

# QFX5100 ETHERNET SWITCH

## Product Overview

*The Juniper Networks QFX5100 line of access and aggregation switches delivers low latency, flexible deployment options, and rich Layer 2 and Layer 3 features, making it the industry's most nimble family of switches. Featuring Topology-Independent In-Service Software Upgrades (TISSU\*) and support for L2 gateway capabilities for bridging between virtualized and bare-metal servers, the QFX5100 is designed for the most demanding, high-performance data center deployments. Highly flexible, the QFX5100 can be deployed in mixed 1GbE, 10GbE, and 40GbE environments within Juniper Virtual Chassis, Virtual Chassis Fabric, and Junos Fusion architectures, as well as within industry-standard architectures such as spine and leaf and Layer 3 fabrics.*

## Product Description

The highly flexible, high-performance Juniper Networks® QFX5100 line of Ethernet switches provides the foundation for today's and tomorrow's dynamic data center. As a critical enabler for IT transformation, the data center network supports cloud and software-defined networking (SDN) adoption, as well as rapid deployment and delivery of applications. Mission-critical applications, network virtualization, and integrated or scale-out storage are driving the need for more adaptable networks. With its diverse set of deployment options, including fabric, Layer 3, and spine and leaf, the QFX5100 is the universal building block for data center switching architectures, enabling users to easily adapt as requirements change over time.

The QFX5100 line includes 10GbE (fiber and copper) and 40GbE fixed-configuration options with rich Layer 2, Layer 3, and MPLS features. The QFX5100 runs the same reliable, high-performance Juniper Networks Junos® operating system that is used by Juniper Networks EX Series Ethernet Switches, Juniper Networks routers, and Juniper Networks SRX Series Services Gateways, ensuring a consistent implementation and operation of control plane features across the entire Juniper infrastructure.

Featuring a built-in Insight Technology capability, the QFX5100 provides valuable performance and troubleshooting data via microburst monitoring and hotspot statistics. The QFX5100 can also be used as a Satellite device in a Junos Fusion fabric architecture, deployed in Juniper's new Virtual Chassis Fabric switching architecture, and installed in Juniper's existing Virtual Chassis switching architecture.

## Architecture and Key Components

The QFX5100 includes the following capabilities. Please refer to the Specifications section for features that are currently shipping vs. those that will be available in a future software release.

### QFX5100 Highlights

- High-density configurations—72 ports of 10GbE in a 1 U platform; 96 ports of 10GbE in a 2 U platform; and 32 ports of 40GbE in a 1 U platform
- Up to 2.56 Tbps Layer 2 and Layer 3 performance and as low as 550 ns latency<sup>1</sup>
- 1.5 GHz dual-core Intel CPU with 8 GB memory and 32 GB SSD storage
- High availability with the industry's only Topology-Independent In-Service Software Upgrade (TISSU)
- Rich automation capabilities with support for Python, Chef, Puppet, and zero-touch provisioning (ZTP)
- Designed-in Insight Technology software capability for microburst monitoring and reporting, as well as hotspot statistics and visibility
- Plug-and-play deployable architectures such as Virtual Chassis, Virtual Chassis Fabric, and Junos Fusion with simplified management and operation
- Support for virtualization protocols such as Virtual Extensible LAN (VXLAN), OpenvSwitch Database (OVSDB) protocol, and integration with Juniper Networks Contrail and VMware NSX SDN controllers

- Advanced Junos OS features such as BGP Add-path, MPLS, L3 VPN, and IPv6 6PE
- Investment protection enabled by compatibility with Juniper Networks EX4300 Ethernet Switch, QFX3500 Switch, and QFX3600 Switch in integrated fabric solutions

TISSU supported only in standalone mode, not in Virtual Chassis Fabric deployments.  
 \*40GbE-to-40GbE port on QFX5100-24Q only.

### QFX5100 Switch Models

The QFX5100 line includes four compact 1 U models and one 2 U model, each providing wire-speed packet performance, very low latency, and a rich set of Junos OS features. In addition to a high throughput Packet Forwarding Engine (PFE), the performance of the control plane running on all QFX5100 models is further enhanced with a powerful 1.5 GHz dual-core Intel CPU with 8 GB of memory and 32 GB SSD storage.

**QFX5100-48S:** Compact 1 U 10GbE data center access switch with 48 small form-factor pluggable and pluggable plus (SFP/SFP+) transceiver ports and six quad SFP+ (QSFP+) ports with an aggregate throughput of 1.44 Tbps or 1.08 Bpps per switch.

**QFX5100-48T:** Compact 1 U 10GbE data center access switch with 48 tri-speed (10GbE/1GbE/100 Mbps) RJ-45 ports and six QSFP+ ports with an aggregate throughput of 1.44 Tbps or 1.08 Bpps per switch.

**QFX5100-24Q:** Compact 1 U high-density 40GbE data center access and aggregation switch starting at a base density of 24 QSFP+ ports with the option to scale to 32 QSFP+ ports with two four-port expansion modules. All 32 ports support wire-speed performance with an aggregate throughput of 2.56 Tbps or 1.44 Bpps per switch.

**QFX5100-24Q-AA:** Compact 1U high-density data center switch starting with a base density of 24 QSFP+ ports. With the addition of an optional double-wide QFX-PFA-4Q Packet Flow Accelerator (PFA) expansion module, the switch can morph into an intelligent application acceleration system. Alternatively, by installing two four-port 40GbE expansion modules, the QFX5100-24Q-AA can expand to support 32 QSFP+ ports. The switch's CPU subsystem is enhanced with a quad-core Intel CPU with 32 GB of DRAM; additional storage capacity is provided via an onboard 128 GB solid-state drive. The QFX-PFA-4Q features an Altera Stratix V 320 Gbps FPGA with 24 GB SDRAM (DDR3) for packet memory and 72 MB of quad data-rate static RAM (SRAM) (QDR2+) for low-latency processing. For additional details, see the [QFX5100-24Q-AA data sheet](#).

**QFX5100-96S:** Compact 2 U high-density 10GbE aggregation switch with 96 SFP+/SFP and eight QSFP+ ports with an aggregate throughput of 2.56 Tbps or 1.44 Bpps per switch.

For added flexibility, the 40GbE ports on all QFX5100 switches can be used as 4x10GbE ports using QSFP+ to SFP+ direct attach copper (DAC) or QSFP+ to SFP+ fiber splitter cables and optics. With splitter cables, the QFX5100-48S supports up to 72 10GbE ports, while the QFX5100-24Q and QFX5100-96S support up to 104 10GbE ports.

### Junos OS

All four high-performance QFX5100 switches run Junos OS, Juniper's powerful and robust network operating system. Key Junos OS features that enhance the functionality and capabilities of the QFX5100 include:

- Software modularity with process modules running independently in their own protected memory space and with the ability to do process restarts
- Uninterrupted routing and forwarding with features such as nonstop routing (NSR) and nonstop bridging (NSB)
- Commit and rollback functionality that ensures error-free network configurations
- A powerful set of scripts for on-box problem detection, reporting, and resolution

### Junos Space Network Director

The QFX5100 switches can be managed through Junos Space Network Director, a next-generation network management solution that allows users to visualize, analyze, and control the entire enterprise network—data center and campus, physical and virtual, wired and wireless—through a single pane of glass. Network Director incorporates sophisticated analytics for real-time intelligence, trended monitoring, and automation to increase agility as well as faster rollout and activation of services.

For cloud deployments, Network Director provides a set of REST APIs that enable on-demand and dynamic network services by simplifying the consumption of services for multitenant environments. With third-party cloud orchestration tool integration, the Network Director API enables automation and provisioning of Layer 2, Layer 3, and security services in the data center without the need for manual operator intervention.

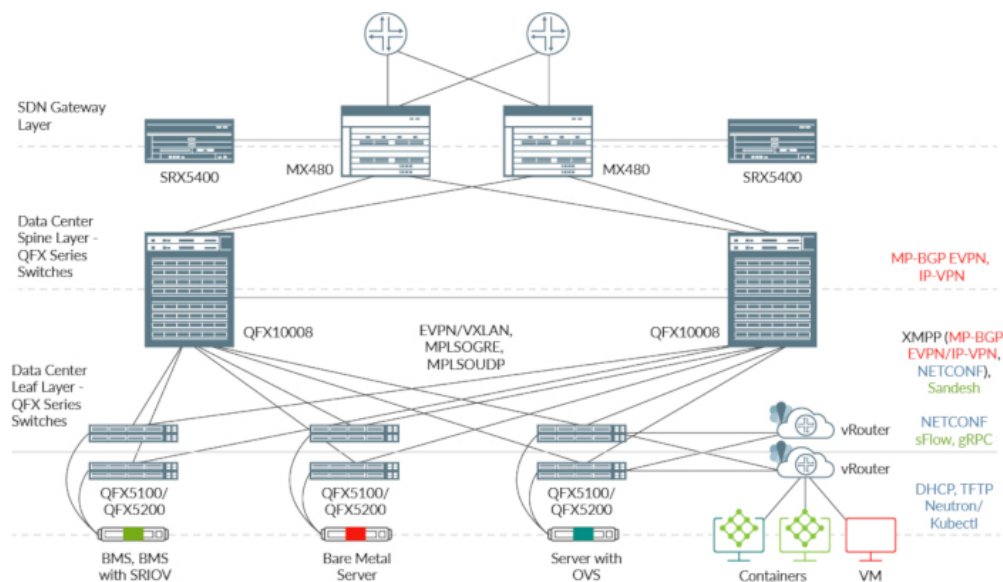


Figure 1: Contrail Networking as a fabric management and SDN overlay for data center infrastructure.

## Contrail Networking

The QFX5100 switches can be managed with Juniper Networks Contrail Networking, a fabric management and SDN overlay solution that provides full lifecycle management for both data center and data center interconnect infrastructures. Contrail Networking automates data center operations so users can focus on revenue-generating services rather than operational networking procedures.

Contrail Networking works with any standard IP Clos architecture, performing configuration operations across virtual networks and physical devices by leveraging open protocols such as NETCONF/RPC. Using a centralized controller with a management interface, Contrail Networking provides customizable configuration templates that adapt to a vast array of architectures and use cases to ease network and device operations.

Contrail Networking abstracts network connectivity using virtual overlays connecting cloud-native workloads with traditional workloads running on bare-metal servers attached to the QFX5100.

Contrail Networking enables the provisioning and automation of data center fabrics and data center interconnect using a common, consistent data model for configuring devices. Key capabilities include:

- Infrastructure, multicloud interconnect, and service lifecycle management
- Open, scalable, and standards-based protocol support: EVPN/VXLAN, BGP, NETCONF/RPC, sFlow/gRPC/SNMP

- Autodiscovery, Zero-Touch Provisioning (ZTP), Zero-Touch Replacement (ZTR), and upgrades of data center fabrics including QFX5100 switches
- Overlay and underlay management from a single orchestration layer
- Seamless connection between legacy and cloud-native workloads
- Network and device topology discovery with role configuration
- BGP EVPN across QFX Series switches and virtual routers

Contrail Networking and AppFormix are fundamental building blocks of Contrail Enterprise Multicloud, a data center software suite to connect, orchestrate, monitor, and secure multiclouds.

## Virtual Chassis Technology

The QFX5100 supports Juniper Networks' unique Virtual Chassis technology, which enables up to 10 interconnected switches to be managed and operated as a single, logical device with a single IP address. Virtual Chassis technology enables enterprises to separate physical topology from logical groupings of endpoints and, as a result, provides efficient resource utilization. All QFX5100 switches can participate in the same Virtual Chassis configuration, along with any combination of EX4300, QFX3500, and QFX3600 Ethernet switches, delivering highly flexible and scalable configuration options for data center deployments.

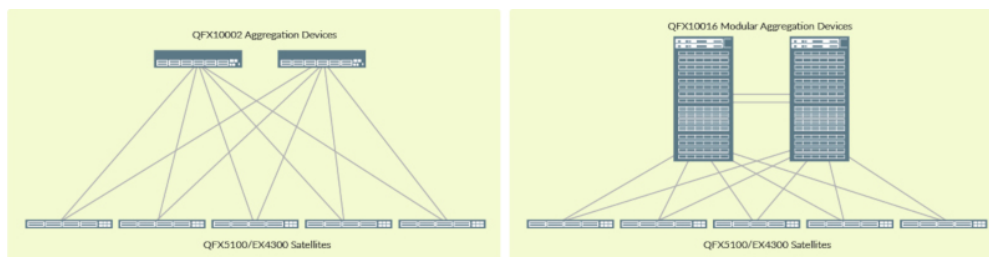


Figure 2: Junos Fusion deployments using QFX1000 switches as Aggregation devices and EX4300 and QFX5100 switches as Satellite devices.

### Virtual Chassis Fabric Switching Architecture

Existing Virtual Chassis technology is further scaled and enhanced to support a spine-and-leaf topology that is ideal for high-performance and low-latency data center deployments. In its first instance, this topology, called Virtual Chassis Fabric, enables up to 20 QFX5100 switches to be deployed in a spine-and-leaf configuration, with two to four QFX5100s in the spine and up to 18 QFX5100s as leaf nodes. This architecture provides any-rack-to-any-rack deterministic throughput and less than 3 microseconds of latency, while significantly simplifying network operations through a single point of management. EX4300, QFX3500, and QFX3600 switches can also act as leaf nodes in a Virtual Chassis Fabric deployment, providing support for data centers with mixed 1GbE, 10GbE, and 40GbE servers as well as environments transitioning from 1GbE to 10GbE or 40GbE servers while protecting existing EX4300, QFX3500, and QFX3600 investments.

The QFX5100 also supports a Layer 2 VxLAN Gateway feature in Virtual Chassis Fabric mode, creating a single Hardware VTEP for an entire Virtual Chassis Fabric pod (a single management domain of up to 20 devices) that would exist on all nodes. Virtual Chassis Fabric enables a plug-and-play architecture; hence no VTEP configuration changes are required when adding or removing nodes

from the Virtual Chassis Fabric pod. For MAC address learning, Virtual Chassis Fabric supports both EVPN as well as OVSD, and also integrates with VMware NSX.

### Junos Fusion

Junos Fusion, an IEEE 802.1Br standards-based Ethernet fabric, is ideal for mid-to-large data center customers who want simplicity at scale.

The open, easy-to-deploy Junos Fusion provides a single point of management and plug-and-play operation for networks with a choice of 1GbE, 10GbE and 40GbE for server access. In a Junos Fusion deployment, QFX5100 switches are deployed as Satellite devices that are managed by the QFX10000 switches deployed as Aggregation devices (see Figure 2).

### Data Center Deployments

Today's data centers are built with high-performance, small form-factor, multicore blade and rack servers. The greater compute capacity and server densities enabled by these devices is increasing traffic levels, creating the need for high-speed, low-latency, storage- and I/O-converged networking solutions that can maximize performance for physical servers, virtual servers, and storage in the data center.

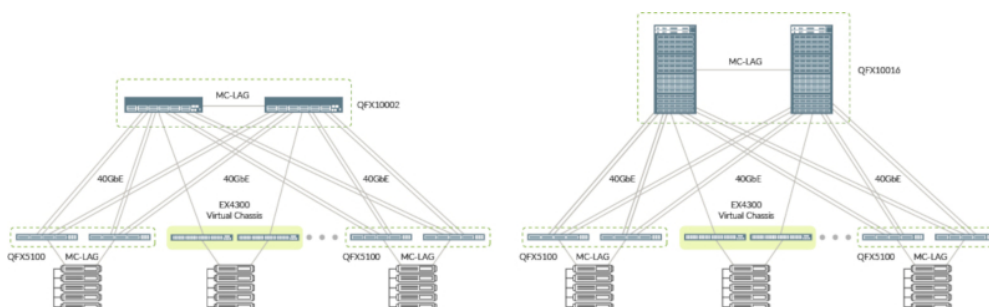


Figure 3: QFX5100 at the access layer

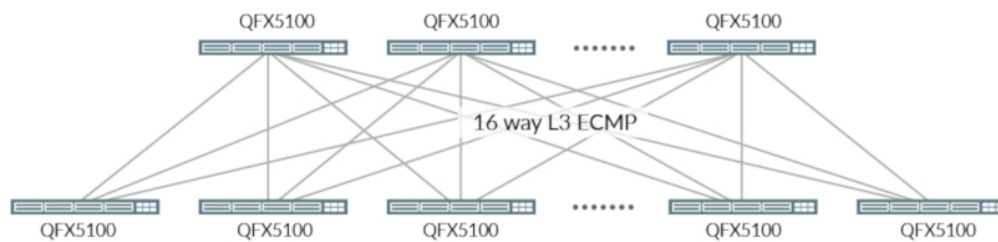


Figure 4: Larger scale data center with Layer 3 to the access

The QFX5100 line offers a portfolio of switches that deliver the low-latency, lossless, high-density 10GbE and 40GbE interfaces with the Fibre Channel over Ethernet (FCoE) transit switch functionality demanded by today's data center. All QFX5100 models are designed to consume the lowest power possible while optimizing space, thereby reducing data center operating costs. Flexible airflow direction options enable the QFX5100 to support back-to-front and front-to-back cooling, ensuring consistency with server designs for hot- and cold-aisle deployments.

### Data Center Server Access

The QFX5100 line of switches is ideal for top-of-rack deployments of various densities and speeds.

The compact 1 U QFX5100-48S offers 48 ports of native 10GbE for server connectivity and up to six 40GbE ports for uplink connectivity, providing very low oversubscription of 2:1 from access to aggregation. Each 40GbE port can be further broken out into four 10GbE ports, providing additional 10GbE for server connectivity.

The QFX5100-48T offers 48 RJ-45-based 10GbE ports and up to six 40GbE ports for providing uplinks to aggregation switches. Each RJ-45 port can operate in three different speeds, providing 10GbE, 1GbE or 100 Mbps server connectivity using the same shielded twisted pair copper cables. Distances up to 100m can be supported using cables that conform to IEEE 802.3-2012 specifications, enabling the QFX5100-48T to be deployed as a top-of-rack, middle-of-row or end-of-row switch.

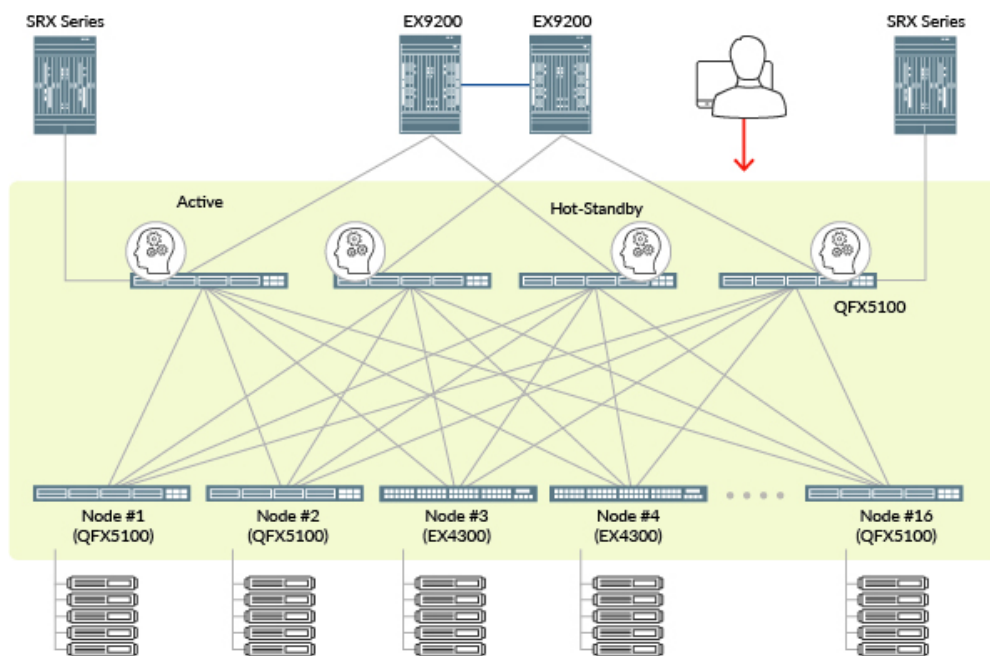


Figure 5: Virtual Chassis Fabric data center deployment with a mix of 1GbE and 10GbE



The 2 U QFX5100-96S is a high-density native 10GbE data center access switch that is ideal for deployments with a high degree of application redundancy. The highly efficient QFX5100-96S offers 96 ports of native 10GbE for server connectivity and eight 40GbE ports for uplink connectivity, providing very low oversubscription of 3:1 from access to aggregation.

The QFX5100-24Q offers 24 QSFP+ ports in the base unit with an option to scale up to 32 QSFP+ ports with two four-port expansion modules. Each QSFP+ port can be used for native 40GbE server port connectivity or channelized into four 10GbE ports for 10GbE server connectivity, offering maximum flexibility and investment protection for data center growth.

Each of the QFX5100 switches can operate in both cut-through and store-and-forward modes, delivering sustained wire-speed switching with sub-microsecond latency and low jitter for any packet size (including jumbo frames) in both modes. All QFX Series switches support extensive Layer 2 features, enabling the device to support high-density 10GbE/FCoE Layer 2 access deployments. With features such as multi-chassis link aggregation group (MC-LAG), the QFX5100 supports active/active server dual homing and can utilize full bisectonal bandwidth from server to switch. When the QFX5100 is deployed in the access layer, MC-LAG on QFX10000 switches in the aggregation layer provides maximum resiliency and full Layer 2 multi-pathing in the network (see Figure 3).

The Junos operating system features the most advanced and robust routing capabilities in the industry. All QFX5100 switches include support for RIP and OSPF for both IPv4 and IPv6 in the base software. Advanced routing capabilities such as IS-IS and BGP are also supported. With additional capabilities like 64-way equal-cost multipath (ECMP) and BGP add path, the QFX5100 is an ideal building block for deploying the most robust Layer 3 underlay for software-defined networks (SDN) (see Figure 4).

In addition, the QFX5100 also supports Virtual Chassis Fabric deployments. This fabric technology supports both Layer 2 multi-pathing and Layer 3 ECMP paths within the same network fabric while dramatically reducing the number of user configured protocols, thus eliminating the need to run protocols such as Virtual Router Redundancy Protocol (VRRP) for Layer 3 gateway load balancing and complex multicast protocols to set up replication trees. Virtual Chassis Fabric technology dramatically reduces the complexity and cost of managing the data center network by making multiple switches appear as a single, logical device. Virtual Chassis Fabric allows up to 20 individual switches to be managed via a single CLI (see Figure 5).

## Features and Benefits

### Topology-Independent In-Service Software Upgrade (TISSU\*):

With its Intel core processor, the QFX5100 allows Junos OS to run within a virtual machine (VM) on Linux. Junos OS runs in two separate VMs in active and standby pairs; during software upgrade cycles, the switches seamlessly move to the newer software version while maintaining intact data plane traffic. This true Topology-Independent ISSU, an industry-first software upgrade feature for a fixed-configuration top-of-rack switch, is supported across all Layer 2 and Layer 3 protocols and doesn't need the support of any other switches to perform an image upgrade.

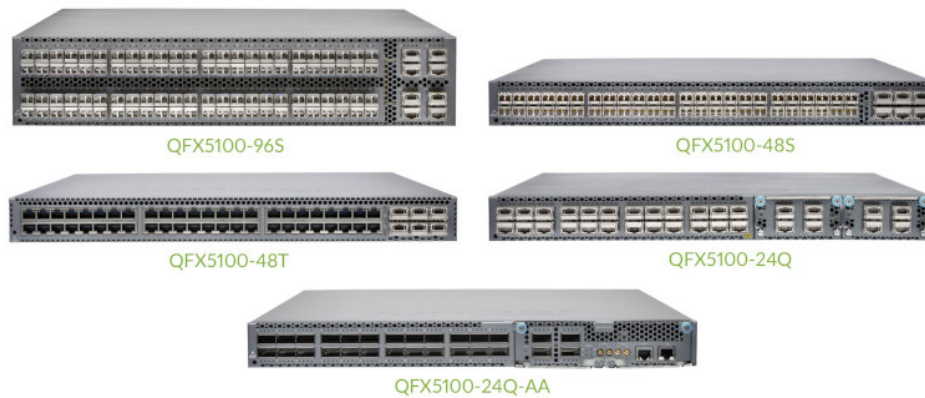
**Automation:** The QFX5100 switches support a number of features for network automation and plug-and-play operations. Features include zero-touch provisioning, operations and event scripts, automatic rollback, and Python scripting. The switch also offers support for integration with VMware NSX Layer 2 Gateway Services, Puppet, and OpenStack.

**Flexible Forwarding Table:** The QFX5100's Flexible Forwarding Table (FFT) allows the hardware table to be carved into configurable partitions of Layer 2 media access control (MAC), Layer 3 host, and Longest Prefix Match (LPM) tables. In a pure L2 environment, the QFX5100 supports 288,000 MAC addresses. In L3 mode, the table can support 128,000 host entries, and in LPM mode, it can support 128,000 prefixes. Junos OS provides configurable options through a command-line interface (CLI) so that each QFX5100 can be optimized for different deployment scenarios.

**Intelligent Buffer Management:** The QFX5100 switches have a total of 12 MB shared buffers. While 25% of the total buffer space is dedicated, the rest is shared among all ports and is user configurable. The intelligent buffer mechanism in the QFX5100 effectively absorbs traffic bursts while providing deterministic performance, significantly increasing performance over static allocation.

**Insight Technology for Analytics:** The QFX5100 provides dynamic buffer utilization monitoring and reporting with an interval of 10 milliseconds to provide microburst and latency insight. The data can be viewed via CLI, system log, or streamed to external servers for more analysis. Supported reporting formats include Java Script Object Notification (JSON), CSV and TSV. These files can be consumed by orchestration systems, SDN controllers, or network management applications (such as Juniper Networks Junos Space Network Director) to make better network design decisions and identify network hotspots.

TISSU supported only in standalone mode, not in Virtual Chassis Fabric deployments.



**MPLS:** QFX5100 switches support a broad set of MPLS features, including L3 VPN, IPv6 provider edge router (6PE), RSVP traffic engineering, and LDP to allow standards-based network segmentation and virtualization. The QFX5100 can be deployed as a low-latency MPLS label-switching router (LSR) or MPLS PE router in smaller scale environments. The QFX5100 is the industry's only compact, low-latency, high-density, low-power switch to offer an MPLS feature set.

**VXLAN:** The QFX5100 supports Layer 2 gateway services that enable VXLAN-to-VLAN connectivity at any tier of the data center network, from server access to the edge. For MAC address learning, the QFX5100 supports both EVPN as well as OVSDB, and also integrates with VMware NSX.

**FCoE:** As a Fibre Channel over Ethernet (FCoE) transit switch, the QFX5100 provides an IEEE data center bridging (DCB) converged network between FCoE-enabled servers and an FCoE-enabled Fibre Channel storage area network (SAN). The QFX5100 offers a full-featured DCB implementation that provides strong monitoring capabilities on the top-of-rack switch for SAN and LAN administration teams to maintain clear separation of management. In addition, FCoE Initiation Protocol (FIP) snooping provides perimeter protection, ensuring that the presence of an Ethernet layer does not impact existing SAN security policies. FCoE link aggregation group (LAG) active/active support is available to achieve resilient (dual-rail) FCoE connectivity.

The FCoE transit switch functionality, including priority-based flow control (PFC), Enhanced Transmission Selection (ETS), and Data Center Bridging Capability Exchange (DCBX), are included as part of the default software.

## QFX5100 Switch Specifications

### Hardware

#### Switching Capacity

- QFX5100-48S: 1.44 Tbps/1.08 Bpps
- QFX5100-48T: 1.44 Tbps/1.08 Bpps
- QFX5100-24Q: 2.56 Tbps/1.44 Bpps
- QFX5100-24Q-AA: 2.56 Tbps/1.44 Bpps
- QFX5100-96S: 2.56 Tbps/1.44 Bpps

#### Weight

- QFX5100-48S: 21.8 lb (9.9 kg)
- QFX5100-48T: 24.8 lb (11.2 kg)
- QFX5100-24Q: 21.6 lb (9.8 kg)
- QFX5100-24Q-AA: 21.6 lb (9.8 kg)
- QFX5100-96S: 32.5 lb (14.74 kg)

#### Dimensions (HxWxD)

- QFX5100-48S: 1.72 x 17.36 x 20.48 in (4.37 x 44.09 x 52.02 cm)
- QFX5100-48T: 1.72 x 17.36 x 21.47 in (4.37 x 44.09 x 54.54 cm)
- QFX5100-24Q: 1.72 x 17.36 x 20.48 in (4.37 x 44.09 x 52.02 cm)
- QFX5100-24Q-AA: 1.72 x 17.36 x 20.48 in (4.37 x 44.09 x 52.02 cm)
- QFX5100-96S: 3.46 x 17.36 x 22.44 in (8.8 x 44.09 x 57 cm)
- Switching mode: Cut-through and store-and-forward
- Front-to-back or back-to-front airflow (for hot aisle/cold aisle deployment)
- Management and rear console port connections

### Power Consumption

- QFX5100-48S-AFO/AFI: 150 W
- QFX5100-48T-AFO/AFI: 335 W
- QFX5100-24Q-AFO/AFI: 161 W
- QFX5100-24Q-AA-AFO/AFI: 175 W
- QFX5100-96S-AFO/AFI: 263 W<sup>2</sup>

### Interface Options

- QFX5100-48S-AFO/AFI:
  - 1GbE SFP: 48 (24 copper 1GbE)
  - 10GbE SFP+: 48/72 (with breakout cable)
  - 40GbE QSFP+: 6
- QFX5100-48T-AFO/AFI:
  - 100 Mbps RJ-45: 48
  - 1GbE RJ-45: 48
  - 10GbE RJ-45: 48
  - 10GbE SFP+: 24 (with breakout cable)
  - 40GbE QSFP+: 6
- QFX5100-24Q-AFO/AFI:
  - 1GbE SFP: N/A
  - 10GbE SFP+: 96/104 (with breakout cable)
  - 40GbE QSFP+: 24/32 (with 2 x QFX-EM-4Q)
- QFX5100-24Q-AA-AFO/AFI:
  - 1GbE SFP: N/A
  - 10GbE SFP+: 96/104 (with breakout cable)
  - 40GbE QSFP+: 24/32 (with 2 x QFX-EM-4Q)
- QFX5100-96S-AFO/AFI:
  - 1GbE SFP: 96 (48 Copper 1GbE)
  - 10GbE SFP+: 104 (with breakout cable)
  - 40GbE QSFP+: 8
- Each QSFP+ port can be configured as a 4 x 10GbE interface
- Each QSFP+ port can be configured as a 40 Gbps port
- USB port
- Console port
- 2 management ports: 1 RJ-45 and 1 SFP
- Supported transceiver and direct attach cable
- SFP+ 10GbE optical modules
- SFP+ DAC cables: 1/3/5 m twinax copper and 1/3/5/7/10 m active twinax copper
- SFP GbE optical and copper module
- QSFP+ to SFP+ 10GbE direct attach break-out copper (1/3 m twinax copper cable)

### Rack Installation Kit

- Versatile four post mounting options for 19-in server rack or datacom rack

### Airflow

- Front-to-back and back-to-front cooling
- Redundant variable-speed fans to reduce power draw

### Power Supply and Fan Modules

- Dual redundant (1+1) and hot-pluggable power supplies
- 110-240 V single phase AC power
- -36 to -72 V DC power
- Redundant (N+1) and hot-pluggable fan modules for front-to-back and back-to-front airflow

### Performance Scale (Unidimensional)

- MAC addresses per system: 288,000<sup>3</sup>
- VLAN IDs: 4,096
- Number of link aggregation groups (LAGs): 128
- Number of ports per LAG: 32
- Number of FCoE VLANs/FC Virtual Fabrics: 4,095
- Firewall filters: 4000
- IPv4 unicast routes: 128,000 prefixes; 208,000 host routes; 64<sup>4</sup> ECMP paths
- IPv4 multicast routes: 104,000
- IPv6 multicast routes: 52,000
- IPv6 unicast routes: 64,000 prefixes
- ARP entries: 48,000
- Jumbo frame: 9,216 bytes
- Spanning Tree Protocol (STP)
  - Multiple Spanning Tree Protocol (MSTP) instances: 64
  - VLAN Spanning Tree Protocol (VSTP) instances: 253
- Traffic mirroring
  - Mirroring destination ports per switch: 4
  - Maximum number of mirroring sessions: 4
  - Mirroring destination VLANs per switch: 4

<sup>3</sup>Measured with 10GbE passive DAC and QSFP passive DAC.

<sup>4</sup>MAC address table uses a hash-based scheme to program entries; therefore, some entries may not be programmed due to hash index collision.

<sup>5</sup>USR optics and QFSP+ SR4 optics.

### Layer 2 Features

- STP—IEEE 802.1D (802.1D-2004)
- Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w); MSTP (IEEE 802.1s)
- Bridge protocol data unit (BPDU) protect
- Loop protect
- Root protect
- RSTP and VSTP running concurrently
- VLAN—IEEE 802.1Q VLAN trunking
- Routed VLAN Interface (RVI)
- Port-based VLAN
- MAC address filtering
- Private VLAN (PVLAN)
- QinQ



- VLAN Translation
- Static MAC address assignment for interface
- Per VLAN MAC learning (limit)
- MAC learning disable
- Link Aggregation and Link Aggregation Control Protocol (LACP) (IEEE 802.3ad)
- IEEE 802.1AB Link Layer Discovery Protocol (LLDP)

#### Link Aggregation

- Multi-chassis link aggregation (MC-LAG)
- Redundant Trunk Group (RTG)
- LAG load sharing algorithm—bridged or routed (unicast or multicast) traffic:
  - IP: SIP, Dynamic Internet Protocol (DIP), TCP/UDP source port, TCP/UDP destination port
  - Layer 2 and non-IP: MAC SA, MAC DA, Ethertype, VLAN ID, source port
  - FCoE packet: Source ID (SID), Destination ID (DID), Originator exchange ID (OXID), source port

#### Layer 3 Features (IPv4)

- Static routing
- Routing policy
- Routing protocols (RIP, OSPF, IS-IS, BGP)
- Virtual Router Redundancy Protocol (VRRP)
- Bidirectional Forwarding Detection (BFD) protocol
- Virtual router
- Dynamic Host Configuration Protocol (DHCP) relay
- Proxy Address Resolution Protocol (ARP)

#### Multicast Features

- Internet Group Management Protocol (IGMP): v1, v2, v3
- IGMP snooping: v1, v2, v3
- IGMP Filter
- PIM-SM
- Multicast Source Discovery Protocol (MSDP)
- Security and Filters
- Secure interface login and password
- RADIUS
- TACACS+
- Ingress and egress filters: Allow and deny, port filters, VLAN filters, and routed filters, including management port filters
- Filter actions: Logging, system logging, reject, mirror to an interface, counters, assign forwarding class, permit, drop, police, mark
- SSH v1, v2
- Static ARP support
- Storm control, port error disable, and autorecovery
- Control plane denial-of-service (DoS) protection
- Dynamic ARP Inspection (DAI)

- Sticky MAC address
- DHCP snooping

#### Quality of Service (QoS)

- L2 and L3 QoS: Classification, rewrite, queuing
- Rate limiting:
  - Ingress policing: 1 rate 2 color, 2 rate 3 color
  - Egress policing: Policier, policier mark down action
  - Egress shaping: Per queue on each port
- 12 hardware queues per port (8 unicast and 4 multicast)
- Strict priority queuing (LLQ), smoothed deficit weighted round-robin (SDWRR), weighted random early detection (WRED), weighted tail drop
- 802.1p remarking
- Layer 2 classification criteria: Interface, MAC address, Ethertype, 802.1p, VLAN
- Congestion avoidance capabilities: WRED
- Trust IEEE 802.1p (ingress)
- Remarking of bridged packets

#### Data Center Bridging (DCB)

- Priority-based flow control (PFC)—IEEE 802.1Qbb
- Enhanced Transmission Selection (ETS)—IEEE 802.1Qaz
- Data Center Bridging Exchange Protocol (DCBX), DCBx FCoE, and iSCSI type, length, and value (TLVs)

#### Fibre Channel over Ethernet (FCoE)

- FCoE transit switch (FIP snooping ACL installation)
- FCoE session path learning
- FCoE session health monitoring
- Graceful restart for FIP snooping
- FC-BB-6 VN2VN snooping

#### Virtual Chassis

- 40GbE and 10GbE as Virtual Chassis port
- Virtual Chassis Routing Engine (RE) election
- Virtual Chassis pre-provisioning (plug and play)
- Auto-LAG formation of Virtual Chassis ports
- Mixed Virtual Chassis support
- FCoE transit across Virtual Chassis members
- QoS on Virtual Chassis ports
- Local Designated Forwarding
- Graceful RE switchover (GRES)
- Nonstop routing (NSR)
- Nonstop bridging (NSB)
- Monitor distributed aggregate interface
- Control plane protection for virtual RE

**High Availability**

- Topology-independent in-service software upgrade (TISSU)
- Bidirectional Forwarding Detection (BFD)
- Uplink failure detection (UFD)

**MPLS**

- Static label-switched paths (LSPs)
- RSVP-based signaling of LSPs
- LDP-based signaling of LSPs
- LDP tunneling (LDP over RSVP)
- MPLS class of service (CoS)
- MPLS access control list (ACL)/policers
- MPLS LSR support
- IPv6 tunneling (6PE) (via IPv4 MPLS backbone)
- MPLS Operation, Administration, and Maintenance (OAM)—LSP ping
- IPv4 L3 VPN (RFC 2547, 4364)

**Server Virtualization Management and SDN-Related Protocols**

- Junos Space Virtual Control
- IEEE 802.1Qbg (VEPA hairpin forwarding)
- VMware NSX VXLAN L2 Gateway
- VXLAN OVSDB
- OpenFlow 1.3 client

**Management and Operations**

- Contrail Networking
- Junos Space Network Director
- Role-based CLI management and access
- CLI via console, telnet, or SSH
- Extended ping and traceroute
- Junos OS configuration rescue and rollback
- Image rollback
- SNMP v1/v2/v3
- Junos XML management protocol
- sFlow v5
- High frequency statistics collection
- Beacon LED for port and system
- Automation and orchestration
- Zero-touch provisioning (ZTP)
- OpenStack Neutron Plug-in
- Puppet
- Chef
- Python
- Junos OS event, commit, and OP scripts

**Traffic Mirroring**

- Port-based
- LAG port
- VLAN-based

- Filter-based
- Mirror to local
- Mirror to remote destinations (L2 over VLAN)

**Standards Compliance****IEEE Standard**

- IEEE standard
- IEEE 802.1D
- IEEE 802.1w
- IEEE 802.1
- IEEE 802.1Q
- IEEE 802.1p
- IEEE 802.1ad
- IEEE 802.3ad
- IEEE 802.1AB
- IEEE 802.3x
- IEEE 802.1Qbb
- IEEE 802.1Qaz
- IEEE 802.3an

**T11 Standards**

- INCITS T11 FC-BB-5

**Supported RFCs**

- RFC 768 UDP
- RFC 783 Trivial File Transfer Protocol (TFTP)
- RFC 791 IP
- RFC 792 ICMP
- RFC 793 TCP
- RFC 826 ARP
- RFC 854 Telnet client and server
- RFC 894 IP over Ethernet
- RFC 903 RARP
- RFC 906 TFTP Bootstrap
- RFC 951 1542 BootP
- RFC 1058 Routing Information Protocol
- RFC 1112 IGMP v1
- RFC 1122 Host requirements
- RFC 1142 OSI IS-IS Intra-domain Routing Protocol
- RFC 1256 IPv4 ICMP Router Discovery (IRDP)
- RFC 1492 TACACS+
- RFC 1519 Classless Interdomain Routing (CIDR)
- RFC 1587 OSPF not-so-stubby area (NSSA) Option
- RFC 1591 Domain Name System (DNS)
- RFC 1745 BGP4/IDRP for IP—OSPF Interaction
- RFC 1772 Application of the Border Gateway Protocol in the Internet
- RFC 1812 Requirements for IP Version 4 routers
- RFC 1997 BGP Communities Attribute
- RFC 2030 SNTP, Simple Network Time Protocol

- RFC 2068 HTTP server
- RFC 2131 BOOTP/DHCP relay agent and Dynamic Host
- RFC 2138 RADIUS Authentication
- RFC 2139 RADIUS Accounting
- RFC 2154 OSPF w/Digital Signatures (Password, MD-5)
- RFC 2236 IGMP v2
- RFC 2267 Network ingress filtering
- RFC 2328 OSPF v2 (edge mode)
- RFC 2338 VRRP
- RFC 2362 PIM-SM (edge mode)
- RFC 2370 OSPF Opaque link-state advertisement (LSA) Option
- RFC 2385 Protection of BGP Sessions via the TCP Message Digest 5 (MD5) Signature Option
- RFC 2439 BGP Route Flap Damping
- RFC 2453 RIP v2
- RFC 2474 Definition of the Differentiated Services Field in the IPv4 and IPv6 Headers
- RFC 2597 Assured Forwarding PHB (per-hop behavior) Group
- RFC 2598 An Expedited Forwarding PHB
- RFC 2697 A Single Rate Three Color Marker
- RFC 2698 A Two Rate Three Color Marker
- RFC 2796 BGP Route Reflection—An Alternative to Full Mesh IBGP
- RFC 2918 Route Refresh Capability for BGP-4
- RFC 3065 Autonomous System Confederations for BGP
- RFC 3376 IGMP v3 (source-specific multicast include mode only)
- RFC 3392 Capabilities Advertisement with BGP-4
- RFC 3446, Anycast RP
- RFC 3569 SSM
- RFC 3618 MSDP
- RFC 3623 Graceful OSPF Restart
- RFC 4271 Border Gateway Protocol 4 (BGP-4)
- RFC 4360 BGP Extended Communities Attribute
- RFC 4456 BGP Route Reflection: An Alternative to Full Mesh Internal BGP (IBGP)
- RFC 4486 Subcodes for BGP Cease Notification Message
- RFC 4724 Graceful Restart Mechanism for BGP
- RFC 4812 OSPF Restart Signaling
- RFC 4893 BGP Support for Four-octet AS Number Space
- RFC 5176 Dynamic Authorization Extensions to RADIUS
- RFC 5396 Textual Representation of Autonomous System (AS) Numbers
- RFC 5668 4-Octet AS Specific BGP Extended Community
- RFC 5880 Bidirectional Forwarding Detection (BFD)
- Configuration Protocol (DHCP) server

#### Supported MIBs

- RFC 1155 SMI
- RFC 1157 SNMPv1
- RFC 1212, RFC 1213, RFC 1215 MIB-II, Ethernet-Like MIB and TRAPs
- RFC 1850 OSPFv2 MIB
- RFC 1901 Introduction to Community-based SNMPv2
- RFC 2011 SNMPv2 for Internet protocol using SMIPv2
- RFC 2012 SNMPv2 for transmission control protocol using SMIPv2
- RFC 2013 SNMPv2 for user datagram protocol using SMIPv2
- RFC 2233, The Interfaces Group MIB Using SMIPv2
- RFC 2287 System Application Packages MIB
- RFC 2570 Introduction to Version 3 of the Internet-standard Network Management Framework
- RFC 2571 An Architecture for describing SNMP Management Frameworks (read-only access)
- RFC 2572 Message Processing and Dispatching for the SNMP (read-only access)
- RFC 2576 Coexistence between SNMP Version 1, Version 2, and Version 3
- RFC 2578 SNMP Structure of Management Information MIB
- RFC 2579 SNMP Textual Conventions for SMIPv2
- RFC 2580 Conformance Statements for SMIPv2
- RFC 2665 Ethernet-like interface MIB
- RFC 2787 VRRP MIB
- RFC 2790 Host Resources MIB
- RFC 2819 RMON MIB
- RFC 2863 Interface Group MIB
- RFC 2932 IPv4 Multicast MIB
- RFC 3410 Introduction and Applicability Statements for Internet Standard Management Framework
- RFC 3411 An architecture for describing SNMP Management Frameworks
- RFC 3412 Message Processing and Dispatching for the SNMP
- RFC 3413 Simple Network Management Protocol (SNMP) (all MIBs are supported except the Proxy MIB)
- RFC 3414 User-based Security Model (USM) for version 3 of SNMPv3
- RFC 3415 View-based Access Control Model (VACM) for the SNMP
- RFC 3416 Version 2 of the Protocol Operations for the SNMP
- RFC 3417 Transport Mappings for the SNMP
- RFC 3418 Management Information Base (MIB) for the SNMP
- RFC 3584 Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework

- RFC 3826 The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model
- RFC 4188 Definitions of Managed Objects for Bridges
- RFC 4318 Definitions of Managed Objects for Bridges with Rapid Spanning Tree Protocol
- RFC 4363b Q-Bridge VLAN MIB

## Approvals

### Safety

- CAN/CSA-C22.2 No. 60950-1 (2007) Information Technology Equipment—Safety
- UL 60950-1 (2nd Ed.) Information Technology Equipment—Safety
- EN 60950-1 (2005) Information Technology Equipment—Safety
- IEC 60950-1 (2005) Information Technology Equipment—Safety (All country deviations): CB Scheme report.
- EN 60825-1 +A1+A2 (1994) Safety of Laser Products—Part 1: Equipment Classification
- GR-63-Core (2006) Network Equipment, Building Systems (NEBS) Physical Protection
- GR-1089-Core (2006) EMC and Electrical Safety for Network Telecommunications Equipment
- SR-3580 (1995) NEBS Criteria Levels (Level 3)

### EMC

- FCC 47CFR, Part 15 Class A (2009) USA Radiated Emissions
- EN 55022 Class A (2006)+ A1 2007 European Radiated Emissions
- VCCI Class A (2007) Japanese Radiated Emissions
- BSMI CNS 13438 and NCC C6357 Taiwan Radiated Emissions
- AS/NZS CISPR22:2009

## Environmental Compliance



Restriction of Hazardous Substances (ROHS) 6/6



Silver PSU Efficiency



Recycled material



Waste Electronics and Electrical Equipment (WEEE)



Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)



China Restriction of Hazardous Substances (ROHS)

### Telco

- Common Language Equipment Identifier (CLEI) code

### Environmental Ranges

- Operating temperature: 32° to 104° F (0° to 40° C)
- Storage temperature: -40° to 158° F (-40° to 70° C)
- Operating altitude: up to 2,000 (610 m)
- Relative humidity operating: 5% to 90% (noncondensing)
- Relative humidity non-operating: 0% to 95% (noncondensing)

## Juniper Networks Services and Support

Juniper Networks leads the market in performance-enabling services designed to accelerate, extend, and optimize your high-performance QFabric System. Our services enable you to maximize operational efficiency, reduce costs, and minimize risk while achieving a faster time-to-value for your network.

By leveraging best practices from across the industry, you get the maximum levels of QFabric System performance, designed and delivered by the world's leading professional QFabric technology experts.

For more information, please visit [www.juniper.net/us/en/products-services](http://www.juniper.net/us/en/products-services).

## Ordering Information

Product Number	Description	Product Number	Description
<b>Switch Hardware</b>			
QFX5100-48S-AFI	QFX5100, 48 SFP+/SFP ports, 6 QSFP ports, redundant fans, redundant AC power supplies, back-to-front airflow	QFX5100-96S-AFI	QFX5100, 96 SFP/SFP+, 8 QSFP+, redundant fans, redundant AC power supplies, back-to-front airflow
QFX5100-48S-AFO	QFX5100, 48 SFP+/SFP ports, 6 QSFP ports, redundant fans, redundant AC power supplies, front-to-back airflow	QFX5100-96S-AFO	QFX5100, 96 SFP/SFP+, 8 QSFP+, redundant fans, redundant AC power supplies, front-to-back airflow
QFX5100-48S-DC-AFI	QFX5100, 48 SFP+/SFP ports, 6 QSFP ports, redundant fans, redundant DC power supplies, back-to-front airflow	QFX5100-96S-DC-AFI	QFX5100, 96 SFP/SFP+, 8 QSFP+, redundant fans, redundant DC power supplies, back-to-front airflow
QFX5100-48S-DC-AFO	QFX5100, 48 SFP+/SFP ports, 6 QSFP ports, redundant fans, redundant DC power supplies, front-to-back airflow	QFX5100-96S-DC-AFO	QFX5100, 96 SFP/SFP+, 8 QSFP+, redundant fans, redundant DC power supplies, front-to-back airflow
QFX5100-48T-AFI	QFX5100, 48 100M/1G/10G RJ-45 ports, 6 QSFP ports, redundant fans, redundant AC power supplies, back-to-front airflow	QFX-PFA-4Q	4-port QSFP+ Packet Flow Accelerator expansion module for QFX5100-24Q-AA
QFX5100-48S-3AFI	QFX5100, 48 SFP+/SFP ports, 6 QSFP+ ports, dual SFP/RJ-45 management ports, redundant fans, 2 AC power supplies, back-to-front airflow	QFX-EM-4Q	4 port QSFP+ expansion module for QFX5100-24Q
QFX5100-48S-3AFO	QFX5100, 48 SFP+/SFP ports, 6 QSFP+ ports, dual SFP/RJ-45 management ports, redundant fans, redundant AC power supplies, front-to-back airflow	EX4600-EM-8F	8 port SFP+/SFP expansion module for EX4600 and QFX5100-24Q
QFX5100-48S-D-3AFI	QFX5100, 48 SFP+/SFP ports, 6 QSFP+ ports, dual SFP/RJ-45 management ports, redundant fans, redundant DC power supplies, back-to-front airflow	JPSU-650W-AC-AFO	AC 650W PSU, front-to-back airflow for QFX5100-48S, QFX5100-48T, QFX5100-24Q
QFX5100-48S-D-3AFO	QFX5100, 48 SFP+/SFP ports, 6 QSFP+ ports, dual SFP/RJ-45 management ports, redundant fans, redundant DC power supplies, front-to-back airflow	JPSU-650W-AC-AFI	AC 650W PSU, back-to-front airflow for QFX5100-48S, QFX5100-48T, QFX5100-24Q
QFX5100-48T-AFO	QFX5100, 48 100M/1G/10G RJ-45 ports, 6 QSFP ports, redundant fans, redundant AC power supplies, built-in port-to-PSU airflow	JPSU-650W-DC-AFO	DC 650W PSU, front-to-back airflow for QFX5100-48S, QFX5100-48T, QFX5100-24Q
QFX5100-48T-DC-AFI	QFX5100, 48 100M/1G/10G RJ-45 ports, 6 QSFP ports, redundant fans, redundant DC power supplies, back-to-front airflow	JPSU-650W-DC-AFI	DC 650W PSU, back-to-front airflow for QFX5100-48S, QFX5100-48T, QFX5100-24Q
QFX5100-48T-DC-AFO	QFX5100, 48 100M/1G/10G RJ-45 ports, 6 QSFP ports, redundant fans, redundant DC power supplies, front-to-back airflow	JPSU-850W-AC-AFO	AC 850W PSU, front-to-back airflow for QFX5100-96S
QFX5100-24Q-AFI	QFX5100, 24 QSFP ports, 2 expansion slots, redundant fans, redundant AC power supplies, back-to-front airflow	JPSU-850W-AC-AFI	AC 850W PSU, back-to-front airflow for QFX5100-96S
QFX5100-24Q-AFO	QFX5100, 24 QSFP ports, 2 expansion slots, redundant fans, redundant power AC supplies, front-to-back airflow	JPSU-850W-DC-AFO	DC 850W PSU, front-to-back airflow for QFX5100-96S
QFX5100-24Q-DC-AFI	QFX5100, 24 QSFP ports, 2 expansion slots, redundant fans, redundant DC power supplies, back-to-front airflow	JPSU-850W-DC-AFI	DC 850W PSU, back-to-front airflow for QFX5100-96S
QFX5100-24Q-DC-AFO	QFX5100, 24 QSFP ports, 2 expansion slots, redundant fans, redundant power AC supplies, front-to-back airflow	QFX5100-FAN-AFI	Back-to-front Airflow Fan Module for QFX5100-96S
QFX5100-24Q-DC-AFI	QFX5100, 24 QSFP ports, 2 expansion slots, redundant fans, redundant DC power supplies, back-to-front airflow	QFX5100-FAN-AFO	Front-to-back Airflow Fan Module for QFX5100
QFX5100-24Q-DC-AFO	QFX5100, 24 QSFP ports, 2 expansion slots, redundant fans, redundant DC power supplies, front-to-back airflow	QFX5100-EM-BLNK	Blank module for QFX5100
QFX5100-24Q-3AFI	QFX5100, 24 QSFP+ ports, 2 expansion slots, dual SFP/RJ-45 management ports, redundant fans, redundant AC power supplies, back-to-front airflow	QFX5100-96S-FANAFO	Front-to-back Airflow Fan Module for QFX5100-96S
QFX5100-24Q-3AFO	QFX5100, 24 QSFP+ ports, 2 expansion slots, dual SFP/RJ-45 management ports, redundant fans, redundant AC power supplies, front-to-back airflow	QFX5100-96S-FANAFI	Back-to-front Airflow Fan Module for QFX5100-96S
QFX5100-24Q-AA-AFI	QFX5100, 24 QSFP+ ports, double-wide expansion slot, redundant fans, redundant AC power supplies, back-to-front airflow		
QFX5100-24Q-AA-AFO	QFX5100, 24 QSFP+ ports, double-wide expansion slot, redundant fans, redundant AC power supplies, front-to-back airflow		
QFX5100-24Q-D-3AFI	QFX5100, 24 QSFP+ ports, 2 expansion slots, dual SFP/RJ-45 management ports, redundant fans, redundant DC power supplies, back-to-front airflow		
QFX5100-24Q-D-3AFO	QFX5100, 24 QSFP+ ports, 2 expansion slots, dual SFP/RJ-45 management ports, redundant fans, redundant DC power supplies, front-to-back airflow		
		<b>Optics and Transceivers</b>	
		QFX-SFP-10GE-SR	SFP+ 10GBASE-SR 10 Gigabit Ethernet Optics, 850 nm for up to 300 m transmission on multimode fiber (MMF)
		QFX-SFP-10GE-USR	SFP+ 10 Gigabit Ethernet Ultra Short Reach Optics, 850 nm for 10 m on OM1, 20 m on OM2, 100 m on OM3 multimode fiber (MMF)
		QFX-SFP-10GE-LR	SFP+ 10GBASE-LR 10 Gigabit Ethernet Optics, 1,310 nm for 10 km transmission on single mode fiber-optic (SMF)
		QFX-SFP-10GE-ER	SFP+ 10GBASE-ER 10 Gigabit Ethernet Optics, 1,550 nm for 40 km transmission on single-mode fiber (SMF)
		EX-SFP-10GE-ZR	SFP+ 10GBASE-ZR 10 Gigabit Ethernet Optics, 1,550 nm for 80 km transmission on single-mode fiber (SMF)
		QFX-SFP-DAC-1M	SFP+ 10 Gigabit Ethernet Direct Attach Copper (twinax copper cable) 1 m
		QFX-SFP-DAC-3M	SFP+ 10 Gigabit Ethernet Direct Attach Copper (twinax copper cable) 3 m
		QFX-SFP-DAC-5M	SFP+ 10 Gigabit Ethernet Direct Attach Copper (twinax copper cable) 5 m
		QFX-SFP-DAC-1MA	SFP+ 10 Gigabit Ethernet Direct Attach Copper (active twinax copper cable) 1 m
		QFX-SFP-DAC-3MA	SFP+ 10 Gigabit Ethernet Direct Attach Copper (active twinax copper cable) 3 m
		QFX-SFP-DAC-5MA	SFP+ 10 Gigabit Ethernet Direct Attach Copper (active twinax copper cable) 5 m
		QFX-SFP-DAC-7MA	SFP+ 10 Gigabit Ethernet Direct Attach Copper (active twinax copper cable) 7 m
		QFX-SFP-DAC-10MA	SFP+ 10 Gigabit Ethernet Direct Attach Copper (active twinax copper cable) 10 m



Product Number	Description
QFX-QSFP-DAC-1M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable) 1m passive
QFX-QSFP-DAC-3M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable) 3m passive
JNP-QSFP-DAC-5M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable) 5m passive
QFX-QSFP-DACBO-1M	QSFP+ to SFP+ 10 Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 1m
QFX-QSFP-DACBO-3M	QSFP+ to SFP+ 10 Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 3m
QFX-QSFP-40G-SR4	QSFP+ 40GBASE-SR4 40 Gigabit Optics, 850 nm for up to 150 m transmission on MMF
QFX-QSFP-40G-ESR4	QSFP+ 40GBASE-ESR4 40 Gigabit Optics, 300 m(400 m) with OM3(OM4) MMF
JNP-QSFP-40G-LR4	QSFP+ 40GBASE-LR4 40 Gigabit Optics, 1310nm for up to 10km Transmission on SMF
QFX-QSFP-DACBO-1M	QSFP+ to SFP+ 10 Gigabit Ethernet Direct Attach Break out Copper (twinax copper cable) 1 m
QFX-QSFP-DACBO-3M	QSFP+ to SFP+ 10 Gigabit Ethernet Direct Attach Break out Copper (twinax copper cable) 3 m
QFX-SFP-1GE-T	SFP 1000BASE-T Copper Transceiver Module for up to 100 m transmission on Cat5
QFX-SFP-1GE-SX	SFP 1000BASE-SX Gigabit Ethernet Optics, 850 nm for up to 550 m transmission on MMF
QFX-SFP-1GE-LX	SFP 1000BASE-LX Gigabit Ethernet Optics, 1,310 nm for 10 km transmission on SMF
JNP-QSFP-40G-LX4	QSFP+ 40GBASE-LX4 40 Gigabit Optics, 100m(150m) with OM3(OM4) duplex MMF

#### Advanced Feature Licenses

QFX-JSL-EDGE-ADV1	QFX3500, QFX3600, QFX5100-48T and QFX5100-48S Advanced Feature License for IS-IS, BGP, VxLAN and MPLS
QFX5100-HDNSE-LIC	QFX5100-24Q and QFX5100-96S Advanced Feature License for IS-IS, BGP, VxLAN and MPLS
QFX-VCF-LIC	License for Virtual Chassis Fabric

## About Juniper Networks

Juniper Networks brings simplicity to networking with products, solutions and services that connect the world. Through engineering innovation, we remove the constraints and complexities of networking in the cloud era to solve the toughest challenges our customers and partners face daily. At Juniper Networks, we believe that the network is a resource for sharing knowledge and human advancement that changes the world. We are committed to imagining groundbreaking ways to deliver automated, scalable and secure networks to move at the speed of business.

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