Port channel: Up to 24 load-balanced physical links grouped in one port channel
Diagnostics	• Power-On-Self-Test (POST) diagnostics • Online Health Management System (OHMS) diagnostics • Internal loopbacks • SPAN • Fibre Channel traceroute • Fibre Channel ping • Fibre Channel debug • Cisco Fabric Analyzer • Syslog • Port-level statistics • Link diagnostics (E-port and F-port links) • Read Diagnostic Parameter
Serviceability	• Configuration file management • Call Home • Port beaconing • Link cable beacon • System LEDs • SNMP traps for alerts

Feature	Description
Reliability and availability	• Cisco In-Service Software Upgrade (ISSU) • Hot-swappable, dual redundant power supplies • Hot-swappable fan tray with switch integrated temperature and power management • Hot-swappable SFP+ optics • Stateful process restart • Any port configuration for port channels • Fabric-based multipathing • Per-VSAN fabric services • Port tracking • FEC with HBA ports • Buffer-to-buffer state change notification with HBA ports
Network management	• Management access through the following out-of-band Ethernet ports ◦ mgmt0: 10/100/1000BASE-T port • RS-232 serial console port • USB power-on auto-provision port • Access protocols • Command-Line Interface (CLI) using the console and Ethernet port • SNMPv3 using the Ethernet port and in-band IP over Fibre Channel access • Storage Networking Industry Association (SNIA) Storage Management Initiative Specification (SMI-S) • NX-API for HTTP/HTTPS full programmability • Distributed device alias service • Network security • Per-VSAN RBAC using LDAP, RADIUS, and TACACS+-based AAA functions • Simple File Transfer Protocol (SFTP) • SSHv2 implementing AES • SNMPv3 implementing AES
Programming interfaces	• Scriptable CLI • Cisco DCNM/NDFC web services API • NX-API HTTP/HTTPS interfaces • Onboard Python interpreter • Cisco Embedded Event Manager (EEM)

Feature	Description
	• Cisco NX-OS Software scheduler
Physical dimensions (H x W x D) and weight	• 1 Rack Unit (1RU) (1.72 x 17.299 x 18 in. [4.37 x 43.94 x 45.72 cm]) excluding Power Supply Unit (PSU) and fan-tray handles • 18.73 lb. (8.5 kg)
Power	• 80 Plus Platinum certified power supplies • Power supply options ◦ 500W AC in base model, port-side exhaust variant (2 per switch) ◦ 500W AC in base model, port-side intake variant (2 per switch) ◦ 1200W AC/ HVAC/ HVDC in base model, Bidirectional airflow (2 per switch) • Power cord ◦ Notched C15 socket connector connecting to C16 plug on the power supply receptacle for 500W Power Supply ◦ Standard CAB-HVAC-C14-2M IEC C14 to Saf-d-grid connector on the power supply receptacle for 1200W Power Supply ◦ Check Ordering Information table in this document for power cords specific to regions • 500W PSU AC input: 100 to 240 VAC (10% range) • 1200W PSU AC input: 90V to 305V • 1200W PSU DC input: 192V to 400V • Frequency: 50 to 60 Hz (nominal) • Typical power consumption ◦ 94W for 24-Port switch in idle status with no optics modules ◦ 113W for 24-Port switch with 8 64G SW optics modules under 50% line rate ◦ 146W for 24-Port switch with 24 64G SW optics modules under 50% line rate • Airflow ◦ Back to front (toward ports) using port-side exhaust fans ◦ Front to back (inward from ports) using port-side intake fans ◦ 50 Cubic Feet per Minute (CFM) through system fan assembly at 77°F (25°C) • 100 CFM maximum
Temperature range	• Temperature, ambient operating: ◦ 32 to 104°F (0 to 40°C) with port-side exhaust and intake airflow variants • Temperature, ambient nonoperating and storage: –40° to 158°F (–40° to 70°C) • Relative humidity, ambient (noncondensing) operating: 10% to 90%

Feature	Description
	• Relative humidity, ambient (noncondensing) nonoperating and storage: 10% to 95% • Altitude, operating: –197 to 6500 ft (–60 to 2000m)
Approvals and compliance	• Safety compliance • CE Marking • UL 60950 • CAN/CSA-C22.2 No. 60950 • EN 60950 • IEC 60950 • TS 001 • AS/NZS 3260 • IEC60825 • EN60825 • 21 CFR 1040 • EMC compliance • FCC Part 15 (CFR 47) Class A • ICES-003 Class A • EN 55022 Class A • CISPR 22 Class A • AS/NZS 3548 Class A • VCCI Class A • EN 55024 • EN 50082-1 • EN 61000-6-1 • EN 61000-3-2 • EN 61000-3-3
Fabric services	• Name server • Registered State Change Notification (RSCN) • Login services • Fabric Configuration Server (FCS) • Broadcast • In-order delivery

Feature	Description
Advanced functions	• VSAN • IVR • NPV • Port Channel with multipath load balancing • Flow- and zone-based QoS
Supported Cisco optics, media, and transmission distances	• For detailed information about all supported transceivers, refer to Cisco MDS 9000 Family pluggable transceivers documentation.

Ordering information

Table 3. Ordering information

Part #	Product Description
DS-C9124V-8EK9	MDS 9124V 64G 1RU FC switch, w/ 8 active ports, 4 Fans, 2 PSUs, exhaust
DS-C9124V-8IK9	MDS 9124V 64G 1RU FC switch, w/ 8 active ports, 4 Fans, 2 PSUs, intake
M9124V-PL8	MDS 9124V 64G FC switch 8-port upgrade license
M9124V-PL8=	MDS 9124V 64G FC switch 8-port upgrade license, spare
DS-C9124V-8EK9=	MDS 9124V 64G 1RU FC switch, w/ 8 active ports, 4 Fans, 2 PSUs, exhaust, spare
DS-C9124V-8IK9=	MDS 9124V 64G 1RU FC switch, w/ 8 active ports, 4 Fans, 2 PSUs, intake, spare
DS-C9124V-8PEVK9	MDS 9124V 64G FC switch, w/ 8 active ports + 8x64G SW Optics, 4 Fans, 2 PSUs, exhaust
DS-C9124V-8PIVK9	MDS 9124V 64G FC switch, w/ 8 active ports + 8x64G SW Optics, 4 Fans, 2 PSUs, intake
DS-C9124V-8PETK9	MDS 9124V 64G FC switch, w/ 8 active ports + 8x32G SW Optics, 4 Fans, 2 PSUs, exhaust
DS-C9124V-8PITK9	MDS 9124V 64G FC switch, w/ 8 active ports + 8x32G SW Optics, 4 Fans, 2 PSUs, intake
DS-C9124V-24PEVK9	MDS 9124V 64G FC switch, w/ 24 active ports + 24x64G SW Optics, 4 Fans, 2 PSUs, exhaust
DS-C9124V-24PIVK9	MDS 9124V 64G FC switch, w/ 24 active ports + 24x64G SW Optics, 4 Fans, 2 PSUs, intake
DS-C9124V-24PETK9	MDS 9124V 64G FC switch, w/ 24 active ports + 24x32G SW Optics, 4 Fans, 2 PSUs, exhaust

Part #	Product Description
DS-C9124V-24PITK9	MDS 9124V 64G FC switch, w/ 24 active ports + 24x32G SW Optics, 4 Fans, 2 PSUs, intake

Part #	Accessories Description
DS-9124V-KIT-CSCO(=)	MDS 9124V Accessory Kit for Cisco (Spare)
DS-9124V-KIT-EM(=)	MDS 9124V Accessory Kit for Dell EMC (Spare)
DS-9124V-KIT-HDS(=)	MDS 9124V Accessory Kit for HDS (Spare)
DS-CAC-500W-E=	MDS 9100 500W port-side exhaust PSU (works with MDS 9124V switch) (Spare)
DS-CAC-500W-I=	MDS 9100 500W port-side intake PSU (works with MDS 9124V switch) (Spare)
DS-CAC-1200W=	AC PSU Bidirectional airflow, spare
DS-C32S-FAN-E=	MDS Switch FAN tray port-side Exhaust (works with MDS 9124V switch) (Spare)
DS-C32S-FAN-I=	MDS Switch FAN tray, port-side intake (works with MDS 9124V switch) (Spare)

Part #	Power Cords Description
CAB-9K10A-AR	Power Cord, 250VAC 10A IRAM 2073 Plug, Argentina
CAB-9K10A-AU	Power Cord, 250VAC 10A 3112 Plug, Australia
CAB-9K10A-CH	Power Cord, 250VAC 10A GB1002 Plug, China
CAB-9K10A-EU	Power Cord, 250VAC 10A CEE 7/7 Plug, EU
CAB-9K10A-ISR	Power Cord, 250VAC 10A SI16S3 Plug, Israel
CAB-9K10A-IT	Power Cord, 250VAC 10A CEI 23-16/VII Plug, Italy
CAB-9K10A-KOR	Power Cord, 125VAC 13A KSC8305 Plug, Korea
CAB-9K10A-SA	Power Cord, 250VAC 10A SABS 164/1 Plug, South Africa
CAB-9K10A-SW	Power Cord, 250VAC 10A, Straight C15, MP232 Plug, SWITZ
CAB-9K10A-TWN	Power Cord, 125VAC 15A CNS10917-2, Taiwan
CAB-9K10A-UK	Power Cord, 250VAC 10A BS1363 Plug (13 A fuse), UK
CAB-9K12A-NA	Power Cord, 125VAC 13A NEMA 5-15 Plug, North America
CAB-250V-10A-BR	Power Cord, 250VAC 10A, Brazil
CAB-C15-CBN	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors
CAB-C15-CBN-CK	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors, China, Republic of Korea
CAB-C15-CBN-EURA	Cabinet Jumper Power Cord, 250 VAC 13A, C14-C15 Connectors, EU, Russian Federation, Belarus, Kazakhstan, and Australia

Part #	Optics Description
DS-SFP-FC64G-SW=*	64G FC Shortwave Optics
DS-SFP-FC32G-SW=*	32G FC Shortwave Optics
DS-SFP-FC32G-LW=*	32G FC Longwave Optics
DS-SFP-FC32G-ELW=*	32 Gbps Fibre Channel Extended LW SFP+
DS-SFP-FC16G-SW=*	16G FC Shortwave Optics
DS-SFP-FC16G-LW=*	16G FC Longwave Optics
DS-SFP-FC16GELW=*	16 Gbps Fibre Channel Extended LW SFP+

*For detailed information about all supported transceivers, refer to the Cisco MDS 9000 Family pluggable transceivers documentation.

Part #	Optional Licenses
M91VXK9-P-1Y	Cisco MDS Premier Subscription License for 1 years for direct sale
M91VXK9-P-3Y	Cisco MDS Premier Subscription License for 3 years for direct sale
M91VXK9-P-5Y	Cisco MDS Premier Subscription License for 5 years for direct sale
M91VXK9-P-7Y	Cisco MDS Premier Subscription License for 7 years for direct sale
M91VXK9-P-1Y-OSM	Cisco MDS Premier Subscription License for 1 year for sale via OSM partners
M91VXK9-P-3Y-OSM	Cisco MDS Premier Subscription License for 3 years for sale via OSM partners
M91VXK9-P-5Y-OSM	Cisco MDS Premier Subscription License for 5 years for sale via OSM partners
M91VXK9-P-7Y-OSM	Cisco MDS Premier Subscription License for 7 years for sale via OSM partners
M91VXK9-A-1Y	Cisco MDS Advantage Subscription License for 1 year for direct sale
M91VXK9-A-3Y	Cisco MDS Advantage Subscription License for 3 years for direct sale
M91VXK9-A-5Y	Cisco MDS Advantage Subscription License for 5 years for direct sale

Part #	Optional Licenses
M91VXK9-P-7Y	Cisco MDS Advantage Subscription License for 7 years for direct sale
M91VXK9-A-1Y-OSM	Cisco MDS Advantage Subscription License for 1 year for sale via OSM partners
M91VXK9-A-3Y-OSM	Cisco MDS Advantage Subscription License for 3 years for sale via OSM partners
M91VXK9-A-5Y-OSM	Cisco MDS Advantage Subscription License for 5 years for sale via OSM partners
M91VXK9-A-7Y-OSM	Cisco MDS Advantage Subscription License for 7 years for sale via OSM partners

Product sustainability

Information about Cisco's Environmental, Social and Governance (ESG) initiatives and performance is provided in Cisco's CSR and sustainability reporting.

Table 4. Product sustainability

Sustainability Topic	Reference
General	
Information on product-material-content laws and regulations	Materials
Information on electronic waste laws and regulations, including our products, batteries and packaging	WEEE Compliance
Information on product takeback and reuse program	Cisco Takeback and Reuse Program
Sustainability Inquiries	Contact: csr_inquiries@cisco.com
Material	
Product packaging, weight and materials	Contact: environment@cisco.com
Size and Weights	Table 2: Product specifications

Cisco makes the packaging data available for informational purposes only. It may not reflect the most current legal developments, and Cisco does not represent, warrant, or guarantee that it is complete, accurate, or up to date. This information is subject to change without notice.

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Document history

New or Revised Topic	Described In	Date
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Cisco MDS 9000 Series Pluggable Transceivers

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Product overview

The Cisco® Small Form-Factor Pluggable (SFP), Enhanced SFP (SFP+), and X2 devices are hot-swappable transceivers. The transceivers plug into Cisco MDS 9000 Series director switching modules and fabric switch ports. They allow you to choose different cabling types and distances on a port-by-port basis.

You can use them with the Cisco MDS 9000 Series products as shown in Table 1.

Table 1. Cisco SFP, SFP+, and X2 Transceivers Available for Use with the Cisco MDS 9000 Series

Switching Module and Fabric Switch	DS-SFP-FC-2G-xx	DS-SFP-FC4G-xx	DS-SFP-FC8G-xx	DS-SFP-FC10G-xx	DS-SFP-FCGE-xx	DS-SFP-GE-T	DS-X2-FC10G-xx (non-CX4) B	DS-SFP-FC16G-xx/DS-SFP-FC16G-XXX	DS-SFP-FC32G-XX	DS-SFP-FC64G-XX
DS-X9232-256K9		Yes[2,10]	Yes[2]	Yes[2]						
DS-X9248-256K9		Yes[2,10]	Yes[2]	Yes[2]						
DS-X9304-18K9		Yes[2]			Yes[1]	Yes[D]				
DS-X9316-SSNK9					Yes[F]	Yes[F,15]				
DS-X9704							Yes[2]			
DS-C9220I-K9*			Yes[2,19]					Yes[2,19]	Yes[2]	
DS-C9222i-K9		Yes[2]			Yes[1]	Yes[D]				
DS-C9124-K9		Yes[2]								
DS-C9148-K9		Yes[2,7]	Yes[2,11]							
DS-X9448-768K9			Yes[2,14]	Yes[2]				Yes[2]		
DS-C9250I-K9			Yes[2,14]		Yes[17]	Yes[17]		Yes[2]		
DS-C9396S-K9			Yes[2,14]	Yes[2]				Yes[2]		
DS-C9148S-K9			Yes[2,14]					Yes[2]		
DS-X9334-K9			Yes[2,14]	Yes	Yes	Yes		Yes[2]		
DS-X9648-1536K9			Yes[2,19]					Yes[2]	Yes[2]	
DS-X9748-3072K9								Yes[2]	Yes[2]	Yes[2]
DS-C9132T-K9			Yes[2,19]					Yes[2,19]	Yes[2]	
DS-C9148T-K9			Yes[2,19]					Yes[2,19]	Yes[2]	
DS-C9396T-K9			Yes[2,19]					Yes[2,19]	Yes[2]	
DS-C9124V-K9								Yes[2]	Yes[2]	Yes[2]
DS-C9148V-K9								Yes[2]	Yes[2]	Yes[2]

Switching Module and Fabric Switch	DS-SFP-FC-2G-xx	DS-SFP-FC4G-xx	DS-SFP-FC8G-xx	DS-SFP-FC10G-xx	DS-SFP-FCGE-xx	DS-SFP-GE-T	DS-X2-FC10G-xx (non-CX4) B	DS-SFP-FC16G-xx/DS-SFP-FC16G-XXX	DS-SFP-FC32G-XX	DS-SFP-FC64G-XX
DS-C9396V-K9								Yes[2]	Yes[2]	Yes[2]

Table 2. Cisco SFP, SFP+, QSFP and X2 Transceivers Available for Use with the Cisco MDS 9000 Series

Switching Module and Fabric Switch	DS-X2-FC10G-CX4=C	DS-X2-E10G-SR=A	DS-CWDM-xxxx=	DS-CWDM4 Gxxxx=A	DS-CWDM8 Gxxxx=	DWDM-SFP-xxxx=A	ONS-SC-4G-xx.x= G	SFP-10G-XX/DS-SFP-10GE-XX	SFP-H10GB-xCUM	DWDM-X2-xx.xx=E	DWDM-SFP10G-xx.xx=	QSFP-40G-CSR4[20], QSFP-40G-LR4[20], QSFP-40G-LR4-S[20], QSFP-40/100G-SRBD[20], QSFP-40G-SR4[20], QSFP-40G-SR-BD[20]
DS-X9232-256K9				Yes[2,13]			Yes[2]	Yes[8,12]				
DS-X9248-256K9				Yes[2,13]			Yes[2]	Yes[8,12]				
DS-X9304-18K9			Yes[6]	Yes[2,13]		Yes[2,6]	Yes[2]					
DS-X9316-SSNK9			Yes[F]			Yes[F]						
DS-X9704	Yes[2]	Yes[2]								Yes[2]		
DS-X9708-K9								Yes[8,12]	Yes[9]			
DS-C9220I-K9*	Yes[14,18]	Yes[14,18]										Yes[21]
DS-C9222i-K9*			Yes[6]	Yes[2,13]		Yes[2,6]	Yes[2]					
DS-C9124-K9			Yes[3]	Yes[2,4]			Yes[2]					
DS-C9148-K9				Yes[2,13]	Yes[2,13,H]		Yes[2]					
DS-X9448-768K9					Yes[2,13,H]			Yes[8]				
DS-C9250I-K9					Yes[2,13,H,14]			Yes[8]	Yes[9]		Yes[2,16]	
DS-X9848-480K9								Yes[8,12]	Yes[9]		Yes[2]	

Switching Module and Fabric Switch	DS-X2-FC10G-CX4=C	DS-X2-E10G-SR=A	DS-CWDM-xxxx=	DS-CWDM4 Gxxxx=A	DS-CWDM8 Gxxxx=	DWDM-SFP-xxxx=A	ONS-SC-4G-xx.x= G	SFP-10G-XX/DS-SFP-10GE-XX	SFP-H10GB-xCUM	DWDM-X2-xx.xx=E	DWDM-SFP10G-xx.xx=	QSFP-40G-CSR4[20], QSFP-40G-LR4[20], QSFP-40G-LR4-S[20], QSFP-40/100G-SRBD[20], QSFP-40G-SR4[20], QSFP-40G-SR-BD[20]
DS-C9396S-K9					Yes[2,13,14]			Yes[8]				
DS-C9148S-K9					Yes[2,13,14]							
DS-X9824-960K9					Yes[2, 13,14]							Yes
DS-X9334-K9					Yes[2,13,14]			Yes	Yes		Yes	Yes[21]
DS-X9648-1536K9					Yes[2,13,14]							
DS-C9132T-K9					Yes[2,13,14]							
DS-C9148T-K9					Yes[2,13,14]							
DS-C9396T-K9					Yes[2,13,14]							

Switching Module and Fabric Switch	DS-8G-ZR-XXXX	DS-16G-ER-XXXX
DS-X9448-768K9	Yes[14,18]	Yes[14,18]
DS-C9250I-K9	Yes[14,18]	Yes[14,18]
DS-C9396S-K9	Yes[14,18]	Yes[14,18]
DS-C9148S-K9	Yes[14,18]	Yes[14,18]
DS-X9334-K9	Yes[14,18]	Yes[14,18]
DS-X9648-1536K9	Yes[14,18]	Yes[14,18]
DS-C9132T-K9	Yes[14,18]	Yes[14,18]
DS-C9148T-K9	Yes[14,18]	Yes[14,18]
DS-C9396T-K9	Yes[14,18]	Yes[14,18]

[A] Supported on switches running Cisco MDS 9000 SAN-OS Software Release 3.1(3) or later.

[B] DS-X2-FC10G-ER supported on switches running Cisco MDS 9000 SAN-OS Software Release 3.1(3) or later.

[C] Supported on switches running Cisco MDS 9000 SAN-OS Software Release 3.2(1) or later.

[D] Supported on switches running Cisco MDS 9000 SAN-OS Software Release 3.3(1) or later.

[E] Supported on switches running Cisco MDS 9000 NX-OS Software Release 4.1(1) or later.

[F] Supported on switches running Cisco MDS 9000 NX-OS Software Release 4.2(1) or later.

[G] Supported on switches running Cisco MDS 9000 NX-OS Software Release 5.0 or later.

[H] Supported on switches running Cisco MDS 9000 NX-OS Software Release 6.2(5) or later.

[1] Supported on Ethernet ports only.

[2] Digital diagnostic monitoring supported.

[3] Limited to 60 km.

[4] Limited to 30 km.

[5] DS-X2-FC10G-ER not supported.

[6] Supported on both Fibre Channel and Ethernet ports.

[7] Only DS-SFP-FC4G-SW is supported.

[8] Only -SR, -LR, and -ER are supported.

[9] Passive copper -CU1M, -CU3M, -CU5M, and active copper -ACU7M and -ACU10M Twinax cables are supported.

[10] DS-SFP-4GF-MR is not supported.

[11] Maximum distance with DS-SFP-FC8G-ER is limited to 31 km.

[12] Maximum distance with SFP-10G-ER is limited to 20 km.

[13] Maximum distance for Coarse Wavelength-Division Multiplexing (CWDM) optics is 25 km to account for dB loss in CWDM multiplexer and demultiplexer.

[14] Refer to Configuration Limits for Optics Modules.

[15] Ethernet autonegotiation is not supported.

[16] Supported only for Fibre Channel over Ethernet (FCoE) ports prior to Cisco MDS 9000 NX-OS Release 6.2(15).

[17] Supported on NX-OS Release 6.2(13) and later.

[18] Refer to Third Party Modules for ordering, support and technical information.

[19] 2G speeds not supported on 32G module. Only 4G speeds and 8G speeds supported when 8G SFPs are used. Only SW and LW supported on 32G module. Supported in NX-OS 8.x version and higher.

[20] Refer to Cisco 40GBASE QSFP Datasheet for detailed specifications.

[21] Supported on NX-OS Release 8.5(1) and later.

[*] DS-C9220i-K9 supports the following Ethernet optics.

Table 3. Cisco Ethernet Transceivers

Speed	Optics PID	Fiber
1G	GLC-SX-MMD	MMF LC
	GLC-LH-SMD	SMF LC
10G	SFP-10G-SR	MMF LC
	SFP-10G-LR/ SFP-10G-LR-S	SMF LC
40G	QSFP-40G-CSR4	MPO12
	QSFP-40G-SR-BD	MMF LC
	QSFP-40G-LR4	SMF LC
	QSFP-40G-LR4-S	SMF LC
	QSFP-40/100G-SRBD	MMF LC
	QSFP-40G-SR4	MPO12

Note: Unless a specific software version is mentioned, the transceivers listed in Table 1 are supported in all versions of Cisco NX-OS Software for which corresponding line cards or chassis are supported.

Cisco 2-Gbps Fibre Channel SFP Modules

Cisco 2-Gbps Fibre Channel SFP modules (Figure 1) provide cost-effective Fibre Channel connectivity for Cisco MDS 9000 Series Fibre Channel switching modules. Two types are available: the Cisco Fibre Channel Shortwave SFP (part number DS-SFP-FC-2G-SW) and the Cisco Fibre Channel Longwave SFP (part number DS-SFP-FC-2G-LW). Each offers 1/2-Gbps autosensing Fibre Channel connectivity.

Figure 1.
Cisco 2-Gbps Fibre Channel SFP Modules

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 4 summarizes the cabling specifications.

Table 4. Cisco 2-Gbps Fibre Channel SFP Cabling Specifications

SFP	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC-2G-SW	850	MMF	62.5 (OM1) 62.5 (OM1) 50.0 (OM2) 50.0 (OM2)	1.0625 2.125 1.0625 2.125	984 ft (300m) 492 ft (150m) 1640 ft (500m) 984 ft (300m)
DS-SFP-FC-2G-LW	1310	SMF	9.0	1.0625 / 2.125	6.2 mi (10 km)

Note: The minimum cable distance for all SFP modules listed (multimode fiber [MMF] and single-mode fiber [SMF]) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.75 x 55.2 mm.

Environmental conditions and Power requirements

Table 5 presents the optical parameters, and Table 6 presents temperature ranges.

Table 5. Optical parameters

SFP	Average Transmit Power (decibels per milliwatt [dBm])		Average Receive Power (dBm)		Fiber Loss Budget (decibels [dB])
	Maximum	**Minimum**	**Maximum**	**Minimum**	
DS-SFP-FC-2G-SW	-2.5	-10.0	0	-	2.1 (OM1) 2.62 (OM2)
DS-SFP-FC-2G-LW	-3	-11.7	-3	-	7.8

Table 6. Operating and storage temperature ranges

SFP	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-SFP-FC-2G-SW	70°C	0°C	85°C	-40°C
DS-SFP-FC-2G-LW	70°C	0°C	85°C	-40°C

Regulatory and Standards Compliance

- Compliant with Fibre Channel FC-PI 200-SM-LC-L, FC-PI 200-M5-SN-I, and 200-M6-SN-I 2.125 GBd specifications.
- Compliant with Fibre Channel FC-PI 100-SM-LC-L, FC-PI 100-M5-SN-I, and FC-PI 100-M6-SN-I; and with FC PH2 100-SM-LC-L, FC-PH2 100-M5-SN-I, and FC-PH2 100-M6-SN-I 1.0625 GBd specifications.
- Laser Class I 21CFR1040.

Ordering information

Table 7 provides ordering information.

Table 7. Cisco 2-Gbps Fibre Channel SFP ordering information

Part Number	Description
DS-SFP-FC-2G-SW	1/2-Gbps Fibre Channel-Shortwave, SFP, LC
DS-SFP-FC-2G-SW=	1/2-Gbps Fibre Channel-Shortwave, SFP, LC, Spare
DS-FC-SW-4PK=	1/2-Gbps Fibre Channel-Shortwave, SFP, LC, 4 pack, Spare
DS-SFP-FC-2G-LW	1/2-Gbps Fibre Channel-Longwave, SFP, LC
DS-SFP-FC-2G-LW=	1/2-Gbps Fibre Channel-Longwave, SFP, LC, Spare

Cisco 4-Gbps Fibre Channel SFP Modules

Cisco 4-Gbps Fibre Channel SFP modules (Figure 2) provide cost-effective Fibre Channel connectivity for 1/2/4-Gbps ports on the Cisco MDS 9000 Series platform. Three types are available: the Cisco Fibre Channel Shortwave SFP (part number DS-SFP-FC4G-SW), the Cisco 4-km Fibre Channel Longwave SFP (part number DS-SFP-FC4G-MR), and the Cisco 10-km Fibre Channel Longwave SFP (part number DS-SFP-FC4G-LW). Each offers 1/2/4 Gbps autosensing Fibre Channel connectivity.

Figure 2.
Cisco 4-Gbps Fibre Channel SFP Modules

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 8 summarizes the cabling specifications.

Table 8. Cisco 4-Gbps Fibre Channel SFP Cabling Specifications

SFP	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC4G-SW	850	MMF	62.5 (OM1)	1.0625	984 ft (300m)
			62.5 (OM1)	2.125	492 ft (150m)
			62.5 (OM1)	4.250	230 ft (70m)
			50.0 (OM2)	1.0625	1640 ft (500m)
			50.0 (OM2)	2.125	984 ft (300m)
			50.0 (OM2)	4.250	492 ft (150m)
			50.0 (OM3)	1.0625	2821 ft (860m)
			50.0 (OM3)	2.125	1640 ft (500m)
			50.0 (OM3)	4.250	1246 ft (380m)

SFP	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC4G-MR	1310	SMF	9.0	1.0625 / 2.125 / 4.250	2.4 mi (4 km)
DS-SFP-FC4G-LW	1310	SMF	9.0	1.0625 / 2.125 / 4.250	6.2 mi (10 km)

Note: The minimum cable distance for all SFP modules listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.75 x 55.2 mm.

Environmental conditions and Power requirements

Table 9 presents the optical parameters, and Table 10 presents temperature ranges.

Table 9. Optical parameters

SFP	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dB)
	Maximum	**Minimum**	**Maximum**	**Minimum**	
DS-SFP-FC4G-SW	-2.5	-9	0	-	1.78 (OM1) 2.06 (OM2) 2.88 (OM3)
DS-SFP-FC4G-MR	-3	-11.2	-1	-	4.8
DS-SFP-FC4G-LW	-3	-8.4	-1	-	7.8

Table 10. Operating and storage temperature ranges

SFP	Operating		Storage	
	Maximum	**Minimum**	**Maximum**	**Minimum**
DS-SFP-FC4G-SW	70° C	0° C	85° C	-40° C
DS-SFP-FC4G-MR	70° C	0° C	85° C	-40° C
DS-SFP-FC4G-LW	70° C	0° C	85° C	-40° C

Regulatory and Standards compliance

- Compliant with Fibre Channel FC-PI 400-SM-LC-L, FC-PI 400-SM-LC-M, FC-PI 400-M5-SN-I, and FC-PI 400-M6-SN-I 4.25 GBd specifications.
- Compliant with Fibre Channel FC-PI 200-SM-LC-L, FC-PI 200-M5-SN-I, and 200-M6-SN-I 2.125 GBd specifications.
- Compliant with Fibre Channel FC-PI 100-SM-LC-L, FC-PI 100-M5-SN-I, and FC-PI 100-M6-SN-I; and with FC PH2 100-SM-LC-L, FC-PH2 100-M5-SN-I, and FC-PH2 100-M6-SN-I 1.0625 GBd specifications.
- Laser Class I 21CFR1040.

Ordering information

Table 11 provides ordering information.

Table 11. Cisco Fibre Channel SFP ordering information

Part Number	Description
DS-SFP-FC4G-SW	1/2/4-Gbps Fibre Channel-Shortwave, SFP, LC
DS-SFP-FC4G-SW=	1/2/4-Gbps Fibre Channel-Shortwave, SFP, LC, Spare
DS-SFP-4G-SW-4=	1/2/4-Gbps Fibre Channel-Shortwave, SFP, LC, 4 pack, Spare
DS-SFP-FC4G-MR	1/2/4-Gbps Fibre Channel-Longwave 4-km, SFP, LC
DS-SFP-FC4G-MR=	1/2/4-Gbps Fibre Channel-Longwave 4-km, SFP, LC, Spare
DS-SFP-FC4G-LW	1/2/4-Gbps Fibre Channel-Longwave 10-km, SFP, LC
DS-SFP-FC4G-LW=	1/2/4-Gbps Fibre Channel-Longwave 10-km, SFP, LC, Spare

Cisco 8-Gbps Fibre Channel SFP+ Modules

Cisco 8-Gbps Fibre Channel SFP+ modules (Figure 3) provide Fibre Channel connectivity for the 2/4/8 Gbps ports on the Cisco MDS 9000 Series platform. Three types are available: the Cisco Fibre Channel Shortwave SFP+ (part number DS-SFP-FC8G-SW), the Cisco Fibre Channel Longwave SFP+ (part number DS-SFP-FC8G-LW), and the Cisco Fibre Channel Extended Reach SFP+ (part number DS-SFP-FC8G-ER). Each offers 2/4/8-Gbps autosensing Fibre Channel connectivity.

Figure 3.
Cisco 8-Gbps Fibre Channel SFP+ Modules

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 12 summarizes the cabling specifications.

Table 12. Cisco 8-Gbps Fibre Channel SFP+ Cabling Specifications

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC8G-SW	850	MMF	62.5 (OM1)	2.125	492 ft (150m)
			62.5 (OM1)	4.250	230 ft (70m)
			62.5 (OM1)	8.500	69 ft (21m)
			50.0 (OM2)	2.125	984 ft (300m)
			50.0 (OM2)	4.250	492 ft (150m)
			50.0 (OM2)	8.500	164 ft (50m)
			50.0 (OM3)	2.125	1640 ft (500m)
			50.0 (OM3)	4.250	1246 ft (380m)
			50.0 (OM3)	8.500	492 ft (150m)
			50.0 (OM4)	2.125	1706 ft (520m)
			50.0 (OM4)	4.250	1312 ft (400m)
			50.0 (OM4)	8.500	623 ft (190m)
			50.0 (OM5)	8.500	623 ft (190m)
DS-SFP-FC8G-LW	1310	SMF	9.0	2.125 / 4.250 / 8.500	6.2 mi (10 km)
DS-SFP-FC8G-ER	1550	SMF	9.0	2.125 / 4.250 / 8.500	24.85 mi (40 km)

Note: The minimum cable distance for all SFP+ modules listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental Conditions and Power Requirements

Table 13 presents the optical parameters, and Table 14 presents temperature ranges.

Table 13. Optical parameters

SFP	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dB)		
	Maximum	Minimum	Maximum	Minimum	OM1	OM2	OM3
DS-SFP-FC8G-SW	-1.3	-10 (2 Gbps) -9 (4 Gbps) -8.2 (8 Gbps)	0	-	2.10 (2 Gbps) 1.78 (4 Gbps) 1.58 (8 Gbps)	2.62 (2 Gbps) 2.06 (4 Gbps) 1.68 (8 Gbps)	3.31 (2 Gbps) 2.88 (4 Gbps) 2.04 (8 Gbps)
DS-SFP-FC8 G-LW	-3 (2 Gbps) -1 (4 Gbps) 0.5 (8 Gbps)	-11.7 (2 Gbps) -8.4 (4 Gbps) -8.4 (8 Gbps)	-3 (2 Gbps) -1 (4 Gbps) 0.5 (8 Gbps)	-	-7.8 (2 Gbps) 7.8 (4 Gbps) 6.4 (8 Gbps)		
DS-SFP-FC8G-ER	4	-4.7	-1	-	10.9		

Table 14. Operating and storage temperature ranges

SFP	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-SFP-FC8G-SW	70° C	0° C	85° C	-40° C
DS-SFP-FC8G-LW	70° C	0° C	85° C	-40° C
DS-SFP-FC8G-ER	70° C	0° C	85° C	-40° C

Regulatory and Standards compliance*

- Compliant with Fibre Channel FC-PI 800-SM-LC-L, FC-PI 800-M5-SN-S, FC-PI 800-M5E-SN-I, and FC PI 800-M6-SN-S 8.5 GBd specifications.
- Compliant with Fibre Channel FC-PI 400-SM-LC-L, FC-PI 400-M5-SN-I, FC-PI 400-M5E-SN-I, and FC PI 400-M6-SN-I 4.25 GBd specifications.
- Compliant with Fibre Channel FC-PI 200-SM-LC-L, FC-PI 200-M5-SN-I, FC-PI 200-M5E-SN-I, and 200 M6 SN-I 2.125 GBd specifications.
- Laser Class I 21CFR1040.

* Applicable only to DS-SFP-FC8G-SW and DS-SFP-FC8G-LW.

Ordering information

Table 15 provides ordering information.

Table 15. Cisco Fibre Channel SFP+ ordering information

Part Number	Description
DS-SFP-FC8G-SW	2/4/8-Gbps Fibre Channel-Shortwave, SFP+, LC
DS-SFP-FC8G-SW=	2/4/8-Gbps Fibre Channel-Shortwave, SFP+, LC, Spare
DS-SFP-8G-SW-4=	2/4/8-Gbps Fibre Channel-Shortwave, SFP+, LC, 4 pack, Spare
DS-SFP-FC8G-LW	2/4/8-Gbps Fibre Channel-Longwave, SFP+, LC
DS-SFP-FC8G-LW=	2/4/8-Gbps Fibre Channel-Longwave, SFP+, LC, Spare
DS-SFP-FC8G-ER	2/4/8-Gbps Fibre Channel Extended Reach SFP+, LC (40 km Reach)
DS-SFP-FC8G-ER=	2/4/8-Gbps Fibre Channel Extended Reach SFP+, LC, Spare (40 km Reach)

Cisco 10-Gbps Fibre Channel SFP+ Modules

Cisco 10-Gbps Fibre Channel SFP+ modules (Figure 4) provide Fibre Channel connectivity for the 10-Gbps Fibre Channel ports on the Cisco MDS 9000 Series platform. Two types are available: the Cisco Fibre Channel Shortwave SFP+ (part number DS-SFP-FC10G-SW) and the Cisco Fibre Channel Longwave SFP+ (part number DS-SFP-FC10G-LW).

Figure 4.
Cisco 10-Gbps Fibre Channel SFP+ Modules

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 16 summarizes the cabling specifications.

Table 16. Cisco 10-Gbps Fibre Channel SFP+ Cabling Specifications

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC10G-SW	850	MMF	62.5 (OM1) 50 (OM2) 50 (OM3)	10.518 10.518 10.518	104 ft (33m) 269 ft (82m) 984 ft (300m)
DS-SFP-FC10G-LW	1310	SMF	9.0	10.518	6.2 mi (10 km)

Note: The minimum cable distance for all SFP+ modules listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental Conditions and Power Requirements

Table 17 presents the optical parameters, and Table 18 presents the temperature ranges.

Table 17. Optical parameters

SFP	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dB)
	Maximum	Minimum	Maximum	Minimum	
DS-SFP-FC10G-SW	-1.2	-7.3	-1.0	-9.9	2.6 (OM3)
DS-SFP-FC10G-LW	0.5	-8.2	0.5	-14.4	6.2

Table 18. Operating and storage temperature ranges

SFP	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-SFP-FC10G-SW	70° C	0° C	85° C	-40° C
DS-SFP-FC10G-LW	70° C	0° C	85° C	-40° C

Regulatory and Standards Compliance

Laser Class I 21CFR1040

Ordering Information

Table 19 provides ordering information.

Table 19. Cisco Fibre Channel SFP+ ordering information

Part Number	Description
DS-SFP-FC10G-SW	10-Gbps Fibre Channel-Shortwave, SFP+, LC
DS-SFP-FC10G-SW=	10-Gbps Fibre Channel-Shortwave, SFP+, LC, Spare
DS-SFP-FC10G-LW	10-Gbps Fibre Channel-Longwave, SFP+, LC
DS-SFP-FC10G-LW=	10-Gbps Fibre Channel-Longwave, SFP+, LC, Spare

Cisco 10-Gbps Ethernet SFP+ Modules

Cisco 10-Gbps Ethernet SFP+ modules (Figure 5) provide 10-Gbps Ethernet connectivity for the Cisco MDS 9500 10-Gbps 8-Port FCoE Module and Cisco MDS 9250i Multiservice Fabric Switch.

Figure 5.
Cisco 10GBASE SFP+ Modules

Technical specifications

Connectors and Cabling

The connectors are dual LC/PC connectors.

Table 20 summarizes the cabling specifications.

Table 20. Cisco 10-Gbps Ethernet SFP+ Cabling Specifications

SFP+	Wavelength (nanometers)	Cable Type	Core Size (microns)	Modal Bandwidth (MHz km)**	Cable Distance*
SFP-10G-SR	850	MMF	50.0 50.0	500 (OM2) 2000 (OM3)	82m 300m
SFP-10G-LR	1310	SMF	9	-	10 km
SFP-10G-ER	1550	SMF	9	-	40 km
SFP-H10GB-CU1M	-	Twinax cable, passive, 30 AWG cable assembly		-	1m
SFP-H10GB-CU3M	-	Twinax cable, passive, 30 AWG cable assembly	-	-	3m
SFP-H10GB-CU5M	-	Twinax cable, passive, 24 AWG cable assembly	-	-	5m
SFP-H10GB-ACU7M	-	Twinax cable, active, 24 AWG cable assembly	-	-	7m
SFP-H10GB-ACU10M	-	Twinax cable, active, 24 AWG cable assembly	-	-	10m

* Minimum cabling distance for -SR, -LRM, -LR, and -ER modules is 2m according to the IEEE 802.3ae.

** Specified at transmission wavelength.

Note: Only connections with patch cords with PC or UPC connectors are supported. Patch cords with APC connectors are not supported. All cables and cable assemblies must comply with the standards specified in the Standards section.

Note: SMF must be ISO/IEC OS2 compliant

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental conditions and Power requirements

The operating temperature range is:

- Commercial temperature range: 32 to 158°F (0 to 70°C).
- Storage temperature range: –40 to 185°F (–40 to 85°C).

Table 21 presents the optical parameters, and Table 22 presents maximum power consumption.

Table 21. Optical parameters

SFP+	Type	Average Transmit Power (dBm)*		Average Receive Power (dBm)		Transmit and Receive Wavelength
		Maximum	Minimum	Maximum	Minimum	
SFP-10G-SR **DS-SFP-10GE-SR**	10GBASE-SR 850 nm MMF	-1.2**	-7.3	-1.0	-9.9	840 to 860
SFP-10G-LR **DS-SFP-10GE-LR**	10GBASE-LR 1310 nm SMF	0.5	-8.2	.05	-14.4	1260 to 1355
SFP-10G-ER	10GBASE-ER 1550 nm SMF	4	-4.7	-1.0	-15.8	1530 to 1565

* Transmitter and receiver power is an average, unless specified.

** The launch power shall be the lesser of the class 1 safety limit or the maximum receive power. Class 1 laser requirements are defined by IEC 60825-1: 2001.

Table 22. SFP+ Modules Maximum Power Consumption

Product	Power Consumption (watts)
SFP-10G-SR **DS-SFP-10GE-SR**	1
SFP-10G-LR **DS-SFP-10GE-LR**	1
SFP-10G-ER	1.2
SFP-H10GB-CU1M	1
SFP-H10GB-CU3M	1
SFP-H10GB-CU5M	1
SFP-H10GB-ACU7M	1
SFP-H10GB-ACU10M	1

Regulatory and Standards Compliance

Standards

- GR-20-CORE: Generic Requirements for Optical Fiber and Optical Fiber Cable.
- GR-326-CORE: Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies.
- GR-1435-CORE: Generic Requirements for Multifiber Optical Connectors.
- IEEE 802.3ae (-SR, -LRM, LR, and ER).
- SFP+ MSA SFF-8431 (Optical Modules and Passive Twinax Cables).
- SFP+ MSA SFF-8461 (Active Twinax Cables).

Safety

- Laser Class 1 21CFR-1040 LN 50 7/2001.
- Laser Class 1 IEC60825-1.
- The cable jackets of SFP+ copper modules are UL E116441 compliant.
- All lengths of SFP+ copper cables are ELV and RoHS compliant.

Warranty

- Standard warranty: The standard warranty is 90 days.
- Extended warranty (optional): Cisco SFP+ modules can be covered in a Cisco SMARTnet™ Service support contract for the Cisco switch or router chassis.

Ordering information

Table 23 provides ordering information.

Table 23. Cisco Fibre Channel over Ethernet SFP+ ordering information

Part Number	Description
Cisco 10GBASE-SR SFP+ Module for MMF	SFP-10G-SR
Cisco 10GBASE-LR SFP+ Module for SMF	SFP-10G-LR
Cisco 10GBASE-ER SFP+ Module for SMF	SFP-10G-ER
10GBASE-CU SFP+ Cable 1 Meter, passive	SFP-H10GB-CU1M
10GBASE-CU SFP+ Cable 3 Meter, passive	SFP-H10GB-CU3M
10GBASE-CU SFP+ Cable 5 Meter, passive	SFP-H10GB-CU5M
10GBASE-CU SFP+ Cable 7 Meter, active	SFP-H10GB-ACU7M
10GBASE-CU SFP+ Cable 10 Meter, active	SFP-H10GB-ACU10M

Cisco 40GBASE QSFP Modules

The Cisco 40GBASE Quad SFP (QSFP) portfolio offers customers a wide variety of high-density and low-power-consumption 40 Gigabit Ethernet connectivity options for data center, high-performance computing networks, enterprise core and distribution layers, and service provider applications.

Three types of 40GBASE QSFP modules are supported for Cisco MDS 40-Gbps line cards (Figure 6).

Figure 6.
Cisco 40GBASE SFP+ Modules

Technical specifications

Connectors and Cabling

QSFP-40G-SR4 and QSFP-40G-CSR4 are MPO-12 connectors, and QSFP-40G-SR-BD is an LC connector.

Table 24 summarizes the cabling specifications.

Table 24. Cisco 40GBASE Ethernet QSFP Cabling Specifications

SFP+	Wavelength (nanometers)	Cable Type	Core Size (microns)	Modal Bandwidth (MHz per km)	Cable Distance*
QSFP-40G-SR4	850	MMF	50.0	500 (OM2)	30m
			50.0	2000 (OM3)	100m
			50.0	4700 (OM4)	150m*
			50.0	4700 (OM5)	150m*
QSFP-40G-CSR4	832	MMF	50.0	500 (OM2)	30m
			50.0	2000 (OM3)	100m
			50.0	4700 (OM4)	150m*
			50.0	4700 (OM5)	150m*
QSFP-40G-SR-BD	832-918	MMF	50.0	500 (OM2)	82m
			50.0	2000 (OM3)	100m
			50.0	4700 (OM4)	150m
			50.0	4700 (OM5)	150m

* Minimum cabling distance is 0.5 meters for -SR4 and -CSR4 modules according to the IEEE 802.3 standard.

Dimensions

The maximum outer dimensions for the QSFP modules are (H x W x D) 13.5 x 18.4 x 72.4 mm.

Cisco QSFP connector modules typically weigh 100 grams or less.

Environmental Conditions and Power Requirements

The operating temperature range is as follows:

- Commercial temperature range: 32 to 158° F (0 to 70° C).
- Exception: QSFP BiDi (QSFP-40G-SR-BD): 50 to 158° F (10 to 70° C).
- Storage temperature range: -40 to 185° F (-40 to 85° C).

Table 25 presents the optical parameters, and Table 26 presents the maximum power consumption.

Table 25. Optical parameters

SFP+	Type	Average Transmit Power (dBm)*		Average Receive Power (dBm)		Transmit and Receive Wavelength
		Maximum	Minimum	Maximum	Minimum	
QSFP-40G-SR4	40GBASE-SR4, 4 lanes, 850-nm MMF	-1, per lane*	-7.6, per lane	2.4, per lane	-9.5, per lane	840 to 860
QSFP-40G-CSR4	40GBASE-CSR4, 4 lanes, 850-nm MMF	0, per lane	-7.3, per lane	0, per lane	-9.9, per lane	840 to 860
QSFP-40G-SR-BD	40GBASE-SR-BiDi, duplex MMF	+5, per lane	-4, per lane	+5, per lane	-6, per lane	832 to 918

* Transmitter and receiver power is an average unless specified otherwise.

Table 26. SFP+ Modules maximum power consumption

Product	Power Consumption (watts)
QSFP-40G-SR4	1.5
QSFP-40G-CSR4	1.5
QSFP-40G-SR-BD	3.5

Regulatory and Standards compliance

Standards

- GR-20-CORE: Generic Requirements for Optical Fiber and Optical Fiber Cable.
- GR-326-CORE: Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies.
- GR-1435-CORE: Generic Requirements for Multifiber Optical Connectors.
- IEEE 802.3ae (-CSR4).
- QSFP+ MSA SFF-8436.
- SFP+ MSA SFF-8431 and -8461.
- RoHS 6.

Safety

- The cable jackets of QSFP copper modules are UL E116441 compliant.
- QSFP copper cables are ELV compliant.

Warranty

- Standard warranty: The standard warranty is 90 days.
- Extended warranty (optional): Cisco SFP+ modules can be covered in a Cisco SMARTnet Service support contract for the Cisco switch or router chassis.

Ordering information

Table 27 provides ordering information.

Table 27. Cisco FCoE SFP+ ordering information

Part Number	Description
Cisco 40GBASE-SR4 QSFP Module for MMF	QSFP-40G-SR4
Cisco 40GBASE-CSR4 QSFP Module for MMF	QSFP-40G-CSR4
Cisco 40GBASE-SR Bi-Directional QSFP Module for Duplex MMF	QSFP-40G-SR-BD

Cisco Tri-Rate Multiprotocol SFP Modules

To ease management and sparing concerns, we offer SFP modules for use in both Fibre Channel and Gigabit Ethernet ports. The Cisco Tri-Rate Multiprotocol SFP modules can run at 1/2-Gbps Fibre Channel and 1 Gigabit Ethernet speeds, enabling the use of one type of SFP module for all ports on the Cisco MDS 9000 Series platform.

Two types of Tri-Rate Multiprotocol SFP modules are available (Figure 7): the Cisco Tri-Rate Multiprotocol Shortwave SFP (part number DS-SFP-FCGE-SW) and the Cisco Tri-Rate Multiprotocol Longwave SFP (part number DS-SFP-FCGE-LW). Each offers autosensing 1/2-Gbps Fibre Channel connectivity and 1 Gigabit Ethernet connectivity.

Figure 7.
Cisco Tri-Rate Multiprotocol SFP Modules

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 28 summarizes the cabling specifications.

Table 28. Cisco Tri-Rate Multiprotocol SFP Cabling Specifications

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FCGE-SW	850	MMF	62.5 62.5 50.0 (OM2) 50.0 (OM2)	1.0625 2.125 1.0625 2.125	984 ft (300m) 492 ft (150m) 1640 ft (500m) 984 ft (300m)
DS-SFP-FCGE-LW	1310	SMF	9.0	1.0625 / 2.125	6.2 mi (10 km)

Note: The minimum cable distance for all SFP modules listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant

Dimensions

The dimensions (H x W x D) are 8.5 x 13.75 x 55.2 mm.

Environmental Conditions and Power Requirements

Table 29 presents the optical parameters, and Table 30 presents temperature ranges.

Table 29. Optical parameters

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dBm)
	Maximum	Minimum	Maximum	Minimum	
DS-SFP-FCGE-SW	-1.2	-10.0 (Fibre Channel) and -9.5 (Gigabit Ethernet)	0	-17 (Gigabit Ethernet)	• 2.1 (Fibre Channel: 62.5 microns) and 2.62 (Fibre Channel: 50.0 microns [OM2]) • 2.38 (Gigabit Ethernet: 62.5 microns) and 3.37 (Gigabit Ethernet: 50.0 microns [OM2])
DS-SFP-FCGE-LW	-3	-11.0	-3	-19 (Gigabit Ethernet)	• 7.8 (Fibre Channel) • 4.57 (Gigabit Ethernet)

Note: The fiber loss budget is derived by taking the difference between the minimum average transmit power and the minimum average receive power and subtracting the link penalties. Use the specified fiber loss budget to calculate the maximum link distance.

Table 30. Operating and storage temperature ranges

SFP	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-SFP-FCGE-SW	70° C	0° C	85° C	-40° C
DS-SFP-FCGE-LW	70° C	0° C	85° C	-40° C

Regulatory and Standards Compliance

- Compliant with Fibre Channel FC-PI 200-SM-LC-L, FC-PI 200-M5-SN-I, and FC-PI 200-M6-SN-I 2.125 GBd; and with IEEE 802.3 Gigabit Ethernet (1.25 GBd) 1000BASE-SX specifications.
- Compliant with the Fibre Channel FC-PI 100-SM-LC-L, FC-PI 100-M5-SN-I, FC-PI 100-M6-SN-I, FC-PH2 100-SM-LC-L, FC-PH2 100-M5-SN-I, and FC-PH2 100-M6-SN-I 1.0625 GBd specifications.
- Laser Class I 21CFR1040.

Warranty

The standard warranty is one year.

Ordering information

Table 31 provides ordering information.

Table 31. Cisco Tri-Rate Multiprotocol SFP ordering information

Part Number	Description
DS-SFP-FCGE-SW	1/2-Gbps Fibre Channel and Gigabit Ethernet-Shortwave, SFP, LC
DS-SFP-FCGE-SW=	1/2-Gbps Fibre Channel and Gigabit Ethernet-Shortwave, SFP, LC, Spare
DS-SFP-FCGE-LW	1/2-Gbps Fibre Channel and Gigabit Ethernet-Longwave, SFP, LC
DS-SFP-FCGE-LW=	1/2-Gbps Fibre Channel and Gigabit Ethernet-Longwave, SFP, LC, Spare

Cisco Copper Gigabit Ethernet SFP Modules

For even more cabling flexibility, the Cisco MDS 9000 Series offers Cisco Copper Gigabit Ethernet SFP modules. Based on the 1000BASE-T standard, Copper Gigabit Ethernet SFP modules (Figure 8) provide cost-effective connectivity for data center applications. Copper Gigabit Ethernet SFP modules (part number DS-SFP-GE-T) allow the use of standard Category 5 Unshielded Twisted Pair (UTP) cabling for Ethernet connectivity.

Figure 8.
Cisco Copper Gigabit Ethernet SFP Modules

Technical specifications

Connectors and Cabling

The connectors are RJ-45 connectors.

Table 32 summarizes the cabling specifications.

Table 32. Cisco Copper Gigabit Ethernet SFP Cabling Specifications

SFP	Cable Type	Cable Distance
DS-SFP-GE-T	Category 5 UTP	100m (328 ft)

Dimensions

The dimensions (H x W x D) are 13.75 x 13.75 x 67.8 mm.

Environmental Conditions and Power Requirements

Table 33 presents the temperature ranges.

Table 33. Operating and storage temperature ranges

SFP	Operating		Storage	
	Maximum	**Minimum**	**Maximum**	**Minimum**
DS-SFP-GE-T	70°C	0°C	85°C	-40°C

Regulatory and Standards Compliance

Compliant with the IEEE 802.3 Gigabit Ethernet (1.25 GBd) 1000BASE-T specification.

Warranty

The standard warranty is one year.

Ordering information

Table 34 provides ordering information.

Table 34. Cisco Copper Gigabit Ethernet SFP ordering information

Part Number	Description
DS-SFP-GE-T	1-Gbps Copper Gigabit Ethernet SFP, 1000Base-T, RJ-45
DS-SFP-GE-T=	1-Gbps Copper Gigabit Ethernet SFP, 1000Base-T, RJ-45, Spare

Cisco 10-Gbps Fibre Channel X2 Transceivers

The Cisco Fibre Channel X2 Transceivers provide high-performance Fibre Channel connectivity for the 10-Gbps Fibre Channel ports on the Cisco MDS 9000 Series platform. There are three types of Cisco 10-Gbps Fibre Channel X2 Transceivers for transmission on optical cables: Cisco Short Reach (up to 300m; part number DS-X2-FC10G-SR), Cisco Long Reach (up to 10 km; part number DS-X2-FC10G-LR), and Cisco Extended Reach (up to 40 km; part number DS-X2-FC10G-ER) (Figure 9). There is also a 10-Gbps Fibre Channel X2 transceiver for transmission on copper cable (up to 15m; part number DS-X2-FC10G-CX4) (Figure 10). Each offers 10 Gbps Fibre Channel connectivity.

Figure 9.
Cisco 10-Gbps Fibre Channel X2 Transceiver (Part Numbers DS-X2-FC10G-SR, DS-X2-FC10G-LR, and DS X2 FC10G-ER)

Figure 10.
Cisco 10-Gbps Fibre Channel CX4 X2 Transceiver (Part Number DS-X2-FC10G-CX4)

Technical specifications

Connectors and Cabling

- Dual SC connector (DS-X2-FC10G-SR, DS-X2-FC10G-LR, and DS-X2-FC10G-ER).
- CX4 connector (DS-X2-FC10G-CX4).

Table 35 summarizes the cabling specifications.

Table 35. X2 Port Cabling Specifications

X2	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-X2-FC10G-SR	850	MMF	62.5 (OM1) 50.0 (OM3)	10.51875 10.51875	108 ft (33m) 984 ft (300m)
DS-X2-FC10G-LR	1310	SMF	9.0	10.51875	6.2 mi (10 km)
DS-X2-FC10G-ER	1550	SMF	9.0	10.51875	24.8 mi (40 km)
DS-X2-FC10G-CX4	-	Copper	-	10.51875	49.2 ft (15m)

Note: The minimum cable distance for all listed transceivers (MMF and SMF) except CX4 is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant

Dimensions

The dimensions (H x W x D) are 19.2 x 41.8 x 90.8 mm.

Environmental Conditions and Power Requirements

Table 36 presents the optical parameters, and Table 37 presents the temperature ranges.

Table 36. Optical parameters

X2	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dBm)
	Maximum	**Minimum**	**Maximum**	**Minimum**	
DS-X2-FC10G-SR	-1.2	-7.3	-1.0	-9.9	2.6 (OM3)
DS-X2-FC10G-LR	0.5	-8.2	0.5	-14.4	6.2
DS-X2-FC10G-ER	4.0	-4.7	-1.0	-15.8	11.1

Note: DS-X2-FC10G-CX4 is not an optical module and is therefore not listed in this table.

Table 37. Operating and storage temperature ranges

X2	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-X2-FC10G-SR	70° C	0° C	85° C	-40° C
DS-X2-FC10G-LR	70° C	0° C	85° C	-40° C
DS-X2-FC10G-ER	70° C	0° C	85° C	-40° C
DS-X2-FC10G-CX4	70° C	0° C	85° C	-40° C

Regulatory and Standards Compliance

- Compliant with Fibre Channel 10GFC 1200-M6-SN-I, 10GFC 1200-M5-SN-I, 10GFC 1200-M5E-SN-I, and 10GFC 1200-SM-LL-L 10.51875 GBd specifications.
- Compliant with IEEE 802.3 10GBASE-ER.
- Compliant with IEEE 802.3 10GBASE-CX4.
- Laser Class I 21CFR1040.

Ordering information

Table 38 provides ordering information.

Table 38. Cisco 10-Gbps Fibre Channel X2 Transceiver ordering information

Part Number	Description
DS-X2-FC10G-SR	10-Gbps Fibre Channel-Short-reach, X2, SC
DS-X2-FC10G-SR=	10-Gbps Fibre Channel-Short-reach, X2, SC, Spare
DS-X2-FC10G-LR	10-Gbps Fibre Channel-Long-reach, X2, SC
DS-X2-FC10G-LR=	10-Gbps Fibre Channel-Long-reach, X2, SC, Spare
DS-X2-FC10G-ER	10-Gbps Fibre Channel-Extended-reach, X2, SC
DS-X2-FC10G-ER=	10-Gbps Fibre Channel-Extended-reach, X2, SC, Spare
DS-X2-FC10G-CX4	10-Gbps Fibre Channel-Copper Transceiver, X2, CX4
DS-X2-FC10G-CX4=	10-Gbps Fibre Channel-Copper Transceiver, X2, CX4, Spare
DS-CAB-15M=	15m Cable for 10G Copper X2 Transceiver, Spare
DS-CAB-1M=	1m Cable for 10G Copper X2 Transceiver, Spare

Cisco 16-Gbps Fibre Channel SFP+ Transceivers

The Cisco 16-Gbps Fibre Channel SFP+ Transceivers (Figure 11) provide Fibre Channel connectivity for 4/8/16-Gbps ports on the Cisco MDS 9000 Series platform. Three types are available: the Cisco Fibre Channel Shortwave SFP+ (part number DS-SFP-FC16G-SW), the Cisco Fibre Channel Longwave SFP+ (part number DS-SFP-FC16G-LW), and the Cisco Fibre Channel Extended Longwave SFP+ (part number DS-SFP-FC16GELW). Each offers 4/8/16-Gbps autosensing Fibre Channel connectivity.

Figure 11.
Cisco 16-Gbps Fibre Channel SFP+ Transceivers

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 39 summarizes the cabling specifications.

Table 39. Cisco 16-Gbps Fibre Channel SFP+ Cabling specifications

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC16G-SW	850	MMF	62.5 (OM1)	14.025	49 ft (15m)
			50.0 (OM2)	14.025	115 ft (35m)
			50.0 (OM3)	14.025	328 ft (100m)
			50.0 (OM4/OM5)	14.025	410 ft (125m)
			62.5 (OM1)	8.5	69 ft (21m)
			50.0 (OM2)	8.5	164 ft (50m)
			50.0 (OM3)	8.5	492 ft (150m)
			50.0 (OM4/OM5)	8.5	623 ft (190m)
			62.5 (OM1)	4.25	230 ft (70m)
			50.0 (OM2)	4.25	492 ft (150m)
			50.0 (OM3)	4.25	1247 ft (380m)
			50.0 (OM4/OM5)	4.25	1312 ft (400m)

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC16G-LW	1310	SMF	9.0	14.025 / 8.5 / 4.25	6.2 mi (10 km)
DS-SFP-FC16GELW	1310	SMF	9.0	14.025 / 8.5 / 4.25	15.5 mi (25 km)

Note: The minimum cable distance for all SFP+ devices listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental conditions and Power requirements

Table 40 presents the optical parameters, and Table 41 presents temperature ranges.

Table 40. Optical parameters

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dB)			
	Maximum	Minimum	Maximum	Minimum	OM1	OM2	OM3	OM4/OM5
DS-SFP-FC16G-SW	-1.3	-7,8	0	-10.3*	2.08 (4 Gbps) 1.68 (8 Gbps) 1.63 (16 Gbps)	2.08 (4 Gbps) 1.68 (8 Gbps) 1.63 (16 Gbps)	2.88 (4 Gbps) 2.04 (8 Gbps) 1.86 (16 Gbps)	2.04 (8 Gbps) 1.95 (16 Gbps) 1.86 (32 Gbps)
DS-SFP-FC16G-LW	2.0	-5.0	2.0	-12.0*	7.8 (4 Gbps) 6.4 (8 Gbps) 6.4 (16 Gbps)			
DS-SFP-FC16GELW	5.0	-2.0	2.0	-14.0	10 (16 Gbps)			

Table 41. Operating and storage temperature ranges

SFP+	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-SFP-FC16G-SW	70° C	0° C	85° C	-40° C
DS-SFP-FC16G-LW	70° C	0° C	85° C	-40° C
DS-SFP-FC16GELW	70° C	0° C	85° C	-40° C

Regulatory and Standards compliance

- Compliant with Fibre Channel FC-PI 1600-SM-LC-L, FC-PI 1600-M5-SN-S, FC-PI 1600-M5E-SN-I, FC-PI 1600-M5F-SN-I, and FC-PI 1600-M6-SN-S 14.025-GBd specifications.
- Compliant with Fibre Channel FC-PI 800-SM-LC-L, FC-PI 800-M5-SN-S, FC-PI 800-M5E-SN-I, and FC-PI 800-M6-SN-S 8.5-GBd specifications.
- Compliant with Fibre Channel FC-PI 400-SM-LC-L, FC-PI 400-M5-SN-I, FC-PI 400-M5E-SN-I, and FC-PI 400-M6-SN-I 4.25-GBd specifications.
- Compliant with Fibre Channel FC-PI 200-SM-LC-L, FC-PI 200-M5-SN-I, FC-PI 200-M5E-SN-I, and 200-M6-SN-I 2.125-GBd specifications.
- Laser Class I 21CFR1040.

* Applicable only to DS-SFP-FC16G-SW and DS-SFP-FC16G-LW.

* Average receiver power (minimum) is based on a 4.5-dB extinction ratio.

* Optical parameters listed here are for 14.025-GBd applications.

Ordering information

Table 42 provides ordering information.

Table 42. Cisco Fibre Channel SFP+ ordering information

Part Number	Description
DS-SFP-FC16G-SW	16 Gbps Fibre Channel SW SFP+, LC
DS-SFP-FC16G-SW=	16 Gbps Fibre Channel SW SFP+, LC, spare
DS-SFP-FC16G-LW	16 Gbps Fibre Channel LW SFP+, LC
DS-SFP-FC16G-LW=	16 Gbps Fibre Channel LW SFP+, LC, spare
DS-SFP-FC16GELW	16 Gbps Fibre Channel ELW SFP+, LC
DS-SFP-FC16GELW=	16 Gbps Fibre Channel ELW SFP+, LC, spare

Cisco 32-Gbps Fibre Channel SFP+ Transceivers

The Cisco 32-Gbps Fibre Channel SFP+ Transceivers (Figure 12) provide Fibre Channel connectivity for 8/16/32-Gbps ports on the Cisco MDS 9000 Series platform. Two types are available: the Cisco Fibre Channel Shortwave SFP+ (part number DS-SFP-FC32G-SW) and the Cisco Fibre Channel Longwave SFP+ (part number DS-SFP-FC32G-LW). Each offers 8/16/32-Gbps autosensing Fibre Channel connectivity.

Figure 12.
Cisco 32-Gbps Fibre Channel SFP+ Transceivers

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 43 summarizes the cabling specifications.

Table 43. Cisco 32-Gbps Fibre Channel SFP+ Cabling Specifications

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC32G-SW	850	MMF	50.0 (OM2)	28.05	65 ft (20m)
			50.0 (OM3)	28.05	230 ft (70m)
			50.0 (OM4/OM5)	28.05	328 ft (100m)
			50.0 (OM2)	14.025	115 ft (35m)
			50.0 (OM3)	14.025	328 ft (100m)
			50.0 (OM4/OM5)	14.025	410 ft (125m)
			50.0 (OM2)	8.5	164 ft (50m)
			50.0 (OM3)	8.5	492 ft (150m)
			50.0 (OM4/OM5)	8.5	623 ft (190m)
DS-SFP-FC32G-LW	1310	SMF	9.0	28.05 / 14.025 / 8.5	6.2 mi (10 km)
DS-SFP-FC32G-ELW	1310	SMF	G.652	28.05 / 14.025 / 8.5	15.5mi (25 km)

Note: The minimum cable distance for all SFP+ devices listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental conditions and Power requirements

Table 44 presents the optical parameters, and Table 45 presents temperature ranges.

Table 44. Optical parameters

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dB)			
	Maximum	Minimum	Maximum	Minimum	OM2	OM3	OM4	OM5
DS-SFP-FC32G-SW	2.0	-6.2	2.0	-8.2	1.68 (8 Gbps) 1.63 (16 Gbps) 2.02 (32 Gbps)	2.04 (8 Gbps) 1.86 (16 Gbps) 1.86 (32 Gbps)	2.04 (8 Gbps) 1.95 (16 Gbps) 1.86 (32 Gbps)	2.04 (8 Gbps) 1.95 (16 Gbps) 1.86 (32 Gbps)
DS-SFP-FC32G-LW	2.0	-5.0	2.0	-11.4	6.4 (8 Gbps) 6.4 (16 Gbps) 6.4 (32 Gbps)			
DS-SFP-FC32G-ELW	7	30	-15.8	4.5	20			

Table 45. Operating and storage temperature ranges

SFP+	Operating		Storage	
	Maximum	**Minimum**	**Maximum**	**Minimum**
DS-SFP-FC32G-SW	70° C	0° C	85° C	-40° C
DS-SFP-FC32G-LW	70° C	0° C	85° C	-40° C
DS-SFP-FC32G-ELW	70° C	0° C	85° C	-40° C

Regulatory and Standards compliance

- Compliant with Fibre Channel (FC-PI-6) 3200-SM-LC-L (OS2), 3200-M5-SN-S (OM2), 3200-M5E-SN-I (OM3), 3200-M5F-SN-I (OM4) 28.05-GBd specifications.
- Compliant with Fibre Channel (FC-PI-5) 1600-SM-LC-L (OS2), 1600-M6-SN-S (OM1), 1600-M5-SN-S (OM2), 1600-M5E-SN-I (OM3), 1600-M5F-SN-I (OM4) 14.025-GBd specifications.
- Compliant with Fibre Channel (FC-PI-4) 800-SM-LC-L (OS2), 800-M6-SN-S (OM1), 800-M5-SN-S (OM2), 800-M5E-SN-I (OM3), 800-M5F-SN-I (OM4) 8.5-GBd specifications.
- Laser Class I 21CFR1040.

Ordering information

Table 46 provides ordering information.

Table 46. Cisco Fibre Channel SFP+ ordering information

Part Number	Description
DS-SFP-FC32G-SW	32 Gbps Fibre Channel SW SFP+, LC
DS-SFP-FC32G-SW=	32 Gbps Fibre Channel SW SFP+, LC, spare
DS-SFP-FC32G-LW	32 Gbps Fibre Channel LW SFP+, LC
DS-SFP-FC32G-LW=	32 Gbps Fibre Channel LW SFP+, LC, spare
DS-SFP-FC32G-ELW	32 Gbps Fibre Channel ELW SFP+, LC
DS-SFP-FC32G-ELW=	32 Gbps Fibre Channel ELW SFP+, LC, spare

Cisco 64-Gbps Fibre Channel SFP+ Transceivers

The Cisco 64-Gbps Fibre Channel SFP+ Transceivers (Figure 13) provide Fibre Channel connectivity for 16/32/64-Gbps ports on the Cisco MDS 9000 Series platform. The following types are available:

- Cisco Fibre Channel Shortwave SFP+ (part number DS-SFP-FC64G-SW).
- Cisco Fibre Channel Longwave SFP+ (part number DS-SFP-FC64G-LW).

Offers 16/32/64-Gbps autosensing Fibre Channel connectivity.

Figure 13.
Cisco 64-Gbps Fibre Channel SFP+ Transceivers

Technical specifications

Connectors and Cabling

The connectors are dual LC connectors.

Table 47 summarizes the cabling specifications.

Table 47. Cisco 64-Gbps Fibre Channel SFP+ Cabling Specifications

SFP+	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Speed (Gbps)	Cable Distance
DS-SFP-FC64G-SW	850	MMF	50.0 (OM3) 50.0 (OM4/OM5) 50.0 (OM2) 50.0 (OM3) 50.0 (OM4/OM5) 50.0 (OM2) 50.0 (OM3) 50.0 (OM4/OM5)	57.8 57.8 28.05 28.05 28.05 14.025 14.025 14.025	230 ft (70m) 328 ft (100m) 66 ft (20m) 230 ft (70m) 328 ft (100m) 115 ft (35m) 328 ft (100m) 410 ft (125m)
DS-SFP-FC64G-LW	1310	SMF	9.0	57.8 / 28.05 / 14.025	6.2 mi (10 km)

Note: The minimum cable distance for all SFP+ devices listed (MMF and SMF) is 6.5 feet (2 meters).

Note: SMF must be ISO/IEC OS2 compliant.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental conditions and Power requirements

Table 48 presents the optical parameters, and Table 49 presents temperature ranges.

Table 48. Optical parameters

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget (dB)			
	Maximum	Minimum	Maximum	Minimum	OM2	OM3	OM4	OM5
DS-SFP-FC64G-SW	4	-7.5	4	-7	1.63 (16 Gbps) 1.57 (32 Gbps) NA (64 Gbps)	1.86 (16 Gbps) 1.75 (32 Gbps) 1.75 (64 Gbps)	1.95 (16 Gbps) 1.86 (32 Gbps) 1.86 (64 Gbps)	1.95 (16 Gbps) 1.86 (32 Gbps) 1.86 (64 Gbps)
DS-SFP-FC64G-LW	4.2	-4.5	4.2	-10.8	6.3			

Table 49. Operating and storage temperature ranges

SFP+	Operating		Storage	
	Maximum	Minimum	Maximum	Minimum
DS-SFP-FC64G-SW	70°C	0°C	85°C	-40°C
DS-SFP-FC64G-LW	70°C	0°C	85°C	-40°C

Regulatory and Standards compliance

- Compliant with Fibre Channel (FC-PI-7) 64GFC-SW (OM3, OM4 and OM5) 64GFC-LW(OS2) 57.8 Gbps specification.
- Compliant with Fibre Channel (FC-PI-6) 3200-SM-LC-L (OS2), 3200-M5-SN-S (OM2), 3200-M5E-SN-I (OM3), 3200-M5F-SN-I (OM4) 28.05-GBd specifications.
- Compliant with Fibre Channel (FC-PI-5) 1600-M6-SN-S (OM1), 1600-M5-SN-S (OM2), 1600-M5E-SN-I (OM3), 1600-M5F-SN-I (OM4) 14.025-GBd specifications.
- Laser Class I 21CFR1040.

Ordering information

Table 50 provides ordering information.

Table 50. Cisco Fibre Channel SFP+ ordering information

Part Number	Description
DS-SFP-FC64G-SW=	64 Gbps Fibre Channel SW SFP+, LC, spare
DS-SFP-FC64G-LW=	64 Gbps Fibre Channel LW SFP+, LC, spare

Cisco 10-Gbps Ethernet X2 Transceivers

The Cisco Ethernet X2 Transceiver short-reach module (up to 300m; part number DS-X2-E10G-SR) enables high-performance Fibre Channel connectivity for the Cisco MDS 9000 Series 10-Gbps Fibre Channel switching module to an existing Ethernet Dense Wavelength-Division Multiplexing (DWDM) transponder (Figure 13). The data format transmitted is identical to that transmitted by the Fibre Channel transceiver (DS-X2-FC10G-SR), except the Fibre Channel packets are clocked at the 10 Gigabit Ethernet rate to carry Fibre Channel packets over a 10-Gbps Ethernet DWDM infrastructure. The Cisco MDS 9000 Series 10-Gbps Fibre Channel switching module automatically detects DS-X2-E10G-SR; no software configuration is required.

Figure 14.
Cisco 10-Gbps Ethernet X2 Transceiver

Technical specifications

Connectors and Cabling

The connectors are dual SC connectors.

Table 51 summarizes the cabling specifications.

Table 51. Cisco 10-Gbps Ethernet X2 Transceiver Cabling Specifications

X2	Wavelength (nanometers)	Fiber Type	Core Size (microns)	Baud Rate (GBd)	Cable Distance
DS-X2-E10G-SR	850	MMF	62.5 50.0 (OM3)	10.3125 10.3125	108 ft (33m) 984 ft (300m)

Note: The minimum cable distance for all transceivers listed (MMF and SMF) is 6.5 feet (2 meters).

Dimensions

The dimensions (H x W x D) are 19.2 x 41.8 x 90.8 mm.

Environmental conditions and Power requirements

Table 52 presents the optical parameters, and Table 53 presents temperature ranges.

Table 52. Optical parameters

X2	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber Loss Budget
	Maximum	**Minimum**	**Maximum**	**Minimum**	
DS-X2-E10G-SR	-1.2	-7.3	-1.0	-9.9	2.6 (50.0 microns [OM3])

Table 53. Operating and storage temperature ranges

X2	Operating		Storage	
	Maximum	**Minimum**	**Maximum**	**Minimum**
DS-X2-E10G-SR	70° C	0° C	85° C	-40° C

Regulatory and Standards compliance

- Compliant with IEEE 802.3 10GBASE-SR.
- Laser Class I 21CFR1040.

Ordering information

Table 54 provides ordering information.

Table 54. Cisco 10-Gbps Ethernet X2 Transceiver ordering information

Part Number	Description
DS-X2-E10G-SR=	10-Gbps Ethernet-Short-reach, X2, SC, Spare

Cisco Coarse Wavelength-Division Multiplexing Extended Distance SFP Solution

The Cisco MDS 9000 Series offers cost-effective multiprotocol extended distance connectivity to optimize to existing optical infrastructure through the Cisco CWDM SFP solution (Figure 15). The solution has two main components: a set of eight wavelength-specific SFP modules and a set of CWDM optical add-drop modules (OADMs). A Cisco CWDM chassis enables rack-mounting of up to two CWDM OADMs. The CWDM OADMs are passive and require no power or configuration.

Figure 15.
Cisco CWDM Extended Distance SFP Solution

The CWDM SFP solution enables the transport of up to eight channels over one pair of single-mode fiber strands, enabling enterprises to increase the bandwidth of an existing optical infrastructure without adding new fiber strands. The solution can be used in parallel with other Cisco SFP devices on the same platform.

Figure 16 shows a common point-to-point deployment scenario for the Cisco MDS 9000 Series using the CWDM SFP solution. Two endpoints are directly connected through a fiber link. The CWDM SFP solution enables customers to add or drop up to eight channels onto a pair of single-mode fiber strands. As a result, the need for additional fiber is reduced. Redundant point-to-point links can be implemented by adding or dropping redundant channels onto a second pair of single-mode fiber strands.

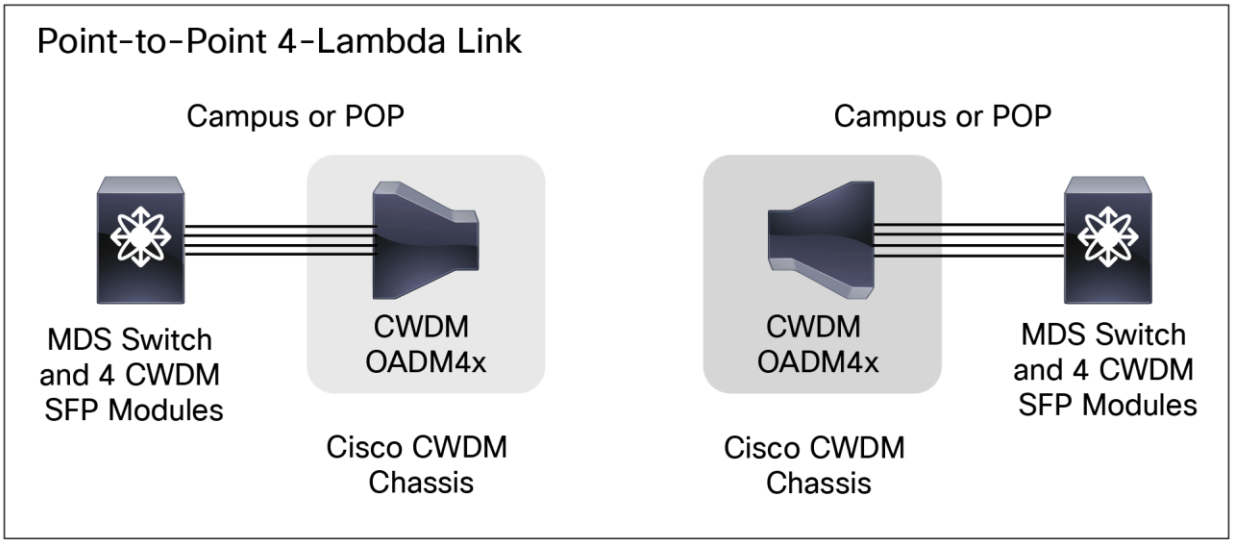

Figure 16.
Point-to-Point Architecture (Dual-Fiber Link)

Cisco 1/2-Gbps CWDM SFP Modules

Technical Specifications for Cisco 1/2-Gbps CWDM SFP Modules

Connectors and Cabling

- Equipment: Standard SFP interface.
- Network: Dual LC connector.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.75 x 55.2 mm.

Environmental conditions and Power requirements

Table 55 presents the optical parameters, and Table 56 presents the temperature ranges.

Table 55. Optical Parameters for Cisco 1/2-Gbps CWDM SFP Modules

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes and Conditions
Transmitter center wavelength	Lambda_c	(x - 4)	-	(x + 7)	nm	Available center wavelengths are 1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610 nm
Side-mode suppression ratio	SMSR	30	-	-	dB	-
Transmitter optical output power	Pout	0.0		5.0	dBm	Average power coupled into single-mode fiber
Receiver optical input power (BER <10-12 with PRBS 2-7-1)	Pin	-28.0	-	-7.0	dBm	At 2.12 Gbps, 140°F (60°C) case temperature
Receiver optical input power (BER <10-12 with PRBS 2-7-1)	Pin	-29.0	-	-7.0	dBm	At 1.25 Gbps, 140°F (60°C) case temperature
Receiver optical input wavelength	Lambda_in	1450	-	1620	nm	-
Transmitter extinction ratio	OMI	9	-	-	dB	-
Dispersion penalty at 100 km (62.1 mi)	-	-	-	3	dB	At 2.12 Gbps
Dispersion penalty at 100 km (62.1 mi)	-	-	-	2	dB	At 1.25 Gbps

Note:

- Parameters are specified over temperature and at end of life unless otherwise noted.
- When shorter distances of single-mode fiber are used, you may need to insert an inline optical attenuator in the link to avoid overloading the receiver.

Table 56. Operating and storage temperature ranges

Operating		Storage	
Maximum	**Minimum**	**Maximum**	**Minimum**
70° C	0° C	85° C	-40° C

Regulatory and Standards compliance

- Compatible with 1000BASE-X standard as specified in IEEE 802.3z.
- Compatible with Fibre Channel Draft Physical Interface Specification (FC-PI 10.0).
- Laser Class I 21CFR1040.

Ordering information

Table 57 provides ordering information.

Table 57. Cisco 1/2-Gbps CWDM SFP ordering information

Part Number	Description	Color
DS-CWDM-1470=	1470 nm CWDM 1/2-Gbps Fibre Channel SFP	Gray
DS-CWDM-1490=	1490 nm CWDM 1/2-Gbps Fibre Channel SFP	Violet
DS-CWDM-1510=	1510 nm CWDM 1/2-Gbps Fibre Channel SFP	Blue
DS-CWDM-1530=	1530 nm CWDM 1/2-Gbps Fibre Channel SFP	Green
DS-CWDM-1550=	1550 nm CWDM 1/2-Gbps Fibre Channel SFP	Yellow
DS-CWDM-1570=	1570 nm CWDM 1/2-Gbps Fibre Channel SFP	Orange
DS-CWDM-1590=	1590 nm CWDM 1/2-Gbps Fibre Channel SFP	Red
DS-CWDM-1610=	1610 nm CWDM 1/2-Gbps Fibre Channel SFP	Brown

Cisco 4-Gbps CWDM SFP Modules

Technical Specifications for Cisco 4-Gbps CWDM SFP Modules

Connectors and Cabling

- Equipment: Standard SFP interface.
- Network: Dual LC connector.

Dimensions

The dimensions (H x W x D) are 8.46 x 13.27 x 56.64 mm.

Environmental conditions and Power requirements

Table 58 presents the optical parameters, and Table 59 presents the temperature ranges.

Table 58. Optical Parameters for Cisco 4-Gbps CWDM SFP Modules

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes and Conditions
Transmitter center wavelength	Lambda_c	(x - 6)	x	(x + 6)	nm	Available center wavelengths are 1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610 nm
Side-mode suppression ratio	SMSR	30	-	-	dB	-
Transmitter optical output power	Pout	1.0	-	5.0	dBm	Average power coupled into single-mode fiber
Receiver optical input power (BER <10-12 with PRBS 2-23-1)	Pin	-15.7	-	0.0	dBm	140°F (60°C) case temperature
Link budget	-	17.8	-	-	dB	
Receiver optical input wavelength	Lambda_in	1450	-	1620	nm	-
Transmitter extinction ratio	OMI	4	-	-	dB	-
Dispersion penalty at 25 km (15.5 mi)	-	-	-	3	dB	-

Note:

- In typical point-to-point deployments, all wavelengths have a minimum reach of 24.8 miles (40 km).
- Parameters are specified over temperature and at end of life unless otherwise noted.
- When shorter distances of single-mode fiber are used, you may need to insert an inline optical attenuator in the link to avoid overloading the receiver.
- Up to 24 Cisco 4-Gbps CWDM SFP Transceivers are supported in a single Cisco MDS 9000 Series switching module.
- When interoperating a Cisco 4-Gbps CWDM SFP Transceiver with a Cisco 1/2-Gbps CWDM SFP Transceiver, you must manually configure the port speeds on the Cisco 4-Gbps CWDM SFP Transceiver to 1 or 2 Gbps.

Table 59. Operating and storage temperature ranges

Operating		Storage	
Maximum	**Minimum**	**Maximum**	**Minimum**
70° C	0° C	85° C	-40° C

Regulatory and Standards compliance

- Compatible with Fibre Channel Draft Physical Interface Specification (FC-PI -4 6.01).
- Laser Class I 21CFR1040.

Ordering information

Table 60 provides ordering information.

Table 60. Cisco 4-Gbps CWDM SFP ordering information

Part Number	Description	Color
DS-CWDM4G1470=	1470 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Gray
DS-CWDM4G1490=	1490 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Violet
DS-CWDM4G1510=	1510 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Blue
DS-CWDM4G1530=	1530 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Green
DS-CWDM4G1550=	1550 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Yellow
DS-CWDM4G1570=	1570 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Orange
DS-CWDM4G1590=	1590 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Red
DS-CWDM4G1610=	1610 nm CWDM 1/2/4-Gbps Fibre Channel SFP	Brown

Cisco 8-Gbps CWDM SFP Modules

Technical Specifications for Cisco 8-Gbps CWDM SFP Modules

Connectors and Cabling

- Equipment: Standard SFP interface.
- Network: Dual LC connector.

Dimensions

The dimensions (H x W x D) are 8.5 x 13.55 x 56.5 mm.

Environmental conditions and Power requirements

Table 61 presents the optical parameters, and Table 62 presents the temperature ranges.

Table 61. Optical Parameters for Cisco 8-Gbps CWDM SFP Modules

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes and Conditions
Transmitter center wavelength	Lambda_c	(x - 65)	x	(x + 6.5)	nm	Available center wavelengths are 1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610 nm
Side-mode suppression ratio	SMSR	30	-	-	dB	-
Transmitter optical output power	Pout	0	-	4.0	dBm	Average power coupled into single-mode fiber
Receiver optical input power (BER <10-12 with PRBS 2-23-1)	Pin	-24	-	-1	dBm	140° F (60° C) case temperature
Receiver optical input wavelength	Lambda_in	1450	-	1620	nm	-
Transmitter extinction ratio	OMI	9	-	-	dB	-
Dispersion penalty at 25 km (15.5 mi)	-	-	-	3	dB	-

Note:

- The link budget is –24 dBm.
- The minimum receiver overload is –1 dBm.
- The Cisco Enhanced Wavelength Division Multiplexing product line is also supported for CWDM optics: https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/transceiver-modules/product_data_sheet0900aecd806a1c36.html.
- In typical point-to-point deployments, all wavelengths have a minimum reach of 24.8 miles (40 km).
- Parameters are specified over temperature and at end of life unless otherwise noted.
- When shorter distances of single-mode fiber are used, you may need to insert an inline optical attenuator in the link to avoid overloading the receiver.
- Up to 24 Cisco 8-Gbps CWDM SFP Transceivers are supported in a single Cisco MDS 9700 Series Multilayer Director switching module. Refer to the Table 66 for maximum ports supported with 8G CWDM transceivers on all Cisco MDS switches.
- When interoperating a Cisco 8-Gbps CWDM SFP Transceiver with a Cisco 4-Gbps CWDM SFP Transceiver, you must manually configure the port speeds.

Table 62. Operating and storage temperature ranges

Operating		Storage	
Maximum	**Minimum**	**Maximum**	**Minimum**
70° C	0° C	85° C	-40° C

Regulatory and Standards Compliance

- Compatible with Fibre Channel Draft Physical Interface Specification (FC-PI -4 8.00).
- Laser Class: Optical output not to exceed the Class 1 maximum permissible exposure limits under any conditions of operation (including open transmitter bore, open fiber, and reasonable single-fault conditions) as stated in EN 60825-2 (reference 15) and CDRH 1040.10 regulations 21 CFR, chapter I and subchapter J (reference 6).

Ordering information

Table 63 provides ordering information.

Table 63. Cisco 8-Gbps CWDM SFP ordering information

Part Number	Description	Color
DS-CWDM8G1470=	1470 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Gray
DS-CWDM8G1490=	1490 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Violet
DS-CWDM8G1510=	1510 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Blue
DS-CWDM8G1530=	1530 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Green
DS-CWDM8G1550=	1550 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Yellow
DS-CWDM8G1570=	1570 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Orange
DS-CWDM8G1590=	1590 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Red
DS-CWDM8G1610=	1610 nm CWDM 2/4/8-Gbps Fibre Channel SFP+	Brown

Cisco CWDM OADMs

Technical Specifications for Cisco CWDM OADMs

The Cisco CWDM OADMs are passive devices that provide the capability to multiplex and demultiplex, or add and drop wavelengths from multiple fibers onto one fiber. The OADM connectors are interfaced with color-matching Cisco CWDM SFP modules on the equipment side. All modules are the same size. The Cisco CWDM chassis enables rack mounting for up to two CWDM OADMs in a single rack unit.

The Cisco MDS 9000 Series offers two CWDM OADMs and a multiplexer and demultiplexer:

- Cisco Dual Fiber 4-Channel OADMs (part numbers DS-CWDMOADM4A= and DS-CWDMOADM4B=): This device allows you to add and drop four channels (with different wavelengths) onto one direction of an optical ring. The other wavelengths are passed through the OADM. Dual fiber is used for both network and SFP connections. The four wavelengths are set to 1470, 1490, 1510, and 1530 nm for DS-CWDMOADM4A=, and to 1550, 1570, 1590, and 1610 nm for DS-CWDMOADM4B=.
- Cisco Dual Fiber 8-Channel Multiplexer/Demultiplexer (DS-CWDM-MUX8A=): This device allows you to multiplex and demultiplex eight separate channels onto one pair of fiber. Dual fiber is used for both network and SFP connections. The eight wavelengths are set to 1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610 nm.

Tables 64 and 65 provide comparisons of the OADM types.

Table 64. OADM Type Comparison

Product Number	Type	Architecture Options
DS-CWDMOADM4x=	OADM	Ring and point to point
DS-CWDM-MUX8A=	Multiplexer/demultiplexer	Ring and point to point

Table 65. Maximum Insertion Loss in dB for Each Passive CWDM Filter

Model	Maximum Insertion Loss (dB)			
	Add/Drop	Pass 1550	Pass 1300	Monitor
DS-CWDMOADM4x=	1.8	2.1	2.1	23
DS-CWDM-MUX8A=	2.2	-		23

Connectors and Cabling

- DS-CWDMOADM4x=: Dual LC connector.
- DS-CWDM-MUX8A=: Dual LC connector.

Environmental Conditions and Power Requirements

The operating temperature range is 23 to 131°F (–5 to 55°C), and the storage temperature range is –40 to 185°F (–40 to 85°C).

The Cisco CWDM OADMs and the CWDM chassis are passive components that do not require power.

Dimensions and Weight

All the Cisco CWDM OADMs have the same dimensions: W x D x H: 21.2 x 3.0 x 26.5 cm. Two of these modules fit into one CWDM chassis. The CWDM chassis is 1 rack unit (1RU) in height and fits in a standard 19-inch rack.

Regulatory and Standards Compliance

Network Equipment Building Standards (NEBS) Level 3.

Warranty

The standard warranty is one year.

Ordering information

Table 66 provides ordering information.

Table 66. Cisco Dual Fiber 4-Channel OADM, Dual Fiber 8-Channel Multiplexer and Demultiplexer, and CWDM Chassis ordering information

Product Number	Description
DS-CWDMOADM4A=	4-channel (1470, 1490, 1510, and 1530 nm) optical add/drop multiplexer OADM
DS-CWDMOADM4B=	4-channel (1550, 1570, 1590, and 1610 nm) optical add/drop multiplexer OADM
DS-CWDM-MUX8A=	8-channel multiplexer/demultiplexer
DS-CWDMCHASSIS=	2-slot chassis for Cisco OADM and multiplexer/demultiplexer

Cisco Dense Wavelength-Division Multiplexing Extended-Distance Solution

2-Gbps DWDM SFP Transceiver

The Cisco DWDM SFP modules enable enterprises and service providers to provide scalable, easy-to-deploy DWDM Fibre Channel services in their networks.

The main features of the Cisco DWDM SFP include:

- Support for International Telecommunication Union (ITU) 100-GHz wavelength grid.
- Match for wavelength plan of Cisco Optical Network Solutions (ONS) 100-GHz products.
- Fixed-wavelength SFP, with 32 SFP models.

Note: Up to eight 2-Gbps DWDM SFP modules are supported in a single Cisco MDS 9000 Series switching module. Refer to https://www.cisco.com/en/US/prod/collateral/modules/ps5455/ps6576/product_data_sheet0900aecd80582763.html for details.

Ordering information

Table 67 provides ordering information.

Table 67. Cisco 2-Gbps DWDM SFP Transceiver ordering information

Part Number	Description
DWDM-SFP-6061=	Cisco 1560.61 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5979=	Cisco 1559.79 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5898=	Cisco 1558.98 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5817=	Cisco 1558.17 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5655=	Cisco 1556.55 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5575=	Cisco 1555.75 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5494=	Cisco 1554.94 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5413=	Cisco 1554.13 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5252=	Cisco 1552.52 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5172=	Cisco 1551.72 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5092=	Cisco 1550.92 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-5012=	Cisco 1550.12 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4851=	Cisco 1548.51 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4772=	Cisco 1547.72 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4692=	Cisco 1546.92 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4612=	Cisco 1546.12 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4453=	Cisco 1544.53 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4373=	Cisco 1543.73 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4294=	Cisco 1542.94 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4214=	Cisco 1542.14 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-4056=	Cisco 1540.56 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3977=	Cisco 1539.77 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3898=	Cisco 1538.98 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3819=	Cisco 1538.19 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3661=	Cisco 1536.61 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare

Part Number	Description
DWDM-SFP-3582=	Cisco 1535.82 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3504=	Cisco 1535.04 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3425=	Cisco 1534.25 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3268=	Cisco 1532.68 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3190=	Cisco 1531.90 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3112=	Cisco 1531.12 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare
DWDM-SFP-3033=	Cisco 1530.33 NM DWDM Gigabit Ethernet and 1/2-Gbps Fibre Channel SFP, Spare

4-Gbps DWDM SFP Transceiver

The Cisco 4-Gbps DWDM SFP modules enable enterprises and service providers to provide scalable, easy-to-deploy DWDM Fibre Channel services in their networks. Direct integration of 4-Gbps DWDM optics in the Cisco MDS 9000 Series platform dramatically reduces capital costs and operating expenses for a Fibre Channel-over-DWDM network, avoiding the need for DWDM transponders and muxponders.

The main features of the Cisco 4-Gbps DWDM SFP include:

- Support for International Telecommunication Union (ITU) 100-GHz wavelength grid.
- Match for wavelength plan of Cisco ONS 100-GHz products.
- Fixed-wavelength SFP, with 40 SFP models.

Ordering information

Using customer use data, Cisco has identified and selected particular high-use wavelengths and will maintain shorter lead times on these items. The short-lead-time 4-Gbps DWDM SFP modules are from 1546.1 to 1560.6 with a 4-skip-1 approach. These part numbers are identified in Table 68. Table 69 identifies the rest of the 4-Gbps DWDM SFP modules.

Table 68. Cisco 4-Gbps DWDM SFP Transceiver ordering information: Commonly Used Wavelengths

Part Number	Description
ONS-SC-4G-50.1=	SFP - 4G FC 1550.12, 100 GHz, LC
ONS-SC-4G-50.9=	SFP - 4G FC 1550.92, 100 GHz, LC
ONS-SC-4G-51.7=	SFP - 4G FC 1551.72, 100 GHz, LC
ONS-SC-4G-52.5=	SFP - 4G FC 1552.52, 100 GHz, LC
ONS-SC-4G-54.1=	SFP - 4G FC 1554.13, 100 GHz, LC
ONS-SC-4G-54.9=	SFP - 4G FC 1554.94, 100 GHz, LC
ONS-SC-4G-55.7=	SFP - 4G FC 1555.75, 100 GHz, LC
ONS-SC-4G-56.5=	SFP - 4G FC 1556.55, 100 GHz, LC

Part Number	Description
ONS-SC-4G-58.1=	SFP - 4G FC 1558.17, 100 GHz, LC
ONS-SC-4G-58.9=	SFP - 4G FC 1558.98, 100 GHz, LC
ONS-SC-4G-59.7=	SFP - 4G FC 1559.79, 100 GHz, LC
ONS-SC-4G-60.6=	SFP - 4G FC 1560.61, 100 GHz, LC

Table 69. Cisco 4-Gbps DWDM SFP Transceiver ordering information: Other Wavelengths

Part Number	Description
ONS-SC-4G-30.3=	SFP - 4G FC 1530.33, 100 GHz, LC
ONS-SC-4G-31.1=	SFP - 4G FC 1531.12, 100 GHz, LC
ONS-SC-4G-31.9=	SFP - 4G FC 1531.90, 100 GHz, LC
ONS-SC-4G-32.6=	SFP - 4G FC 1532.68, 100 GHz, LC
ONS-SC-4G-33.4=	SFP - 4G FC 1533.47, 100 GHz, LC
ONS-SC-4G-34.2=	SFP - 4G FC 1534.25, 100 GHz, LC
ONS-SC-4G-35.0=	SFP - 4G FC 1535.04, 100 GHz, LC
ONS-SC-4G-35.8=	SFP - 4G FC 1535.82, 100 GHz, LC
ONS-SC-4G-36.6=	SFP - 4G FC 1536.61, 100 GHz, LC
ONS-SC-4G-37.4=	SFP - 4G FC 1537.40, 100 GHz, LC
ONS-SC-4G-38.1=	SFP - 4G FC 1538.19, 100 GHz, LC
ONS-SC-4G-38.9=	SFP - 4G FC 1538.98, 100 GHz, LC
ONS-SC-4G-39.7=	SFP - 4G FC 1539.77, 100 GHz, LC
ONS-SC-4G-40.5=	SFP - 4G FC 1540.56, 100 GHz, LC
ONS-SC-4G-41.3=	SFP - 4G FC 1541.35, 100 GHz, LC
ONS-SC-4G-42.1=	SFP - 4G FC 1542.14, 100 GHz, LC
ONS-SC-4G-42.9=	SFP - 4G FC 1542.94, 100 GHz, LC

Part Number	Description
ONS-SC-4G-43.7=	SFP - 4G FC 1543.73, 100 GHz, LC
ONS-SC-4G-44.5=	SFP - 4G FC 1544.53, 100 GHz, LC
ONS-SC-4G-45.3=	SFP - 4G FC 1545.32, 100 GHz, LC
ONS-SC-4G-46.1=	SFP - 4G FC 1546.12, 100 GHz, LC
ONS-SC-4G-46.9=	SFP - 4G FC 1546.92, 100 GHz, LC
ONS-SC-4G-47.7=	SFP - 4G FC 1547.72, 100 GHz, LC
ONS-SC-4G-48.5=	SFP - 4G FC 1548.51, 100 GHz, LC
ONS-SC-4G-49.3=	SFP - 4G FC 1549.32, 100 GHz, LC
ONS-SC-4G-53.3=	SFP - 4G FC 1553.33, 100 GHz, LC
ONS-SC-4G-57.3=	SFP - 4G FC 1557.36, 100 GHz, LC
ONS-SC-4G-61.4=	SFP - 4G FC 1561.43, 100 GHz, LC

Third Party Optical Modules

Cisco MDS products do not support third party optics with the exception of whats documented in this guide.

Smartoptics branded optics modules

Current generation of 32G and 16G Cisco MDS switches is now qualified to work with third party SFP modules from Smartoptics, a leading OEM of SFP modules. These long reach optics allow Cisco MDS customers a unique, seamless and self-configure option of connecting their existing and new Cisco MDS 16G switches over long distances transporting Fibre channel natively on dark fiber. Refer to Table 1-10 of the Cisco MDS and Nexus interoperability matrix for a current list of qualified variants. For information on order-ability, support and detailed technical specifications visit https://www.smartoptics.com/products/cisco-collection. Table 70 presents the configuration limits on these optical modules.

Table 70. Configuration Limits for optics modules

Switching Module and Fabric Switch	DS-SFP-FC8G-ER	DS-CWDM8Gxxxx	Smartoptics DS-8G-ZR-XXXX	Smartoptics DS-16G-ER-XXXX	Smartoptics DS-32G-IR-XXXX
DS-X9448-768K9	Max 32 out of 48 Ports	Max 32 out of 48 Ports	Max 32 out of 48 Ports	Max 32 out of 48 Ports	Not Applicable
DS-C9250I-K9	Odd ports only	Odd Ports only	Odd Ports only	Odd Ports only	Not Applicable
DS-C9396S-K9	Odd ports only	Odd Ports only	Odd Ports only	Odd Ports only	Not Applicable
DS-C9148S-K9	Ports 1 - 12	Ports 1 - 12	Ports 1 - 12	Ports 1 - 12	Not Applicable
DS-X9334-K9	Max 16 out of 24 Ports	Max 16 out of 24 Ports	Max 16 out of 24 Ports	Max 16 out of 24 Ports	Not Applicable

Switching Module and Fabric Switch	DS-SFP-FC8G-ER	DS-CWDM8Gxxxx	Smartoptics DS-8G-ZR-XXXX	Smartoptics DS-16G-ER-XXXX	Smartoptics DS-32G-IR-XXXX
DS-X9648-1536K9	Max 32 out of 48 Ports	Max 32 out of 48 Ports	Max 32 out of 48 Ports	Max 32 out of 48 Ports	Not Applicable
DS-C9132T-K9	Odd ports only	Odd Ports only	Odd Ports only	Odd Ports only	Not Applicable
DS-C9148T-K9	All Ports	All Ports	All Ports	All Ports	Not Applicable
DS-C9396T-K9	All Ports	All Ports	All Ports	All Ports	Not Applicable
DS-C9220I-K9	All Ports	All Ports	All Ports	All Ports	All Ports
DS-X9748-3072K9				All Ports	All Ports
DS-C9124V-K9				All Ports	All Ports
DS-C9148V-K9				All Ports	All Ports
DS-C9396V-K9				All Ports	All Ports

Cisco 10-Gbps Ethernet DWDM X2 Transceiver

Detailed data sheets are available at https://www.cisco.com/en/US/products/ps6576/index.html and https://www.cisco.com/en/US/products/hw/modules/ps5455/products_data_sheets_list.html.

Cisco 10GBASE DWDM SFP+ Modules

The Cisco 10GBASE Dense Wavelength-Division Multiplexing SFP+ Module offer the following features and benefits:

- Supports 10-Gigabit data rates from 9.9G to 11.1G (LAN, WAN, and OTU2/OTU2e) to accommodate different long distance Fibre channel applications.
- Smallest SFP+ module footprint in the industry.
- Hot-swappable input/output device plugs into an Ethernet SFP+ port of a Cisco switch or router to link the port with the network.
- Digital optical monitoring capability for enhanced diagnostics and troubleshooting.
- DWDM fixed module supports 40 non-tunable ITU 100-GHz wavelengths.
- DWDM tunable module supports 96 tunable ITU 50-GHz wavelengths.
- Supports the Cisco quality identification (ID) feature, which enables a Cisco switch or router to identify whether or not the module is an SFP+ module certified and tested by Cisco.

For the Cisco 10GBASE DWDM data sheet and ordering information, visit https://www.cisco.com/c/en/us/products/collateral/interfaces-modules/dwdm-transceiver-modules/data_sheet_c78-711186.html.

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For more information

For more information about the Cisco MDS 9000 Series Multilayer Switches, visit https://www.cisco.com/go/san.

Document history

New or revised topic	Described In	Date
Transceiver support for MDS 9396V	Table 1	March 2024
Configuration limit for optics modules for MDS 9396V	Table 70	March 2024
DS-SFP-FC64G-LW Transceivers	Page 35 Table 47 Table 49 Table 50	May 2024

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Cisco Nexus Dashboard Fabric Controller

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Product overview

Cisco Nexus® Dashboard Fabric Controller (NDFC) is the comprehensive management and automation solution for all Cisco Nexus and Cisco Multilayer Distributed Switching (MDS) platforms powered by Cisco NX-OS. NDFC provides management, automation, control, monitoring, and integration for deployments spanning LAN, SAN, and IP Fabric for Media (IPFM) fabrics. NDFC facilitates seamless interconnectivity and automation.

- **Management:** NDFC provides fabric-oriented configuration and operations management. It is optimized for large deployments with little overhead, but traditional deployments are supported and can be customized by the user to meet business needs. NDFC also provides representational state transfer (RESTful) APIs to allow easy integration from Cisco® or third-party overlay managers, enabling the automation to meet customers' needs.
- **Automation:** NDFC brings an easy-to-understand and simple deployment approach to bootstrapping new fabrics in a private cloud environment. Cisco's best practices are built into the fabric builder policy templates, and automatic bootstrap occurs with the click of a button, reducing provisioning times and simplifying deployments.
- **Monitoring and visualization:** NDFC brings in active topology monitoring views at a multi-fabric level into the new NDFC UI. When combined with Cisco's Nexus Dashboard Insights (NDI), customers can complement their solution with advanced support for day-2 operations.

Cisco Nexus Dashboard Fabric Controller Release 12 features

Cisco NDFC is fully integrated as a native service on the Cisco Nexus Dashboard (ND), providing a single sign-on and a simplified user experience across the entire data center software portfolio. Simply download a single Nexus Dashboard software image and enable NDFC as a service. Scale and performance were top of mind in the development of NDFC and as such included modern architectures that include microservices and containerization of functions to help ensure reliability and allow for growth over time.

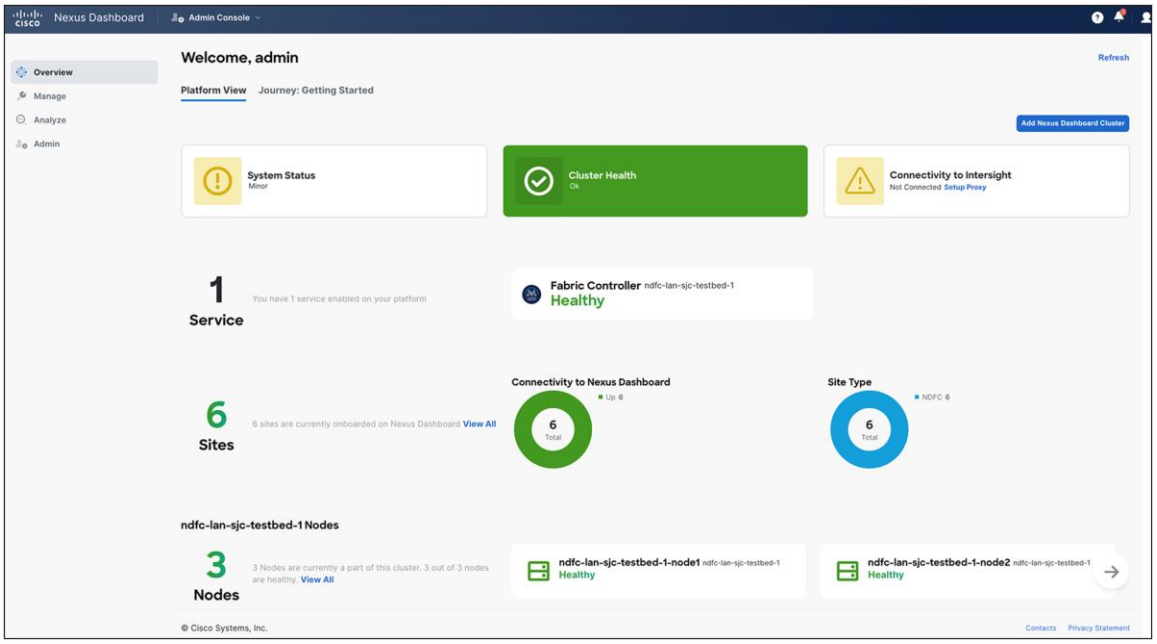

Figure 1.
Nexus Dashboard Platform View

Enriched UI

The architecture in NDFC is based on microservices, running on Nexus Dashboard. By moving away from a monolithic to a containerized and modular infrastructure, users will be able to leverage this new model to enable elastic scale out. NDFC will also support active/active high availability with L2 reachability or L3 reachability for 3-node clusters. NDFC offers a great look and feel with an intuitive React JS GUI that will align to the GUI in Nexus Dashboard, and other services and support modernized topology views. The dashboard overview (Figure 2) provides a summary of the major details of all of the fabrics managed by that instance.

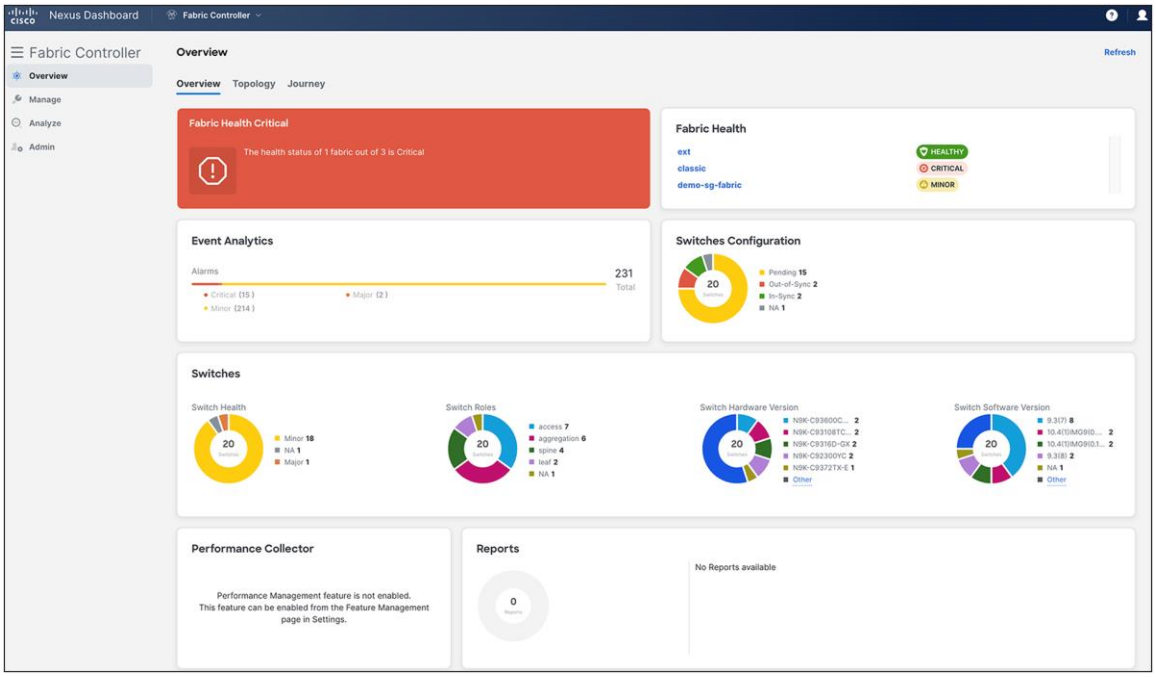

Figure 2.
Cisco Nexus Dashboard Fabric Controller UI: overview

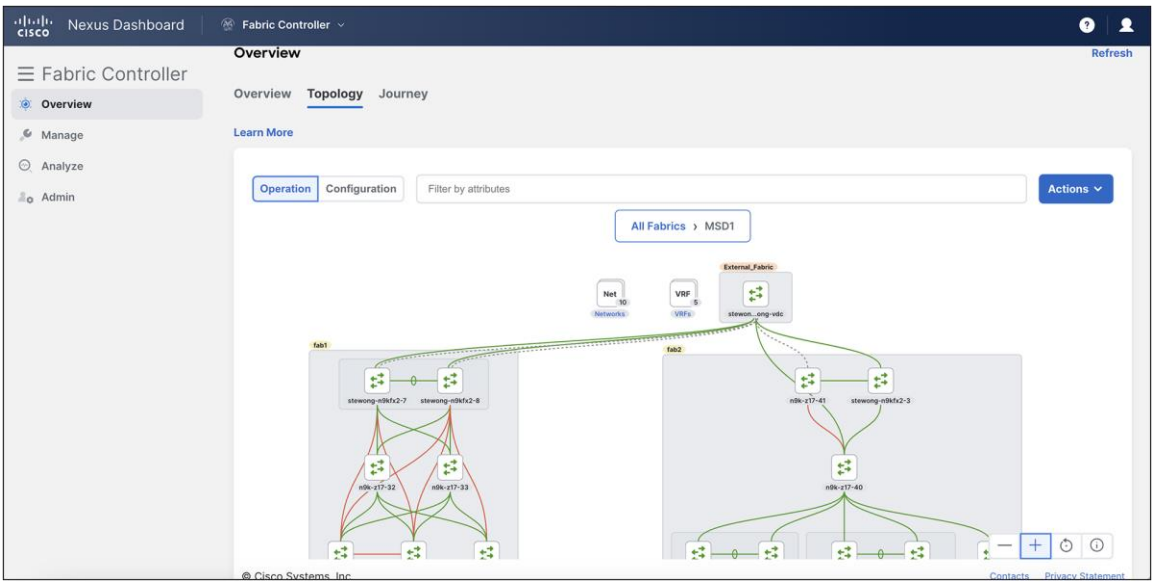

Figure 3.
Cisco Nexus Dashboard Fabric Controller UI: enhanced common topology

Journey

NDFC offers you guided workflows on the various milestones in your NDFC journey. These guided workflows give you details on the items required in each milestone, starting with setting up the controller service and including creating fabrics, adding switches, etc.

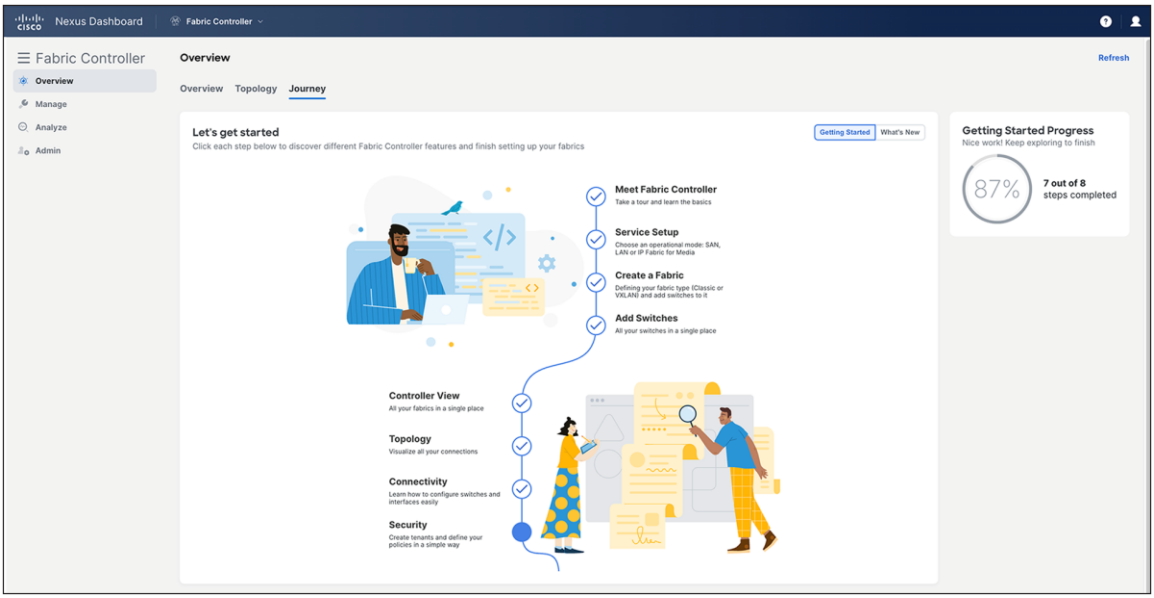

Figure 4.
Cisco Nexus Dashboard Fabric Controller UI: journey

Feature manager

NDFC has a runtime feature installer, which helps you to select a mode at installation for LAN, SAN, or IPFM. This feature-management capability will allow you to selectively enable or disable different features, including Fabric Controller (LAN), SAN, IPFM, and Fabric Discovery.

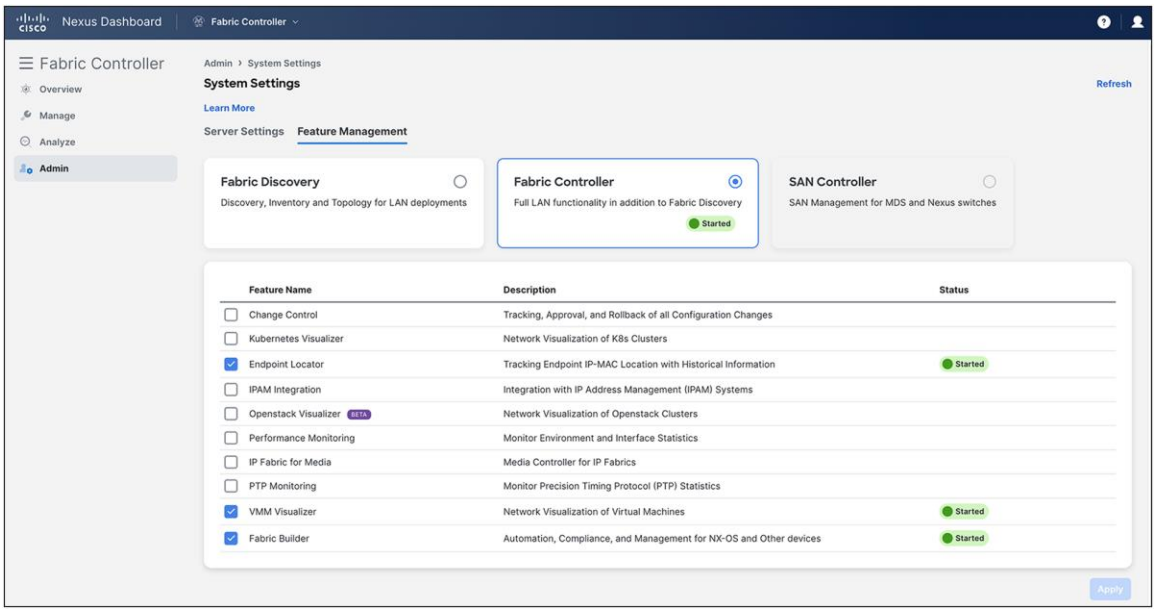

Figure 5.
NDFC feature manager UI

LAN Fabric One Manage

The LAN Fabric One Manage feature offers centralized management for fabric groups and multisite groups across multiple NDFC clusters in a multicluster environment. You can create a multisite domain (MSD) using One Manage, where you can select one NDFC instance to be the parent instance, add child fabrics from any NDFC instance that is part of a multicluster fabric, and perform all necessary multisite functionality available in a regular VXLAN EVPN multisite fabric. You can import an existing MSD from any NDFC instance that is part of a multicluster fabric and connect it to other VXLAN EVPN fabrics from the multicluster fabric. In one click, you can recalculate and deploy, and the multisite underlay will be configured automatically. The One Manage feature eliminates the necessity for a separate tool to orchestrate multisite connectivity.

NDFC provides an all-cluster dashboard, aggregating information from multiple federated NDFC-managed LAN fabric clusters. It provides remote users with a comprehensive overview of the network, including the number of LAN clusters, fabrics, and switches, along with detailed displays of health statuses, release versions, and switch models. Users can access the dashboard by logging in remotely to Nexus Dashboard, allowing for efficient monitoring and management of multicluster networks from a single screen. Users can also launch detailed views of any fabrics residing in any NDFC cluster from this screen.

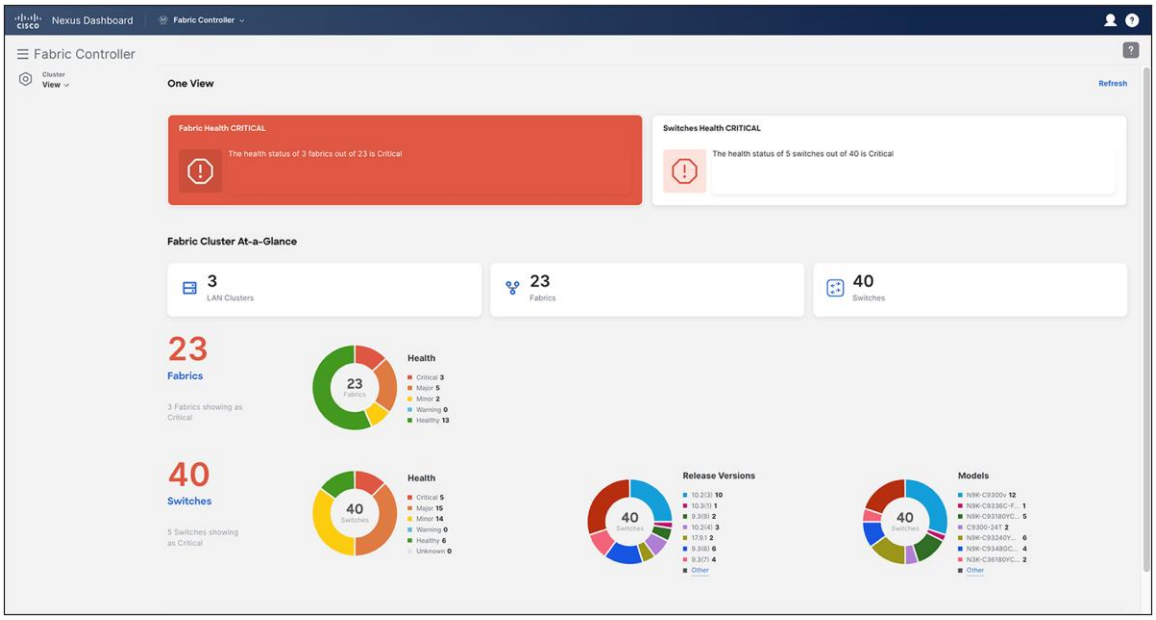

Figure 6.
NDFC LAN Controller All Cluster Dashboard

Microsegmentation using VXLAN Group Policy objects

Microsegmentation using the VXLAN Group Policy Option (GPO) utilizes security group policies to create a simplified approach to understanding and controlling your network traffic. This feature allows users to classify endpoints by IP, VLAN, and VM attributes to create security groups and remove endpoints from security groups as necessary. The policies are pushed to the switches by NDFC, and traffic is segmented based on whether the selected attributes match on the switch. Additionally, users will be able to create new fabrics with VXLAN GPO enforced across multiple sites. All your security groups, policies, and contracts can easily be managed from a single pane in the "Security" tab of NDFC. With microsegmentation using group policy, you now have greater flexibility in choosing attributes to craft policies that segment your network according to your architecture's logic. Additionally, using VXLAN GPO enables the ability to segment east-west traffic, minimize threat vulnerabilities by creating a smaller attack surface, allow for flexible security isolation, and, overall, improve the security posture of your VXLAN fabrics.

L4-L7 service insertion, service chaining, and load balancing

L4-L7 service insertion, service chaining, and load balancing enables the ability to insert and redirect traffic to service devices in a data-center fabric. The service devices can sit in the same VXLAN EVPN fabric, and an external fabric is not necessary. You can add an L4-L7 service cluster, create service function between the L4-L7 service cluster and the L4-L7 service leaf switch, and then selectively redirect traffic to these L4-L7 service clusters. NDFC effortlessly manages the switches and interfaces attached to a service cluster. L4-L7 service insertion can be easily enabled by editing a fabric and in the advanced settings, enabling L4-L7 services redirection. Furthermore, support is available for enhanced Policy-Based Redirection (ePBR) used for L4-L7 service load-balancing and single-site traffic steering and redirection. ePBR utilizes a policy-based redirect solution to direct traffic and facilitate application-based routing. It also enables service chaining within and across fabrics. This feature delivers a simplified and automated workflow to onboard service nodes and redirects traffic to them. Additionally, it ensures that network security requirements are met with built-in compliance.

Change control management

The new change control management feature (starting with NDFC Release 12.1(3)) enables tracking and approval of network intent changes. It associates unique tickets with specific actions, allowing deployment operations to occur only through these change control tickets, ensuring a controlled and auditable process. This feature streamlines network configuration changes by enforcing a structured approval workflow, enhancing operational control and compliance.

Fabric software management

Large networks need to be maintained efficiently. NDFC will have fully redesigned image management, making upgrades easy and less time-consuming. This new, easy, and customizable workflow will be for device upgrades and downgrades, patching, Electronic Programmable Logic Device Upgrades (EPLDs), Software Maintenance Updates (SMUs), and more. NDFC can recommend or create groups for switch upgrades, allowing users to track the upgrade of switches in a fabric in a more controlled way than previously. Users can either use the groups suggested by NDFC, or they can create their own groups, based on user roles, switch roles, type of switches, etc. NDFC will continue to support maintenance-mode and RMA actions right on the actual topology display – you can put a switch into maintenance mode and swap serial numbers with a replacement unit with a few clicks.

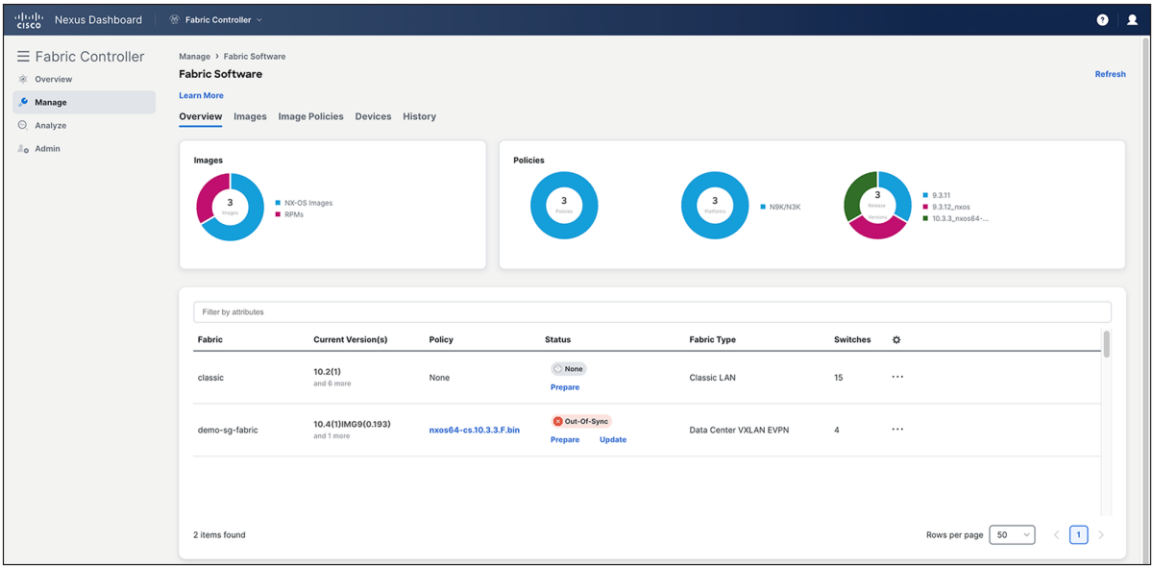

Figure 7.
NDFC fabric software management

Git repository integration

The addition of this feature allows users to seamlessly integrate their Git repository with NDFC, enabling synchronization for nondefault templates. This feature facilitates external nondefault template modifications, ensuring a streamlined process as changes are pulled into NDFC and deployed across fabrics. You can also push any template updates back to the Git repository, as needed. Network administrators benefit from this enhanced flexibility, particularly in managing scaled environments with multiple NDFC instances, allowing them to leverage uniform templates across their network infrastructure effortlessly.

Quantum key distribution for MACsec through SKIP protocol

Cisco Secure Key Integration Protocol (SKIP) is supported in your Nexus switches and empowers establishing communication with QKD devices and utilizing these devices in the exchange of MACSec encryption keys used for inter-fabric connectivity. NDFC now automates the configuration of quantum keys that are used to connect two fabrics using inter-fabric links for data- center VXLAN EVPN, enhanced classic LAN, and external connectivity network. Experience the benefits of using a QKD server to manage MACsec keys, such as auto key management and auto key refresh, ultimately making the traffic quantum more secure.

Compute visibility on fabric topology view

NDFC integrates VMware topology onto its dynamic topology views. You simply “Discover” a vCenter that controls the host-based networking on the fabric to show how the virtual machine, host, and virtual switches are interconnected. This is a great benefit for the network operator because it provides compute visibility, which is ordinarily the purview of compute administration.

Cisco Smart Licensing Policy

Implementation of Cisco Smart Licensing Policy (SLP) with NDFC will further enhance the current smart licensing capabilities. SLP aims to increase ease of use by enforcing fewer restrictions with a goal of reducing the overall license friction.

Non-Nexus Platform Support: IOS-XE and IOS-XR

For Cisco IOS® XE platform Cisco Catalyst® 9000 Series Switches, NDFC will now support VXLAN EVPN automation. Using this new fabric-builder template with built-in best practices, you can extend your VXLAN EVPN overlay networks for greenfield deployments of Catalyst 9000 switches.

NDFC will also provide additional support for Cisco IOS® XR devices, Cisco ASR 9000 Series, and Cisco Network Convergence (NCS) 5500 Series, to be managed in external fabric in managed mode. NDFC will be able to generate and push configurations to these switches, and configuration compliance will also be enabled for these platforms.

Granular Role-Based Access Control (RBAC) model for existing roles

With NDFC, RBAC will be orchestrated directly in the Nexus Dashboard. NDFC offers granular RBAC roles, allowing users to have varying levels of access across different fabrics within the NDFC instance. For example, one user could be a network administrator for one fabric while being a network stager for another. The latest NDFC release supports new user roles such as change approver and change deployer in addition to the existing roles, to facilitate change control management.

Programmable reports for performance monitoring

NDFC previously introduced programmable reports, which provided detailed information on devices. A new template will be added to support NDFC to generate these programmable reports for performance monitoring. These reports can be used for LAN, IPFM, and SAN deployments. You will also be able to email these generated reports to users.

Multitenancy VRF

With this feature, we are bringing in VRF support for Non-Blocking Multicast (NBM) deployments where we can logically isolate multiple customers so that they can co-exist on the same fabric. Multiple VRFs can be enabled in either an IPFM NBM active or NBM passive mode.

Fabric builder for IPFM

To ease your IPFM network provisioning, NDFC will now start supporting availability of preconfigured policy templates that were created keeping best practices in mind – to build your IPFM underlay in minutes.

Cat9k Provisioning in IPFM Fabric: NDFC serves as a single control point, simplifying operation and management for hybrid Cat9k and Nexus9k IPFM Fabrics. Provision your Cat9k devices with NDFC.

ST 2022-7 Fabric Redundancy Visualization with NDFC: In NDFC, will enhance visibility into SMPTE 2022-7 fabrics by providing a side-by-side view of the red and blue fabrics so enabling operators to monitor both network paths in tandem, ensuring a seamless flow of content.

NDFC SAN Insights brings SAN Analytics to life

One of NDFC's most important features is SAN Insights, which provide collection and visualization of the MDS SAN Analytics capabilities. This feature provides insight into end-to-end flow-based metrics, custom graphing, outlier detection, ECT analysis, summary dashboards, and the newest feature: anomaly detection. Anomaly detection provides a fully customizable infrastructure that can be used to identify and alert on issues captured by the SAN Insights capabilities. SAN Insights also include new infrastructure to help consume all the new streaming telemetry data available on the new 64Gbps and 32Gbps MDS switches from Cisco.

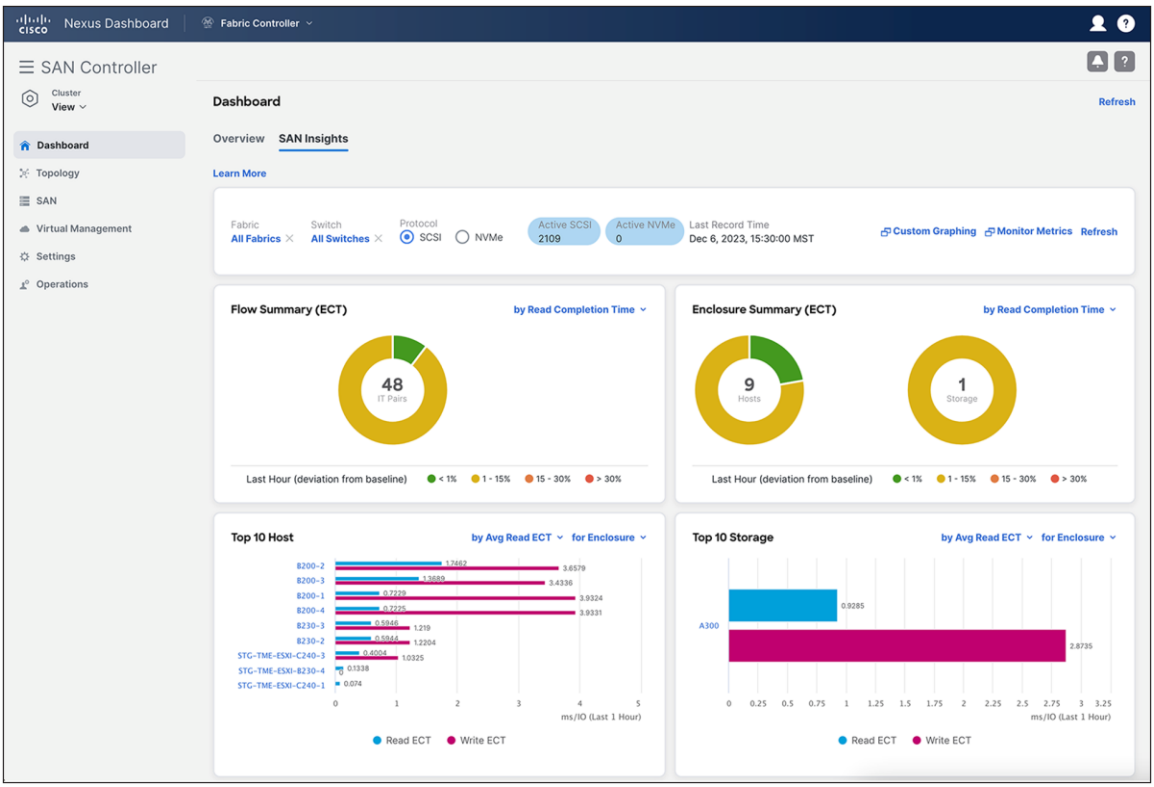

Figure 8.
NDFC SAN insights dashboard

NDFC SAN Controller OneView

NDFC SAN Controller OneView is a new feature that provides a single pane of glass to get a holistic view of the larger enterprise from within NDFC. This view will provide high-level summary information about all the managed fabrics from within NDFC. This manager-of-managers view is critical for successful management of multisite deployments and comes at no additional cost. The functionality also provides native click-through capabilities so that the end user can explore that site in more detail to further enhance management and troubleshooting operations.

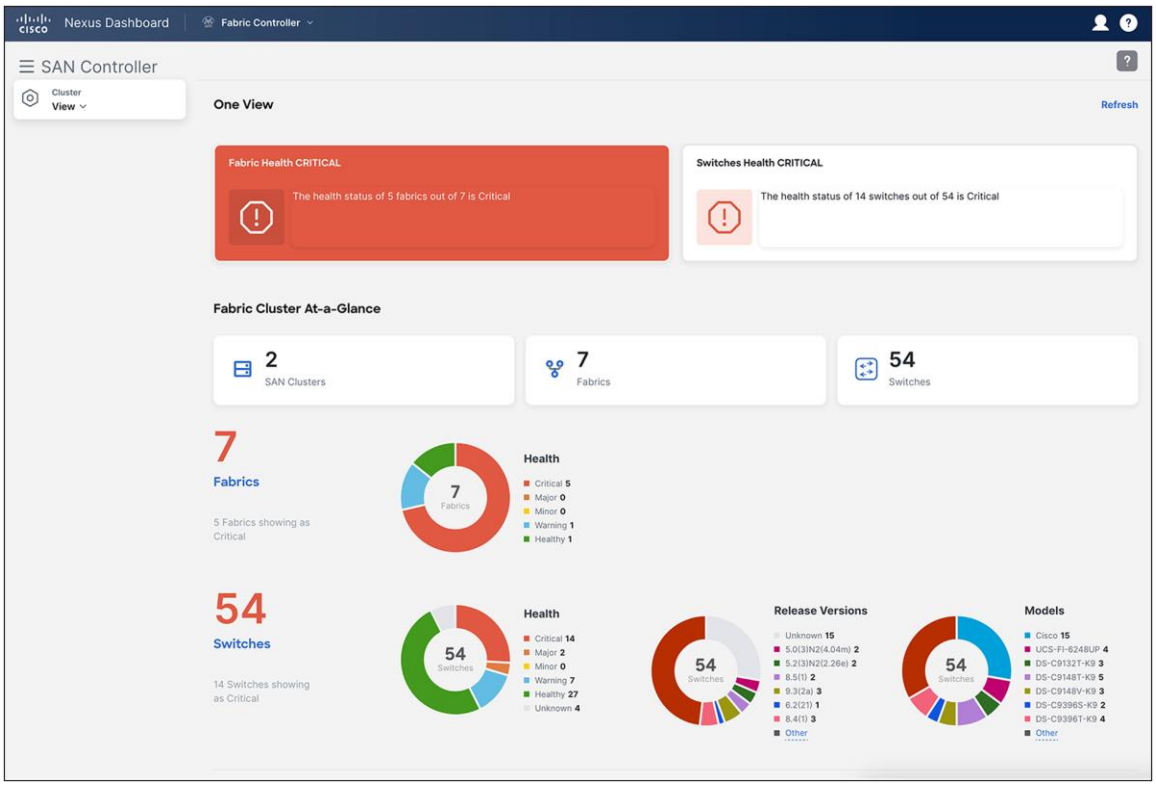

Figure 9.
NDFC SAN Controller OneView

Host and storage views

NDFC introduces a new interface that allows customers to see host and storage devices connected to the fabrics they manage. In these new views the user is provided end-device-specific information that can be used to understand pathing health, optics trends, SAN analytics metrics, events, diagnostics data, errors, driver and HBA firmware versions, and much more. This data is provided within the context of the host or storage device the administrator chooses to explore. This view also allows the administrators to view in depth virtual machine information and can now track virtual machine analytics metrics, CPU/Mem utilization, and disk I/O data as well. This is a powerful feature that will make managing connected devices even easier; it provides a wealth of information to help understand overall host and storage health, with a single interface into all of the relevant information.

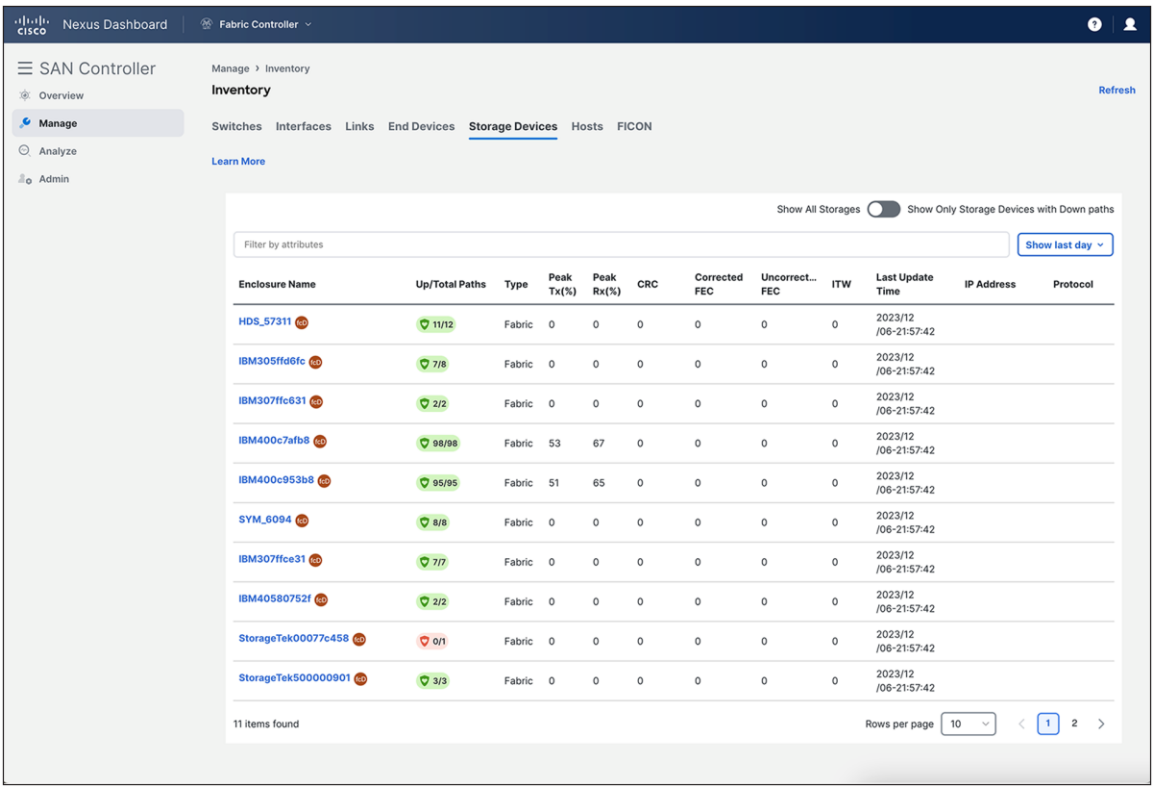

Figure 10.
NDFC SAN Controller host and storage views

Dynamic Ingress Rate Limiting

NDFC also plays an important part in integrating some of the most modern software features Cisco has created to help eliminate congestion in SAN fabrics. NDFC provides an interface to fully configure Dynamic Ingress Rate Limiting (DIRL) so that any congestion in the fabric can be eliminated automatically and with almost no impact. DIRL can help with both credit starvation and over-utilization situations that can have big implications on the SAN fabric by controlling the rate of frames from the anomaly in the fabric while at the same time reducing the impact to operations. NDFC plays an important role in helping to simplify the deployment of DIRL so that it can be implemented quickly to easily to solve slow-drain conditions.

Optics information for SAN interfaces

NDFC introduces a new interface that allows customers to see trends in optics temperature and power over time. This new feature provides insight into how optics are working overtime and can help reduce individual outages that are often due to optics failures.

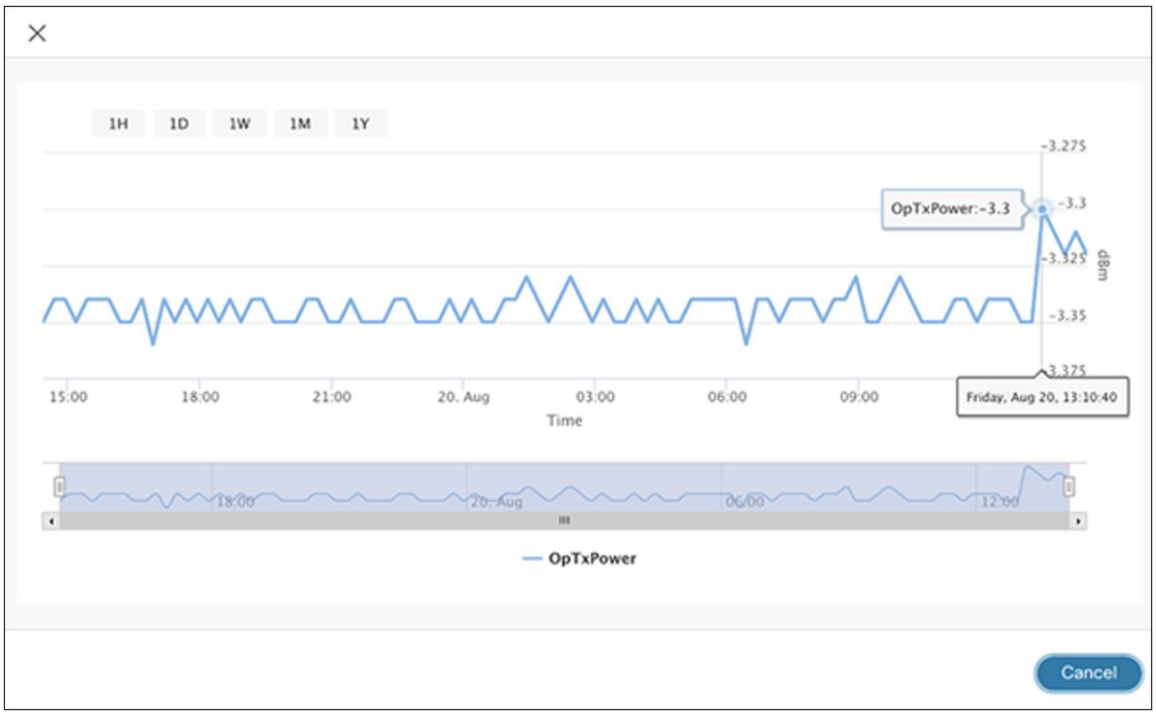

Figure 11.
NDFC SAN Controller – optics insights

Zoning interface

NDFC has reinvented the way customers will do SAN zoning in the future. This includes a new interface in the web-user interface that focuses on managing regular and IVR zones. This is a feature many customers use every day, and Cisco has worked to improve the look, feel, and navigation of the zoning interface to make the data easier to use and faster to deploy correctly.

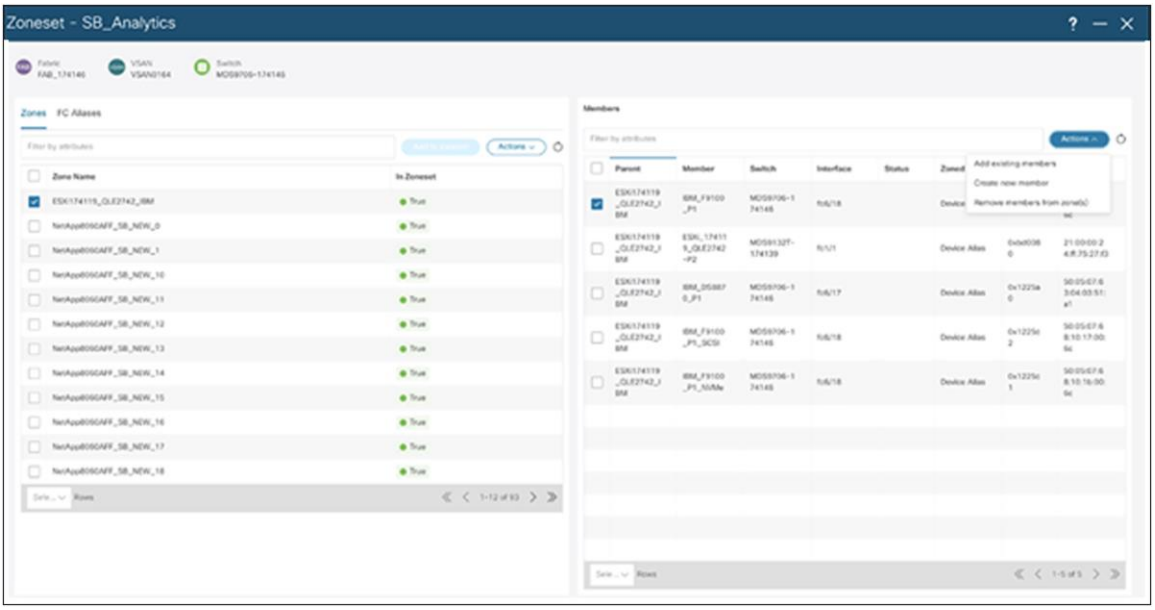

Figure 12.
Zoning interface

Optics health predictions

The optics health predictions provided in previous releases are enhanced in the new release, where NDFC displays a unique health score for each optics parameter. This health grade lets customers see when optics have moved from healthy to warning, to critical. Voltage, current, Rx power, Tx power, and temperature are each graded by the system; when a change occurs, Nexus Dashboard displays the change and includes an alarm that can be forwarded to an SNMP trap recipient, to get ahead of potential outages due to optics failures. This capability can also display a chart of the monitored parameters, so that the user can see which values have changed vis-à-vis those of the other parameters.

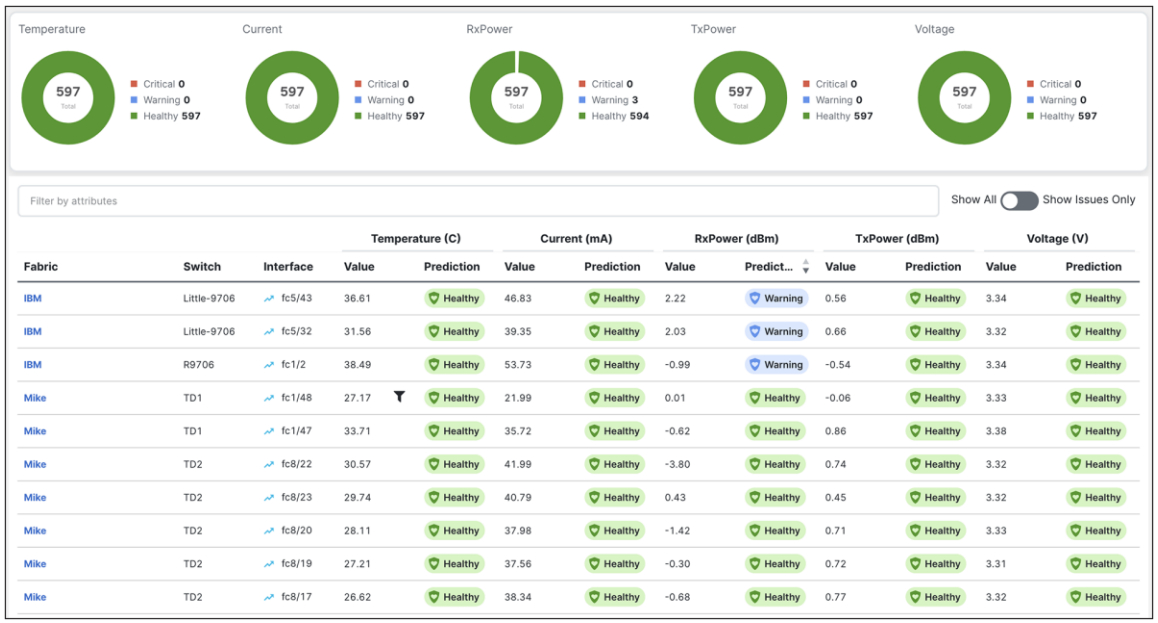

Figure 13.
Optics Health Prediction

Topology utilization visualization

A new capability has been added that displays the performance of the Fibre Channel links; it also includes path visualization that indicates traffic speed by using hash marks on the link moving in the direction of the traffic flow. This capability also indicates the speed of the link, using a color-coded overlay on the link. Both items greatly improve visualization of the links and help reduce the time troubleshooting link performance.

NDFC feature details and benefits

Table 1. NDFC features and benefits

Feature	Benefits
Infrastructure and GUI	• Modular, microservices-based architecture to enable scale-out models • React JS-based UI to simplify and enhance GUI interactions • Supports active/active high availability for either LAN or SAN deployments • All cluster view dashboard for LAN fabrics across multiple NDFC clusters • Includes runtime feature manager for LAN, SAN, and IPFM deployments • Journey map to guide users across different NDFC milestones. • User feedback tool integration to allow users to submit feedback/requests to be reviewed by product team
Dashboards	• Provides last-24-hours summary of events and top “talkers” • Offers custom summary view of LAN and SAN domains and topology groups • Provides host, switch, and fabric dashboards and provides views of configurations, control, events, and traffic and context-based searches from dashboards • Brings the NDFC computing dashboard into the VMware vCenter for dependency mapping and inventory, performance, configuration, and event views
Customizable templates	• Includes best-practice policy templates with Python support and built-in compliance checking for fabric builder • Provides prebuilt templates for classic LAN mode provisioning • Allows creation of new customizable templates using template editor • Allows import and conversion of configuration scripts to templates
REST and JavaScript Object Notation (JSON) API	• All northbound APIs are REST. NDFC’s GUI uses these REST APIs for all GUI functions. • Includes self-documented “swagger”-style built-in documentation, with examples • Enables integration with third-party or custom orchestration and automation tools like Ansible
Automation for classic Layer2/Layer3 networks	• New enhanced classic LAN fabric, to provide fully automated workflows for any classic Layer2/Layer3 deployments • Includes intuitive fabric management with built-in best practices and maximum visibility • Supports configuration compliance
Configuration and change management for classic LAN Mode	• Provides predeployment validation of configuration changes to help reduce human errors (POAP includes this feature as well.) • Provides a general configuration archive to track changes, allowing rollback to a last-known good state • Provides capability to back up configuration files from all switches for classic LAN-mode operations • Brownfield host port interface configuration sync-up capability supports resync of out-of-band host port configurations to NDFC
Fabric software	• Includes support for Cisco In-Service Switch Upgrade (ISSU), Graceful Insertion and Removal (GIR) and Return Material Authorization (RMA) functions • Includes installation/uninstallation of SMUs and RPMs for Cisco Nexus platforms • Supports NX-OS image and EPLD Installation and upgrades from the GUI

Feature	Benefits
LAN fabric with VXLAN EVPN	
Fabric control and overlay visibility and management	• Provides fabric management for multiple types of LAN solutions, including VXLAN-EVPN, and traditional 3-tier LAN deployments with workflows for provisioning LAN services such as VPCs • Microsegmentation for VXLAN EVPN fabrics using security groups in both single-site and multi-site use cases • Includes intuitive overlay management with built-in best practices and maximum visibility for robust Cisco NX-OS configuration profiles • Autodetects unprovisioned switches for use in fabric builder with day-0 POAP for policy-based bootstrapping of fabric infrastructure • Compliance management ensures that network is in sync with intended deployment and notifies users when out of compliance, allowing users to deploy any corrections • Supports easy provisioning using interface groups. Attaches overlay networks to groups in one go, allowing new interfaces added to the group to automatically inherit the configuration. • Integration with Nexus Dashboard Orchestrator (NDO) to extend overlay networks or VRFs between VXLAN-EVPN fabrics managed by different NDFC instances • Support for overlay network and VRF provisioning using CLI • Load balance and service chain across cluster of service nodes using enhanced L4-L7 workflows • One Manage for Multi-cluster NDFC deployments
Unified topology views and control	• Presents topology views showing physical and overlay networks on the same page, helping IT administrators quickly identify the extent of virtual overlay networks on a programmable fabric • In topology view, shows VXLAN details, VXLAN Tunnel Endpoint (VTEP) status, and VXLAN Network Identifier (VNI) status on a per-switch basis • Presents smart topology views showing virtual port channels (vPCs) and virtual device contexts for Cisco Nexus networks (Topology views include VXLAN search.) • Zoom in and out and search in a site
Role-Based Access Control (RBAC) for fabric objects	• Allows Role-Based Access Control (RBAC) within the fabric to separate administrative tasks between functional domains • Granularized RBAC model supports the same user having different roles across different fabrics
IP Fabric for Media (IPFM)	
Flow control	• Flow and host policy manager
Visualization and health	• Topology and endpoint visibility. • One View dashboard for IPFM fabrics • End-to-end flow visualization. • Network health monitoring. • RTP and EDI flow monitoring • 2022-7 Side by Side View: end-to-end flow visibility for Red and Blue fabrics within same instance of NDFC
Provisioning and automation	• Fabric bootstrap: day-0 provisioning. • API gateway for broadcast controller. • Fabric builder for IPFM underlay network with nonblocking multicast

Feature	Benefits
Storage Networking (SAN)	
SAN Analytics integration with Cisco SAN Insights	• Provides SAN Analytics visualization at scale, providing a single pane of glass into hundreds of thousands of FC flows • SAN Insights anomaly detection can find real-world issues and send alerts in real time • Fully customizable infrastructure to create and manage SAN Insights events • Always on and auto-learned approach for all FC flows
Storage topology and visibility	• Switch, end device, VSAN, and zoning visualization on the topology maps • Allows you to see trends and explore link bandwidth straight from the topology map • Health color coding to quickly find and troubleshoot issues • Device manager integration for all switches in the topology • Storage and host visualization on the topology map
SAN zoning	• Totally redesigned web-based zoning interface to drastically reduce the cycle time for common administration tasks. Provides IVR zoning function as well, on the same page. • Provides a web-based FC and device-alias configuration to ease transition to a web-based user interface for zoning and other management tasks
Automated analysis	• SAN host-path-redundancy feature to better organize and identify virtual and physical hosts with path-redundancy problems in the fabric • Slow-drain analysis features to increase efficiency and reduce the time to discovery for slow-drain devices
Storage management	• Provides visibility into all modern storage products to help provide information to storage administrators in the context of SAN management • Port channel and VSAN management updated • FICON management
Visibility, monitoring, and troubleshooting (common features)	
Automated discovery	• Using automated network discovery provides up-to-date physical and logical inventory information. • Tracks inventory and performance information in real time
Topology overlays and views	• Provides detailed visibility into real-time and historical performance statistics in the data center. • In topology views, link-layer and overlay status details alongside switch details to aid troubleshooting and visibility. • Provides general visibility into Layer-2 network connectivity mapped on the physical topology view • Provides topology, configuration, and information for virtual machines, port groups, DVS/vSwitches, vNICs, and VMNICs correlated with the physical network topology • Provides insight into port and bandwidth use, error count, traffic statistics, etc.
Event management, reports, and alarms	• Provides real-time network-health summary with detailed views of individual network components, enabling operations staff to respond quickly to events based on event severity • Alarm function provides stateful alarm monitoring to show if an error condition is active. Users can define an alarm policy for the device, interface, or syslog conditions and can email alarms to users. • Provides easy-to-schedule reports using predefined templates, including inventory, use, health, and performance monitoring reports. These reports can be exported for postprocessing or sent by email. • Allows creation of custom port groups based on priority and severity level of the application and implementation of rule-based event-forwarding to notify the system or user of traps and syslog messages generated for the custom port group

Platform support information

Table 2. Platform support information

Product family	Platforms supported
Cisco Nexus switches	Cisco NDFC supports most current Nexus switch family product offerings. See the Compatibility Matrix and Release Notes for NDFC Release details.
Cisco MDS storage switches	Cisco NDFC supports most current MDS switch family product offerings. See the Compatibility Matrix and Release Notes for NDFC Release details.

Server requirements

Cisco NDFC Release 12 runs on the Nexus Dashboard platform. It is supported on:

- Virtual Nexus Dashboard for LAN, IPFM, and SAN deployments
- Physical Nexus Dashboard for LAN, IPFM, and SAN deployments

The table below lists the server resource requirements for deploying the Nexus Dashboard Fabric Controller Release 12 on Nexus Dashboard.

Table 3. Server requirements

Mode	Virtual ND	Physical ND
LAN	16vCPUs and 64G RAM, 500G SSD	40vCPUs and 256G RAM, 4* 2.2 TB HDD, 370G SSD, 1.5 TB NVMe
IPFM	16vCPUs and 64G RAM, 500G SSD	40vCPUs and 256G RAM, 4* 2.2 TB HDD, 370G SSD, 1.5 TB NVMe
SAN	Small Node: 16vCPUs and 64G RAM, 500G SSD (No SAN Insights) Large Node: 32vCPUs and 128G RAM, 3TB (with SAN Insights)	40vCPUs and 256G RAM, 4* 2.2 TB HDD, 370G SSD, 1.5 TB NVMe

Ordering information

To order Cisco Nexus Dashboard Fabric Controller Release 12 licenses, contact your Cisco sales representative. Or access Cisco Commerce at Cisco.com.

Cisco Capital

Flexible payment solutions to help you achieve your objectives.

Cisco Capital® makes it easier to get the right technology to achieve your objectives, enable business transformation and help you stay competitive. We can help you reduce the total cost of ownership, conserve capital, and accelerate growth. In more than 100 countries, our flexible payment solutions can help you acquire hardware, software, services and complementary third-party equipment in easy, predictable payments. Learn more.

For more information

See https://cisco.com/go/ndfc or contact your Cisco sales representative or partner.

Document history

New or Revised Topic	Described In	Date
Inclusion of enhanced topology image	Product Overview	August 14 ,2024
LAN Fabric One Manage	Product Overview	August 14 ,2024
Inclusion of optics health prediction image	Product Overview	August 14 ,2024
L4-L7 service insertion, service chaining, and load balancing	Product Overview	August 14 ,2024
Quantum key distribution for MACSec through SKIP protocol	Product Overview	August 14 ,2024
Microsegmentation using VXLAN Group Policy objects	Product Overview	August 14 ,2024
ST 2022-7 Fabric Redundancy Visualization with NDFC	Product Overview	August 14 ,2024
Cat9k Provisioning in IPFM fabric	Product Overview	August 14 ,2024
Topology utilization visualization	Product Overview	August 14 ,2024
Optics health prediction	Product Overview	August 14 ,2024

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Cisco MDS Smart Licensing Using Policy

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Cisco® MDS Smart Licensing is a cloud-based licensing solution that enables compliance for hardware and software licenses with no interruption to network operations.

Product overview

Smart Licensing using Policy (SLP) is the new Cisco MDS licensing model which is supported starting with Cisco MDS NX-OS Release 9.2(2) and it will be the only licensing mechanism available from this release and onward. It provides a cloud-based licensing solution that enables a compliance relationship to the account for the hardware and software licenses purchased and used, with no interruption to network operations.

The SLP provides a seamless experience as follows:

- Purchase: Licenses are purchased through the existing channels and use the Cisco Smart Software Manager (CSSM) portal to view product instances and licenses.
- Use: There are two categories of Cisco MDS switch licenses – software licenses and port activation licenses. For both categories, there is no requirement for license registration. Only for Port activation licenses, an authorization key has to be generated to enable ports. In online mode, generation and installation of authorization code is automatically handled and requires no manual intervention. In offline mode, it requires manual generation and installation of authorization code. License usage is recorded on the switch with timestamps, and the required workflows can be completed at a later time.
- Report license usage to Cisco Smart Software Manager (CSSM): There are multiple options available for Cisco MDS license usage reporting to CSSM. An MDS SLP deployment can be configured to either report directly to CSSM through the internet or through mediated access using the Cisco Smart License Utility (CSLU) or Smart Software Manager (SSM) on premises. For air-gapped MDS networks, there is a provision for offline reporting. License usage reports can be manually downloaded from the switch/CSLU/SSM on premises, depending on the deployment model, and uploaded to CSSM. The license usage report is provided in plain XML format.

Features and benefits

Table 1. Primary features and benefits

Feature	Benefit
Seamless day-0 operations	It provides a completely seamless day-0 operation for Cisco MDS licenses. There is no evaluation mode for licenses, and there is no requirement for registration of licenses. For software licenses, a key is not required to be generated before allowing the use of the software. To enable switch ports using port activation license, a licenses authorization key has to be generated on the CSSM and installed on the switch. In online mode, this is automatically taken care of and doesn't require any manual intervention; in offline mode it must be done manually.
Cisco MDS NX-OS	Devices running Cisco MDS NX-OS software have a consistent uniform licensing experience.
Visibility and manageability	Through a Cisco Smart Account, customers can easily view and manage all Cisco Smart Licenses and entitlements across the organization. An administrator can create virtual accounts (sub accounts) to help manage the licenses for departments, areas, or locations within the organization. Licenses can be pooled for virtual accounts as needed. Smart accounts have role-based user access controls, which allows the delegation of authority to account administrators at the Smart Account level or at the Cisco Virtual Account level. A customer can also delegate visibility and management rights to its Virtual or Enterprise level Smart Account to its partners.

Feature	Benefit
Flexible time-series reporting	Easy reporting options are available to remain compliant, whether you are directly or indirectly connected to CSSM or in an air-gapped network.
License portability	Cisco software licenses are no longer node-locked to a switch. Customers can easily pool software license entitlements and move them across devices in the organization as and when needed. This flexibility is not available for port-activation and FCIP upgrade licenses; both these licenses will be tied to a serial number and will be perpetual in nature.

Deployment Modes

New deployment

For greenfield Cisco MDS deployments, new Cisco MDS switch purchases with Cisco MDS NX-OS Release 9.2(2) pre-installed will have their first-time license reporting done at the Cisco factory. Therefore, Cisco MDS switches will not have to send a license report to Cisco for the next 365 days, based on the default reporting policy. If the switch fails to report within the SLP reporting period, the device will be marked out of compliance in the Cisco Smart Account, syslog messages will be generated on the switch depending on the SLP policy, but the features will continue to work in honor mode.

Upgrade from non-SLP release

For existing Cisco MDS deployments, where a Cisco MDS switch having PAK license is upgraded to Cisco MDS NX-OS Release 9.2(2), the software recognizes those PAK licenses and automatically triggers a "device-led license conversion" process to convert the PAK licenses to license entitlements without any user intervention. In air-gapped mode, the conversion must be done manually. Details can be found in the Cisco MDS Smart Licensing Using Policy Guide.

Licensing

Cisco MDS subscription bundles

The Cisco subscription license bundles simplify ordering and maximize savings. This Cisco subscription license model does not offer a-la-carte licenses as they are no longer price attractive. Port activation licenses remain outside subscription bundles.

Table 2. Cisco MDS subscription bundles

Subscription	Description
Premier	• Enterprise and Cisco Nexus® Dashboard Fabric Controller (NDFC; formerly DCNM), SAN Analytics • 1-, 3-, 5-, and 7-year options • Available with Cisco MDS NX-OS Release 9.2.2 or higher
Advantage	• Enterprise and Cisco Nexus® Dashboard Fabric Controller (NDFC; formerly DCNM) • 1-, 3-, 5-, and 7-year options • Available with Cisco MDS NX-OS Release 9.2.2 or higher
FICON	• FICON subscriptions will be available when a Cisco Smart Licensing enabled NX-OS release is FICON certified.
Port Expansion Licensing (fixed switches only)	• Requires Auth-code with Smart Licensing using Policy (SLP) • Treated like hardware, it will be perpetual and will decommission with the switch. • Available with Cisco MDS NX-OS Release 9.2.2 or higher

Subscription	Description
FCIP Upgrade Licensing (MDS 9220i only)	• Requires Auth-code with Cisco Smart Licensing using Policy (SLP) • Enables all FC and FCIP ports • Treated like hardware, it will be perpetual and will decommission with the switch. • Available with Cisco MDS NX-OS Release 9.2.2 or higher

License ordering information

A license can be ordered from Cisco Commerce just like any other Cisco® product. The Smart Account of the end customer or the Smart holding account of the partner must be indicated when placing the order for the licenses. Once the order is placed and successfully processed, the licenses are digitally credited to the Smart Account or the Smart holding account.

Spare subscription license ordering

To order a spare subscription license, you have to create a Cisco Commerce estimate for MDS-M9K-ADD-T; then pick “Select option” and pick one of the available licenses.

Ordering information

Cisco MDS Switch License PIDs

Table 3. Cisco MDS 9132T License PIDs

License PID	Description
M91XK9-A-1Y	MDS9100 Advantage Subscription License bundle for 1 year
M91XK9-A-3Y	MDS9100 Advantage Subscription License bundle for 3 years
M91XK9-A-5Y	MDS9100 Advantage Subscription License bundle for 5 years
M91XK9-A-7Y	MDS9100 Advantage Subscription License bundle for 7 years
M91XK9-P-1Y	MDS9100 Premier Subscription License bundle for 1 year
M91XK9-P-3Y	MDS9100 Premier Subscription License bundle for 3 years
M91XK9-P-5Y	MDS9100 Premier Subscription License bundle for 5 years
M91XK9-P-7Y	MDS9100 Premier Subscription License bundle for 7 years
M9132T-PL8	MDS 9132T 8-Port Upgrade License
M9132T-PL8-SL=	MDS 9132T 8-Port Upgrade Smart License, Spare

Table 4. Cisco MDS 9148T License PIDs

License PID	Description
M91XK9-A-1Y	MDS9100 Advantage Subscription License bundle for 1 year
M91XK9-A-3Y	MDS9100 Advantage Subscription License bundle for 3 years
M91XK9-A-5Y	MDS9100 Advantage Subscription License bundle for 5 years
M91XK9-A-7Y	MDS9100 Advantage Subscription License bundle for 7 years
M91XK9-P-1Y	MDS9100 Premier Subscription License bundle for 1 year
M91XK9-P-3Y	MDS9100 Premier Subscription License bundle for 3 years
M91XK9-P-5Y	MDS9100 Premier Subscription License bundle for 5 years
M91XK9-P-7Y	MDS9100 Premier Subscription License bundle for 7 years
M9148T-PL8	MDS 9148T 8-port Upgrade license
M9148T-PL8-SL=	MDS 9148T 8-port Upgrade Smart license, Spare

Table 5. Cisco MDS 9396T License PIDs

License PID	Description
M93XK9-A-1Y	MDS9300 Advantage Subscription License bundle for 1 year
M93XK9-A-3Y	MDS9300 Advantage Subscription License bundle for 3 years
M93XK9-A-5Y	MDS9300 Advantage Subscription License bundle for 5 years
M93XK9-A-7Y	MDS9300 Advantage Subscription License bundle for 7 years
M93XK9-P-1Y	MDS9300 Premier Subscription License bundle for 1 year
M93XK9-P-3Y	MDS9300 Premier Subscription License bundle for 3 years
M93XK9-P-5Y	MDS9300 Premier Subscription License bundle for 5 years
M93XK9-P-7Y	MDS9300 Premier Subscription License bundle for 7 years
M9396T-PL16	MDS 9396T 16-Port Upgrade License
M9396T-PL16-SL=	MDS 9396T 16-Port Upgrade Smart License, Spare

Table 6. Cisco MDS 9148V License PIDs

License PID	Description
M91VXK9-A-1Y	MDS M9100V Advantage Subscription License bundle for 1 year
M91VXK9-A-3Y	MDS M9100V Advantage Subscription License bundle for 3 years
M91VXK9-A-5Y	MDS M9100V Advantage Subscription License bundle for 5 years
M91VXK9-A-7Y	MDS M9100V Advantage Subscription License bundle for 7 years
M91VXK9-P-1Y	MDS M9100V Premier Subscription License bundle for 1 year
M91VXK9-P-3Y	MDS M9100V Premier Subscription License bundle for 3 years
M91VXK9-P-5Y	MDS M9100V Premier Subscription License bundle for 5 years
M91VXK9-P-7Y	MDS M9100V Premier Subscription License bundle for 7 years
M9148V-PL8	MDS 9148V 64G FC switch 8-port upgrade license
M9148V-PL8=	MDS 9148V 64G FC switch 8-port upgrade license, Spare

Table 7. Cisco MDS 9124V License PIDs

License PID	Description
M91VXK9-A-1Y	MDS M9100V Advantage Subscription License bundle for 1 year
M91VXK9-A-3Y	MDS M9100V Advantage Subscription License bundle for 3 years
M91VXK9-A-5Y	MDS M9100V Advantage Subscription License bundle for 5 years
M91VXK9-A-7Y	MDS M9100V Advantage Subscription License bundle for 7 years
M91VXK9-P-1Y	MDS M9100V Premier Subscription License bundle for 1 year
M91VXK9-P-3Y	MDS M9100V Premier Subscription License bundle for 3 years
M91VXK9-P-5Y	MDS M9100V Premier Subscription License bundle for 5 years
M91VXK9-P-7Y	MDS M9100V Premier Subscription License bundle for 7 years
M9124V-PL8	MDS 9124V 64G FC switch 8-port upgrade license
M9124V-PL8=	MDS 9124V 64G FC switch 8-port upgrade license, Spare

Table 8. Cisco MDS 9250i License PIDs

License PID	Description
M92XK9-A-1Y	MDS9200 Advantage Subscription License bundle for 1 year
M92XK9-A-3Y	MDS9200 Advantage Subscription License bundle for 3 years
M92XK9-A-5Y	MDS 9200 Advantage Subscription License bundle for 5 years
M92XK9-A-7Y	MDS 9200 Advantage Subscription License bundle for 7 years
M9250IP20-16G-SL=	MDS 9250i 20-port FC Upgrade Smart License, Spare

Table 9. Cisco MDS 9220i License PIDs

License PID	Description
M92XK9-A-1Y	MDS9200 Advantage Subscription License bundle for 1 year
M92XK9-A-3Y	MDS9200 Advantage Subscription License bundle for 3 years
M92XK9-A-5Y	MDS9200 Advantage Subscription License bundle for 5 years
M92XK9-A-7Y	MDS9200 Advantage Subscription License bundle for 7 years
M9220I-UPGK9-SL=	MDS 9220I Upgrade Smart license to enable all ports, Spare

Table 10. Cisco MDS 9700 License PIDs

License PID	Description
M97XK9-A-1Y	MDS9700 Advantage Subscription License bundle for 1 year
M97XK9-A-3Y	MDS9700 Advantage Subscription License bundle for 3 years
M97XK9-A-5Y	MDS9700 Advantage Subscription License bundle for 5 years
M97XK9-A-7Y	MDS9700 Advantage Subscription License bundle for 7 years
M97XK9-P-1Y	MDS9700 Premier Subscription License bundle for 1 year
M97XK9-P-3Y	MDS9700 Premier Subscription License bundle for 3 years
M97XK9-P-5Y	MDS9700 Premier Subscription License bundle for 5 years
M97XK9-P-7Y	MDS9700 Premier Subscription License bundle for 7 years

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For more information about the Cisco MDS Smart Licensing using Policy, visit Smart Licensing Using Policy Guide or contact your local Cisco account representative.

Document history

New or revised topic	Described in	Date
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Cisco Nexus 3548-X, 3524-X, 3548-XL, and 3524-XL Switches

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Cisco Nexus 3000 Series Switches overview

The Cisco Nexus® 3000 Series Switches are a comprehensive portfolio of 1, 10, and 40 Gigabit Ethernet switches built from a Switch-on-a-Chip (SoC) architecture. Introduced in April 2011, this series of switches provides line-rate Layer 2 and 3 performance and is suitable for Top-of-the-Rack (ToR) architecture. This series of switches has established itself as a leader in High-Frequency Trading (HFT), High-Performance Computing (HPC), and big data environments by pairing high performance and low latency with innovations in performance visibility, automation, and time synchronization.

Cisco Nexus 3500 platform overview

The Cisco Nexus 3500 platform further extends the leadership of the Cisco Nexus 3000 Series by including the innovative Cisco® Algorithm Boost (or Algo Boost) technology. Algo Boost technology, built into the switch Application-Specific Integrated Circuit (ASIC), allows the Cisco Nexus 3500 platform to achieve exceptional Layer 2 and 3 switching latencies of less than 200 nanoseconds (ns). In addition, Algo Boost offers several innovations in latency, forwarding, and performance visibility capabilities:

- Three configurable modes for low latency
    - Normal mode: This mode is excellent for environments needing low latency and high scalability. In this mode, latencies as low as 250 ns can be paired with the higher of the Layer 2 and 3 scaling values listed later in this document, in Table 6 and 7.
    - Warp mode: For those customers with smaller environments who demand the lowest latencies possible, warp mode consolidates forwarding operations within the switch ASIC, lowering latency by up to an additional 20 percent compared to normal operation. In this mode, latencies as low as 200 ns can be paired with the smaller of the Layer 2 and 3 scaling values listed later in this document, in Table 8.
    - Warp SPAN: In some environments, a stream of traffic entering one port simply needs to be copied to a list of outgoing ports as quickly as possible without processing or modification. The Cisco Nexus 3500 platform's warp SPAN capability allows all traffic entering a single port on the switch to be replicated to any number of destination ports at latencies as low as 50 ns.
- Hitless Network Address Translation (NAT): In many financial trading environments, trade orders must be sourced from the IP space of the provider, requiring NAT at the border between networks. The Cisco Nexus 3500 platform can perform NAT for IPv4 unicast routed packets without incurring any additional latency. The Cisco Nexus 3548-X and 3524-X Switches introduce multicast NAT to the platform's capability. Customers hosting co-locations will find this feature useful in simplifying their network topologies and concealing details of their data centers.
- Latency monitoring: When nanoseconds matter, switch latency monitoring is essential to your company's profitability. The Cisco Nexus 3548-X, 3524-X, 3548-XL and 3524-XL enable users to finely control their environments to increase network performance. Customers can identify latency on a specific egress port through the Command-Line Interface (CLI) and export this information to a file. The programmability of the Cisco Nexus 3548-X allows users to use this information in real time.

- Active buffer monitoring: Even on the lowest-latency switches, data packets can incur a millisecond or more of latency during periods of congestion. Today's switches do not adequately inform administrators about the presence of this congestion, leaving them unaware and hindered in their ability to address the conditions causing suboptimal performance. Previous buffer utilization monitoring techniques were based entirely on software polling algorithms with polling intervals higher than 100 ms, which can miss important congestion events. In contrast, Algo Boost accelerates the collection of buffer utilization data in hardware, allowing sampling intervals of 10 ns or less.
- Advanced traffic mirroring: The Algo Boost technology on the Cisco Nexus 3500 platform facilitates not only network troubleshooting by supporting Cisco Switched Port Analyzer (SPAN) and Encapsulated Remote SPAN (ERSPAN) technologies, but also in-service network monitoring with enhancements including the capability to:
    - Apply user-configurable filters to reduce the amount of captured traffic to a specified flow or protocol
    - Capture a sample of eligible packets, such as one out of every thousand
    - Truncate packets after a user-defined threshold
    - Insert a nanosecond-level timestamp in the ERSPAN header of captured packets (requires ERSPAN and Precision Time Protocol [PTP])
- IEEE 1588 PTP with Pulse-Per-Second (PPS) output*
    - The capability to build and maintain a synchronized, accurate timing solution is the basis for successful provisioning and management of HFT networks and applications. Using IEEE 1588 PTP, Cisco Nexus 3000 Series Switches can deliver highly accurate precision time synchronization to applications within existing network infrastructure with no need to invest in and deploy a separate timing network.
    - Network administrators deploying IEEE 1588 PTP often find it challenging to measure the accuracy to which each device is synchronized. To assist in this effort, the Cisco Nexus 3500 platform includes a 1-PPS output port that can be used to measure timing drift from the grandmaster clock.
- Network traffic monitoring with Cisco Nexus Data Broker
    - Build simple, scalable and cost-effective network tap or SPAN aggregation for network traffic monitoring and analysis. With Cisco Nexus 3500 platform switches, you can:
        - Truncate packets after a user-defined threshold at ingress
        - Time-stamp packets using Precision Time Protocol (PTP) with nanosecond accuracy

Cisco Nexus 3548 and 3524 Switches

The Cisco Nexus 3548 and 3524 Switches (Figure 1) are based on identical hardware, differentiated only by their software licenses, which allow the Cisco Nexus 3524 to operate 24 ports, and enable the use of all 48 ports on the Cisco Nexus 3548. These fixed switches are compact One-Rack-Unit (1RU) form-factor 10 Gigabit Ethernet switches that provide line-rate Layer 2 and 3 switching with ultra-low latency. Both software licenses run the industry-leading Cisco NX-OS Software operating system, providing customers with comprehensive features and functions that are deployed globally. The Cisco Nexus 3548 and 3524 contain no physical layer (PHY) chips, allowing low latency and low power consumption. These switches support both forward and reversed airflow schemes and both AC and DC power inputs.

Figure 1.
Cisco Nexus 3548 and 3524 Switch

The Cisco Nexus 3548 and 3524 have the following hardware configuration:

- 48 fixed Enhanced Small Form-Factor Pluggable (SFP+) ports (1 or 10 Gbps); the Cisco Nexus 3524 enables only 24 ports
- Dual redundant hot-swappable power supplies
- Four individual redundant hot-swappable fans
- One 1-PPS timing port, with the RF1.0/2.3 QuickConnect connector type*
- Two 10/100/1000 management ports[1]
- One RS-232 serial console port
- One USB port
- Locator LED
- Locator LED button

[1] *Only one management port is enabled and active with no plan to enable both.

Support for both port-side exhaust and port-side intake airflow schemes is available. Port-side exhaust airflow is useful when the port side of the switch sits on a hot aisle and the power supply side sits on a cold aisle. Port-side intake airflow is useful when the power supply side of the switch sits on a hot aisle and the port side sits on a cold aisle.

Colored handles on each fan or power supply clearly indicate the airflow direction, as seen in Figures 2 and 3.

Figure 2.
Cisco Nexus 3548 and 3524 with blue handles indicating port-side exhaust airflow

Figure 3.
Cisco Nexus 3548 and 3524 with red handles indicating port-side intake airflow

Cisco Nexus 3548-X and 3524-X Switches

The Cisco Nexus 3548-X and 3524-X Switches (Figure 4) are the next generation of the Cisco Nexus 3500 platform. Like the previous generation, these switches are compact 1RU form-factor 10 Gigabit Ethernet switches and provide line-rate Layer 2 and 3 switching with ultra-low latency. In addition, they consume 25 percent less power. This new generation introduces powerful hardware-based multicast NAT and latency monitoring capabilities and a second USB port for easier manageability.

Figure 4.
Cisco Nexus 3548-X and 3524-X Switches

The Cisco Nexus 3548-X and 3524-X have the following hardware configuration:

- 48 fixed SFP+ ports (1 or 10 Gbps); the Cisco Nexus 3524-X enables only 24 ports
- Dual redundant hot-swappable power supplies
- Four individual redundant hot-swappable fans
- One 1-PPS timing port, with the RF1.0/2.3 QuickConnect connector type*
- One 10/100/1000 management port
- One RS-232 serial console port
- Two USB ports
- Locator LED
- Locator LED button

Support for both port-side exhaust and port-side intake airflow schemes is available. Port-side exhaust airflow is useful when the port side of the switch sits on a hot aisle and the power supply side sits on a cold aisle. Port-side intake airflow is useful when the power supply side of the switch sits on a hot aisle and the port side sits on a cold aisle.

Colored handles on each fan or power supply clearly indicate the airflow direction, as seen in Figures 5 and 6.

Figure 5.
Cisco Nexus 3548-X and 3524-X with blue handles indicating port-side exhaust airflow

Figure 6.
Cisco Nexus 3548-X and 3524-X with red handles indicating port-side intake airflow

Cisco Nexus 3548-XL and 3524-XL Switches

The Cisco Nexus 3548-XL and 3524-XL Switches (Figure 7) are, respectively, Cisco Nexus 3548-X and 3524-X Switches with a faster CPU, running at 2.5 GHz; system memory increased to 16 GB; and bootflash memory increased to 16 GB. These enhancements allow the switches to support the Cisco NX-OS Data Management Engine (DME) model.

Figure 7.
Cisco Nexus 3548-XL and 3524-XL Switch

The Cisco Nexus 3548-XL and 3524-XL have the following hardware configuration:

- 48 fixed SFP+ ports (1 or 10 Gbps); the Cisco Nexus 3524-XL enables only 24 ports
- Dual redundant hot-swappable power supplies
- Four individual redundant hot-swappable fans
- One 1-PPS timing port, with the RF1.0 and 2.3 QuickConnect connector type*
- One 10/100/1000 management port
- One RS-232 serial console port
- Two USB ports
- Locator LED
- Locator LED button

Support for both port-side exhaust and port-side intake airflow schemes is available. Port-side exhaust airflow is useful when the port side of the switch sits on a hot aisle and the power supply side sits on a cold aisle. Port-side intake airflow is useful when the power supply side of the switch sits on a hot aisle and the port side sits on a cold aisle.

Colored handles on each fan or power supply clearly indicate the airflow direction, as shown in Figures 8 and 9.

Figure 8.
Cisco Nexus 3548-XL and 3524-XL with blue handles indicating port-side exhaust airflow

Figure 9.
Cisco Nexus 3548-XL and 3524-XL with red handles indicating port-side intake airflow

Cisco NX-OS Software overview

Cisco NX-OS is a data center-class operating system built with modularity, resiliency, and serviceability at its foundation. Cisco NX-OS helps ensure continuous availability and sets the standard for mission-critical data center environments. The self-healing and highly modular design of Cisco NX-OS makes zero-impact operations a reality and provides exceptional operational flexibility.

Focused on the requirements of the data center, Cisco NX-OS provides a robust and comprehensive feature set that meets the networking requirements of present and future data centers. With an XML interface and a Command-Line Interface (CLI) like that of Cisco IOS® Software, Cisco NX-OS provides state-of-the-art implementations of relevant networking standards as well as a variety of true data center-class Cisco innovations.

Cisco NX-OS Software benefits

Table 1 summarizes the benefits that Cisco NX-OS Software offers.

Table 1. Benefits of Cisco NX-OS Software

Feature	Benefit
Common software throughout the data center: Cisco NX-OS runs on all Cisco data center switch platforms (Cisco Nexus 7000, 5000, 4000, and 1000V Series Switches and Cisco Nexus 2000 Series Fabric Extenders).	• Simplification of data center operating environment • End-to-end Cisco Nexus and Cisco NX-OS fabric • No retraining necessary for data center engineering and operations teams
Software compatibility: Cisco NX-OS interoperates with Cisco products running any variant of Cisco IOS Software and also with any networking OS that conforms to the networking standards listed as supported in this data sheet.	• Transparent operation with existing network infrastructure • Open standards • No compatibility concerns

Feature	Benefit
Modular software design: Cisco NX-OS is designed to support distributed multithreaded processing. Cisco NX-OS modular processes are instantiated on demand, each in a separate protected memory space. Thus, processes are started and system resources allocated only when a feature is enabled. The modular processes are governed by a real-time preemptive scheduler that helps ensure timely processing of critical functions.	• Robust software • Fault tolerance • Increased scalability • Increased network availability
Troubleshooting and diagnostics: Cisco NX-OS is built with unique serviceability functions to allow network operators to take early action based on network trends and events, enhancing network planning and improving Network Operations Center (NOC) and vendor response times. Cisco Smart Call Home and Cisco Online Health Management System (OHMS) are some of the features that enhance the serviceability of Cisco NX-OS.	• Quick problem isolation and resolution • Continuous system monitoring and proactive notifications • Improved productivity of operations teams
Ease of management: Cisco NX-OS provides a programmatic XML interface based on the NETCONF industry standard. The Cisco NX-OS XML interface provides a consistent API for devices. Cisco NX-OS also provides support for Simple Network Management Protocol (SNMP) Versions 1, 2, and 3 MIBs.	• Rapid development and creation of tools for enhanced management • Comprehensive SNMP MIB support for efficient remote monitoring
Using the Cisco Nexus Data Broker software and Cisco Plug-in for OpenFlow agent, the Cisco Nexus 3500 platform can be used to build a scalable, cost-effective, and programmable tap or SPAN aggregation infrastructure. This approach replaces the traditional purpose-built matrix switches with these switches. You can interconnect these switches to build a multilayer topology for tap or SPAN aggregation infrastructure.	• Scalable and cost effective • Traffic aggregation from multiple input ports across different switches • Traffic replication and forwarding to multiple monitoring tools • Support for packet truncation and time stamping
Role-Based Access Control (RBAC): With RBAC, Cisco NX-OS enables administrators to limit access to switch operations by assigning roles to users. Administrators can customize access and restrict it to only the users who require it.	• Effective access control mechanism based on user roles • Improved network device security • Reduction in network problems arising from human error

Cisco NX-OS Software packages for the Cisco Nexus 3500 platform

The software packages for the Cisco Nexus 3500 offer flexibility and a comprehensive feature set and are consistent with Cisco Nexus access switches. The default system software has a comprehensive Layer 2 feature set with extensive security and management features. To enable certain Layer 3 IP unicast and multicast routing functions, NAT, warp mode, and warp SPAN, additional licenses must be installed, as described in Table 2. See Table 9 later in this document for a complete software feature list.

Table 2. Software licensing for Cisco Nexus 3500

Software package	Features supported
System default (no license required)	• Comprehensive Layer 2 feature set: VLAN, IEEE 802.1Q trunking, Link Aggregation Control Protocol (LACP), Unidirectional Link Detection (UDLD; Standard and Aggressive), Multiple Spanning Tree Protocol (MSTP), Rapid Spanning Tree Protocol (RSTP), and Spanning Tree Protocol guard • Security: Authentication, Authorization, and Accounting (AAA), Access Control Lists (ACLs), storm control, and configurable Control-Plane Policing (CoPP) • Management features: Cisco Data Center Network Manager (DCNM) support, Secure Shell Version 2 (SSHv2) access, Cisco Discovery Protocol, SNMP, syslog, and IEEE 1588 PTP • Monitoring features: Advanced buffer monitoring, SPAN, and ERSPAN
Base license	• Layer 3 IP routing: Inter-VLAN Routing (IVR), static routes, Routing Information Protocol Version 2 (RIPv2), ACLs, Open Shortest Path First Version 2 (OSPFv2; limited to 256 routes), Enhanced Interior Gateway Routing Protocol (EIGRP) stub, Hot Standby Router Protocol (HSRP), and Virtual Router Redundancy Protocol (VRRP) • Multicast: Protocol-Independent Multicast Sparse Mode (PIM-SM), Source-Specific Multicast (SSM), and Multicast Source Discovery Protocol (MSDP)
LAN Enterprise license (N3548-LAN1K9, N3524-LAN1K9); requires Base license	• Advanced Layer 3 IP routing: OSPFv2, EIGRP, Border Gateway Protocol (BGP), and Virtual Routing and Forwarding Lite (VRF-Lite)
Algo Boost license (N3548-ALGK9)	• Algo Boost features: NAT, warp mode, and warp SPAN
Cisco Nexus Data Broker license (NDB-FX-SWT-K9)	• License for using the tap and SPAN aggregation functions with Cisco Nexus Data Broker; only the Base license is needed for this feature
N3548-24P-UPG=	• Cisco Nexus 3524 24-Port Upgrade License
L-N3548-24P-UPG=	• Cisco Nexus 3524 24-Port Upgrade License (e- delivery)

Cisco Data Center Network Manager

The Cisco Nexus 3500 platform is supported in Cisco DCNM. Cisco DCNM is designed for the Cisco Nexus hardware platforms, which are enabled for Cisco NX-OS. Cisco DCNM is a Cisco management solution that increases overall data center infrastructure uptime and reliability, improving business continuity. Focused on the management requirements of the data center network, Cisco DCNM provides a robust framework and comprehensive feature set that can meet the routing, switching, and storage administration needs of present and future data centers. Cisco DCNM automates the provisioning process, proactively monitors the LAN by detecting performance degradation, secures the network, and simplifies the diagnosis of dysfunctional network elements.

Cisco Nexus Data Broker

The Cisco Nexus 3500 platform switches with Cisco Nexus Data Broker can be used to build a scalable and cost-effective traffic monitoring infrastructure using network taps and SPAN. This approach replaces the traditional purpose-built matrix switches with one or more OpenFlow-enabled Cisco Nexus switches. You can interconnect these switches to build a scalable tap or SPAN aggregation infrastructure. You also can combine tap and SPAN sources to bring the copy of the production traffic to this tap or SPAN aggregation infrastructure. In addition, you can distribute these sources and traffic monitoring and analysis tools across multiple Cisco Nexus switches. For more details, visit https://www.cisco.com/go/nexusdatabroker.

Transceiver and cabling options

The Cisco Nexus 3500 platform supports a wide variety of 100 Megabit Ethernet and 1, 10, and 40 Gigabit Ethernet connectivity options. For in-rack or adjacent-rack cabling, the Cisco Nexus 3500 platform supports SFP+ direct-attach copper cabling, an innovative solution that integrates transceivers with Twinax cables into an energy-efficient and low-cost solution. For longer cable runs, multimode and single-mode optical SFP+ transceivers are supported.

Table 3 lists the supported 40 Gigabit Ethernet transceiver options. 40 Gigabit Ethernet is achieved on the Cisco Nexus 3500 platform by combining four sequential SFP+ interfaces into a logical 40 Gigabit Ethernet port. The resulting interface is fully compliant with the IEEE standard for 40 Gigabit Ethernet and thus is interoperable with any other 40 Gigabit Ethernet device, regardless of interface form factor, including Quad SFP (QSFP).

Table 3. Cisco Nexus 3500 platform 40 Gigabit Ethernet transceiver support matrix

Part number	Description
SFP-10G-SR	10GBASE-SR SFP+ module (multimode fiber [MMF])
SFP-10G-LR	10GBASE-LR SFP+ module (single-mode fiber [SMF])
QSFP-4SFP10G-CU1M	QSFP to 4 x SFP 10-Gbps passive copper splitter cable, 1m (Twinax cable)
QSFP-4SFP10G-CU3M	QSFP to 4 x SFP 10-Gbps passive copper splitter cable, 3m (Twinax cable)
QSFP-4SFP10G-CU5M	QSFP to 4 x SFP 10-Gbps passive copper splitter cable, 5m (Twinax cable)

Table 4 lists the supported 10 Gigabit Ethernet transceiver options.

Table 4. Cisco Nexus 3500 platform 10 Gigabit Ethernet transceiver support matrix

Part number	Description
SFP-10G-SR	10GBASE-SR SFP+ module (MMF)
SFP-10G-LR	10GBASE-LR SFP+ module (single-mode fiber [SMF])
SFP-10G-ER	Cisco 10GBASE-ER SFP+ module for SMF
DWDM-SFP10G-*	10GBASE-DWDM modules (multiple varieties)
SFP-H10GB-CU1M	10GBASE-CU SFP+ cable, 1m (Twinax cable)
SFP-H10GB-CU3M	10GBASE-CU SFP+ cable, 3m (Twinax cable)
SFP-H10GB-CU5M	10GBASE-CU SFP+ cable, 5m (Twinax cable)
SFP-H10GB-ACU7M	Active Twinax cable assembly, 7m
SFP-H10GB-ACU10M	Active Twinax cable assembly, 10m

The Cisco Nexus 3500 platform is compatible with existing Gigabit Ethernet infrastructures. Both the uplink and downlink 10 Gigabit Ethernet interfaces can also operate in 100 Megabit Ethernet and 1 Gigabit Ethernet modes. Table 5 lists the Gigabit Ethernet SFP transceivers that are supported. 100 Megabit Ethernet connectivity can be achieved by using copper-based SFP transceivers (GLC-T).

Table 5. Cisco Nexus 3500 Platform Gigabit Ethernet transceiver support matrix

Part number	Description
GLC-TE	1000BASE-T SFP
GLC-SX-MM	GE SFP, LC connector SX transceiver (MMF)
GLC-SX-MMD	1000BASE-SX SFP transceiver module, MMF, 850 nm, DOM
GLC-LH-SM	GE SFP, LC connector LX and LH transceiver
GLC-LH-SMD	1000BASE-LX/LH SFP transceiver module, MMF and SMF, 1310 nm, DOM

For more information about the transceiver types, see https://www.cisco.com/en/US/products/hw/modules/ps5455/prod_module_series_home.html.

Product specifications

Table 6 lists the specifications for the Cisco Nexus 3548 and 3524 Switches, and Table 7 lists the specifications for the Cisco Nexus 3548-X, 3524-X, 3548-XL, and 3524-XL Switches. Table 8 lists hardware specifications common to all four switches, and Table 9 lists software features common to all four switches. Table 10 lists management standards and support.

Table 6. Cisco Nexus 3548 and 3524 specifications

Specification	Cisco Nexus 3548	Cisco Nexus 3524
Physical	• 48 fixed SFP+ ports (1 or 10 Gbps) • Dual redundant hot-swappable power supplies • Four individual redundant hot-swappable fans • One 1-PPS timing port, with the RF1.0/2.3 QuickConnect connector type* • Two 10/100/1000-Mbps management ports • One RS-232 serial console port • One USB port • Locator LED • Locator LED button	• 24 fixed SFP+ ports (1 or 10 Gbps); expandable to 48 ports • Dual redundant hot-swappable power supplies • Four individual redundant hot-swappable fans • One 1-PPS timing port, with the RF1.0/2.3 QuickConnect connector type* • Two 10/100/1000-Mbps management ports • One RS-232 serial console port • One USB port • Locator LED • Locator LED button
Performance	• 960-Gbps switching capacity • Forwarding rate of 720 million packets per second (mpps) • Line-rate traffic throughput (both Layer 2 and 3) on all ports • Configurable Maximum Transmission Units (MTUs) of up to 9216 bytes (jumbo frames)	• 480-Gbps switching capacity • Forwarding rate of 360 mpps • Line-rate traffic throughput (both Layer 2 and 3) on all ports • Configurable MTUs of up to 9216 bytes (jumbo frames)
Typical operating power	• 152 watts (W)	• 142W
Maximum power	• 265W	• 245W
Typical heat dissipation	• 519 BTUs per hr	• 484 BTUs per hr
Maximum heat dissipation	• 904 BTUs per hr	• 835 BTUs per hr

* 1-PPS output will be enabled in a future software revision.

Table 7. Cisco Nexus 3548-X, 3524-X, 3548-XL, and 3524-XL specifications

Specification	Cisco Nexus 3548-X	Cisco Nexus 3524-X
Physical	• 48 fixed SFP+ ports (1 or 10 Gbps) • Dual redundant hot-swappable power supplies • Four individual redundant hot-swappable fans • One 1-PPS timing port, with the RF1.0/2.3 QuickConnect connector type* • One 10/100/1000-Mbps management port • One RS-232 serial console port • Two USB ports • Locator LED • Locator LED button	• 24 fixed SFP+ ports (1 or 10 Gbps); expandable to 48 ports • Dual redundant hot-swappable power supplies • Four individual redundant hot-swappable fans • One 1-PPS timing port, with the RF1.0/2.3 QuickConnect connector type* • One 10/100/1000-Mbps management port • One RS-232 serial console port • Two USB ports • Locator LED • Locator LED button
Performance	• 960-Gbps switching capacity • Forwarding rate of 720 mpps • Line-rate traffic throughput (both Layer 2 and 3) on all ports • Configurable MTUs of up to 9216 bytes (jumbo frames)	• 480-Gbps switching capacity • Forwarding rate of 360 mpps • Line-rate traffic throughput (both Layer 2 and 3) on all ports • Configurable MTUs of up to 9216 bytes (jumbo frames)
Typical operating power	• 112W	• 102W
Maximum power	• 213W	• 193W
Typical heat dissipation	• 383 BTUs per hr	• 348 BTUs per hr
Maximum heat dissipation	• 727 BTUs per hr	• 658 BTUs per hr

* 1-PPS output will be enabled in a future software revision.

Table 8. Hardware specifications common to all switches

	Mode	Normal mode	Warp mode
Hardware tables and scalability	Number of MAC addresses	64,000	8000
	Number of IPv4 unicast routes	24,000	4000
	Number of IPv4 hosts	64,000	8000
	Number of IPv4 multicast routes	8000	8000
	Number of VLANS	4096	
	Number of ACL entries	4096	
	Number of spanning-tree instances	Rapid Spanning Tree Protocol (RSTP): 512 Multiple Spanning Tree (MST) Protocol: 64	
	Number of EtherChannels	24	
	Number of ports per EtherChannel	24	
	Buffer size	6 MB shared among 16 ports; 18 MB total	
	System memory	4 GB (3524 and 3548 models) 4 GB (3524-X and 3548-X models) 16 GB (3524-XL and 3548-XL models)	
	Boot flash memory	2 GB (3524 and 3548 models) 4 GB (3524-X and 3548-X models) 16 GB (3524-XL and 3548-XL models)	
Power	Number of power supplies	2 (redundant)	
	Power supply types	• AC (forward and reversed airflow) • DC (forward and reversed airflow)	
	Input voltage	100 to 240 VAC	
	Frequency	50 to 60 Hz	
	Power supply efficiency	89 to 91% at 220V	

	Mode	Normal mode	Warp mode
Cooling	Forward and reversed airflow schemes • Forward airflow: Port-side exhaust (air enters through fan tray and power supplies and exits through ports) • Reversed airflow: Port-side intake (air enters through ports and exits through fan tray and power supplies) Four individual, hot-swappable fans (3+1 redundant)		
Environment	Dimensions (height x width x depth)	1.72 x 17.3 x 18.38 in. (4.36 x 43.9 x 46.7 cm)	
	Weight	17.4 lb (7.9 kg)	
	Operating temperature	32 to 104° F (0 to 40° C)	
	Storage temperature	-40 to 158° F (-40 to 70° C)	
	Relative humidity (operating)	• 10 to 85% noncondensing • Up to 5 days at maximum (85%) humidity • Recommend ASHRAE data center environment	
	Relative humidity (nonoperating)	5 to 95% noncondensing	
	Altitude	0 to 10,000 ft (0 to 3000m)	

Table 9. Software features common to all switches

Description	Specifications
Layer 2	• Layer 2 switch ports and VLAN trunks • IEEE 802.1Q VLAN encapsulation • Support for up to 4096 VLANs • Rapid Per-VLAN Spanning Tree Plus (PVRST+) (IEEE 802.1w compatible) • MSTP (IEEE 802.1s): 64 instances • Spanning Tree PortFast • Spanning Tree Root Guard • Spanning Tree Bridge Assurance • Cisco EtherChannel technology (up to 24 ports per EtherChannel) • LACP: IEEE 802.3ad, IEEE 802.1ax • Advanced PortChannel hashing based on Layer 2, 3, and 4 information • Jumbo frames on all ports (up to 9216 bytes) • Storm control (multicast and broadcast) • Link-level flow control (IEEE 802.3x) • vPC*[2]

[2] vPC is not supported in WARP mode. For more information please see the configuration guide.

Description	Specifications
Layer 3	• Layer 3 interfaces: Routed ports on interfaces, Switch Virtual Interfaces (SVIs), PortChannels, and subinterfaces (total: 1024) • 24-way Equal-Cost Multipath (ECMP) • 4096 ACL entries • Routing protocols: Static, RIPv2, EIGRP, OSPF, and BGP • HSRP and VRRP • ACL: Routed ACL with Layer 3 and 4 options to match ingress and egress ACLs • VRF: VRF-Lite (IP VPN), VRF-aware unicast (BGP, OSPF, and RIP), and VRF-aware multicast • VRF route leaking • Jumbo frame support (up to 9216 bytes)
Multicast	• Multicast: PIMv2, PIM Sparse Mode (PIM-SM), SSM, and BiDir • Bootstrap router (BSR), Auto-RP, and Static RP • MSDP and Anycast RP • Internet Group Management Protocol (IGMP) Versions 2 and 3
Security	• Ingress ACLs (standard and extended) on Ethernet • Standard and extended Layer 3 to 4 ACLs include IPv4, Internet Control Message Protocol (ICMP), TCP, and User Datagram Protocol (UDP) • VLAN-based ACLs (VACLs) • Port-based ACLs (PACLs) • Named ACLs • ACLs on virtual terminals (VTYs) • Dynamic Host Configuration Protocol (DHCP) relay • Control Plane Policing (CoPP)
Cisco Nexus Data Broker	• Topology support for tap and SPAN aggregation • Traffic load balancing to multiple monitoring tools • Time stamping using PTP • Packet truncation • Traffic filtering based on Layer 1 through Layer 4 header information • Traffic replication and forwarding to multiple monitoring tools • Robust RBAC • Northbound Representational State Transfer (REST) API for all programmability support
Management	• Power On Auto Provisioning (POAP) • Python scripting • Switch management using 10/100/1000-Mbps management or console ports • CLI-based console to provide detailed out-of-band management • In-band switch management • Locator and beacon LEDs • Configuration rollback • SSHv2 • Telnet • AAA • AAA with RBAC • RADIUS • TACACS+ • Syslog

Description	Specifications
	• Embedded packet analyzer • SNMP v1, v2, and v3 • Enhanced SNMP MIB support • XML (NETCONF) support • Remote monitoring (RMON) • Advanced Encryption Standard (AES) for management traffic • Unified username and passwords across CLI and SNMP • Microsoft Challenge Handshake Authentication Protocol (MS-CHAP) • Digital certificates for management between switch and RADIUS server • Cisco Discovery Protocol Versions 1 and 2 • RBAC • SPAN on physical, PortChannel, and VLAN • ERSPAN Versions 2 and 3 • Ingress and egress packet counters per interface • Network Time Protocol (NTP) • Cisco OHMS • Comprehensive bootup diagnostic tests • Cisco Call Home • Cisco DCNM • Active buffer monitoring • PTP (IEEE 1588) boundary clock

Table 10. Management and standards support

Description	Specification	
MIB support	Generic MIBs • SNMPv2-SMI • CISCO-SMI • SNMPv2-TM • SNMPv2-TC • IANA-ADDRESS-FAMILY-NUMBERS-MIB • IANAifType-MIB • IANAiprouteprotocol-MIB • HCNUM-TC • CISCO-TC • SNMPv2-MIB • SNMP-COMMUNITY-MIB • SNMP-FRAMEWORK-MIB • SNMP-NOTIFICATION-MIB • SNMP-TARGET-MIB • SNMP-USER-BASED-SM-MIB • SNMP-VIEW-BASED-ACM-MIB • CISCO-SNMP-VACM-EXT-MIB Ethernet MIBs • CISCO-VLAN-MEMBERSHIP-MIB	Monitoring MIBs • NOTIFICATION-LOG-MIB • CISCO-SYSLOG-EXT-MIB • CISCO-PROCESS-MIB • RMON-MIB • CISCO-RMON-CONFIG-MIB • CISCO-HC-ALARM-MIB Security MIBs • CISCO-AAA-SERVER-MIB • CISCO-AAA-SERVER-EXT-MIB • CISCO-COMMON-ROLES-MIB • CISCO-COMMON-MGMT-MIB • CISCO-SECURE-SHELL-MIB Miscellaneous MIBs • CISCO-LICENSE-MGR-MIB • CISCO-FEATURE-CONTROL-MIB • CISCO-CDP-MIB • CISCO-RF-MIB Layer 3 and Routing MIBs

Description	Specification	
	Configuration MIBs • ENTITY-MIB • IF-MIB • CISCO-ENTITY-EXT-MIB • CISCO-ENTITY-FRU-CONTROL-MIB • CISCO-ENTITY-SENSOR-MIB • CISCO-SYSTEM-MIB • CISCO-SYSTEM-EXT-MIB • CISCO-IP-IF-MIB • CISCO-IF-EXTENSION-MIB • CISCO-NTP-MIB • CISCO-IMAGE-MIB • CISCO-IMAGE-UPGRADE-MIB	• UDP -MIB • TCP-MIB • OSPF-MIB • OSPF-TRAP-MIB • BGP4-MIB • CISCO-HSRP-MIB • PIM-MIB
Standards	• IEEE 802.1D: Spanning Tree Protocol • IEEE 802.1p: CoS Prioritization • IEEE 802.1Q: VLAN Tagging • IEEE 802.1s: Multiple VLAN Instances of Spanning Tree Protocol • IEEE 802.1w: Rapid Reconfiguration of Spanning Tree Protocol • IEEE 802.3z: Gigabit Ethernet • IEEE 802.3ad: Link Aggregation Control Protocol (LACP) • IEEE 802.1ax: Link Aggregation Control Protocol (LACP) • IEEE 802.3ae: 10 Gigabit Ethernet • IEEE 802.3ba: 40 Gigabit Ethernet • IEEE 802.1ab: LLDP	
RFC	BGP • RFC 1997: BGP Communities Attribute • RFC 2385: Protection of BGP Sessions with the TCP MD5 Signature Option • RFC 2439: BGP Route Flap Damping • RFC 2519: A Framework for Inter-Domain Route Aggregation • RFC 2545: Use of BGPv4 Multiprotocol Extensions • RFC 2858: Multiprotocol Extensions for BGPv4 • RFC 3065: Autonomous System Confederations for BGP • RFC 3392: Capabilities Advertisement with BGPv4 • RFC 4271: BGPv4 • RFC 4273: BGPv4 MIB: Definitions of Managed Objects for BGPv4 • RFC 4456: BGP Route Reflection • RFC 4486: Subcodes for BGP Cease Notification Message • RFC 4724: Graceful Restart Mechanism for BGP • RFC 4893: BGP Support for Four-Octet AS Number Space OSPF • RFC 2328: OSPF Version 2 • 8431RFC 3101: OSPF Not-So-Stubby-Area (NSSA) Option • RFC 3137: OSPF Stub Router Advertisement • RFC 3509: Alternative Implementations of OSPF Area Border Routers	

Description	Specification
	• RFC 3623: Graceful OSPF Restart • RFC 4750: OSPF Version 2 MIB RIP • RFC 1724: RIPv2 MIB Extension • RFC 2082: RIPv2 MD5 Authentication • RFC 2453: RIP Version 2 • IP Services • RFC 768: User Datagram Protocol (UDP) • RFC 783: Trivial File Transfer Protocol (TFTP) • RFC 791: IP • RFC 792: Internet Control Message Protocol (ICMP) • RFC 793: TCP • RFC 826: ARP • RFC 854: Telnet • RFC 959: FTP • RFC 1027: Proxy ARP • RFC 1305: Network Time Protocol (NTP) Version 3 • RFC 1519: Classless Interdomain Routing (CIDR) • RFC 1542: BootP Relay • RFC 1591: Domain Name System (DNS) Client • RFC 1812: IPv4 Routers • RFC 2131: DHCP Helper • RFC 2338: VRRP IP Multicast • RFC 2236: Internet Group Management Protocol, version 2 • RFC 3376: Internet Group Management Protocol, Version 3 • RFC 3446: Anycast Rendezvous Point Mechanism Using PIM and MSDP • RFC 3569: An Overview of SSM • RFC 3618: Multicast Source Discovery Protocol (MSDP) • RFC 4601: Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised) • RFC 4607: Source-Specific Multicast for IP • RFC 4610: Anycast-RP using PIM • RFC 5015: PIM BiDir • RFC 5132: IP Multicast MIB

Software requirements

Cisco Nexus 3000 Series Switches are supported by Cisco NX-OS Software Release 5.0 and later. Cisco NX-OS interoperates with any networking OS, including Cisco IOS Software, that conforms to the networking standards mentioned in this data sheet.

Regulatory standards compliance

Table 11 summarizes regulatory standards compliance for the Cisco Nexus 3000 Series.

Table 11. Regulatory standards compliance: Safety and EMC

Specification	Description
Regulatory compliance	• Products should comply with CE Markings per directives 2004/108/EC and 2006/95/EC
Safety	• UL 60950-1 Second Edition • CAN/CSA-C22.2 No. 60950-1 Second Edition • EN 60950-1 Second Edition • IEC 60950-1 Second Edition • AS/NZS 60950-1 • GB4943
EMC: Emissions	• 47CFR Part 15 (CFR 47) Class A • AS/NZS CISPR22 Class A • CISPR22 Class A • EN55022 Class A • ICES003 Class A • VCCI Class A • EN61000-3-2 • EN61000-3-3 • KN22 Class A • CNS13438 Class A
EMC: Immunity	• EN55024 • CISPR24 • EN300386 • KN24
RoHS	RoHS 5 compliant except for lead press-fit connectors

Ordering information

Table 12 provides ordering information for the Cisco Nexus 3548-X, 3524-X, 3548-XL, and 3524-XL.

Table 12. Ordering information

Part number	Description
Chassis	
N3K-C3548P-XL	Nexus 3548-XL Switch, 48 SFP+
N3K-C3524P-XL	Nexus 3524-XL Switch, 24 SFP+
N3K-C3548P-10GX	Nexus 3548-X Switch, 48 SFP+
N3K-C3524P-10GX	Nexus 3524-X Switch, 24 SFP+
NXA-FAN-30CFM-F	N2K/3K Individual Fan, Forward airflow (port side exhaust)
NXA-FAN-30CFM-B	N2K/3K Individual Fan, Reversed airflow (port side intake)
N2200-PAC-400W	N2K/3K 400W AC Power Supply, Forward airflow (port side exhaust)
N2200-PAC-400W-B	N2K/3K 400W AC Power Supply, Reversed airflow (port side intake)
N2200-PDC-400W	N2K/3K 400W DC Power Supply, Forward airflow (port side exhaust)
N3K-PDC-350W-B	N2K/3K 350W DC Power Supply, Reversed airflow (port side intake)
Software Licenses	
N3548-BAS1K9	Nexus 3000 Layer 3 Base License
N3524-LAN1K9	Nexus 3524 Layer 3 LAN Enterprise License (Requires N3K-BAS1K9 License)
N3548-LAN1K9	Nexus 3548 Layer 3 LAN Enterprise License (Requires N3K-BAS1K9 License)
N3548-ALGK9	Nexus 3500 Algo Boost License
NDB-FX-SWT-K9	License for Tap/SPAN aggregation using Cisco Nexus Data Broker
N3548-24P-UPG=	Nexus 3524 additional 24 port license
Spares	
NXA-FAN-30CFM-F=	N2K/3K Individual Fan, Forward airflow (port side exhaust), Spare
NXA-FAN-30CFM-B=	N2K/3K Individual Fan, Reversed airflow (port side intake), Spare
N2000-PAC-400W=	N2K/3K 400W AC Power Supply, Forward airflow (port side exhaust), Spare
N2000-PAC-400W-B=	N2K/3K 400W AC Power Supply, Reversed airflow (port side intake), Spare
N2200-PDC-400W=	N2K/3K 400W DC Power Supply, Forward airflow (port side exhaust), Spare

Part number	Description
N3K-PDC-350W-B=	N3K Series 350W DC Power Supply, Reversed airflow (port side intake), Spare
N3K-C3064-ACC-KIT=	Nexus 3548 Accessory Kit (same as Nexus 3064)

Warranty

The Cisco Nexus 3000 Series Switches have a 1-year limited hardware warranty. The warranty includes hardware replacement with a 10-day turnaround from receipt of a Return Materials Authorization (RMA).

Product sustainability

Information about Cisco's Environmental, Social and Governance (ESG) initiatives and performance is provided in Cisco's CSR and sustainability reporting.

Table 13. Product sustainability

Sustainability Topic		Reference
General	Information on product-material-content laws and regulations	Materials
	Information on electronic waste laws and regulations, including our products, batteries and packaging	WEEE Compliance
	Information on product takeback and resuse program	Cisco Takeback and Reuse Program
	Sustainability Inquiries	Contact: csr_inquiries@cisco.com
Material	Product packaging weight and materials	Contact: environment@cisco.com

Service and Support

Cisco offers a wide range of services to help accelerate your success in deploying and optimizing the Cisco Nexus 3000 Series in your data center. The innovative Cisco Services offerings are delivered through a unique combination of people, processes, tools, and partners and are focused on helping you increase operation efficiency and improve your data center network. Cisco Advanced Services uses an architecture-led approach to help you align your data center infrastructure with your business goals and achieve long-term value. Cisco SMARTnet® Service helps you resolve mission-critical problems with direct access at any time to Cisco network experts and award-winning resources. With this service, you can take advantage of the Cisco Smart Call Home service capability, which offers proactive diagnostics and real-time alerts on your Cisco Nexus 3000 Series Switches. Spanning the entire network lifecycle, Cisco Services helps increase investment protection, optimize network operations, support migration operations, and strengthen your IT expertise.

Cisco Capital

Flexible payment solutions to help you achieve your objectives

Cisco Capital makes it easier to get the right technology to achieve your objectives, enable business transformation and help you stay competitive. We can help you reduce the total cost of ownership, conserve capital, and accelerate growth. In more than 100 countries, our flexible payment solutions can help you acquire hardware, software, services and complementary third-party equipment in easy, predictable payments. Learn more.

For more information

For more information, please visit https://www.cisco.com/go/nexus3000. For information about Cisco Nexus Data Broker, please visit https://www.cisco.com/go/nexusdatabroker.

Document history

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Cisco 10GBASE SFP+ Modules

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A broad range of industry-compliant SFP+ modules for 10 Gigabit Ethernet deployments in diverse networking environments.

Product overview

The Cisco® 10GBASE SFP+ modules (Figure 1) give you a wide variety of 10 Gigabit Ethernet connectivity options for data center, enterprise wiring closet, and service provider transport applications.

Figure 1.
Cisco 10GBASE SFP+ modules

Features and benefits

Cisco SFP+ modules offer the following features and benefits.

- Industry's smallest 10G form factor for greatest density per chassis
- Hot-swappable input/output device that plugs into an Ethernet SFP+ port of a Cisco switch (no need to power down if installing or replacing)
- Supports "pay-as-you-populate" model for investment protection and ease of technology migration
- Digital optical monitoring capability for strong diagnostic capabilities
- Optical interoperability with 10GBASE XENPAK, 10GBASE X2, and 10GBASE XFP interfaces on the same link
- Cisco quality Identification (ID) feature enables a Cisco platform to identify whether the module is certified and tested by Cisco

Cisco SFP-10G-T-X module

The Cisco 10GBASE-T module (Figure 2) offers connectivity options at the following data rates: 100M/1G/10Gbps. It has the SFP+ form factor and an RJ-45 interface so that CAT5e/CAT6A/CAT7 cables can be used to connect to end points with embedded 10GBASE-T ports. They are suitable for distances up to 30 meters and offers a cost-effective way to connect within racks and across adjacent racks.

Figure 2.
Cisco SFP+ 10GBASE-T module with RJ-45 connector

Table 1, details the specifications for the SFP-10G-T-X module, including cable type, distance, and data rates supported.

Table 1. SFP-10G-T-X cabling specifications

Cisco PIDs	Speeds	Cable Type	Distance	Max. Power Consumption (W)
SFP-10G-T-X	10Gbps	Cat6A/Cat7 or better	Up to 30 meters	2.5W
SFP-10G-T-X	100M/1Gbps	Cat5e/Cat6A/Cat7 or better	Up to 100 meters	1.0W

Cisco SFP-10G-SR-S module (S-Class)

The Cisco 10GBASE-SR module supports a link length of 26 meters on standard Fiber Distributed Data Interface (FDDI)-grade Multimode Fiber (MMF). Using 2000 MHz*km MMF (OM3), up to 300-meter link lengths are possible. Using 4700 MHz*km MMF (OM4), up to 400 meter link lengths are possible. SFP-10G-SR-S does not support FCoE.

Cisco SFP-10G-SR module

The Cisco 10GBASE-SR Module supports a link length of 26m on standard Fiber Distributed Data Interface (FDDI)-grade Multimode Fiber (MMF). Using 2000MHz*km MMF (OM3), up to 300m link lengths are possible. Using 4700MHz*km MMF (OM4), up to 400m link lengths are possible.

Cisco SFP-10G-SR-X module

The Cisco SFP-10G-SR-X is a multirate* 10GBASE-SR, 10GBASE-SW and OTU2/OTU2e module for extended operating temperature range. It supports a link length of 26m on standard Fiber Distributed Data Interface (FDDI)-grade Multimode Fiber (MMF). Using 2000MHz*km MMF (OM3), up to 300m link lengths are possible. Using 4700MHz*km MMF (OM4), up to 400m link lengths are possible.

* Except for version 1, which supports only 10GBASE-SR.

Cisco SFP-10G-SR-I module

The Cisco SFP-10G-SR-I is a multirate 10GBASE-SR, 10GBASE-SW and OTU2/2e module for industrial operating temperature range. This module also supports CPRI datarate options 3, 4, 5, 6, 7, 7a, 8. It supports a link length of 26m on standard Fiber Distributed Data Interface (FDDI)-grade Multimode Fiber (MMF). Using 2000MHz*km MMF(OM3), up to 300m link lengths are possible. Using 4700MHz*km MMF (OM4), up to 400m link lengths are possible.

Cisco SFP-10G-LRM module

The Cisco 10GBASE-LRM Module supports link lengths of 220m on standard Fiber Distributed Data Interface (FDDI) grade Multimode Fiber (MMF). To make sure that specifications are met over FDDI-grade, OM1 and OM2 fibers, the transmitter should be coupled through a mode conditioning patch cord. No mode conditioning patch cord is required for applications over OM3 or OM4. For additional information on mode conditioning patch cord requirements please see:
https://www.cisco.com/en/US/prod/collateral/modules/ps5455/product_bulletin_c25-530836.html.

The Cisco 10GBASE-LRM Module also supports link lengths of 300m on standard Single-Mode Fiber (SMF, G.652).

Cisco FET-10G module

The Cisco FET-10G Fabric Extender Transceiver supports link lengths up to 100m on laser-optimized OM3 or OM4 multimode fiber. It is supported on fabric links from a Nexus 2000 to a Cisco parent switch only. Note this product is not orderable individually. For more information refer to Nexus 2000 datasheet:
https://www.cisco.com/en/US/prod/collateral/switches/ps9441/ps10110/data_sheet_c78-507093.html.

Cisco SFP-10G-LR-S module (S-Class)

The Cisco 10GBASE-LR module supports a link length of 10 kilometers on standard Single-Mode Fiber (SMF) (G.652). SFP-10G-LR-S does not support FCoE.

Cisco SFP-10G-LR module

The Cisco 10GBASE-LR Module supports a link length of 10 kilometers on standard Single-Mode Fiber (SMF, G.652).

Cisco SFP-10G-LR-X module

The Cisco SFP-10G-LR-X is a multirate 10GBASE-LR, 10GBASE-LW, and OTU2/OTU2e module for extended operating temperature range. It supports a link length of 10 kilometers on standard Single-Mode Fiber (SMF, G.652).

Cisco SFP-10G-LR10-I module

The Cisco SFP-10G-LR10-I supports a link length of 10 kilometers on standard Single-Mode Fiber (SMF, G.652). The SFP-10G-LR10-I is for industrial operating temperature range. The SFP-10G-LR10-I also supports CPRI datrates options 3, 4, 5, 6, 7, 7a, 8.

Cisco SFP-10G-BXD-I and SFP-10G-BXU-I for 10Km (single-fiber bidirectional applications)

The Cisco SFP-10G-BXD-I and SFP-10G-BXU-I SFPs operate on a single strand of standard SMF.

A SFP-10G-BXD-I device is always connected to a SFP-10G-BXU-I device with a single strand of standard SMF with an operating transmission range up to 10 km.

The communication over a single strand of fiber is achieved by separating the transmission wavelength of the two devices, as depicted in Figure 3. SFP-10G-BXD-I transmits a 1330-nm channel and receives a 1270-nm signal, whereas SFP-10G-BXU-I transmits at a 1270-nm wavelength and receives a 1330-nm signal. Note in Figure 3 the presence of a Wavelength-Division Multiplexing (WDM) splitter integrated into the SFP to split the 1270-nm and 1330-nm light paths. This module also supports CPRI datarate options 3, 4, 5, 6, 7, 7a, 8.*

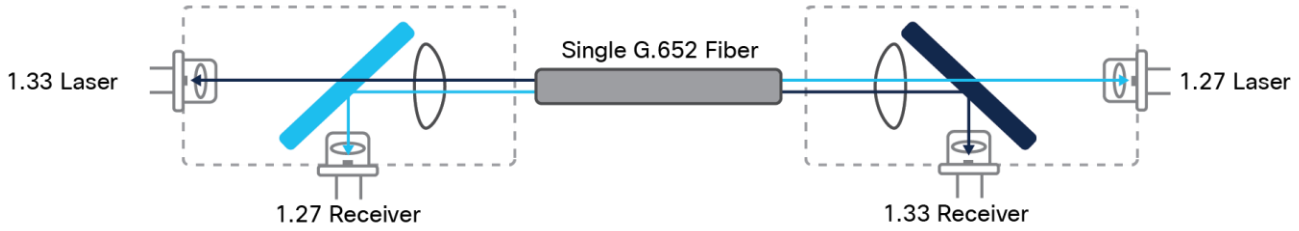

Figure 3.
Bidirectional transmission of a single strand of SMF

The SFP-10G-BXD-I and SFP-10G-BXU-I SFPs also support Digital Optical Monitoring (DOM) functions according to the industry-standard SFF-8472 Multisource Agreement (MSA). This feature gives the end user the ability to monitor real-time parameters of the SFP, such as optical output power, optical input power, temperature, laser bias current, and transceiver supply voltage.

*Version -02 of SFP-10G-BXD-I and SFP-10G-BXU-I supports the CPRI rates.

Cisco SFP-10G-ER-S module (S-Class)

The Cisco 10GBASE-ER module supports a link length of up to 40 kilometers on SMF (G.652). SFP-10G-ER-S does not support FCoE.

Cisco SFP-10G-ER module

The Cisco 10GBASE-ER Module supports a link length of up to 40 kilometers on standard Single-Mode Fiber (SMF, G.652).

Cisco SFP-10G-ER-I module

The Cisco 10GBASE-ER Industrial Temperature Module supports a link length of up to 40 kilometers on standard Single-Mode Fiber (SMF, G.652). The SFP-10G-ER-I for Industrial Operating Temperature Range is a multirate 10GBASE-ER, 10GBASE-EW and OTU2/2e module.

Cisco SFP-10G-BX40D-I and SFP-10G-BX40U-I (for 40Km single-fiber bidirectional applications)

The Cisco SFP-10G-BX40D-I and SFP-10G-BX40U-I SFPs operate on a single strand of standard SMF.

A SFP-10G-BX40D-I device is always connected to a SFP-10G-BX40U-I device with a single strand of standard SMF with an operating transmission range up to 40 km.

The communication over a single strand of fiber is achieved by separating the transmission wavelength of the two devices. SFP-10G-BX40D-I transmits a 1330-nm channel and receives a 1270-nm signal. The SFP-10G-BX40U-I transmits at a 1270-nm wavelength and receives a 1330-nm signal.

The SFP-10G-BX40D-I and SFP-10G-BX40U-I SFPs support Digital Optical Monitoring (DOM) functions according to the industry-standard SFF-8472 Multisource Agreement (MSA). This feature gives the end user the ability to monitor real-time parameters of the SFP, such as optical output power, optical input power, temperature, laser bias current, and transceiver supply voltage.

Cisco SFP-10G-ZR-S module (S-Class)

The Cisco 10GBASE-ZR module supports link lengths of up to about 80 kilometers on standard SMF (G.652). This interface is not specified as part of the 10 Gigabit Ethernet standards and is, instead, built according to Cisco specifications. SFP-10G-ZR-S does not support FCoE.

Cisco SFP-10G-ZR module

The Cisco SFP-10G-ZR is a multirate 10GBASE-ZR, 10GBASE-ZW, and OTU2/OTU2e module. It supports link lengths of up to about 80 kilometers on standard Single-Mode Fiber (SMF, G.652). This interface is not specified as part of the 10 Gigabit Ethernet standard and is instead built according to Cisco specifications.

Cisco SFP-10G-ZR-I module

The Cisco SFP-10G-ZR-I is a multirate 10GBASE-ZR, 10GBASE-ZW, and OTU2/OTU2e module for industrial operating temperature range. The SFP-10G-ZR-I has a limiting electrical interface receiver, which does not require EDC PHY on the host board, it can be plugged into any SFP+ port. It supports link lengths of up to 70 kilometers on standard Single-Mode Fiber (SMF, G.652), assuming a fiber chromatic dispersion of 20 ps/(nm*km). This interface is not specified as part of the 10 Gigabit Ethernet standard and is instead built according to Cisco specifications. The SFP-10G-ZR-I has a cold start at -40ºC; the transceiver will be operational except optical traffic is not supported from -40º to -28ºC, all other low speed features (DOM, I2C, etc.) are operational. The module is fully operational from -28ºC to 85ºC.

Cisco SFP+ Twinax copper cables

Cisco SFP+ Copper Twinax (Figure 4) direct-attach cables are suitable for very short distances and offer a cost-effective way to connect within racks and across adjacent racks. Cisco offers passive Twinax cables in lengths of 1, 1.5, 2, 2.5, 3, 4 and 5 meters, and active Twinax cables in lengths of 7 and 10 meters.

Figure 4.
Cisco direct-attach twinax copper cable assembly with SFP+ connectors

Cisco SFP+ Active optical cables

Cisco SFP+ Active Optical Cables (Figure 5) are direct-attach fiber assemblies with SFP+ connectors. They are suitable for very short distances and offer a cost-effective way to connect within racks and across adjacent racks. Cisco offers Active Optical Cables in lengths of 1, 2, 3, 5, 7, and 10 meters.

Figure 5.
Cisco direct-attach active optical cables with SFP+ connectors

Platform support

Cisco SFP+ modules are supported on a wide range of Cisco switches and routers*:

Table 2. Cisco Platforms

• 7600 Series Router	• Catalyst 4500 and 4500-X Series Switches
• ASR 901	• CRS Router
• ASR 903	• MDS 9000
• ASR 1000 Series Router	• ME 4500
• ASR 9000 Series Router	• ME 4900NCS 6000 Series Router
• ASR 9000v Series Router	• Nexus 2000, 3000, and 4000 Series Switches
• Catalyst 2350 and 2360 Series Switches	• Nexus 9000 and 9500 (modular) Series Switches
• Catalyst 2960-S, 2960-X, and 2960-XR Series Switches	• RF Gateway Series
• Catalyst 3100 Blade Switches	• SCE 8000
• Catalyst 3560, 3560-E, and 3560-X Series Switches	• Shared Port Adapter (SPA)
• Catalyst 3750, 3750-E, and 3750-X Series Switches	• Unified Computing System (UCS) Switches
• Catalyst 3850 Series Switches	

* Not all devices listed support every module. For details about which modules run in which devices and other compatibility information, refer to the document "Cisco 10 Gigabit Ethernet Transceiver Modules Compatibility Matrix": https://www.cisco.com/en/US/docs/interfaces_modules/transceiver_modules/compatibility/matrix/OL_6974.html.

Additional platforms may continually be added; please check the compatibility matrix for the latest information and for the Cisco compatible operating system for each platform.

Connectors: Dual LC/PC connector (-SR, -LRM, -LR, -ER, -ZR and FET-10G).

Note: Only connections with patch cords with PC or UPC connectors are supported. Patch cords with APC connectors are not supported. All cables and cable assemblies used must be compliant with the standards specified in the standards section.

Product specifications

Table 3 provides cabling specifications for the SFP+ modules.

Table 3. SFP+ port cabling specifications

SFP+	Wavelength (nm)	Cable Type	Core Size (Microns)	Modal Bandwidth (MHz*km)*3	Cable Distance*1
SFP-10G-SR-S[a] **SFP-10G-SR** **SFP-10G-SR-X** **SFP-10G-SR-I**[a]	850	MMF	62.5 62.5 50.0 50.0 50.0 50.0 50.0	160 (FDDI) 200 (OM1) 400 500 (OM2) 2000 (OM3) 4700 (OM4) 4700 (OM5)	26m 33m 66m 82m 300m 400m 400m
SFP-10G-LRM	1310	MMF SMF	62.5 50.0 50.0 G.652	500 400 500 -	220m 100m 220m 300m
FET-10G	850	MMF	50.0 50.0 50.0 50.0	500 (OM2) 2000 (OM3) 4700 (OM4) 4700 (OM5)	25m 100m 100m 100m
SFP-10G-LR-S[a] **SFP-10G-LR** **SFP-10G-LR-X** **SFP-10G-LR10-I**[b]	1310	SMF	G.652	-	10km
SFP-10G-BXD-I	1330	SMF	G.652	-	10km[b]
SFP-10G-BXU-I	1270	SMF	G.652	-	10km[b]
SFP-10G-ER-S*[4a] **SFP-10G-ER***[4] **SFP-10G-ER-I***[4]	1550	SMF	G.652	-	40km*[2]

SFP+	Wavelength (nm)	Cable Type	Core Size (Microns)	Modal Bandwidth (MHz*km)[*3]	Cable Distance[*1]
SFP-10G-BX40D-I[*6]	1330	SMF	G.652	-	40km
SFP-10G-BX40U-I[*6]	1270	SMF	G.652	-	40km
SFP-10G-ZR-S[*5a] **SFP-10G-ZR**[*5]	1550	SMF	G.652	-	80km
SFP-10G-ZR-I[*5a]	1550	SMF	G.652	-	70km
SFP-H10GB-CU1M[c]	-	Twinax cable, passive, 30AWG cable assembly	-	-	1m
SFP-H10GB-CU1-5M	-	Twinax cable, passive, 30AWG cable assembly	-	-	1.5m
SFP-H10GB-CU2M	-	Twinax cable, passive, 30AWG cable assembly	-	-	2m
SFP-H10GB-CU2-5M	-	Twinax cable, passive, 30AWG cable assembly	-	-	2.5m
SFP-H10GB-CU3M[c]	-	Twinax cable, passive, 30AWG cable assembly	-	-	3m
SFP-H10GB-CU4M	-	Twinax cable, passive, 24AWG or 26AWG cable assembly	-	-	4m
SFP-H10GB-CU5M[c]	-	Twinax cable, passive, 24AWG or 26AWG cable assembly	-	-	5m
SFP-H10GB-ACU7M	-	Twinax cable, active, 30 AWG cable assembly	-	-	7m
SFP-H10GB-ACU10M	-	Twinax cable, active, 28 AWG cable assembly	-	-	10m
SFP-10G-AOC1M	-	Active Optical Cable assembly	-	-	1m
SFP-10G-AOC2M	-	Active Optical Cable assembly	-	-	2m
SFP-10G-AOC3M	-	Active Optical Cable assembly	-	-	3m

SFP+	Wavelength (nm)	Cable Type	Core Size (Microns)	Modal Bandwidth (MHz*km)*3	Cable Distance*1
SFP-10G-AOC5M	-	Active Optical Cable assembly	-	-	5m
SFP-10G-AOC7M	-	Active Optical Cable assembly	-	-	7m
SFP-10G-AOC10M	-	Active Optical Cable assembly	-	-	10m

*1 Minimum cabling distance for -SR, -LRM, -LR, -ER modules is 2m, according to the IEEE 802.3ae.

*2 Links longer than 30km are considered engineered links as per IEEE 802.3ae.

*3 Specified at transmission wavelength.

*4 Requires 5 dB 1550nm fixed loss attenuator for < 20km. Attenuator is available as a spare. The part number is 15216 ATT LC 5=.

*5 Requires 15dB attenuator if Link Distance < 5km.

Requires 10dB attenuator if Link Distance is between 5km and 25km.

Requires 5dB attenuator if Link Distance is between 25km and 45km.

*6 Requires 15dB attenuator if Link Distance < 5km.

Requires 10dB attenuator if Link Distance is between 5km and 15km.

Requires 5dB attenuator if Link Distance is between 15km and 25km.

Attenuator is available as a spare. The part numbers:

- 5dB - 15216 ATT LC 5=
- 10dB - 15216 ATT LC 10=
- 15dB - 15216 ATT LC 15=

a - No FCoE support.

b - Links up to 15 km are supported as engineered links as long as channel insertion loss < 6.2 dB.

c - Only Version -02 and later of this DAC cable is qualified on all Cisco platforms.

Table 4 lists the main optical characteristics for the SFP+ modules.

Table 4. Optical transmit and receive specifications

Product	Type	Transmit Power (dBm)*		Receive Power (dBm)*		Transmit and Receive Wavelength (nm)
		Maximum	Minimum	Maximum	Minimum	
SFP-10G-SR-S **SFP-10G-SR**	10GBASE-SR 850nm MMF	-1.2**	-7.3	-1.0	-9.9	840 to 860
SFP-10G-SR-X **SFP-10G-SR-I**	10GBASE-SR, 10GBASE-SW and OTU2e 850nm MMF	-1.2**	-7.3	-1.0	-9.9	840 to 860

Product	Type	Transmit Power (dBm)*		Receive Power (dBm)*		Transmit and Receive Wavelength (nm)
		Maximum	Minimum	Maximum	Minimum	
SFP-10G-LRM	10GBASE-LRM 1310nm MMF and SMF	0.5	-6.5	0.5	-8.4 (in average) and -6.4 (in OMA)***	1260 to 1355
FET-10G	FET-10G 850nm MMF	-1.3	-8	-1	-9.9	840 to 860
SFP-10G-LR-S **SFP-10G-LR**	10GBASE-LR 1310nm SMF	0.5	-8.2	0.5	-14.4	1260 to 1355
SFP-10G-LR-X	10GBASE-LR, 10GBASE-LW and OTU2e 1310nm SMF	0.5	-8.2	0.5	-14.4	1260 to 1355
SFP-10G-LR10-I	10GBASE-LR, CPRI 1310 SMF	0.5	-8.2	0.5	-14.4	1260 to 1355
SFP-10G-BXD-I	10G-SFP Bidirectional for 10km	0.5	-8.2	0.5	-14.4	1320 to 1340 (Tx) 1260 to 1280 (Rx)
SFP-10G-BXU-I	10G-SFP Bidirectional for 10km	0.5	-8.2	0.5	-14.4	1260 to 1280 (Tx) 1320 to 1340 (Rx)
SFP-10G-ER-S **SFP-10G-ER** **SFP-10G-ER-I**	10GBASE-ER 1550nm SMF	4.0	-4.7	-1	-15.8	1530 to 1565
SFP-10G-BX40D-I	10G-SFP Bidirectional for 40km	4.5	-2.7	-9	-21.2	1320 to 1340 (Tx) 1260 to 1280 (Rx)
SFP-10G-BX40U-I	10G-SFP Bidirectional for 40km	4.5	-2.7	-9	-21.2	1260 to 1280 (Tx) 1320 to 1340 (Rx)
SFP-10G-ZR-S **SFP-10G-ZR** **SFP-10G-ZR-I**	10GBASE-ZR 1550nm SMF	4.0	0	-7	-24	1530 to 1565

* Transmitter and receiver power is in average, unless specified.

** The launch power shall be the lesser of the class 1 safety limit or the maximum receive power. Class 1 laser requirements are defined by IEC 60825-1: 2001.

*** Both average and OMA specifications must be met simultaneously.

Table 5 details optical specifications for the SFP-10G-ZR modules.

Table 5. SFP-10G-ZR, SFP-10G-ZR-S optical parameters

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes and Conditions
Transmitter						
Transmitter wavelength		1530		1565	nm	
Side-mode suppression ratio	SMSR	30			dB	
Transmitter extinction ratio		9			dB	
Transmitter optical output power	Pout	0		4.0	dBm	Average power coupled into single-mode fiber
Receiver						
Receiver optical input wavelength		1260		1565	nm	Receiver Sensitivity specified over 1530-1565nm only, with 3dB degradation permitted from 1260-1530nm
Receiver damage threshold		+5			dBm	
Receiver Overload		-7			dBm	
Receiver performance at 10GE LAN and 10GE WAN rates, non-FEC application						
Receiver sensitivity		-24			dBm	At BER=1E-12 with PRBS31 and 10GE frame
Chromatic Dispersion Penalty@ 1600 ps/nm*				3	dB	
Receiver performance at OTU2/OTU2e rates, FEC application						
Receiver sensitivity		-27			dBm	At Pre-FEC BER=1E-5 for GFEC and Pre-FEC BER=7E-4 for EFEC with PRBS31 and OTU2 frame
Chromatic Dispersion Penalty@ 1300 ps/nm				3	dB	

*Maximum chromatic dispersion for SFP-10G-ZR and SFP-10G-ZR-S is 1600 ps/nm.

Note: Parameters are specified over temperature and at end of life unless otherwise noted. When shorter distances of single-mode fiber are used (<40km), an inline optical attenuator must be used to avoid overloading and damaging the receiver.

Table 6. SFP-10G-ZR-I optical parameters

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes and Conditions
Transmitter						
Transmitter wavelength		1530		1565	nm	
Side-mode suppression ratio	SMSR	30			dB	
Transmitter extinction ratio		9			dB	
Transmitter optical output power	Pout	0		4.0	dBm	Average power coupled into single-mode fiber
Receiver						
Receiver optical input wavelength		1260		1565	nm	Receiver Sensitivity specified over 1530-1565nm only, with 3dB degradation permitted from 1260-1530nm
Receiver damage threshold		+5			dBm	
Receiver Overload		-7			dBm	
Receiver performance at 10GE LAN and 10GE WAN rates, non-FEC application						
Receiver sensitivity		-24			dBm	At BER=1E-12 with PRBS31 and 10GE frame
Chromatic Dispersion Penalty@ 1400 ps/nm*				3	dB	
Receiver performance at OTU2/OTU2e rates, FEC application						
Receiver sensitivity		-27			dBm	At Pre-FEC BER=1E-5 for GFEC and Pre-FEC BER=7E-4 for EFEC with PRBS31 and OTU2 frame
Chromatic Dispersion Penalty@ 1300 ps/nm				3	dB	

*Maximum chromatic dispersion for SFP-10G-ZR-I is 1400 ps/nm.

Note: Parameters are specified over temperature and at end of life unless otherwise noted. When shorter distances of single-mode fiber are used (<40km), an inline optical attenuator must be used to avoid overloading and damaging the receiver.

Table 7 describes the bail latch color code for each type of optical SFP+ module.

Table 7. SFP+ optical modules color code

Product	Bail Latch Color
SFP-10G-T-X	Golden/Yellow
SFP-10G-SR-S **SFP-10G-SR** **SFP-10G-SR-X** **SFP-10G-SR-I**	Beige
SFP-10G-LRM	Orange
FET-10G	Brown
SFP-10G-LR-S **SFP-10G-LR** **SFP-10G-LR-X** **SFP-10G-LR10-I**	Blue
SFP-10G-BXD-I **SFP-10G-BXU-I**	Blue
SFP-10G-ER-S **SFP-10G-ER** **SFP-10G-ER-I**	Red
SFP-10G-BX40D-I **SFP-10G-BX40U-I**	Red
SFP-10G-ZR-S **SFP-10G-ZR** **SFP-10G-ZR-I**	Green
SFP-H10GB-CU1M	Beige
SFP-H10GB-CU1-5M	Black
SFP-H10GB-CU2M	Brown
SFP-H10GB-CU2-5M	Yellow
SFP-H10GB-CU3M	Orange
SFP-H10GB-CU4M	Green
SFP-H10GB-CU5M	Gray
SFP-H10GB-ACU7M	Blue

Product	Bail Latch Color
SFP-H10GB-ACU10M	Red
SFP-10G-AOC1M	Beige
SFP-10G-AOC2M	Brown
SFP-10G-AOC3M	Orange
SFP-10G-AOC5M	Gray
SFP-10G-AOC7M	Blue
SFP-10G-AOC10M	Red

Table 8 provides the maximum power consumption and operating temperature range ratings per SFP+ module.

Table 8. SFP+ modules power consumption

Product	Power Consumption (W)	Operating Temperature Range
SFP-10G-T-X	2.5W	EXT
SFP-10G-SR-S **SFP-10G-SR**	1	COM
SFP-10G-SR-I	1	IND
SFP-10G-SR-X	1	EXT
SFP-10G-LRM	1	COM
FET-10G	1	COM
SFP-10G-LR-S **SFP-10G-LR**	1	COM
SFP-10G-LR-X	1	EXT
SFP-10G-LR10-I	1	IND
SFP-10G-BXD-I **SFP-10G-BXU-I**	1	IND
SFP-10G-ER-S **SFP-10G-ER**	1.5	COM
SFP-10G-ER-I	1.5	IND
SFP-10G-BX40D-I **SFP-10G-BX40U-I**	1.2	IND

Product	Power Consumption (W)	Operating Temperature Range
SFP-10G-ZR-S **SFP-10G-ZR**	1.5	COM
SFP-10G-ZR-I	2	IND*
SFP-H10GB-CU1M	0.1	COM
SFP-H10GB-CU1-5M	0.1	COM
SFP-H10GB-CU2M	0.1	COM
SFP-H10GB-CU2-5M	0.1	COM
SFP-H10GB-CU3M	0.1	COM
SFP-H10GB-CU4M	0.1	COM
SFP-H10GB-CU5M	0.1	COM
SFP-H10GB-ACU7M	1	COM
SFP-H10GB-ACU10M	1	COM
SFP-10G-AOC1M	1	COM
SFP-10G-AOC2M	1	COM
SFP-10G-AOC3M	1	COM
SFP-10G-AOC5M	1	COM
SFP-10G-AOC7M	1	COM
SFP-10G-AOC10M	1	COM

* The SFP-10G-ZR-I has a cold start at -40ºC, the transceiver will be operational except optical traffic is not supported from -40ºC to -28ºC, all other low speed features (DOM, I2C, etc.) are operational. The module is fully operational -28ºC to 85ºC.

Dimensions

Dimensions (H x W x D): 8.5 x 13.4 x 56.5mm. Cisco SFP+ connectors typically weigh 75 grams or less.

Environmental Conditions and Power Requirements

Operating temperature range:

- Commercial temperature range (COM): 0 to 70° C (32 to 158° F)
- Extended temperature range (EXT): -5 to 85° C (23 to 185° F)
- Industrial temperature range (IND): -40 to 85° C (-40 to 185° F)
- Storage temperature range: -40 to 85° C (-40 to 185° F)

Warranty

- Standard warranty: 5 years
- Expedited replacement available via a Cisco SMARTnet® Service support contract

Cisco environmental sustainability

Information about Cisco's environmental sustainability policies and initiatives for our products, solutions, operations, and extended operations or supply chain is provided in the "Environment Sustainability" section of Cisco's Corporate Social Responsibility (CSR) Report.

Reference links to information about key environmental sustainability topics (mentioned in the "Environment Sustainability" section of the CSR Report) are provided in the following table:

Sustainability	Topic	Reference
General	Information on product-material-content laws and regulations	Materials
	Information on electronic waste laws and regulations, including our products, batteries and packaging	WEEE Compliance
	Information on product takeback and resuse program	Cisco Takeback and Reuse Program
	Sustainability Inquiries	Contact: csr_inquiries@cisco.com
	Countries and Regions Supported	Regulatory Compliance Page 19
Power	Power (Including Pluggable)	Table 6: Power Consumption
Material	Product packaging weight and materials	Contact: environment@cisco.com
	Weight	Dimensions Page 17

Cisco makes the packaging data available for informational purposes only. It may not reflect the most current legal developments, and Cisco does not represent, warrant, or guarantee that it is complete, accurate, or up to date. This information is subject to change without notice.

Ordering information

Table 9 provides the ordering information for SFP+ modules and related cables.

Table 9. Ordering information

Description	Product Number
10GBASE-T SFP+ Module for CAT6A cables (up to 30 meters)	SFP-10G-T-X
10GBASE-SR SFP+ Module for MMF S-Class	SFP-10G-SR-S
10GBASE-SR SFP+ Module for MMF	SFP-10G-SR
Multirate 10GBASE-SR, 10GBASE-SW and OTU2e SFP+ Module for MMF, extended temperature range	SFP-10G-SR-X
Multirate 10GBASE-SR, 10GBASE-SW and OTU2e SFP+ Module for MMF, industrial temperature range	SFP-10G-SR-I
10GBASE-LRM SFP+ Module for MMF and SMF	SFP-10G-LRM
10GBASE-LR SFP+ Module for SMF S-Class	SFP-10G-LR-S
10GBASE-LR SFP+ Module for SMF	SFP-10G-LR
Multirate 10GBASE-LR, 10GBASE-LW and OTU2e SFP+ Module for SMF, extended temperature range	SFP-10G-LR-X
Multirate 10GBASE-LR, CPRI 3-8, Industrial Temperature Module	SFP-10G-LR10-I
10GBASE-BX10-D Bidirectional for 10km	SFP-10G-BXD-I
10GBASE-BX10-U Bidirectional for 10km	SFP-10G-BXU-I
10GBASE-ER SFP+ Module for SMF S-Class	SFP-10G-ER-S
10GBASE-ER SFP+ Module for SMF	SFP-10G-ER
Multirate 10GBASE-ER, 10GBASE-EW and OTU2e SFP+ Module for SMF, Industrial Temperature range	SFP-10G-ER-I
10GBASE-BX40-D Bidirectional for 40km	SFP-10G-BX40D-I
10GBASE-BX40-U Bidirectional for 40km	SFP-10G-BX40U-I
10GBASE-ZR SFP+ Module for SMF S-Class	SFP-10G-ZR-S
Multirate 10GBASE-ZR, 10GBASE-ZW and OTU2e SFP+ Module for SMF	SFP-10G-ZR
Multirate 10GBASE-ZR, 10GBASE-ZW and OTU2e SFP+ Module for SMF	SFP-10G-ZR-I
10GBASE-CU SFP+ Cable 1 Meter, passive	SFP-H10GB-CU1M
10GBASE-CU SFP+ Cable 1.5 Meter, passive	SFP-H10GB-CU1-5M
10GBASE-CU SFP+ Cable 2 Meter, Passive	SFP-H10GB-CU2M

Description	Product Number
10GBASE-CU SFP+ Cable 2.5 Meter, Passive	SFP-H10GB-CU2-5M
10GBASE-CU SFP+ Cable 3 Meter, passive	SFP-H10GB-CU3M
10GBASE-CU SFP+ Cable 4 Meter, passive	SFP-H10GB-CU4M
10GBASE-CU SFP+ Cable 5 Meter, passive	SFP-H10GB-CU5M
10GBASE-CU SFP+ Cable 7 Meter, active	SFP-H10GB-ACU7M
10GBASE-CU SFP+ Cable 10 Meter, active	SFP-H10GB-ACU10M
10GBASE-AOC SFP+ Cable 1 Meter	SFP-10G-AOC1M
10GBASE-AOC SFP+ Cable 2 Meter	SFP-10G-AOC2M
10GBASE-AOC SFP+ Cable 3 Meter	SFP-10G-AOC3M
10GBASE-AOC SFP+ Cable 5 Meter	SFP-10G-AOC5M
10GBASE-AOC SFP+ Cable 7 Meter	SFP-10G-AOC7M
10GBASE-AOC SFP+ Cable 10 Meter	SFP-10G-AOC10M

Regulatory and standards compliance

Standards:

- GR-20-CORE: Generic Requirements for Optical Fiber and Optical Fiber Cable
- GR-326-CORE: Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies
- GR-1435-CORE: Generic Requirements for Multifiber Optical Connectors
- IEEE 802.3: 10-Gigabit Ethernet
- ITU-T G.709: Interfaces for the Optical Transport Network
- ITU-T G.975: GFEC
- ITU-T G.975.1: EFEC
- SFP+ MSA SFF-8431 (Optical Modules, Active Optical Cables, and Passive Twinax cables)
- SFP+ MSA SFF-8461 (Active Twinax cables)

Safety:

- Laser Class 1 21CFR-1040 LN#50 7/2001
- Laser Class 1 IEC60825-1
- Cable jacket of SFP+ copper modules is UL #E116441 Compliant
- All length SFP+ copper cables are ELV and RoHS Compliant

Cisco Capital

Flexible payment solutions to help you achieve your objectives

Cisco Capital makes it easier to get the right technology to achieve your objectives, enable business transformation and help you stay competitive. We can help you reduce the total cost of ownership, conserve capital, and accelerate growth. In more than 100 countries, our flexible payment solutions can help you acquire hardware, software, services and complementary third-party equipment in easy, predictable payments. Learn more.

Next steps

Learn more about Cisco 10GBASE SFP+ fiber modules or 10GBase SFP+ copper modules (twinax cable) by contacting your sales representative or visiting https://www.cisco.com/en/US/products/ps6574/index.html.

For S-Class SFP+ 10 Gigabit Modules, refer to the link below:
https://www.cisco.com/c/en/us/products/interfaces-modules/transceiver-modules/datasheet-listing.html.

Document history

New or revised topic	Described in	Date
New PID SFP-10G-LR10-I added	Ordering Information	March 04, 2021
New PIDs SFP-10G-SR-I, SFP-10G-ZR-I added	Ordering Information	July 15, 2022

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