T1600 Internet Routing Node

PIC Guide

This guide provides an overview and description of the Physical Interface Cards (PICs) supported by the Juniper Networks T1600 Internet routing node. The PICs are described alphabetically. Table 1 on page 3 lists the PICs supported by the T1600 Internet routing node by PIC family.

PICs provide the physical connection to various network media types. The PICs are mounted on Flexible PIC Concentrators (FPCs), which are inserted into a slot in a routing node. A PIC typically occupies a single slot on an FPC. PICs receive incoming packets from the network and transmit outgoing packets to the network. During this process, each PIC performs framing and high-speed signaling for its media type. Before transmitting outgoing data packets, the PICs encapsulate the packets received from the FPCs. Each PIC is equipped with a media-specific ASIC that performs control functions tailored to the PIC's media type. For complete information about installing PICs and transceivers, see the *PIC and Transceiver Installation Instructions* located at http://www.juniper.net/techpubs/.

Blank PICs resemble other PICs but do not provide any physical connection or activity. When a slot is not occupied by a PIC, you must insert a blank PIC to fill the empty slot and ensure proper cooling of the system.

T1600 routing nodes support the Type 1, Type 2, Type 3, and Type 4 FPCs listed in Table 2 on page 6. Table 3 on page 7 through Table 11 on page 10 provide PIC/FPC compatibility matrices for the current PICs for T1600 routing nodes.

For a complete list of end-of-life FPCs and end-of-life Enhanced FPCs for M-series and T-series routing platforms, see the *M-series and T-series Routing Platform End-of-Life FPC Guide* located at http://www.juniper.net/techpubs/.

Combinations of PICs—In most cases, you can install PICs of different media types on the same FPC as long as the FPC and the routing platform support those PICs. However, configuration rules might limit certain combinations of PICs on some platforms. If you have different PIC families on a single FPC and are running JUNOS 6.3 or later, review the configuration rules to plan which PICs to install on the FPCs for your routing platform. Consult the most recent technical bulletins about configuration rules for PIC combinations on the Juniper Networks Support site at http://www.juniper.net/support/.

Newer JUNOS services for some PICs can require significant Internet Processor ASIC memory. Ethernet and SONET PICs typically do not use large amounts of memory. Gigabit Ethernet, ATM2, IQ serial PICs, and Adaptive Services PICs use more. To conserve memory, you can group PICs in the same family together on the same FPC.

When you upgrade to JUNOS Release 7.5 or later, a warning appears if any configuration rules affect your PIC combinations. If you continue the installation, one or more PICs might appear to be online (the LEDs are on), but the JUNOS software cannot enable them and they cannot pass traffic. As a workaround, you can:

- Install a JUNOS release that supports the combination

- Install PICs on a different FPC

- Remove PICs from the affected FPC

Table 1: PICs Supported in the T1600 Internet Routing Node

PIC Family and Type	Ports	First JUNOS Support	Page
ATM2 IQ			
ATM2 E3 IQ	4	8.5	18
ATM2 OC3/STM1 IQ	2	8.5	20
ATM2 OC12/STM4 IQ	2	8.5	23
ATM2 OC12/STM4 IQ	1	8.5	23
ATM2 OC48/STM16 IQ with SFP	1	8.5	26
Channelized IQ			
Channelized DS3 IQ	4	8.5	29
Channelized OC3 IQ	1	8.5	31
Channelized OC12 IQ	1	8.5	34
Channelized STM1 IQ	1	8.5	36
DS3			
DS3	4	8.5	38
E3 IQ			
E3 IQ	4	8.5	40
Ethernet			
Fast Ethernet	4	8.5	42
Gigabit Ethernet with SFP	1	8.5	44
Gigabit Ethernet with SFP	2	8.5	44
Gigabit Ethernet with SFP	4	8.5	44
Gigabit Ethernet with SFP	10	8.5	44
10-Gigabit Ethernet			
10-Gigabit Ethernet with XENPAK (10G-BASE-ER, 10G-BASE-LR, 10G-BASE-SR, and 10G-BASE-ZR)	1	8.5	57
10-Gigabit Ethernet with XENPAK (XENPAK-OTN)	1	9.0R2	57
10-Gigabit Ethernet LAN/WAN with XFP	1	9.0	62
10-Gigabit Ethernet DWDM	1	8.5	65
Ethernet IQ			
Gigabit Ethernet IQ	1	8.5	47

Table 1: PICs Supported in the T1600 Internet Routing Node *(continued)*

PIC Family and Type	Ports	First JUNOS Support	Page
Gigabit Ethernet IQ	2	8.5	47
Ethernet IQ2			
Gigabit Ethernet IQ2	4	8.5	50
Gigabit Ethernet IQ2	8	8.5	50
Gigabit Ethernet IQ2	8	8.5	50
10-Gigabit Ethernet IQ2	1	8.5	54
Services			
Adaptive Services II	0	8.5	12
Adaptive Services II Layer 2 Services	0	8.5	15
Monitoring Services II	0	8.5	67
Monitoring Services III	0	8.5	69
MultiServices 100	0	8.5	71
MultiServices 400	0	8.5	71
MultiServices 500	0	8.5	71
Tunnel Services	0	8.5	110
Tunnel Services	0	8.5	110
Tunnel Services	0	8.5	110
40-Gigabit Tunnel Services	0	8.5	111
SONET/SDH			
SONET/SDH OC3c/STM1	4	8.5	74
SONET/SDH OC3/STM1 (Multi-Rate) with SFP	4	8.5	77
SONET/SDH OC3/STM1 (Multi-Rate) with SFP	4	8.5	77
SONET/SDH OC12c/STM4 SMIR	1	8.5	81
SONET/SDH OC12c/STM4 MM	1	8.5	81
SONET/SDH OC12/STM4 (Multi-Rate) with SFP	1	8.5	84
SONET/SDH OC12/STM4 (Multi-Rate) with SFP	4	8.5	84
SONET/SDH OC48c/STM16 with SFP	4	8.5	89
SONET/SDH OC48/STM16 (Multi-Rate) with SFP	1	8.5	93

Table 1: PICs Supported in the T1600 Internet Routing Node *(continued)*

PIC Family and Type	Ports	First JUNOS Support	Page
SONET/SDH OC192c/STM64	1	8.5	98
SONET/SDH OC192c/STM64 with XFP	1	8.5	102
SONET/SDH OC192c/STM64 with XFP	4	8.5	102
SONET/SDH OC768c/STM256	1	8.5	106

FPCs Supported

T1600 routing nodes support the FPCs listed in Table 2 on page 6.

Table 2: FPCs Supported by the T1600 Routing Node

FPC Type	FPC Name	FPC Model Number	Maximum Number of PICs	Maximum Throughput per FPC	First JUNOS Release
1	Enhanced FPC1	T640-FPC1-E	4	4 Gbps	6.3
1	Enhanced II FPC1	T640-FPC1-E2	4	4 Gbps	7.4
2	FPC2	T640-FPC2	4	16 Gbps	5.3
2	Enhanced FPC2	T640-FPC2-E	4	16 Gbps	6.3
2	Enhanced II FPC2	T640-FPC2-E2	4	16 Gbps	7.4
3	FPC3	T640-FPC3	4	40 Gbps	5.3
3	Enhanced FPC3	T640-FPC3-E	4	40 Gbps	6.3
3	Enhanced Scaling FPC3	T640-FPC3-ES	4	40 Gbps	9.0
4	T640 Enhanced Scaling FPC4	T640-FPC4-ES	1	40 Gbps	7.5
4	T1600 Enhanced Scaling FPC4	T1600-FPC4-ES	2	100 Gbps	8.5

PIC/FPC Compatibility

Table 3 on page 7 through Table 12 on page 11 provide PIC/FPC compatibility matrices for the current PICs for T1600 routing nodes. The table lists the first JUNOS release in which the FPC supports the PIC. For example, JUNOS 8.5 is the first release in which the T640-FPC1-E2 supports the ATM2 OC3/STM1 IQ, 2-port PIC.

Table 3: T1600 ATM PIC/FPC Compatibility

FPC	ATM2 E3 IQ, 4-port	ATM2 OC3/STM1 IQ, 2-port	ATM2 OC12/ STM4 IQ, 2-port	ATM2 OC48/ STM16 IQ, 1-port SFP
T640-FPC1-E	8.5	8.5	8.5	–
T640-FPC1-E2	8.5	8.5	8.5	–
T640-FPC2	–	–	8.5	8.5
T640-FPC2-E	–	–	8.5	8.5
T640-FPC2-E2	–	–	8.5	8.5

Table 4: T1600 Channelized PIC/FPC Compatibility

FPC	ChDS3 IQ, 4-port	ChOC3 IQ, 1-port	ChOC12 IQ, 1-port	ChSTM1 IQ, 1-port
T640-FPC1-E	8.5	8.5	8.5	8.5
T640-FPC1-E2	8.5	8.5	8.5	8.5

Table 5: T1600 DS3 and E3 PIC/FPC Compatibility

FPC	DS3, 4-port	E3 IQ, 4-port
T640-FPC1-E	8.5	8.5
T640-FPC1-E2	8.5	8.5

Table 6: T1600 Ethernet PIC/FPC Compatibility

FPC	Fast Ethernet, 4-port	Gigabit Ethernet, 1-port SFP	Gigabit Ethernet, 2-port SFP	Gigabit Ethernet, 4-port SFP	Gigabit Ethernet, 10-port SFP
T640-FPC1-E	8.5	8.5	–	–	–
T640-FPC1-E2	8.5	8.5	–	–	–
T640-FPC2	–	–	8.5	8.5	–

Table 6: T1600 Ethernet PIC/FPC Compatibility *(continued)*

FPC	Fast Ethernet, 4-port	Gigabit Ethernet, 1-port SFP	Gigabit Ethernet, 2-port SFP	Gigabit Ethernet, 4-port SFP	Gigabit Ethernet, 10-port SFP
T640-FPC2-E	–	–	8.5	8.5	–
T640-FPC2-E2	–	–	8.5	8.5	–
T640-FPC3	–	–	–	–	8.5
T640-FPC3-E	–	–	–	–	8.5
T640-FPC3-E2	–	–	–	–	8.5
T640-FPC3-ES	–	–	–	–	9.0

Table 7: T1600 10-Gigabit Ethernet PIC/FPC Compatibility

FPC	10-Gigabit Ethernet, 1-port XENPAK	10-Gigabit LAN/WAN, 4-port XFP	10-Gigabit Ethernet, 1-port DWDM
T640-FPC3	8.5: 10 GBase-ER, 10GBase-LR, 10GBase-SR and 10GBase-ZR transceivers 9.0R2: XENPAK-OTN transceivers	–	8.5
T640-FPC3-E	8.5: 10 GBase-ER, 10GBase-LR, 10GBase-SR and 10GBase-ZR transceivers 9.0R2: XENPAK-OTN transceivers	–	8.5
T640-FPC3-E2	8.5: 10 GBase-ER, 10GBase-LR, 10GBase-SR and 10GBase-ZR transceivers 9.0R2: XENPAK-OTN transceivers	–	8.5
T640-FPC3-ES	9.0	–	9.0
T640-FPC4-ES	–	9.0	–
T1600- FPC4-ES	–	9.0	–

Table 8: T1600 Ethernet IQ PIC/FPC Compatibility

FPC	Gigabit Ethernet IQ, 1-port SFP	Gigabit Ethernet IQ, 2-port SFP	Gigabit Ethernet IQ2, 4-port SFP	Gigabit Ethernet IQ2, 8-port SFP
T640-FPC1-E	8.5	–	8.5	–
T640-FPC1-E2	8.5	–	8.5	–
T640-FPC2	–	8.5	–	–
T640-FPC2-E	–	8.5	–	8.5
T640-FPC2-E2	–	8.5	–	8.5

Table 9: T1600 Ethernet IQ2 PIC/FPC Compatibility

FPC	Gigabit Ethernet IQ2, 4-port SFP	Gigabit Ethernet IQ2, 8-port SFP (Type 2)	Gigabit Ethernet IQ2, 8-port SFP (Type 3)	10-Gigabit Ethernet IQ2, 1-port XFP
T640-FPC1-E	8.5	–	–	–
T640-FPC1-E2	8.5	–	–	–
T640-FPC2	–	–	–	–
T640-FPC2-E	–	8.5	–	–
T640-FPC2-E2	–	8.5	–	–
T640-FPC3	–	–	8.5	8.5
T640-FPC3-E	–	–	8.5	8.5
T640-FPC3-E2	–	–	8.5	8.5
T640-FPC3-ES	–	–	–	9.0

Table 10: T1600 Services PIC/FPC Compatibility

FPC	Adaptive Services II (AS)	Adaptive Services II Layer 2 Services	Monitoring Services II	Monitoring Services III	MultiServices	Tunnel Services	40-Gigabit Tunnel Services
T640-FPC1-E	8.5	8.5	–	–	MultiServices 100: 8.5	8.5	–
T640-FPC1-E2	8.5	8.5	–	–	MultiServices 100: 8.5	8.5	–

Table 10: T1600 Services PIC/FPC Compatibility *(continued)*

FPC	Adaptive Services II (AS)	Adaptive Services II Layer 2 Services	Monitoring Services II	Monitoring Services III	MultiServices	Tunnel Services	40-Gigabit Tunnel Services
T640-FPC2	–	–	8.5	8.5	–	8.5	–
T640-FPC2-E	–	–	8.5	8.5	MultiServices 400: 8.5	8.5	–
T640-FPC2-E2	–	–	8.5	8.5	MultiServices 400: 8.5	8.5	–
T640-FPC3	–	–	–	–	–	8.5	–
T640-FPC3-E	–	–	–	–	MultiServices 500: 8.5	8.5	–
T640-FPC3-E2	–	–	–	–	MultiServices 500: 8.5	8.5	–
T640-FPC3-ES	–	–	–	–	–	9.0	–
T640-FPC4-ES	–	–	–	–	–	–	8.5
T1600-FPC4-ES	–	–	–	–	–	–	8.5

Table 11: T1600 SONET/SDH PIC/FPC Compatibility

FPC	OC3c/ STM1, 4-port	OC12c/ STM4, 1-port	OC12c/ STM4, 4-port	OC48c/ STM16, 1-port SFP	OC48c/ STM16, 4-port SFP	OC192c / STM64, 1-port	OC192c / STM64, 1-port XFP	OC192c / STM64, 4-port XFP	OC768c/ STM256, 1-port
T640-FPC1-E	8.5	8.5	–	–	–	–	–	–	–
T640-FPC1-E2	8.5	8.5	–	–	–	–	–	–	–
T640-FPC2	8.5	–	8.5	8.5	–	–	–	–	–
T640-FPC2-E	8.5	–	8.5	8.5	–	–	–	–	–
T640-FPC2-E2	8.5	–	8.5	8.5	–	–	–	–	–

Table 11: T1600 SONET/SDH PIC/FPC Compatibility (continued)

FPC	OC3c/ STM1, 4-port	OC12c/ STM4, 1-port	OC12c/ STM4, 4-port	OC48c/ STM16, 1-port SFP	OC48c/ STM16, 4-port SFP	OC192c / STM64, 1-port	OC192c / STM64, 1-port XFP	OC192c / STM64, 4-port XFP	OC768c/ STM256, 1-port
T640-FPC3	–	–	–	–	8.5	8.5	–	–	–
T640-FPC3-E	–	–	–	–	8.5	8.5	8.5	–	–
T640-FPC3-E2	–	–	–	–	8.5	8.5	8.5	–	–
T640-FPC3-ES	–	–	–	–	9.0	9.0	9.0	–	–
T640-FPC4-ES	–	–	–	–	–	–	–	8.5	8.5
T1600-FPC4-ES	–	–	–	–	–	–	–	8.5	8.5

Table 12: T1600 SONET/SDH Multi-Rate PIC/FPC Compatibility

FPC	OC3c/STM1, (Multi-Rate), 4-port (Type 1)	OC3c/STM1, (Multi-Rate), 4-port (Type 2)	OC12c/STM4, (Multi-Rate), 1-port (Type 1)	OC12c/STM4, (Multi-Rate), 4-port (Type 2)	OC48/STM16, (Multi-Rate), 4-port (Type 2)
T640- FPC1-E	8.5	–	8.5	–	–
T640- FPC1-E2	8.5	–	8.5	–	–
T640- FPC2	–	–	–	–	–
T640- FPC2-E	–	8.5	–	8.5	8.5
T640- FPC2-E2	–	8.5	–	8.5	8.5
T640- FPC3	–	–	–	–	–
T640- FPC3-E	–	–	–	–	–
T640- FPC3-E2	–	–	–	–	–
T640- FPC4-ES	–	–	–	–	–
T1600- FPC4-ES	–	–	–	–	–

Adaptive Services II PIC

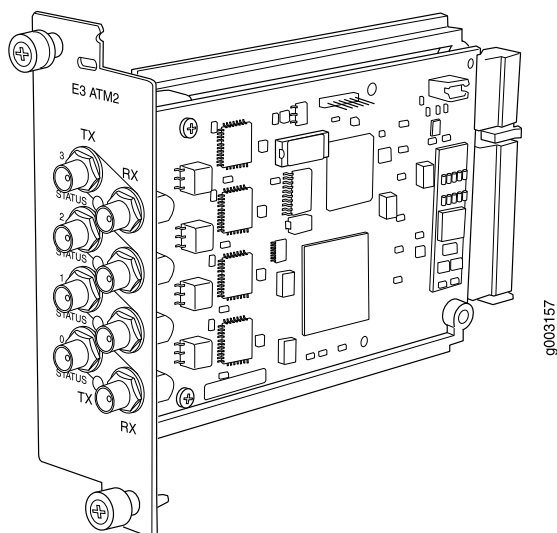|	
Software release	■ JUNOS 8.5 and later (Type 1)
Description	■ Supports tunnel services. This feature is included with the PIC and does not require an individual license. ■ Individual licenses must be purchased for additional services. ■ Power requirement: 0.4 A @ 48 V (19 W)
Hardware features	■ Support for up to 2000 service sets ■ Active monitoring on up to 1 million flows ■ Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces
Software features	Depending on your JUNOS release and individual licenses, software features for this PIC can include the features listed in Table 13 on page 13. For more information about the software features available for services PICs, see the *JUNOS Services Interfaces Configuration Guide*.
LEDs	Status LED, one tricolor: ■ Off—PIC is offline and it is safe to remove it from the chassis. ■ Green—PIC is operating normally. ■ Amber—PIC is initializing. ■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis. Application LED, one bicolor: ■ Off—Service is not running. ■ Green—Service is running under acceptable load. ■ Amber—Service is overloaded.

Table 13: Adaptive Services PICs Software Features

Software Feature	Adaptive Services II PIC	Adaptive Services II Layer 2 Services PIC
GRE Key	–	–
GRE dont-fragment	–	–
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks	8.5	–
Network Address Translation (NAT) for IP addresses	8.5	–
Port Address Translation (PAT) for port numbers	8.5	–
IP Security (IPSec) encryption	8.5	–
Active flow monitoring exports cflowd version 5 and version 8 records	8.5	–
Active flow monitoring exports version 9 records, based on RFC 3954 (IP v4 templates only)	8.5	–
Passive flow monitoring	–	–
Passive flow collection	–	–
Flow-tap	8.5	–
Dynamic flow capture	–	–
Real-time performance monitoring	8.5	–
Link Services	8.5	8.5
Tunnel services: ■ IP-IP unicast tunneling ■ GRE unicast tunneling—Supports GRE fragmentation ■ Protocol Independent Multicast (PIM) sparse mode unicast tunneling	8.5	8.5
Virtual tunnel interface for Layer 3 VPNs	8.5	–
Layer 2 Tunneling Protocol (L2TP)	–	–
Voice services: Compressed Real-Time Transport Protocol (CRTP)	8.5	8.5

Table 13: Adaptive Services PICs Software Features *(continued)*

Encapsulations	8.5	8.5
■ Multilink Frame Relay (MLFR) ■ Multilink Point-to-Point Protocol (MLPP)		

Adaptive Services II Layer 2 Services PIC

Software release	■ JUNOS 8.5 and later (Type 1)
Description	■ Supports Layer 2 Service package only. Tunnel services are included with the PIC. Other services require an individual license.
	■ Power requirement: 0.4 A @ 48 V (19 W)
Hardware features	■ Support for up to 2000 service sets
	■ Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces
Software features	Depending on your JUNOS release and individual licenses, software features for this PIC can include the features listed in Table 14 on page 16. For more information about the software features available for services PICs, see the *JUNOS Services Interfaces Configuration Guide*.
LEDs	Status LED, one tricolor:
	■ Off—PIC is offline and it is safe to remove it from the chassis.
	■ Green—PIC is operating normally.
	■ Amber—PIC is initializing.
	■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis.
	Application LED, one bicolor:
	■ Off—Service is not running.
	■ Green—Service is running under acceptable load.
	■ Amber—Service is overloaded.

Table 14: Adaptive Services PICs Software Features

Software Feature	Adaptive Services II PIC	Adaptive Services II Layer 2 Services PIC
GRE Key	–	–
GRE dont-fragment	–	–
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks	8.5	–
Network Address Translation (NAT) for IP addresses	8.5	–
Port Address Translation (PAT) for port numbers	8.5	–
IP Security (IPSec) encryption	8.5	–
Active flow monitoring exports cflowd version 5 and version 8 records	8.5	–
Active flow monitoring exports version 9 records, based on RFC 3954 (IP v4 templates only)	8.5	–
Passive flow monitoring	–	–
Passive flow collection	–	–
Flow-tap	8.5	–
Dynamic flow capture	–	–
Real-time performance monitoring	8.5	–
Link Services	8.5	8.5
Tunnel services: ■ IP-IP unicast tunneling ■ GRE unicast tunneling—Supports GRE fragmentation ■ Protocol Independent Multicast (PIM) sparse mode unicast tunneling	8.5	8.5
Virtual tunnel interface for Layer 3 VPNs	8.5	–
Layer 2 Tunneling Protocol (L2TP)	–	–
Voice services: Compressed Real-Time Transport Protocol (CRTP)	8.5	8.5

Table 14: Adaptive Services PICs Software Features *(continued)*

Encapsulations	8.5	8.5
■ Multilink Frame Relay (MLFR)		
■ Multilink Point-to-Point Protocol (MLPP)		

ATM2 E3 IQ PIC

Software release	■	JUNOS 8.5 and later (Type 1)

Description	■	Four E3 ports
	■	Power requirement: 0.41 A @ 48 V (20 W)
	■	Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■	ATM standards compliant

Hardware features	■	16-MB SDRAM memory for ATM segmentation and reassembly (SAR)
	■	ATM switch ID
	■	Configurable framing options:
		■ G.751 direct mapping
		■ G.751 with PLCP encapsulation (default)
		■ G.832 ATM direct mapping
	■	Internal and loop timing

Software features	■	Per-virtual circuit (VC) and per-virtual path (VP) traffic shaping
	■	Unspecified bit rate (UBR) traffic shaping
	■	Fine-grained variable bit rate (VBR) traffic shaping
	■	Circuit cross-connect (CCC)
	■	ATM Inverse Address Resolution Protocol (ARP), which enables routers to automatically learn the IP address of the router on the far end of an ATM permanent virtual circuit (PVC)
	■	Simple Network Management Protocol (SNMP):
		■ Management Information Base (MIB) 2 (RFC 1213)
		■ ATM MIB (RFC 1695)
		■ SONET MIB
	■	AAL5 encapsulations:
		■ ATM-VC-MUX
		■ ATM-NLPID
		■ ATM-Cisco-LLPID
		■ ATM-SNAP
		■ ATM-CCC-VC-MUX

Cables and connectors	■	10 ft (3.05 m) posilock SMB to BNC (provided)
	■	Four pairs of Rx and Tx coaxial cables

LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■	Alarm indication signal (AIS)
	■	Frame error
	■	Line code violation
	■	Local and remote loopback
	■	Loss of signal (LOS)
	■	Out of frame (OOF)
	■	Yellow alarm

ATM2 OC3/STM1 IQ PIC

Software release	■ JUNOS 8.5 and later (Type 1)

Description	■ Two OC3 ports
	■ Power requirement: 0.41 A @ 48 V (20 W)
	■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1
	■ ATM and SONET/SDH standards compliant
	■ Alarm and event counting and detection
	■ Compatible with well-known ATM switches
	■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches

Hardware features	■ Single 3010 SAR for segmentation and reassembly into 53 byte ATM cells
	■ High-performance parsing of SONET/SDH frames
	■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing
	■ 64 MB SDRAM memory for ATM SAR
	■ Packet buffering, Layer 2 parsing

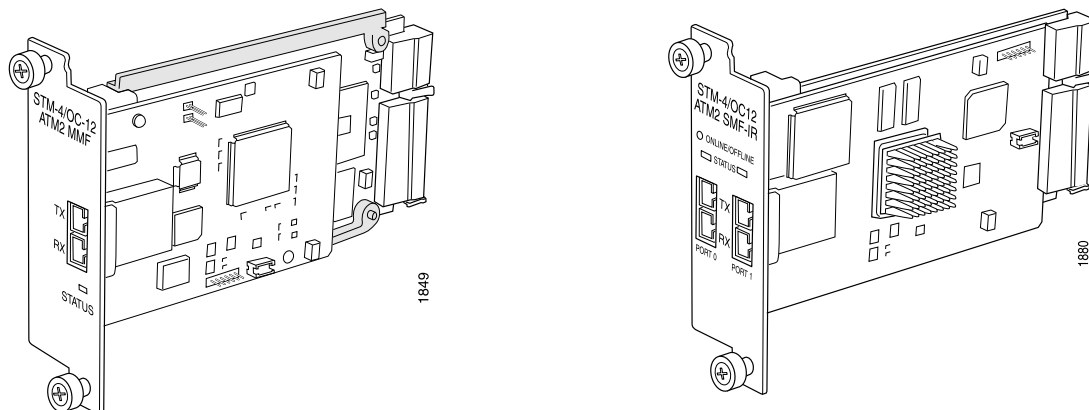|	
Software features	■ Circuit cross-connect (CCC) for leveraging ATM access networks
	■ User-configurable virtual circuit (VC) and virtual path (VP) support
	■ Support for idle cell or unassigned cell transmission
	■ OAM fault management processes alarm indication signal (AIS), remote defect indicator (RDI) cells, and loop cells
	■ Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP
	■ Local and remote loopback
	■ ATM Inverse Address Resolution Protocol (ARP), which enables routers to automatically learn the IP address of the router on the far end of an ATM permanent virtual circuit (PVC)
	■ Simple Network Management Protocol (SNMP):
	■ Management Information Base (MIB) 2 (RFC 1213)
	■ ATM MIB (RFC 1695)
	■ SONET MIB
	■ Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping
	■ Per-VC or per-VP traffic shaping
	■ Support for F4 OAM cells
	■ Support for 16 bit VCI range
Cables and connectors	■ Duplex SC/PC connector (RX and TX)
	■ Optical interface support—See Table 15 on page 21
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS-L, AIS-P)
	■ Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity errors B1, B2, B3
	■ Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Loss of cell delineation (LOC), loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS)
	■ Payload mismatch (PLM-P), payload unequipped (UNEQ-P)
	■ Remote defect indication (RDI-L, RDI-P)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 15: Optical Interface Support for ATM2 OC3 IQ PICs

Parameter	Intermediate Reach (IR)	Multimode
Optical interface	Single-mode	Multimode
Transceiver type	Fixed	Fixed

Table 15: Optical Interface Support for ATM2 OC3 IQ PICs *(continued)*

Parameter	Intermediate Reach (IR)	Multimode
Standard	Telcordia GR-253	Multivendor agreement
Maximum distance	9.3 miles/15 km	1.2 miles/2 km
Transmitter wavelength	1260 through 1360 nm	1270 through 1380 nm
Average launch power	−15 through −8 dBm	−20 through −14 dBm
Receiver saturation	−8 dBm	−14 dBm
Receiver sensitivity	−28 dBm	−30 dBm

ATM2 OC12/STM4 IQ PICs

Left: 1-port ATM2 OC12/STM4 IQ PIC; Right: 2-port ATM2 OC12/STM4 IQ PIC

Software release	■ 1-port: JUNOS 8.5 and later (Type 1) ■ 2-port: JUNOS 8.5 and later (Type 2)
Description	■ One or two OC12 ports ■ Power requirement: 0.52 A @ 48 V (25 W) ■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface ■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 ■ Complies with ATM and SONET/SDH standards ■ Alarm and event counting and detection ■ Compatible with well-known ATM switches ■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches
Hardware features	■ ATM2 IQ 1-port OC12 PICs have one 3010 SAR for segmentation and reassembly into 53-byte ATM cells; ATM2 IQ 2-port OC12 PICs have dual 3010 SAR ■ High-performance parsing of SONET/SDH frames ■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing ■ 64 MB SDRAM memory for ATM SAR ■ Packet buffering, Layer 2 parsing

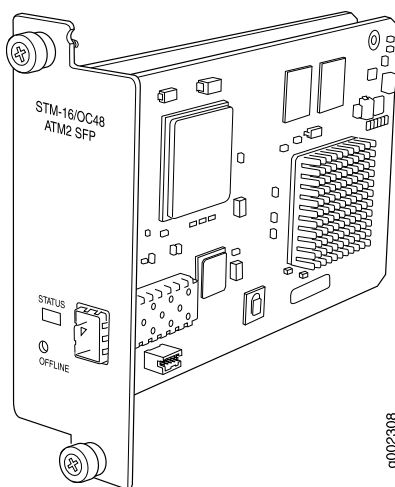|	
Software features	■ Circuit cross-connect for leveraging ATM access networks
	■ User-configurable virtual circuit (VC) and virtual path (VP) support
	■ Support for idle cell or unassigned cell transmission
	■ OAM fault management processes alarm indication signal (AIS), remote defect indication (RDI), and loop cells
	■ Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP
	■ Local and remote loopback
	■ ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC
	■ Simple Network Management Protocol (SNMP):
	■ Management Information Base (MIB) 2 (RFC 1213)
	■ ATM MIB (RFC 1695)
	■ SONET MIB
	■ Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping
	■ Per-VC or per-VP traffic shaping
	■ Support for F4 OAM cells
	■ Support for 16-bit VCI range
Cables and connectors	■ Duplex SC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 16 on page 24
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS-L, AIS-P)
	■ Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity errors B1, B2, B3
	■ Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Loss of cell delineation (LOC), loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS)
	■ Payload mismatch (PLM-P), payload unequipped (UNEQ-P)
	■ Remote defect indication (RDI-L, RDI-P)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 16: Optical Interface Support for ATM2 OC12/STM4 IQ PICs

Parameter	Intermediate Reach (IR) Transceiver	Multimode Transceiver
Optical interface	Single-mode	Multimode
Transceiver type	Fixed	Fixed

Table 16: Optical Interface Support for ATM2 OC12/STM4 IQ PICs *(continued)*

Parameter	Intermediate Reach (IR) Transceiver	Multimode Transceiver
Standard	Telcordia GR-253	Multivendor agreement
Maximum distance	9.3 miles/15 km	546.8 yards/500 m
Transmitter wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–26 dBm

ATM2 OC48/STM16 IQ PIC with SFP

Software release	■ JUNOS 8.5 and later (Type 2)

Description	■ One OC48 port
	■ Power requirements: 0.41 A @ 48 V (20 W)
	■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1
	■ ATM and SONET/SDH standards compliant
	■ Alarm and event counting and detection
	■ Compatible with well-known ATM switches
	■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches
	■ Optical interface support—see Table 17 on page 27

Hardware features	■ ATM2 IQ 1-port OC48 PICs have one 3010 SAR for segmentation and reassembly into 53-byte ATM cells.
	■ High-performance parsing of SONET/SDH frames
	■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing
	■ 64-MB SDRAM memory for ATM SAR
	■ Packet buffering, Layer 2 parsing

Software features	■	Multiprotocol Label Switching (MPLS) circuit cross-connect for leveraging ATM access networks
	■	User-configurable virtual circuit (VC) and virtual path (VP) support
	■	Support for idle cell or unassigned cell transmission
	■	OAM Fault Management processes Alarm Indication Signal (AIS), Remote Defect Indicator (RDI), and loop cells
	■	Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP
	■	Local and remote loopback
	■	ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC
	■	Simple Network Management Protocol (SNMP):
		■ Management Information Base (MIB) 2 (RFC 1213)
		■ ATM MIB (RFC 1695)
		■ SONET MIB
	■	Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping
	■	Per-VC or per-VP traffic shaping
	■	Support for F4 OAM cells
	■	Support for 16-bit VCI range

Cables and connectors	■	You can install different transceivers on the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■	Duplex SC/PC connector (RX and TX)
	■	Optical interface support—see Table 17 on page 27

LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

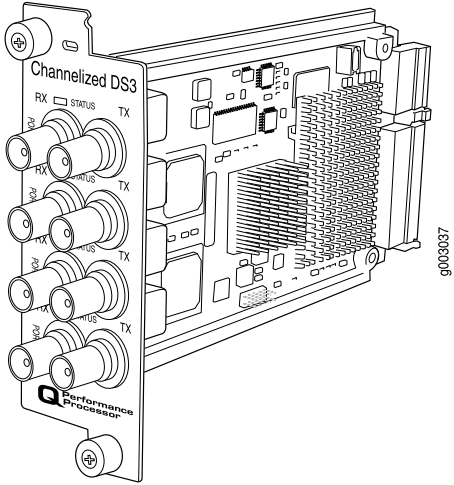| Alarms, errors, and events	■	Alarm indication signal (AIS-L, AIS-P)
	■	Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF)
	■	Bit interleaved parity errors B1, B2, B3
	■	Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■	Loss of cell delineation (LOC), loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS)
	■	Payload mismatch (PLM-P), payload unequipped (UNEQ-P)
	■	Remote defect indication (RDI-L, RDI-P)
	■	Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 17: Optical Interface Support for ATM2 OC48/STM16 IQ PICs

Optical Parameter	Intermediate Reach (IR)	Multimode
Optical interface	Single-mode	Multimode

Table 17: Optical Interface Support for ATM2 OC48/STM16 IQ PICs *(continued)*

Optical Parameter	Intermediate Reach (IR)	Multimode
Transceiver type	SFP	SFP
Standard	Telcordia GR-253	Multivendor agreement
Maximum distance	9.3 miles/15 km	546.8 yards/500 m
Wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–26 dBm

Channelized DS3 IQ PIC

Software release	■	JUNOS 8.5 and later (Type 1)

Description	■	Four DS3 ports
	■	Power requirement: 0.32 A @ 48 V (15.6 W)
	■	Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■	Channelization: DS3, DS0

Hardware features	■	Data service unit (DSU) functionality
	■	Subrate and scrambling:
		■ Digital Link/Quick Eagle
		■ Kentrox
		■ Larscom
		■ ADTRAN
		■ Verilink
	■	B3ZS line encoding
	■	M13 or C-bit parity
	■	Full bit error rate test (BERT)
	■	Local and remote loopback testing

Software features	■ Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ Simple Network Management Protocol (SNMP): DS1 MIB, DS3 MIB
	■ Dynamic, arbitrary channel configuration
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
Cables and connectors	■ Standard DS3 BNC coaxial cable interfaces
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS)
	■ Excessive zeros (EXZ)
	■ Far-end block error (FEBE)
	■ Frame error
	■ Idle code, Idle received
	■ Line code violation (LCV)
	■ Loss of signal (LOS)
	■ Out of frame (OOF)
	■ Parity bit (P-bit) disagreements
	■ Path parity error
	■ Yellow alarm bit (X-bit) disagreements
Instrumentation (counters)	■ Layer 2 per-queue and per-channel packet and byte counters

Channelized OC3 IQ PIC

Software release	■ JUNOS 8.5 and later (Type 1)
Description	■ One OC3 port ■ Power requirement: 0.39 A @ 48 V (18.6 W) ■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface ■ Channelization: DS3, DS1, DS0
Hardware features	■ Subrate and scrambling: 　■ Digital Link/Quick Eagle 　■ Kentrox 　■ Larscom 　■ ADTRAN 　■ Verilink ■ Packet buffering, Layer 2 parsing ■ M13/C-bit parity encoding ■ DS3 far-end alarm and control (FEAC) channel support ■ Local and remote loopback testing

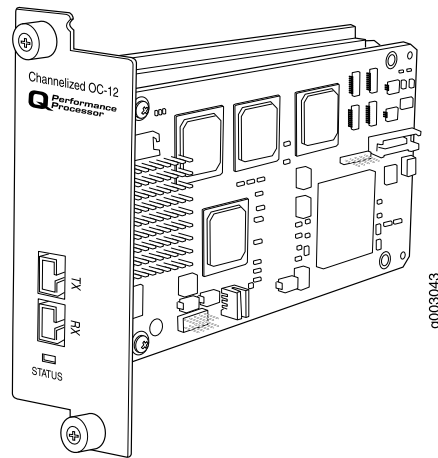|	
Software features	■ Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB
	■ Dynamic, arbitrary channel configuration
	■ Full bit error rate test (BERT)
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
Cables and connectors	■ Duplex SC/PC connector (Rx and Tx); single-mode fiber intermediate-reach fiber
	■ Optical interface support—See Table 18 on page 32
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS-L, AIS-P)
	■ Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity errors B1, B2, B3
	■ Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end block error (FEBE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Frame error
	■ Idle code, Idle received
	■ Loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS)
	■ Out of frame (OOF)
	■ Payload mismatch (PLM-P), payload unequipped (UNEQ-P)
	■ Parity bit (P-bit) disagreements
	■ Path parity error
	■ Remote defect indication (RDI-L, RDI-P)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)
	■ Yellow alarm bit (X-bit) disagreements

Table 18: Optical Interface Support for Channelized OC3 IQ PICs

Optical Parameter	Intermediate Reach (IR) SFP Transceiver
Optical interface	Single-mode
Standard	Telcordia GR-253
Maximum Distance	9.3 miles/15 km

Table 18: Optical Interface Support for Channelized OC3 IQ PICs *(continued)*

Optical Parameter	Intermediate Reach (IR) SFP Transceiver
Wavelength	1274 through 1356 nm
Average launch power	–15 through –8 dBm
Receiver saturation	–8 dBm
Receiver sensitivity	–28 dBm

Channelized OC12 IQ PIC

Software release	■	JUNOS 8.5 and later (Type 1)
Description	■	One OC12 port
	■	Power requirement: 0.23 A @ 48 V (10.8 W)
	■	Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■	Channelization: OC3, DS3, DS1, DS0
Hardware features	■	Subrate and scrambling:
		■ Digital Link/Quick Eagle
		■ Kentrox
		■ Larscom
		■ ADTRAN
		■ Verilink
	■	Packet buffering, Layer 2 parsing
	■	M13/C-bit parity encoding
	■	DS3 far-end alarm and control (FEAC) channel support
	■	Local and remote loopback testing
Software features	■	Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■	Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB
	■	Dynamic, arbitrary channel configuration
	■	Full bit error rate test (BERT)
	■	Encapsulations:
		■ High-Level Data Link Control (HDLC)
		■ Frame Relay
		■ Circuit cross-connect (CCC)
		■ Translational cross-connect (TCC)
		■ Point-to-Point Protocol (PPP)

Cables and connectors	■ Duplex SC/PC connector (Rx and Tx); single-mode fiber ■ Optical interface support—See Table 19 on page 35
LEDs	One tricolor per port: ■ Off—Not enabled ■ Green—Online with no alarms or failures ■ Amber—Online with alarms for remote failures ■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS-L, AIS-P) ■ Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF) ■ Bit interleaved parity errors B1, B2, B3 (CV-S, CV-L, CV-P) ■ Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), far-end block error (FEBE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE) ■ Frame error ■ Idle code, Idle received ■ Loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS) ■ Out of frame (OOF) ■ Payload mismatch (PLM-P), payload unequipped (UNEQ-P) ■ Parity bit (P-bit) disagreements ■ Path parity error ■ Remote defect indication (RDI-L, RDI-P) ■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P) ■ Yellow alarm bit (X-bit) disagreements
Instrumentation (counters)	■ Layer 2 per-queue and per-channel packet and byte counters

Table 19: Optical Interface Support for Channelized OC12 IQ PICs

Parameter	Intermediate Reach (IR)
Optical interface	Single-mode
Standard	Telcordia GR-253
Maximum distance	9.3 miles/15 km
Transmitter wavelength	1274 through 1356 nm
Average launch power	−15 through −8 dBm
Receiver saturation	−8 dBm
Receiver sensitivity	−28 dBm

Channelized STM1 IQ PIC

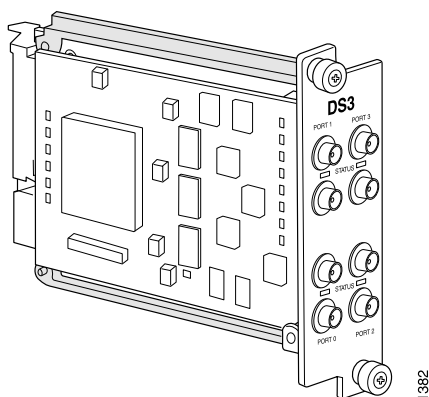| Software release	■ JUNOS 8.5 and later (Type 1)
Description	■ One STM1 port
	■ Power requirement: 0.39 A @ 48 V (18.6 W)
	■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■ Channelization: STM1c, fractional E1, framed and unframed DS0
Hardware features	■ Packet buffering, Layer 2 parsing
	■ Local and remote loopback testing
Software features	■ Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ SNMP: SONET/SDH MIB, T1/E1 MIB
	■ Dynamic, arbitrary channel configuration
	■ Full bit error rate test (BERT) patterns at E1 and DS0 levels
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
Cables and connectors	■ Duplex SC/PC connector (Rx and Tx); single-mode intermediate-reach fiber
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■ Alarm indication signal (AIS-L, AIS-P)
	■ Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity errors B1, B2, B3 (CV-S, CV-L, CV-P)
	■ Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS)
	■ Payload mismatch (PLM-P), payload unequipped (UNEQ-P)
	■ Remote defect indication (RDI-L, RDI-P)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)
Instrumentation (counters)	■ Layer 2 per-queue and per-channel packet and byte counters

DS3 PIC

Software release	■	JUNOS 8.5 and later (Type 1)
Description	■	Four DS3 ports
	■	Power requirement: 0.47 A @ 48 V (22.5 W)
	■	Integrated DSU interoperability with leading DSU vendors
Hardware features	■	High-performance throughput on each port at speeds up to 44.736 Mbps, full duplex
	■	C-bit framing
	■	B3ZS line encoding
	■	Subrate and scrambling:
		■ Digital Link
		■ Kentrox
		■ Larscom
	■	Per-port rate policing on input
	■	Per-port rate shaping on output
	■	Packet buffering, Layer 2 parsing
Software features	■	DS3 functionality:
		■ C-bit framing
		■ B3ZS line encoding
	■	DS3 diagnostics and loopback control
	■	DS3 alarm and event counting and detection
	■	Per-packet counts and byte counts
	■	Local and remote loopback testing, as well as BERT testing per DS3
	■	DS3 far-end alarm and control (FEAC) channel support
	■	Encapsulations:
		■ High-Level Data Link Control (HDLC)
		■ Frame Relay
		■ Circuit cross-connect (CCC)
		■ Point-to-Point Protocol (PPP)

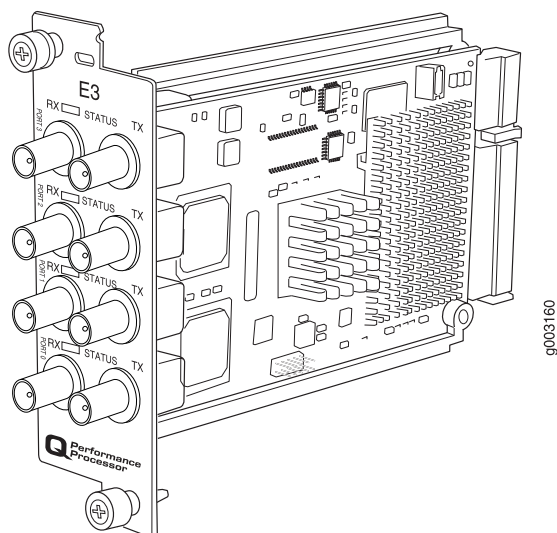|	
Cables and connectors	■ Custom 10-ft (3.05-m) posilock SMB to BNC male cable, separate Rx and Tx (provided)
LEDs	One tricolor per port: ■ Off—Not enabled ■ Green—Online with no alarms or failures ■ Amber—Online with alarms for remote failures ■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS) ■ Bit error rate test (BERT) functionality on PIC (you can configure one DS3 channel in BERT mode and configure the remaining channels to transmit and receive normal traffic) ■ Equipment failure (does not affect service) ■ Far-end block error (FEBE) ■ Frame error ■ Idle code, Idle received ■ Local and remote loopback ■ Loss of signal (LOS) ■ Out of frame (OOF) ■ Parity bit (P-bit) disagreements ■ Path parity error ■ Yellow alarm bit (X-bit) disagreements

E3 IQ PIC

Software release	■	JUNOS 8.5 and later (Type 1)

Description	■	Four E3 ports
	■	Power requirement: 0.38 A @ 48 V (18 W)
	■	Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
Hardware features	■	Clear-channel (34.368-Mbps) and subrate E3
	■	Unframed or ITU G.751 framing
	■	Data service unit (DSU) functionality
	■	Subrate and scrambling:
		■ Digital Link/Quick Eagle
		■ Kentrox
	■	HDB3 line encoding
	■	Full bit error rate test (BERT)
	■	Local and remote loopback testing

Software features	■ Quality of service (QoS) per port: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ Simple Network Management Protocol (SNMP): E3 MIB, QoS MIB
	■ Input policing and output shaping
	■ Provider-side rate limiting
	■ Full data link connection identifier (DLCI) range with sparse channel numbering
	■ Per-DLCI queues with weighted deficit round-robin and strict priority
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
Cables and connectors	■ Standard E3 BNC coaxial cable interfaces
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ Alarm indication signal (AIS)
	■ Equipment failure (does not affect service)
	■ Frame error
	■ Line code violation
	■ Loss of signal (LOS)
	■ Out of frame (OOF)
	■ Yellow alarm bit (A-bit) disagreements
Instrumentation (counters)	■ Layer 2 per-queue packet and byte counters

Fast Ethernet PIC

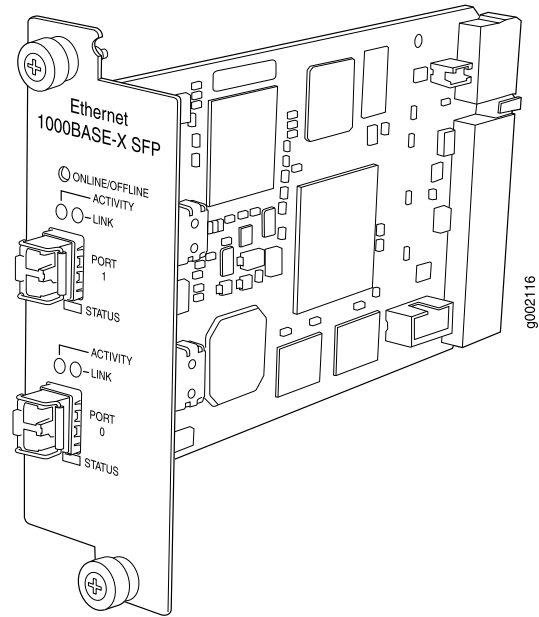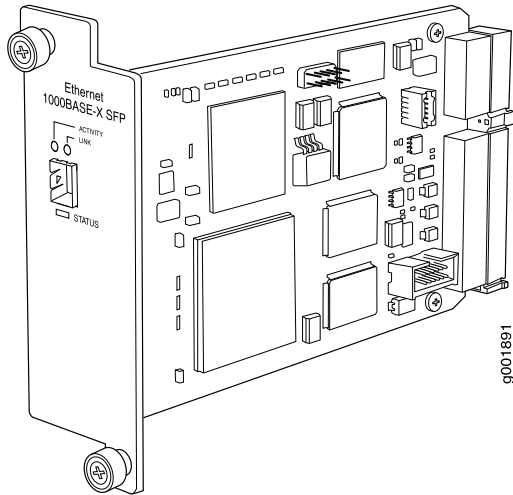| Software release	■ JUNOS 8.5 and later (Type 1)
Description	■ 4 100Base-TX ports ■ Power requirement: 0.14 A @ 48 V (6.8 W)
Hardware features	■ High-performance throughput on each port at speeds up to 100 Mbps ■ Source and destination Media Access Control (MAC) address filtering ■ RMON EtherStats packet buffering ■ 802.3 Ethernet standard compliant ■ MTUs up to 4500 bytes ■ 1,024 autosensing 802.1q VLANs per port
Software features	■ Autosensing full-duplex and half-duplex modes ■ Virtual Router Redundancy Protocol (VRRP) ■ 802.1q virtual LANs (VLANs) ■ Circuit cross-connect (CCC) VLAN
Cables and connectors	4-port PIC: ■ Connector: Two-pair, Category 5 unshielded twisted-pair connectivity through an RJ-45 connector ■ Pinout: MDI noncrossover

LEDs	Status LED, one bicolor:

- Off—PIC ports not enabled
- Green—PIC is operating normally
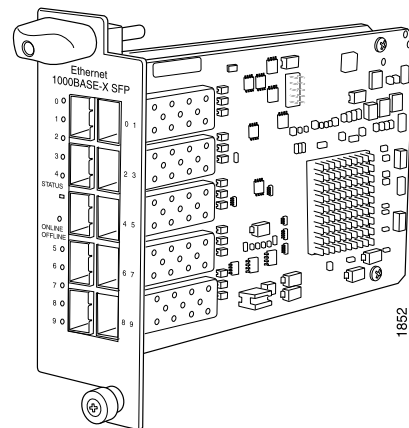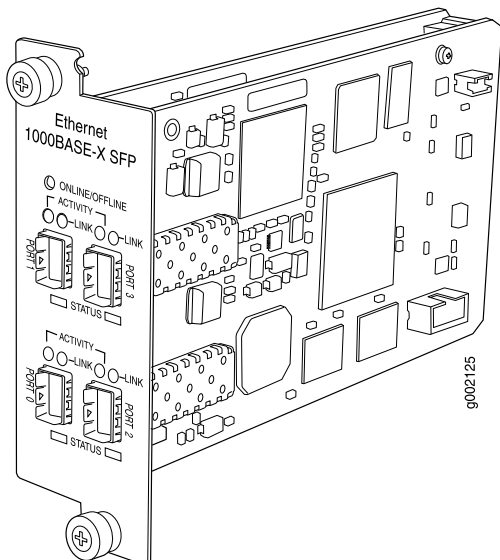- Red—PIC has an error or failure

4-port PIC—One pair of port LEDs:

- Link LED—If green, the port is online; if there is no light, the port is down
- RX LED—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data

Gigabit Ethernet PICs with SFP

Left: 1-port Gigabit Ethernet PIC; Right: 2-port Gigabit Ethernet PIC

Left: 4-port Gigabit Ethernet PIC; Right: 8-port Gigabit Ethernet PIC

Software release	■ 1-port: JUNOS 8.5 and later (Type 1)
	■ 2-port: JUNOS 8.5 and later (Type 2)
	■ 4-port: JUNOS 8.5 and later (Type 2)
	■ 10-port: JUNOS 8.5 and later (Type 3)
Description	■ One, two, four, or ten Gigabit Ethernet ports
	■ Power requirement:
	■ 1-port: 0.25 A @ 48 V (11.9 W)
	■ 2-port: 0.25 A @ 48 V (11.9 W)
	■ 4-port: 0.50 A @ 48 V (23.8 W)
	■ 10-port: 0.62 A @ 48 V (29.9 W)
	■ Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network
Hardware features	■ High-performance throughput on each port at speeds up to 1 Gbps
	■ Autonegotiation between Gigabit Ethernet circuit partners
	■ Full-duplex mode
	■ Maximum transmission units (MTUs) of up to 9192 bytes
Software features	■ Virtual Router Redundancy Protocol (VRRP) support
	■ 802.1q virtual LANs (VLANs) support
	■ 960 destination MAC filters per port
	■ Optical diagnostics and related alarms on the 2-port, 4-port, and 10-port PICs
	■ 64 source MAC filters per VLAN on the 1-port, 2-port, and 4-port PICs
	■ 1024 source MAC filters per port on the 1-port, 2-port, and 4-port PICs
	■ Flexible Ethernet encapsulation on the 1-port, 2-port, and 4-port PICs
	■ Multiple tag protocol identifiers (TPID) support on the 1-port, 2-port, and 4-port PICs
	■ Source MAC learning on the 1-port, 2-port, and 4-port PICs
	■ MAC accounting and policing—Dynamic local address learning of source MAC addresses on the 1-port, 2-port, and 4-port PICs
	NOTE: The 10-port Gigabit Ethernet PIC with SFP does not support MAC accounting and policing, MAC learning, TPID, or flexible Ethernet encapsulation.
	The 10-port Gigabit Ethernet PIC supports 64 source MAC filters per port.

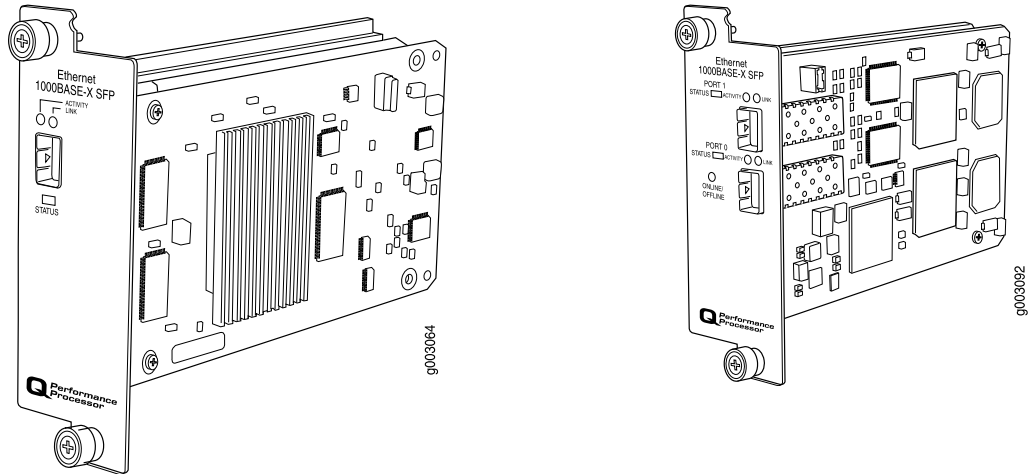|	
Cables and connectors	■ You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Fiber-optic SFP transceivers:
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 20 on page 46
	■ 1000Base-T SFP transceivers:
	■ Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector
	■ Pinout: MDI crossover
	■ Length: 328 ft/100 m
	NOTE: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.
LEDs	Status LED, one bicolor:
	■ Off—PIC is not enabled
	■ Green—PIC is operating normally
	■ Red—PIC has an error or failure
	Port LEDs, one pair per port:
	■ Link—If green, the port is online; if there is no light, the port is down
	■ Activity—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data

Table 20: Optical Interface Support for Gigabit Ethernet PICs with SFP

Parameter	1000Base-SX	1000Base-LX	1000Base-LH
Optical interface	Multimode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	62.5/125 MMF cable: 656 ft/200 m 50/125 MMF cable: 1640 ft/500 m	9/125 SMF cable: 6.2 miles/10 km 62.5/125 and 50/125 MMF cable: 1804.5 ft/550 m	9/125 SMF cable: 43.5 miles/70 km
Transmitter wavelength	770 through 860 nm	1270 through 1355 nm	1355 through 1580 nm
Average launch power	−9.5 through 0 dBm	−11.5 through −3 dBm	−3 through +3 dBm
Average receive power	−17 through 0 dBm	−19 through −3 dBm	−20 through −3 dBm
Receiver saturation	0 dBm	−3 dBm	−3 dBm
Receiver sensitivity	−17 dBm	−19 dBm	−20 dBm

Gigabit Ethernet IQ PICs with SFP

Left: 1-port Gigabit Ethernet IQ PIC; Right: 2-port Gigabit Ethernet IQ PIC

Software release		
	■	1-port: JUNOS 8.5 and later (Type 1)
	■	2-port: JUNOS 8.5 and later (Type 2):

Description		
	■	One or two Gigabit Ethernet ports
	■	Power requirement: 0.46 A @ 48 V (22 W)
	■	Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface
	■	Optical interface support—See Table 21 on page 48

Hardware features		
	■	High-performance throughput on each port at speeds up to 1 Gbps
	■	Full-duplex mode
	■	Large MTUs of up to 9192 bytes

Software features		
	■	Optical diagnostics and related alarms
	■	Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■	Virtual Router Redundancy Protocol (VRRP) support
	■	802.1q virtual LANs (VLANs)
	■	VLAN stacking and rewriting
	■	Flexible Ethernet encapsulation
	■	MAC policing, accounts, and filters

|	
Cables and connectors	■ You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Fiber-optic SFP transceivers:
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—see Table 21 on page 48
	■ 1000Base-T SFP transceivers:
	■ Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector
	■ Pinout: MDI crossover
	■ Length: 328 ft/100 m
	NOTE: Do not install SONET/SDH OC48c/STM16 SFPs in the Gigabit Ethernet port. The port will not recognize the SFP.
LEDs	Status LED, one tricolor:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
	NOTE: The green status LED is lit on the 2-port Gigabit Ethernet IQ PIC when at least one port is online.
	Port LEDs, one per port:
	■ Off—Port is down
	■ Green—Link is established

Table 21: Optical Interface Support for Gigabit Ethernet IQ PICs with SFP

| Parameter	1000Base-SX	1000Base-LX	1000Base-LH
Optical interface	Multimode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Standard	IEEE 802.3—1998	IEEE 802.3—1998	Multivendor agreement
Maximum distance	62.5/125 MMF cable: 656 ft/200 m 50/125 MMF cable: 1640 ft/500 m	9/125 SMF cable: 6.2 miles/10 km 62.5/125 or 50/125 MMF cable: 1804.5 ft/550 m	9/125 SMF cable: 43.5 miles/70 km
Transmitter wavelength	770 through 860 nm	1270 through 1355 nm	1480 through 1580 nm
Average launch power	−9.5 through 0 dBm	−11.5 through −3 dBm	−3 through +3 dBm

Table 21: Optical Interface Support for Gigabit Ethernet IQ PICs with SFP *(continued)*

Parameter	1000Base-SX	1000Base-LX	1000Base-LH
Average receive power	–17 through 0 dBm	–19 through –3 dBm	–20 through –3 dBm
Receiver saturation	0 dBm	–3 dBm	–3 dBm
Receiver sensitivity	–17dBm	–19 dBm	–20 dBm

Gigabit Ethernet IQ2 PICs with SFP
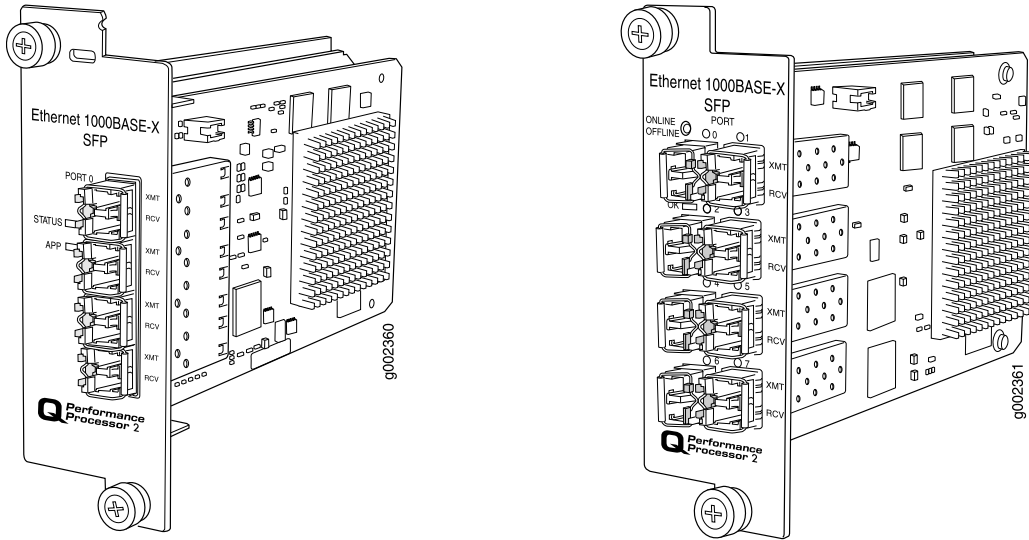
Left: 1-port Gigabit Ethernet IQ2 PIC (Type 1); Right: 8-port Gigabit Ethernet IQ2 PIC (Type 2)
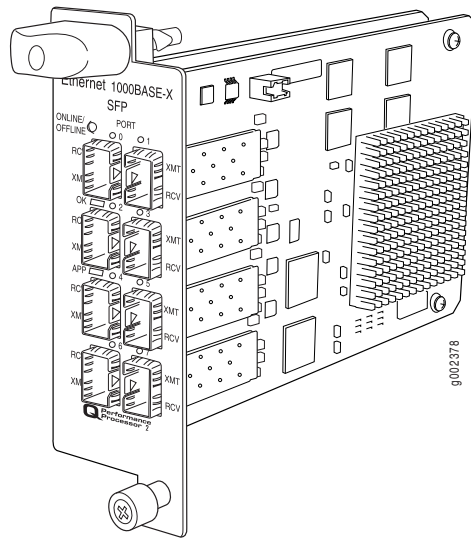
Center: 10-port Gigabit Ethernet IQ2 PIC (Type 3)

Software release	■ 4-port: JUNOS 8.5 and later (Type 1)
	■ 8-port: JUNOS 8.5 and later (Type 2)
	■ 8-port: JUNOS 8.5 and later (Type 3)
Description	■ Four or eight Gigabit Ethernet ports
	■ Power requirement:
	■ 4-port: 0.65 A @ 48 V (31 W)
	■ 8-port (Type 2): 0.89 A @ 48 V (42.5 W)
	■ 8-port (Type 3): 1.25 A @48 V (60 W)
Hardware features	■ High-performance throughput on each port:
	■ 4-port with SFP: speeds up to 1 Gbps
	■ 8-port with SFP: speeds up to 4 Gbps (Type 2)
	■ 8-port with SFP: speeds up to 8 Gbps (Type 3)
	■ Full-duplex mode
	■ Large maximum transmission units (MTUs) of up to 9192 bytes

|	
Software features	■ Intelligent handling of oversubscribed traffic for Type 1 and Type 2 PICs
	■ Optical diagnostics and related alarms
	■ Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ Virtual Router Redundancy Protocol (VRRP) support
	■ Hierarchical shaping
	■ Fine-grained queuing and shaping per logical interface at both ingress and egress
	■ 802.1q virtual LANs (VLANs)
	■ VLAN stacking and rewriting
	■ Channels defined by two stacked VLAN tags
	■ Multiple tag protocol identifiers (TPID) support
	■ IP service for nonstandard TPID and stacked VLAN tags
	■ 802.1p rewrite per channel
	■ Flexible mapping of channels and scheduler resources at both ingress and egress
	■ Flexible Ethernet encapsulation
	■ MAC learning, policing, accounting, and filtering
Cables and connectors	■ You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	NOTE: Do not install SONET/SDH SFPs in the Gigabit Ethernet port. The port will not recognize the SFP.
	■ Fiber-optic small form-factor pluggable transceivers (SFPs):
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 22 on page 53
	■ Copper 1000Base-T SFPs:
	■ Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector
	■ Pinout: MDI crossover
	■ Length: 328 ft/100 m
LEDs	OK or Status LED, one tricolor:
	■ Off—PIC is offline and it is safe to remove it from the router.
	■ Green—PIC is operating normally.
	■ Amber—PIC is initializing.
	■ Red—PIC has an error or failure.
	APP LED, one bicolor:
	■ Off—Monitoring application is not running.
	■ Green—Monitoring application is running under acceptable load.
	Port LEDs, one per port:
	■ Off—Port is not enabled.
	■ Green—Port is online with no alarms or failures.

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Table 22: Optical Interface Support for Gigabit Ethernet IQ2 PICs with SFP

Parameter	1000Base-SX	1000Base-LX	1000Base-LH
Optical interface	Multimode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Standard	IEEE 802.3—1998	IEEE 802.3—1998	Multivendor agreement
Maximum distance	62.5/125 MMF cable: 656 ft/200 m 50/125 MMF cable: 1640 ft/500 m	9/125 SMF cable: 6.2 miles/10 km 62.5/125 or 50/125 MMF cable: 1804.5 ft/550 m	9/125 SMF cable: 43.5 miles/70 km
Transmitter wavelength	770 through 860 nm	1270 through 1355 nm	1480 through 1580 nm
Average launch power	–9.5 through 0 dBm	–11.5 through –3 dBm	–3 through + 3 dBm
Average receive power	–17 through 0 dBm	–19 through –3 dBm	–20 through –3 dBm
Receiver saturation	0 dBm	–3 dBm	–3 dBm
Receiver sensitivity	–17dBm	–19 dBm	–20 dBm

10-Gigabit Ethernet IQ2 PIC with XFP
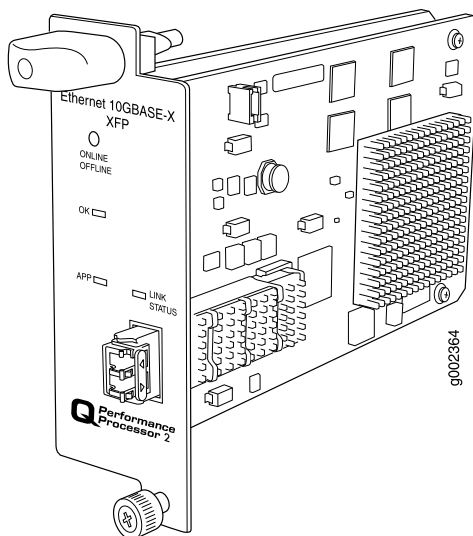
Software release	■	JUNOS 8.5 and later (Type 3)

Description	■	One 10-Gigabit Ethernet port
	■	Power requirements: 1.2 A @48 V (56 W)
Hardware features	■	High-performance throughput
	■	WAN-PHY mode at 9.953 Gbps
	■	LAN-PHY mode at 10.3125 Gbps
	■	Full-duplex mode
	■	Large maximum transmission units (MTUs) of up to 9192 bytes

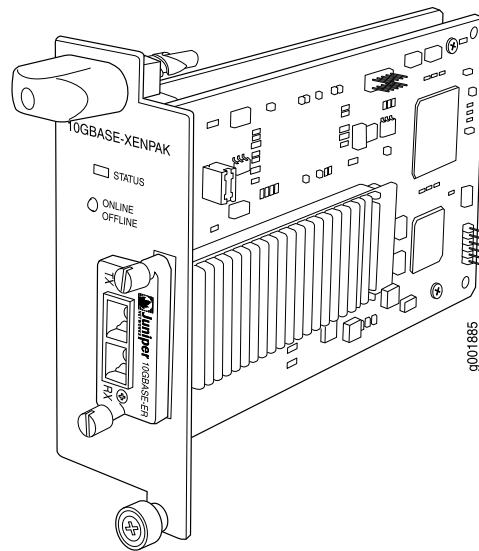|	
Software features	■ Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ Configurable WAN-PHY mode options:
	■ loopback
	■ mpls
	■ path-trace
	■ trigger
	■ Virtual Router Redundancy Protocol (VRRP) support
	■ Hierarchical shaping
	■ Fine-grained queueing and shaping per logical interface at both ingress and egress
	■ 802.1q virtual LANs (VLANs)
	■ VLAN stacking and rewriting
	■ Channels defined by two stacked VLAN tags
	■ Multiple tag protocol identifiers (TPID) support
	■ IP service for nonstandard TPID and stacked VLAN tags
	■ 802.1p rewrite per channel
	■ Flexible mapping of channels and scheduler resources at both ingress and egress
	■ Flexible Ethernet encapsulation
	■ MAC learning, policing, accounting, and filtering
Cables and connectors	■ You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Fiber-optic 10-gigabit small form-factor pluggable (XFP) transceivers:
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 23 on page 56
LEDs	OK LED, one tricolor:
	■ Off—PIC is offline and safe to remove from the router.
	■ Green—PIC is operating normally.
	■ Amber—PIC is initializing.
	■ Red—PIC has an error or failure.
	APP LED, one:
	■ Off—Monitoring application is not running
	■ Green—Monitoring application is running under acceptable load
	■ Amber—Monitoring application is overloaded
	Link Status LED, one:
	■ Off—Port is down
	■ Green—Port is online. Link is established

Table 23: Optical Interface for 10-Gigabit Ethernet IQ2 PICs

Parameter	10-GBase-S	10-GBase-L	10-GBase-E	10-GBase-Z
Transceiver model number	XFP-10G-S	XFP-10G-L-OC192-SR1	XFP-10G-E-OC192-IR2	XFP-10G-Z-OC192-LR2
Optical interface	Multimode	Single-mode	Single-mode	Single-mode
Transceiver type	XFP	XFP	XFP	XFP
Standard	IEEE 802.3ae—2002	IEEE 802.3ae—2002	IEEE 802.3ae—2002	Multivendor agreement
Maximum distance	50/125 MMF cable, 2000 MHz-km: 984 feet/300 m 50/125 MMF cable, 500 MHz-km: 269 feet/82 m 50/125 MMF cable, 400 MHz-km: 217 feet/66 m 62.5/125 MMF cable, 200 MHz-km: 108 feet/33 m 62.5/125 MMF cable, 160 MHz-km: 85 feet/26 m	9/125 SMF cable: 6.2 miles/10 km	9/125 SMF cable: 24.8 miles/40 km: Distances greater than 30 km are considered to be engineered links.	9/125 SMF cable: 49.6 miles/80 km
Transmitter wavelength	840 nm through 860 nm	1260 through 1355 nm	1530 through 1565 nm	1530 through 1565 nm
Average launch power	−4.5 through −1 dBm	−8.2 through 0.5 dBm	−4.7 through 4 dBm	0 through 4 dBm
Average receive power	−9.9 through −1.0 dBm	−14.4 through 0.5 dBm	−15.8 through −1.0 dBm	−24.0 through −7.0 dBm
Receiver saturation	−1.0 dBm	0.5 dBm	−1.0 dBm	−7 dBm
Receiver sensitivity	−9.9 dBm	−14.4 dBm	−15.8 dBm	−24 dBm

10-Gigabit Ethernet PIC with XENPAK

| Software release | ■ | JUNOS 8.5 and later (Type 3): 10GBase-ER, 10GBase-LR, 10GBase-SR, and 10GBase-ZR transceivers |
| | ■ | JUNOS 9.0R2 and later (Type 3): XENPAK-OTN transceivers |

Description	■	One 10-Gigabit Ethernet port
	■	Power requirement: 0.55 A @ 48 V (26.6 W)
	■	Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network
	■	Optical interface support—See Table 24 on page 58 and Table 25 on page 59

Hardware features	■	High-performance throughput at speeds up to 10 Gbps
	■	Full-duplex mode
	■	Maximum transmission units (MTUs) up to 9192 bytes
	■	64 source MAC address filters
	■	960 destination MAC filters

Software features	■	Virtual Router Redundancy Protocol (VRRP) support
	■	802.1q virtual LANs (VLANs) support
	■	802.3ae link aggregation support
	■	RMON EtherStats
	■	Optical diagnostics and related alarms :
		■ Transceiver temperature
		■ Laser bias current
		■ Laser output power
		■ Receive optical power

Cables and connectors	■ Duplex SC/PC connector (RX and TX)
	■ Optical interface support—See Table 24 on page 58 and Table 25 on page 59
LEDs	Status LED, one bicolor:
	■ Off—PIC not enabled
	■ Green—PIC is operating normally
	■ Red—PIC has an error or failure
	Port LEDs, one pair:
	■ Link—If green, the port is online; if there is no light, the port is down
	■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data

Table 24: Optical Interface Support for 10-Gigabit Ethernet PICs with XENPAK

Parameter	Short Wavelength Serial (10GBase-SR), LAN Rate	Long Wavelength Serial (10GBase-LR), LAN Rate	Extra-Long Wavelength Serial (10GBase-ER), LAN Rate	Extra-Long Wavelength Serial (10GBase-ZR), LAN Rate
Transceiver model number	XENPAK-1XGE-SR	XENPAK-1XGE-LR	XENPAK-1XGE-ER	XENPAK-1XGE-ZR
Optical interface	Multimode	Single-mode	Single-mode	Single-mode
Transceiver type	XENPAK module	XENPAK module	XENPAK module	XENPAK module
Standard	IEEE 802.3ae—2002	IEEE 802.3ae—2002	IEEE 802.3ae—2002	Multivendor agreement
Maximum distance	50/125 MMF cable, 2000 MHz-km: 984 feet/300 m 50/125 MMF cable, 500 MHz-km: 269 feet/82 m 50/125 MMF cable, 400 MHz-km: 217 feet/66 m 62.5/125 MMF cable, 200 MHz-km: 108 feet/33 m 62.5/125 MMF cable, 160 MHz-km: 85 feet/26 m	9/125 SMF cable: 6.2 miles/10 km	9/125 SMF cable: 24.8 miles/40 km: Distances greater than 30 km are considered to be engineered links.	9/125 SMF cable: 49.6 miles/80 km
Transmitter wavelength	840 nm through 860 nm	1260 through 1355 nm	1530 through 1565 nm	1530 through 1565 nm
Average launch power	−4.5 through −1 dBm	−4 through 0.5 dBm	−4.7 through 4 dBm	0 through 4 dBm

Table 24: Optical Interface Support for 10-Gigabit Ethernet PICs with XENPAK *(continued)*

Parameter	Short Wavelength Serial (10GBase-SR), LAN Rate	Long Wavelength Serial (10GBase-LR), LAN Rate	Extra-Long Wavelength Serial (10GBase-ER), LAN Rate	Extra-Long Wavelength Serial (10GBase-ZR), LAN Rate
Average receive power	–9.9 through –1.0 dBm	–14.4 through 0.5 dBm	–15.8 through –1.0 dBm	–24.0 through –7.0 dBm
Receiver saturation	–1.0 dBm	0.5 dBm	–1.0 dBm	–7 dBm
Receiver sensitivity	–9.9 dBm	–14.4 dBm	–15.8 dBm	–24 dBm

These tables describe the 10-Gigabit Ethernet XENPAK-OTN transceivers: Table 25 on page 59, Table 26 on page 60, and Table 27 on page 61.

Table 25: Optical Interface Support for 10-Gigabit Ethernet PICs with XENPAK-OTNs

Model numbers	■ XENPAK-1XGE-32A-OTN
	■ XENPAK-1XGE-34A-OTN
	■ XENPAK-1XGE-36A-OTN
	■ XENPAK-1XGE-38A-OTN
	■ XENPAK-1XGE-40A-OTN
	■ XENPAK-1XGE-42A-OTN
Features	■ 10-Gigabit digital wrapper with over-clocked G.709 framing
	■ Generic Reed-Solomon forward error correction (GFEC) to transport 10GBASE-R (10-Gigabit Ethernet LAN)
	■ Reduced cost of deploying and maintaining the network due to:
	■ Fewer optical-electrical-optical (OEO) conversions
	■ Fewer optical amplifiers and regenerators
	■ Two tunable wavelengths (channels) supported per XENPAK-OTN module
	■ Link fault switchover
	■ PC-1XGE-XENPAK-PIC feature support
Transceiver type	■ XENPAK module
Standards	■ ITU-T G.709—Interfaces for the Optical Transport Network (OTN)
	■ ITU-T G.873.1—Optical Transport Network (OTN): Linear Protection
	■ RFC 3591—Definitions of Managed Objects for the Optical Interface Type
Line interface	■ Line rate: 11.09 Gbps
	■ Line rate deviation: ±20 ppm (G.709 LAN PHY with stuffing)
	■ Dispersion window: –600 to +1200 ps/nm or –700 to +1500 ps/nm (maximum)
	■ FEC type: Generic Reed-Solomon RS (255, 239) code computed as specified in Annex A/G. 709

Table 25: Optical Interface Support for 10-Gigabit Ethernet PICs with XENPAK-OTNs *(continued)*

Optical transmitter	■ Transmitter type: Electro-absorption Modulated Laser (EML) ■ Modulation format: Non-return-to-zero (NRZ) ■ Channel-plan wavelength range: 1551.72 through 1542.94 nm ■ Channel-plan frequency range: 193.2 through 194.3 THz ■ Channel spacing: 100 GHz ■ Channel tunability: 2 channels ■ Output power (on): 0 to $+$ 3 dBm ■ Output power (off): $\leq -$ 40 dBm ■ Output power stability: $\pm$ 0.6 dB ■ Wavelength accuracy: $\pm$ 100 pm ■ Tuning time: Warm tune – 10 seconds; Cold start – 40 seconds ■ Extinction ratio: $\geq$ 9 dB ■ Side-mode suppression ratio: $\geq$ 30 dB ■ Jitter generation compliance: GR-253/G.8251
Optical receiver	■ Receiver type: Avalanche photodiode (APD) ■ Jitter tolerance compliance: GR-53/G.8251/802.3ae (LAN PHY) ■ Rx DTV setting: Auto ■ Rx wavelength range: 1527 to 1567 nm ■ Overload: $-$ 5 dBm ■ Damage input power: $+$ 5 dBm ■ Optical return loss: $\geq$ 27 dB
Optical performance	Optical Applications—Power-Limited Receiver: ■ Sensitivity: $-$ 28 dBm ($>$ 33dB/0.1 nm OSNR, 0 ps/nm CD, 10^{-15} post-FEC BER) ■ Chromatic dispersion (CD) power penalty: 3 dB (typical penalty at $+$ 1600 ps/nm and $-$ 700 ps/nm CD) Optical Applications—Noise-Limited Receiver: ■ Required OSNR: 16 dB/0.1 nm ($-$ 8 to $-$ 20 dBm Rx input power, 0 ps/nm CD, 10^{-15} post-FEC BER) ■ CD OSNR penalty: 4 dB (typical penalty at $+$ 1500 ps/nm and $-$ 700 ps/nm CD with Rx input power from $-$ 8 to $-$ 20 dBm). For more detailed information, see Table 26 on page 60.

Table 26: XENPAK-OTN Optical Signal-to-Noise Ratio (OSNR) Performance

OSNR (dB/0.1 nm)	OSNR (dB/0.5 nm)	FEC Type	Pre-FEC BER	Post-FEC BER	Input-Power Range (dBm)	CD Tolerance (ps/nm)
33	26	GFEC	10^{-5}	10^{-15}	–5 to –28	0
33	26	GFEC	10^{-5}	10^{-15}	–5 to –26	–700 to +1600
16	9	GFEC	10^{-5}	10^{-15}	–8 to –20	0

Table 26: XENPAK-OTN Optical Signal-to-Noise Ratio (OSNR) Performance *(continued)*

OSNR (dB/0.1 nm)	OSNR (dB/0.5 nm)	FEC Type	Pre-FEC BER	Post-FEC BER	Input-Power Range (dBm)	CD Tolerance (ps/nm)
17	10	GFEC	10^{-5}	10^{-15}	−8 to −20	−400 to +800
18	11	GFEC	10^{-5}	10^{-15}	−8 to −20	−600 to +1200
20	13	GFEC	10^{-5}	10^{-15}	−8 to −20	−700 to +1500

In Table 27 on page 61, one Juniper index number corresponds to the factory-set frequency that corresponds to the XENPAK-OTN model number. For example, Juniper index number 32 corresponds to the factory-set frequency 193.2 THz, which corresponds to model number XENPAK-1XGE-32A-OTN. The other Juniper index number corresponds to the alternate frequency. For example, Juniper index number 33 corresponds to the alternate frequency 193.3 THz.

Table 27: XENPAK-OTN Factory-Set/Alternate Frequency/Wavelength Reference

Factory-Set Wavelength (nm)	Factory-Set Frequency (THz)	Juniper Index Number (corresponds to factory-set frequency)	Alternate Wavelength (nm)	Alternate Frequency (THz)	Juniper Index Number (corresponds to alternate frequency)	Model Number ("A" denotes two wavelengths)
1551.72	193.2	32	1550.92	193.3	33	XENPAK-1XGE-32A-OTN
1550.12	193.4	34	1549.32	193.5	35	XENPAK-1XGE-34A-OTN
1548.51	193.6	36	1547.72	193.7	37	XENPAK-1XGE-36A-OTN
1546.92	193.8	38	1546.12	193.9	39	XENPAK-1XGE-38A-OTN
1545.32	194.0	40	1544.53	194.1	41	XENPAK-1XGE-40A-OTN
1543.73	194.2	42	1542.94	194.3	43	XENPAK-1XGE-42A-OTN

10-Gigabit Ethernet LAN/WAN PIC with XFP
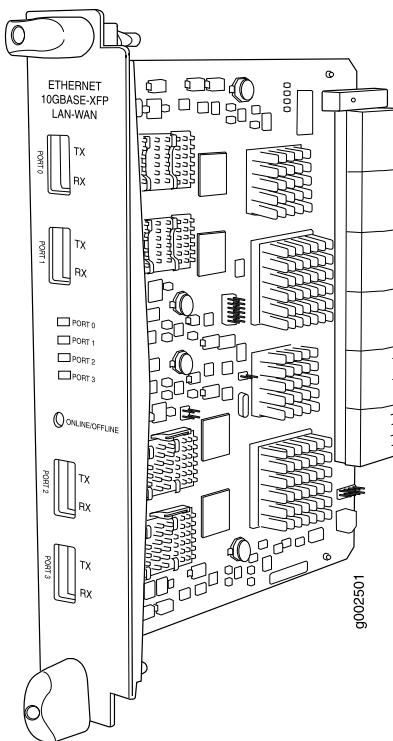
Software release	■	JUNOS 9.0 and later (Type 4)

Description	■	Four 10-Gigabit Ethernet ports
	■	Power requirements: 0.9 A @48 V (43 W)

Hardware features	■	High-performance throughput
	■	WAN-PHY mode at 9.953 Gbps
	■	LAN-PHY mode at 10.3125 Gbps
	■	Full-duplex mode
	■	Large maximum transmission units (MTUs) of up to 9192 bytes

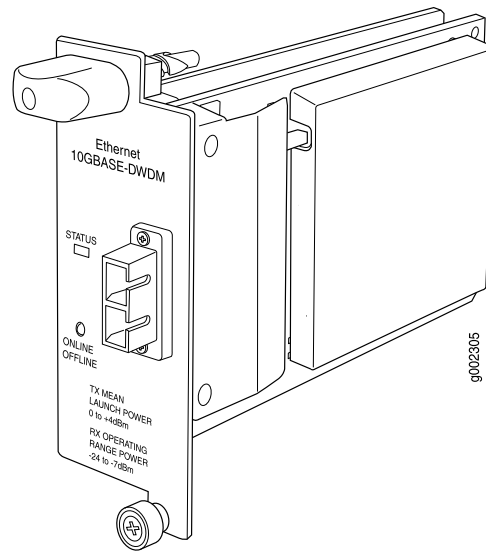|	
Software features	■ Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
	■ Configurable WAN-PHY mode options:
	■ loopback
	■ mpls
	■ path-trace
	■ trigger
	■ Flexible Ethernet Services Encapsulation
	■ 802.1q virtual LANs (VLANs)
	■ Ethernet OAM 802.1ag continuity check
	■ Ethernet OAM 802.3ah (remote loopback is not supported for this PIC)
	■ VLAN stacking
	■ Channels defined by two stacked VLAN tags
	■ Multiple tag protocol identifiers (TPID) support
	■ IP service for nonstandard TPID and stacked VLAN tags
	■ MAC learning, accounting, and filtering
	■ Virtual Router Redundancy Protocol (VRRP) support
Cables and connectors	■ You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Fiber-optic 10-gigabit small form-factor pluggable (XFP) transceivers:
	■ Connector: Duplex LC/PC (Rx and Tx)
	■ Optical interface support—See Table 28 on page 64
LEDs	Port LED, one for each port:
	■ Off—Port is not enabled
	■ Green—Port is online with no alarms or failures
	■ Amber—Port is online with alarms for remote failures
	■ Red—The router has detected a failure with alarms for local failures

Table 28: Optical Interface for 10-Gigabit Ethernet LAN/WAN PICs

Parameter	10-GBase-S	10-GBase-L	10-GBase-E	10-GBase-Z
Transceiver model number	XFP-10G-S	XFP-10G-L-OC192-SR1	XFP-10G-E-OC192-IR2	XFP-10G-Z-OC192-LR2
Optical interface	Multimode	Single-mode	Single-mode	Single-mode
Transceiver type	XFP	XFP	XFP	XFP
Standard	IEEE 802.3ae—2002	IEEE 802.3ae—2002	IEEE 802.3ae—2002	Multivendor agreement
Maximum distance	50/125 MMF cable, 2000 MHz-km: 984 feet/300 m 50/125 MMF cable, 500 MHz-km: 269 feet/82 m 50/125 MMF cable, 400 MHz-km: 217 feet/66 m 62.5/125 MMF cable, 200 MHz-km: 108 feet/33 m 62.5/125 MMF cable, 160 MHz-km: 85 feet/26 m	9/125 SMF cable: 6.2 miles/10 km	9/125 SMF cable: 24.8 miles/40 km: Distances greater than 30 km are considered to be engineered links.	9/125 SMF cable: 49.6 miles/80 km
Transmitter wavelength	840 nm through 860 nm	1260 through 1355 nm	1530 through 1565 nm	1530 through 1565 nm
Average launch power	−4.5 through −1 dBm	−8.2 through 0.5 dBm	−4.7 through 4 dBm	0 through 4 dBm
Average receive power	−9.9 through −1.0 dBm	−14.4 through 0.5 dBm	−15.8 through −1.0 dBm	−24.0 through −7.0 dBm
Receiver saturation	−1.0 dBm	0.5 dBm	−1.0 dBm	−7 dBm
Receiver sensitivity	−9.9 dBm	−14.4 dBm	−15.8 dBm	−24 dBm

10-Gigabit Ethernet DWDM PIC

Software release	■	JUNOS 8.5 and later (Type 3)
Description	■	One 10-Gigabit Ethernet port
	■	Power requirement: 0.55 A @ 48 V (26.6 W)
	■	Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network
Hardware features	■	C-band ITU-Grid with 100 GHz spacing
	■	High-performance throughput at speeds up to 10 Gbps
	■	Full-duplex mode
	■	Maximum transmission units (MTUs) up to 9192 bytes
	■	64 source MAC address filters
	■	960 destination MAC filters
	■	45 individual wavelengths: 1528.77 nm, 1529.55 nm, 1530.33 nm, 1531.12 nm, 1531.90 nm, 1532.68 nm, 1533.47 nm, 1534.25 nm, 1535.04 nm, 1535.82 nm, 1536.61 nm, 1537.40 nm, 1538.19 nm, 1538.98 nm, 1539.77 nm, 1540.56 nm, 1541.35 nm, 1542.14 nm, 1542.94 nm, 1543.73 nm, 1544.53 nm, 1545.32 nm, 1546.12 nm, 1546.92 nm, 1547.72 nm, 1548.52 nm, 1549.32 nm, 1550.12 nm, 1550.92 nm, 1551.72 nm, 1552.52 nm, 1553.33 nm, 1554.13 nm, 1554.94 nm, 1555.75 nm, 1556.56 nm, 1557.36 nm, 1558.17 nm, 1558.98 nm, 1559.79 nm, 1560.61 nm, 1561.42 nm, 1562.23 nm, 1563.05 nm, 1563.86 nm
Software features	■	Enhanced optical monitoring capabilities
	■	CLI configurable wavelength support
	■	Virtual Router Redundancy Protocol (VRRP) support
	■	802.1q virtual LANs (VLANs) support
	■	802.3ae link aggregation support
	■	RMON EtherStats

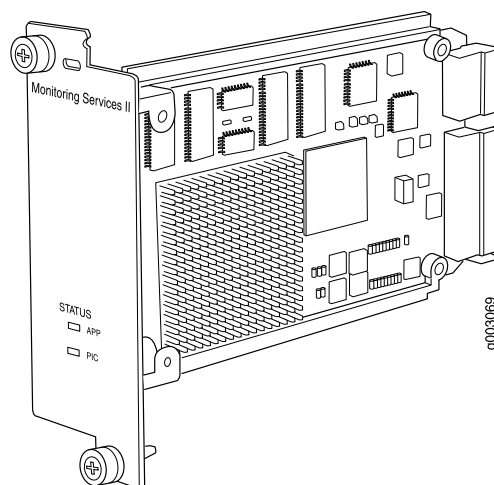|	
Cables and connectors	■ Duplex SC/PC connector (RX and TX)
LEDs	Status LED, one bicolor: ■ Off—PIC is not enabled ■ Green—PIC is operating normally ■ Red—PIC has an error or failure Port LEDs, one pair: ■ Link—If green, the port is online; if there is no light, the port is down ■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data

Table 29: Optical Interface Support for 10-Gigabit Ethernet DWDM PICs

Parameter	Extra-Long Wavelength Serial DWDM, LAN Rate
Optical interface	Single-mode
Transceiver type	Dense wavelength division multiplexing (DWDM)
Standard	ITU-T G.694.1
Maximum distance	9/125 SMF cable: 49.6 miles/80 km
Transmitter wavelength	1528.77 through 1563.86 nm, 100-GHz ITU grid
Average launch power	0 through 4 dBm
Transmit extinction ratio	9 dBm
Average receive power	−7 dBm through −24 dBm
Receiver saturation	−7 dBm
Receiver sensitivity	−24 dBm

Monitoring Services II PIC

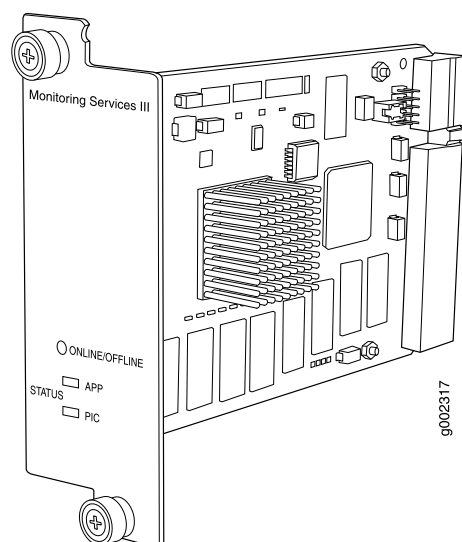|	
Software release	■ JUNOS 8.5 and later (Type 1)
Description	■ Passive traffic monitoring or flow collection services ■ Power requirement: 0.4 A @ 48 V (19 W) ■ Monitors IPv4 packets ■ Support for collecting and exporting cflowd records
Hardware features	■ Monitors up to 400,000 packets per second ■ Support for MTUs up to 4474 bytes for SONET interfaces
Software features	For more information about the software features for services PICs, see the *JUNOS Services Interfaces Configuration Guide*. ■ Load distribution across multiple PICs ■ Active monitoring cflowd version 5 support ■ Provides start and end times of each export ■ Encapsulations: 　■ Multilink Frame Relay (MLFR) 　■ Multilink Point-to-Point Protocol (MLPP) ■ Supports firewall filtering and filter-based forwarding (FBF) **NOTE:** Flow collection services are supported. **NOTE:** This PIC does not support graceful Routing Engine switchover.
Cables and connectors	■ None

LEDs

Status LED, one tricolor:

- ■ Off—PIC is offline and it is safe to remove it from the chassis.
- ■ Green—PIC is operating normally.
- ■ Amber—PIC is initializing.
- ■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis.

Application LED, one bicolor:

- ■ Off—Flow collector is not running.
- ■ Green—Flow collector is running under acceptable load.
- ■ Amber—Flow collector is overloaded.

Monitoring Services III PIC

Software release	■	JUNOS 8.5 and later (Type 2)
Description	■	Power requirement: 0.4 A @ 48 V (19 W)
	■	Supports dynamic flow capture
	■	2 Gbps of sustained packet bandwidth
Hardware features	■	Supports MTUs up to 4474 bytes for SONET interfaces
Software features		For more information about the software features for services PICs, see the *JUNOS Services Interfaces Configuration Guide*.
	■	Dynamic flow capture
Cables and connectors	■	None

LEDs   Two Status LEDs: PIC and APP

PIC LED, one tricolor:

■   Off—PIC is offline and it is safe to remove it from the chassis.

■   Green—PIC is operating normally.

■   Amber—PIC is initializing.

■   Red—PIC has an error or failure and no further harm can be done by removing it from the chassis.
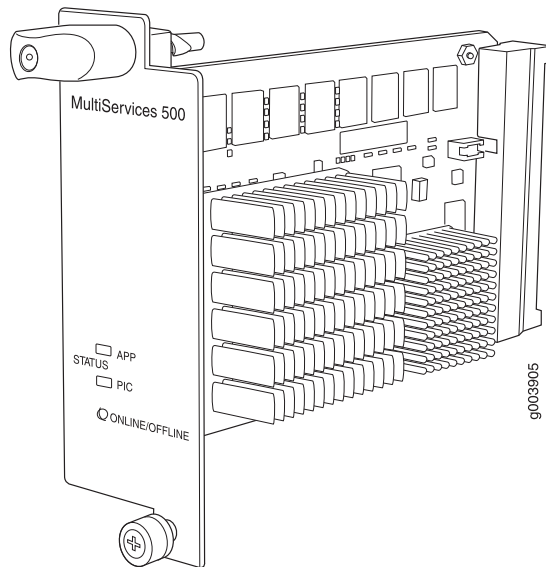
Application LED, one tricolor:

■   Off—Monitoring application is not running.

■   Green—Monitoring application is running under acceptable load.

■   Amber—Monitoring application is overloaded.

■   Red—Not used.

MultiServices PICs
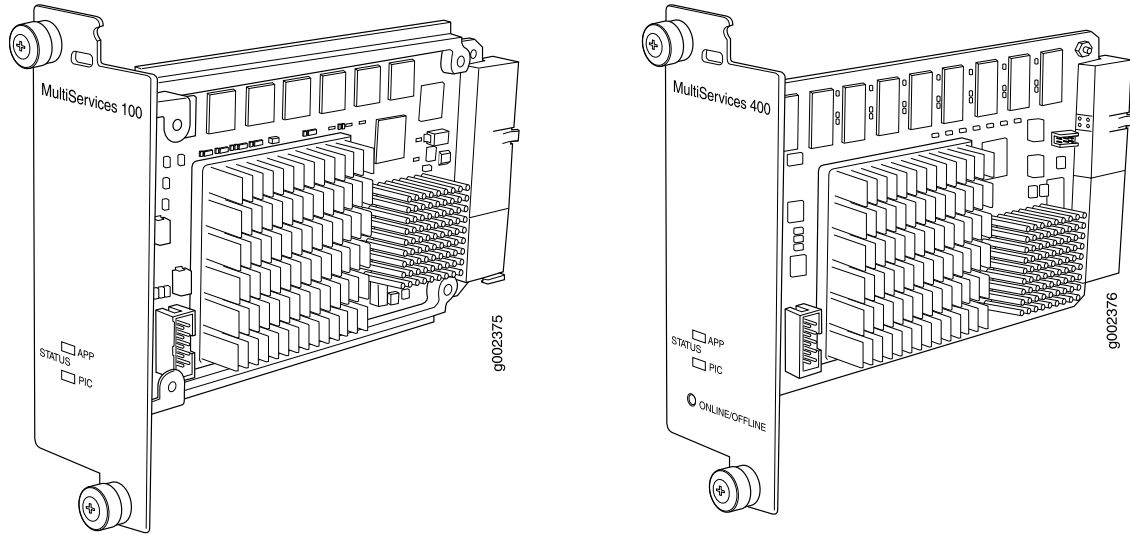
Left: MultiServices 100 PIC; Right: MultiServices 400 PIC

Center: MultiServices 500 PIC

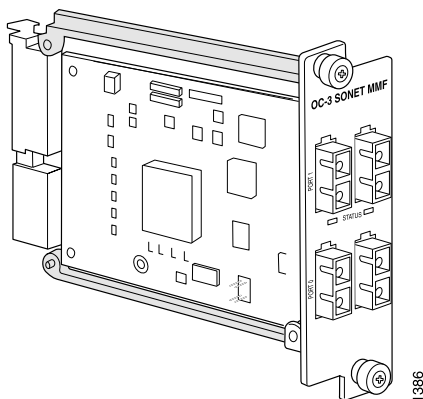|	
Software release	■ MultiServices 100: JUNOS 8.5 and later (Type 1)
	■ MultiServices 400: JUNOS 8.5 and later (Type 2)
	■ MultiServices 500: JUNOS 8.5 and later (Type 3)
Description	■ Supports tunnel services. This feature is included with the PIC and does not require an individual license.
	■ Individual licenses must be purchased for additional services.
	■ Power requirement:
	■ Type 1: 0.52 A @ 48 V (25 W)
	■ Type 2: 0.69 A @ 48 V (33 W)
	■ Type 3: 0.83 A @ 48 V (40 W)
Hardware features	■ Active monitoring on:
	■ Type 1: up to 1.6 million flows
	■ Type 2: up to 3.2 million flows
	■ Type 3: up to 3.2 million flows
Software features	■ Support for up to 2000 service sets
	■ Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces
	Depending on your JUNOS release and individual licenses, software features for this PIC can include the features listed in Table 30 on page 72. For more information about the software features available for services PICs, see the *JUNOS Services Interfaces Configuration Guide*.
LEDs	Status LED, one tricolor:
	■ Off—PIC is offline and it is safe to remove it from the chassis.
	■ Green—PIC is operating normally.
	■ Amber—PIC is initializing.
	■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis.
	Application LED, one bicolor:
	■ Off—Service is not running.
	■ Green—Service is running under acceptable load.
	■ Amber—Service is overloaded.

Table 30: MultiServices PICs Software Features Supported on the T1600 Routing Node

Software Feature	MultiServices 100	MultiServices 400	MultiServices 500
GRE Key	–	–	–
GRE dont-fragment	–	–	–
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks	8.5	8.5	8.5
Network Address Translation (NAT) for IP addresses	8.5	8.5	8.5

Table 30: MultiServices PICs Software Features Supported on the T1600 Routing Node *(continued)*

Port Address Translation (PAT) for port numbers	8.5	8.5	8.5
IP Security (IPSec) encryption	8.5	8.5	8.5
Active flow monitoring exports cflowd version 5 and version 8 records	8.5	8.5	8.5
Active flow monitoring exports flow monitoring version 9 records, based on RFC 3954	8.5	8.5	8.5
Passive flow monitoring	–	8.5	–
Passive flow collection	–	8.5	–
Flow-tap	8.5	8.5	8.5
Dynamic flow capture	–	8.5	–
Real-time performance monitoring	8.5	8.5	8.5
Link Services	8.5	8.5	8.5
Tunnel services: ■ IP-IP unicast tunneling ■ GRE unicast tunneling—Supports GRE fragmentation ■ Protocol Independent Multicast (PIM) sparse mode unicast tunneling	8.5	8.5	8.5
Virtual tunnel interface for Layer 3 VPNs	8.5	8.5	8.5
Layer 2 Tunneling Protocol (L2TP)	–	–	–
Voice services: ■ Compressed Real-Time Transport Protocol (CRTP)	8.5	8.5	8.5
Encapsulations: ■ Multilink Frame Relay (MLFR) ■ Multilink Point-to-Point Protocol (MLPP)	8.5	8.5	8.5

SONET/SDH OC3c/STM1 PIC

Software release	■	JUNOS 8.5 and later (Type 1)

NOTE: Although the illustration shows a multimode PIC, a multimode PIC and a single-mode intermediate reach PIC are both supported.

Description	■	Four OC3 ports
	■	Power requirement: 0.49 A @ 48 V @ 23.7 W)

Hardware features	■	Multiplexing and demultiplexing
	■	Rate policing on input
	■	Rate shaping on output
	■	Packet buffering, Layer 2 parsing

Software features	■	SONET/SDH framing
	■	Link aggregation
	■	Alarm and event counting and detection
	■	Dual-router automatic protection switching (APS)
	■	Multiprotocol Label Switching (MPLS) fast reroute
	■	Encapsulations:
		■ High-Level Data Link Control (HDLC)
		■ Frame Relay
		■ Circuit cross-connect (CCC)
		■ Translational cross-connect (TCC)
		■ Point-to-Point Protocol (PPP)

Cables and connectors	■	Duplex SC/PC connector (Rx and Tx)
	■	Optical interface support—See Table 31 on page 76

NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the *JUNOS System Basics and Services Command Reference*.

| LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■ SONET alarms:
	■ Alarm indication signal—line (AIS-L)
	■ Alarm indication signal—path (AIS-P)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (LOP-P)
	■ Loss of signal (LOS)
	■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
	■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
	■ Payload mismatch (path label mismatch) (PLM-P)
	■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
	■ Remote defect indication—line (RDI-L)
	■ Remote defect indication—path (RDI-P)
	■ SDH alarms:
	■ Multiplex section alarm indication signal (MS-AIS)
	■ Administrative unit alarm indication signal (AU-AIS)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (HP-LOP)
	■ Loss of signal (LOS)
	■ Multiplex section remote error indication (MS-REI)
	■ Higher path label mismatch (HP-PLM)
	■ Higher path unequipped (HP-UNEQ)
	■ Multiplex section remote defect indication (MS-RDI)
	■ Higher path remote defect indication (HP-RDI)
	■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 31: Optical Interface Support for SONET/SDH OC3c/STM1 PICs

Parameter	Intermediate Reach	Multimode
Optical interface	Single-mode	Multimode
Transceiver type	Fixed	Fixed
Standard	Telcordia GR-253	Multivendor agreement
Maximum distance	SMF cable: 9.3 miles/15 km	MMF cable: 1.2 miles/2 km
Transmitter wavelength	1260 through 1360 nm	1270 through 1380 nm
Average launch power	−15 through −8 dBm	−20 through −14 dBm
Receiver saturation	−8 dBm	−14 dBm
Receiver sensitivity	−28 dBm	−30 dBm

SONET/SDH OC3/STM1 (Multi-Rate) PICs with SFP
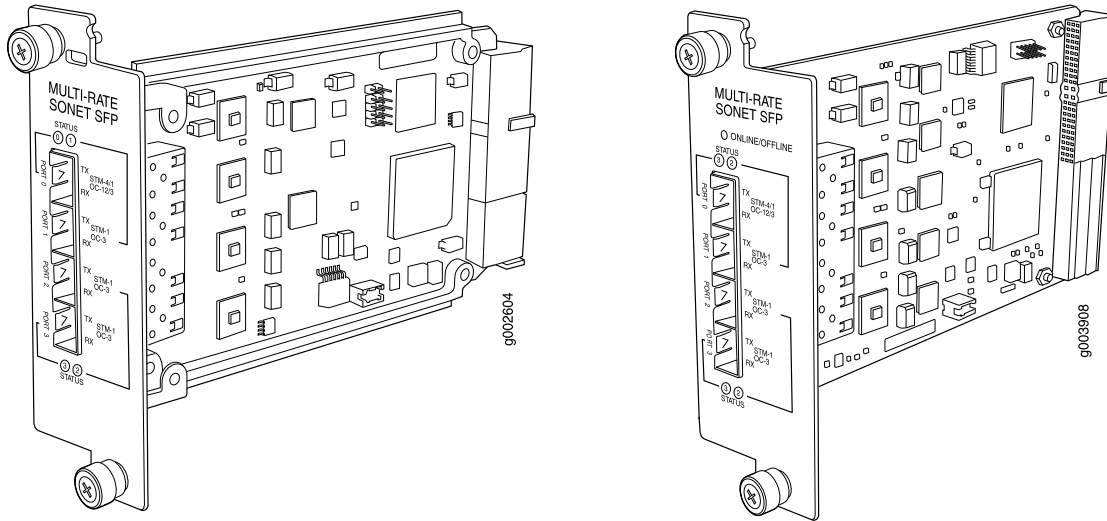
Left: SONET/SDH OC3/STM1 (Multi-Rate) PIC (Type 1); Right: SONET/SDH OC3/STM1 (Multi-Rate) PIC (Type 2)

Software release	■ 4-port: JUNOS 8.5 and later (Type 1)
	■ 4-port: JUNOS 8.5 and later (Type 2)

Description	■ Rate-selectable using one of the following rates:
	■ 1-port OC12
	■ 1-port OC12c
	■ 4-port OC3c
	■ Power requirement: 0.40 A @ 48 V (19 W)

Hardware features	■ Multiplexing and demultiplexing
	■ Rate policing on input
	■ Rate shaping on output
	■ Packet buffering, Layer 2 parsing

Software features	■ Optical diagnostics and related alarms ■ Per-port SONET/SDH framing ■ Link aggregation ■ Alarm and event counting and detection ■ Dual-router automatic protection switching (APS) ■ Multiprotocol Label Switching (MPLS) fast reroute ■ Encapsulations: 　■ High-Level Data Link Control (HDLC) 　■ Frame Relay 　■ Circuit cross-connect (CCC) 　■ Translational cross-connect (TCC) 　■ Point-to-Point Protocol (PPP)
Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*. ■ Duplex LC/PC connector (Rx and Tx) ■ Optical interface support—See Table 32 on page 79 and Table 33 on page 80 **NOTE:** To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor per port: ■ Off—Not enabled ■ Green—Online with no alarms or failures ■ Amber—Online with alarms for remote failures ■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■ SONET alarms:

- ■ SONET alarms:
    - ■ Alarm indication signal—line (AIS-L)
    - ■ Alarm indication signal—path (AIS-P)
    - ■ Bit error rate signal degrade (BERR-SD)
    - ■ Bit error rate signal fail (BERR-SF)
    - ■ Bit interleaved parity (BIP) error B1
    - ■ Bit interleaved parity (BIP) error B2
    - ■ Bit interleaved parity (BIP) error B3
    - ■ Loss of frame (LOF)
    - ■ Loss of pointer (LOP-P)
    - ■ Loss of signal (LOS)
    - ■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
    - ■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
    - ■ Payload mismatch (path label mismatch) (PLM-P)
    - ■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
    - ■ Remote defect indication—line (RDI-L)
    - ■ Remote defect indication—path (RDI-P)
- ■ SDH alarms:
    - ■ Multiplex section alarm indication signal (MS-AIS)
    - ■ Administrative unit alarm indication signal (AU-AIS)
    - ■ Bit error rate signal degrade (BERR-SD)
    - ■ Bit error rate signal fail (BERR-SF)
    - ■ Bit interleaved parity (BIP) error B1
    - ■ Bit interleaved parity (BIP) error B2
    - ■ Bit interleaved parity (BIP) error B3
    - ■ Loss of frame (LOF)
    - ■ Loss of pointer (HP-LOP)
    - ■ Loss of signal (LOS)
    - ■ Multiplex section remote error indication (MS-REI)
    - ■ Higher path label mismatch (HP-PLM)
    - ■ Higher path unequipped (HP-UNEQ)
    - ■ Multiplex section remote defect indication (MS-RDI)
    - ■ Higher path remote defect indication (HP-RDI)
- ■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
- ■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 32: Optical Interface Support for SONET/SDH OC3/STM1 (Multi-Rate) PICs Configured at an OC3/STM1 Rate

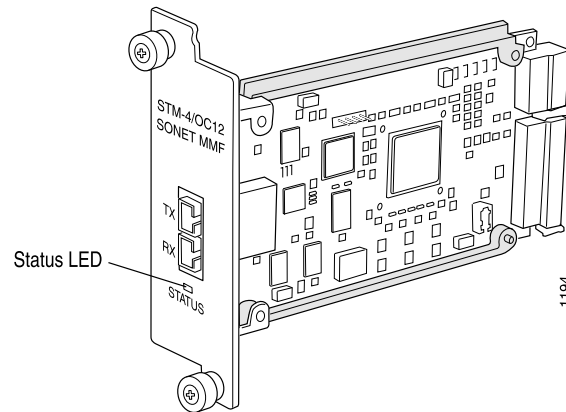| Parameter	Multimode	Intermediate Reach (IR-1)	Long Reach (LR-1)
Transceiver model number	SFP-OC3-SR	SFP-OC3-IR	SFP-OC3-LR

Table 32: Optical Interface Support for SONET/SDH OC3/STM1 (Multi-Rate) PICs Configured at an OC3/STM1 Rate *(continued)*

Parameter	Multimode	Intermediate Reach (IR-1)	Long Reach (LR-1)
Optical interface	Multimode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	MMF cable: 1.2 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 24.85 miles/40 km
Standard	Multivendor agreement	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1270 through 1380 nm	1261 through 1360 nm	1263 through 1360 nm
Average launch power	−20 through −14 dBm	−15 through −8 dBm	−5 through 0 dBm
Receiver saturation	−14 dBm	−8 dBm	−10 dBm
Receiver sensitivity	−30 dBm	−28 dBm	−34 dBm

Table 33: Optical Interface Support for SONET/SDH OC3/STM1 (Multi-Rate) PICs Configured at an OC12/STM4 Rate

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-1)
Transceiver model number	SFP-OC12-SR	SFP-OC12-IR	SFP-OC12-LR
Optical interface	Single-mode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	SMF cable: 1.24 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 24.85 miles/40 km
Standard	Telcordia GR-253	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1261 through 1360 nm	1274 through 1356 nm	1280 through 1335 nm
Average launch power	−15 through −8 dBm	−15 through −8 dBm	−3 through +2 dBm
Receiver saturation	−8 dBm	−8 dBm	−8 dBm
Receiver sensitivity	−23 dBm	−28 dBm	−28 dBm

SONET/SDH OC12c/STM4 PIC

Software release	■ JUNOS 8.5 and later
Description	■ One port ■ Power requirement: 0.23 A @ 48 V (10.8 W)
Hardware features	■ Multiplexing and demultiplexing ■ Rate policing on input ■ Rate shaping on output ■ Packet buffering, Layer 2 parsing

Software features	■ SONET/SDH framing
	■ Link aggregation
	■ Alarm and event counting and detection
	■ Dual-router automatic protection switching (APS)
	■ Multiprotocol Label Switching (MPLS) fast reroute
	■ Encapsulations:
	    ■ High-Level Data Link Control (HDLC)
	    ■ Frame Relay
	    ■ Circuit cross-connect (CCC)
	    ■ Translational cross-connect (TCC)
	    ■ Point-to-Point Protocol (PPP)

Cables and connectors	■ Duplex SC/PC connector (Rx and Tx) ■ Optical interface support—See Table 34 on page 83

NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the *JUNOS System Basics and Services Command Reference*.

|	
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	■ SONET alarms:
	■ Alarm indication signal—line (AIS-L)
	■ Alarm indication signal—path (AIS-P)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (LOP-P)
	■ Loss of signal (LOS)
	■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
	■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
	■ Payload mismatch (path label mismatch) (PLM-P)
	■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
	■ Remote defect indication—line (RDI-L)
	■ Remote defect indication—path (RDI-P)
	■ SDH alarms:
	■ Multiplex section alarm indication signal (MS-AIS)
	■ Administrative unit alarm indication signal (AU-AIS)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (HP-LOP)
	■ Loss of signal (LOS)
	■ Multiplex section remote error indication (MS-REI)
	■ Higher path label mismatch (HP-PLM)
	■ Higher path unequipped (HP-UNEQ)
	■ Multiplex section remote defect indication (MS-RDI)
	■ Higher path remote defect indication (HP-RDI)
	■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 34: Optical Interface Support for SONET/SDH OC12c/STM4 PICs

Parameter	Intermediate Reach	Multimode
Optical interface	Single-mode	Multimode
Transceiver type	Fixed	Fixed
Standard	Telcordia GR-253	Multivendor agreement
Maximum distance	SMF cable: 9.3 miles/15 km	MMF cable: 546.8 yards/500 m
Transmitter wavelength	1274 through 1356 nm	1270 through 1380 nm
Average launch power	–15 through –8 dBm	–20 through –14 dBm
Receiver saturation	–8 dBm	–14 dBm
Receiver sensitivity	–28 dBm	–26 dBm

SONET/SDH OC12/STM4 (Multi-Rate) PICs with SFP
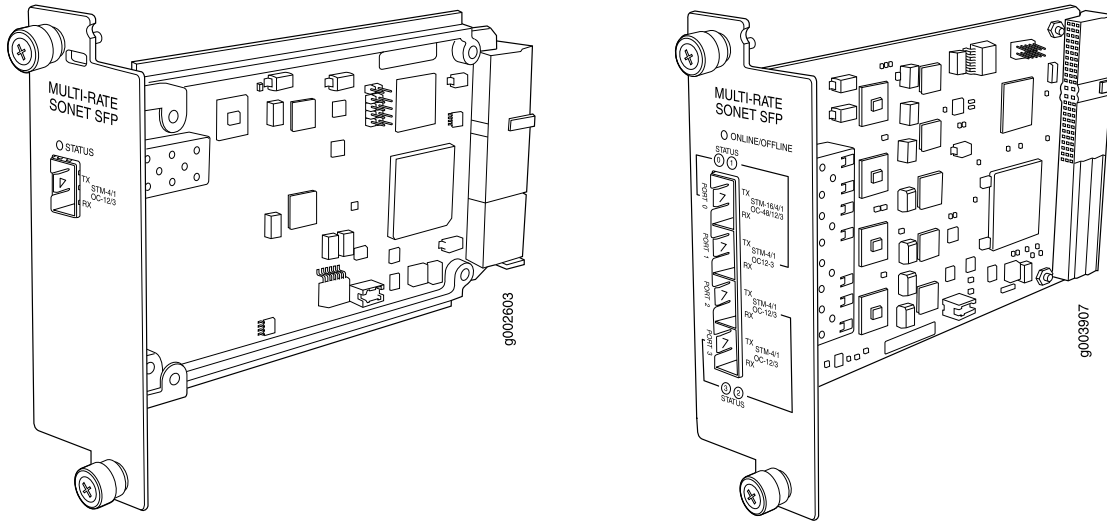
Left: 1-port SONET/SDH OC12/STM4 (Multi-Rate) PIC; Right: 4-port SONET/SDH OC12/STM4 (Multi-Rate) PIC

Software release	■ 1-port: JUNOS 8.5 and later (Type 1)
	■ 4-port: JUNOS 8.5 and later (Type 2)
Description	■ 1-port: Rate-selectable using one of the following rates:
	■ 1-port OC3
	■ 1-port OC12
	■ 1-port OC12c
	■ 4-port: Rate-selectable using one of the following rates:
	■ 1-port OC12
	■ 1-port OC48
	■ 1-port OC48c
	■ 4-port OC3c
	■ 4-port OC12c
	■ Power requirement:
	■ 1-port: 0.20 A @ 48 V (9.5 W)
	■ 4-port: 0.40 A @ 48 V (19 W)
Hardware features	■ Multiplexing and demultiplexing
	■ Rate policing on input
	■ Rate shaping on output
	■ Packet buffering, Layer 2 parsing

Software features	■ Optical diagnostics and related alarms
	■ Per-port SONET/SDH framing
	■ Link aggregation
	■ Alarm and event counting and detection
	■ Dual-router automatic protection switching (APS)
	■ Multiprotocol Label Switching (MPLS) fast reroute
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 35 on page 86, Table 36 on page 87, and Table 37 on page 87
	NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■ SONET alarms:
	■ Alarm indication signal—line (AIS-L)
	■ Alarm indication signal—path (AIS-P)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (LOP-P)
	■ Loss of signal (LOS)
	■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
	■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
	■ Payload mismatch (path label mismatch) (PLM-P)
	■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
	■ Remote defect indication—line (RDI-L)
	■ Remote defect indication—path (RDI-P)
	■ SDH alarms:
	■ Multiplex section alarm indication signal (MS-AIS)
	■ Administrative unit alarm indication signal (AU-AIS)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (HP-LOP)
	■ Loss of signal (LOS)
	■ Multiplex section remote error indication (MS-REI)
	■ Higher path label mismatch (HP-PLM)
	■ Higher path unequipped (HP-UNEQ)
	■ Multiplex section remote defect indication (MS-RDI)
	■ Higher path remote defect indication (HP-RDI)
	■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 35: Optical Interface Support for SONET/SDH OC12/STM4 (Multi-Rate) PICs Configured at an OC3/STM1 Rate

Parameter	Multimode	Intermediate Reach (IR-1)	Long Reach (LR-1)
Transceiver model number	SFP-OC3-SR	SFP-OC3-IR	SFP-OC3-LR

Table 35: Optical Interface Support for SONET/SDH OC12/STM4 (Multi-Rate) PICs Configured at an OC3/STM1 Rate *(continued)*

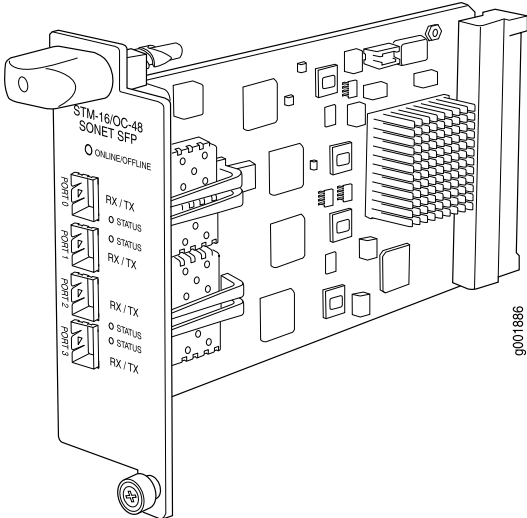| Parameter	Multimode	Intermediate Reach (IR-1)	Long Reach (LR-1)
Optical interface	Multimode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	MMF cable: 1.2 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 24.85 miles/40 km
Standard	Multivendor agreement	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1270 through 1380 nm	1261 through 1360 nm	1263 through 1360 nm
Average launch power	−20 through −14 dBm	−15 through −8 dBm	−5 through 0 dBm
Receiver saturation	−14 dBm	−8 dBm	−10 dBm
Receiver sensitivity	−30 dBm	−28 dBm	−34 dBm

Table 36: Optical Interface Support for SONET/SDH OC12/STM4 (Multi-Rate) PICs Configured at an OC12/STM4 Rate

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-1)
Transceiver model number	SFP-OC12-SR	SFP-OC12-IR	SFP-OC12-LR
Optical interface	Single-mode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	SMF cable: 1.24 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 24.85 miles/40 km
Standard	Telcordia GR-253	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1261 through 1360 nm	1274 through 1356 nm	1280 through 1335 nm
Average launch power	−15 through −8 dBm	−15 through −8 dBm	−3 through +2 dBm
Receiver saturation	−8 dBm	−8 dBm	−8 dBm
Receiver sensitivity	−23 dBm	−28 dBm	−28 dBm

Table 37: Optical Interface Support for SONET/SDH OC12/STM4 (Multi-Rate) PICs Configured at an OC48/STM16 Rate

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-2)
Transceiver model number	SFP-OC48-SR	SFP-OC48-IR	SFP-OC48-LR
Optical interface	Single-mode	Single-mode	Single-mode

Table 37: Optical Interface Support for SONET/SDH OC12/STM4 (Multi-Rate) PICs Configured at an OC48/STM16 Rate *(continued)*

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-2)
Transceiver type	SFP	SFP	SFP
Maximum distance	SMF cable: 1.24 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 49.71 miles/80 km
Standard	Telcordia GR-253	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1266 through 1360 nm	1260 through 1360 nm	1500 through 1580 nm
Average launch power	−10 through −3 dBm	−5 through 0 dBm	−2 through +3 dBm
Receiver saturation	−3 dBm	0 dBm	−9 dBm
Receiver sensitivity	−18 dBm	−18 dBm	−28 dBm

SONET/SDH OC48c/STM16 PIC with SFP

Software release	■ JUNOS 8.5 and later
Description	■ Four OC48 ports ■ Power requirement: 0.46 A @ 48 V (22.1 W)
Hardware features	■ Multiplexing and demultiplexing on the 1-port PIC ■ Rate policing on input ■ Rate shaping on output ■ Packet buffering, Layer 2 parsing

Software features	■ Optical diagnostics and related alarms
	■ Configuration of SONET or SDH framing on a per-port basis
	■ SONET/SDH framing
	■ Link aggregation
	■ Alarm and event counting and detection
	■ Dual-router automatic protection switching (APS)
	■ Multiprotocol Label Switching (MPLS) fast reroute
	■ Encapsulations:
	    ■ High-Level Data Link Control (HDLC)
	    ■ Frame Relay
	    ■ Circuit cross-connect (CCC)
	    ■ Translational cross-connect (TCC)
	    ■ Point-to-Point Protocol (PPP)

Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 38 on page 91
	NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■	SONET alarms:

■ SONET alarms:

- ■ Alarm indication signal—line (AIS-L)
- ■ Alarm indication signal—path (AIS-P)
- ■ Bit error rate signal degrade (BERR-SD)
- ■ Bit error rate signal fail (BERR-SF)
- ■ Bit interleaved parity (BIP) error B1
- ■ Bit interleaved parity (BIP) error B2
- ■ Bit interleaved parity (BIP) error B3
- ■ Loss of frame (LOF)
- ■ Loss of pointer (LOP-P)
- ■ Loss of signal (LOS)
- ■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
- ■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
- ■ Payload mismatch (path label mismatch) (PLM-P)
- ■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
- ■ Remote defect indication—line (RDI-L)
- ■ Remote defect indication—path (RDI-P)

■ SDH alarms:

- ■ Multiplex section alarm indication signal (MS-AIS)
- ■ Administrative unit alarm indication signal (AU-AIS)
- ■ Bit error rate signal degrade (BERR-SD)
- ■ Bit error rate signal fail (BERR-SF)
- ■ Bit interleaved parity (BIP) error B1
- ■ Bit interleaved parity (BIP) error B2
- ■ Bit interleaved parity (BIP) error B3
- ■ Loss of frame (LOF)
- ■ Loss of pointer (HP-LOP)
- ■ Loss of signal (LOS)
- ■ Multiplex section remote error indication (MS-REI)
- ■ Higher path label mismatch (HP-PLM)
- ■ Higher path unequipped (HP-UNEQ)
- ■ Multiplex section remote defect indication (MS-RDI)
- ■ Higher path remote defect indication (HP-RDI)

■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)

■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 38: Optical Interface Support for SONET/SDH OC48c/STM16 PICs with SFP

Parameter	Short Reach (SR)	Intermediate Reach (IR)	Long Reach (LR)
Optical interface	Single-mode	Single-mode	Single-mode; compatible with 1550-nm single-mode LR
Transceiver type	SFP	SFP	SFP

Table 38: Optical Interface Support for SONET/SDH OC48c/STM16 PICs with SFP *(continued)*

Parameter	Short Reach (SR)	Intermediate Reach (IR)	Long Reach (LR)
Maximum distance	SMF cable: 1.24 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 49.71 miles/80 km
Standard	Telcordia GR-253	Telcordia GR-253	Telcordia GR-253—L-16.3
Transmitter wavelength	1266 through 1360 nm	1260 through 1360 nm	1500 through 1580 nm
Average launch power	−10 through −3 dBm	−5 through 0 dBm	−2 through +3 dBm
Receiver saturation	−3 dBm	0 dBm	−9 dBm
Receiver sensitivity	−18 dBm	−18 dBm	−28 dBm

SONET/SDH OC48/STM16 (Multi-Rate) PIC with SFP
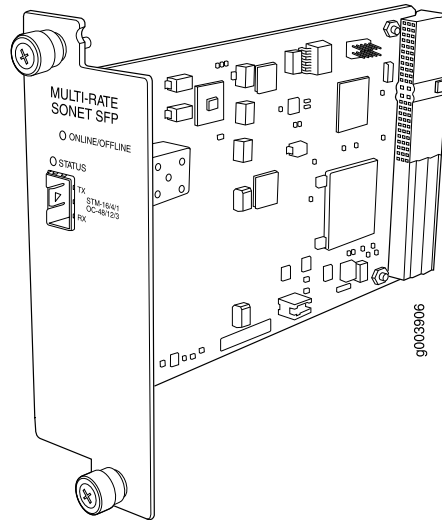
Software release	■	JUNOS 8.5 and later (Type 2)

Description	■	Rate-selectable using one of the following rates:
	■	1-port OC3c
	■	1-port OC12
	■	1-port OC12c
	■	1-port OC48
	■	1-port OC48c
	■	Power requirement: 0.20 A @ 48 V (9.5 W)

Hardware features	■	Multiplexing and demultiplexing
	■	Rate policing on input
	■	Rate shaping on output
	■	Packet buffering, Layer 2 parsing

Software features	■	Optical diagnostics and related alarms
	■	Per-port SONET/SDH framing
	■	Link aggregation
	■	Alarm and event counting and detection
	■	Dual-router automatic protection switching (APS)
	■	Multiprotocol Label Switching (MPLS) fast reroute
	■	Encapsulations:
	■	High-Level Data Link Control (HDLC)
	■	Frame Relay
	■	Circuit cross-connect (CCC)
	■	Translational cross-connect (TCC)
	■	Point-to-Point Protocol (PPP)

Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing transceivers, see the *PIC and Transceiver Installation Instructions*.
	■ Duplex LC/PC connector (Rx and Tx)
	■ Optical interface support—See Table 39 on page 95, Table 40 on page 96, and Table 41 on page 96
	NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
    - Alarm indication signal—line (AIS-L)
    - Alarm indication signal—path (AIS-P)
    - Bit error rate signal degrade (BERR-SD)
    - Bit error rate signal fail (BERR-SF)
    - Bit interleaved parity (BIP) error B1
    - Bit interleaved parity (BIP) error B2
    - Bit interleaved parity (BIP) error B3
    - Loss of frame (LOF)
    - Loss of pointer (LOP-P)
    - Loss of signal (LOS)
    - Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
    - Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
    - Payload mismatch (path label mismatch) (PLM-P)
    - Payload unequipped (unequipped STS at path level) (UNEQ-P)
    - Remote defect indication—line (RDI-L)
    - Remote defect indication—path (RDI-P)
- SDH alarms:
    - Multiplex section alarm indication signal (MS-AIS)
    - Administrative unit alarm indication signal (AU-AIS)
    - Bit error rate signal degrade (BERR-SD)
    - Bit error rate signal fail (BERR-SF)
    - Bit interleaved parity (BIP) error B1
    - Bit interleaved parity (BIP) error B2
    - Bit interleaved parity (BIP) error B3
    - Loss of frame (LOF)
    - Loss of pointer (HP-LOP)
    - Loss of signal (LOS)
    - Multiplex section remote error indication (MS-REI)
    - Higher path label mismatch (HP-PLM)
    - Higher path unequipped (HP-UNEQ)
    - Multiplex section remote defect indication (MS-RDI)
    - Higher path remote defect indication (HP-RDI)
- Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
- Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 39: Optical Interface Support for SONET/SDH OC48/STM16 (Multi-Rate) PICs Configured at an OC3/STM1 Rate

Parameter	Multimode	Intermediate Reach (IR-1)	Long Reach (LR-1)
Transceiver model number	SFP-OC3-SR	SFP-OC3-IR	SFP-OC3-LR

Table 39: Optical Interface Support for SONET/SDH OC48/STM16 (Multi-Rate) PICs Configured at an OC3/STM1 Rate *(continued)*

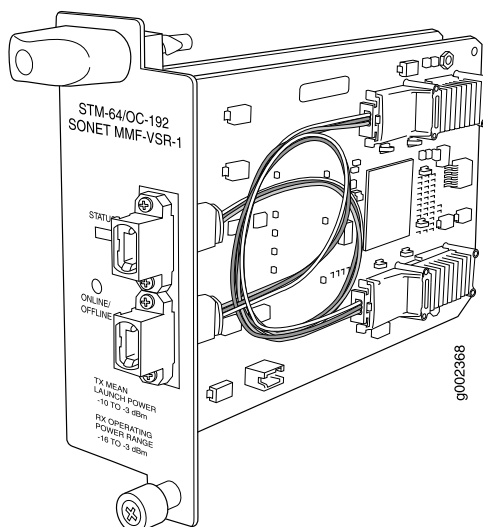| Parameter	Multimode	Intermediate Reach (IR-1)	Long Reach (LR-1)
Optical interface	Multimode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	MMF cable: 1.2 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 24.85 miles/40 km
Standard	Multivendor agreement	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1270 through 1380 nm	1261 through 1360 nm	1263 through 1360 nm
Average launch power	–20 through –14 dBm	–15 through –8 dBm	–5 through 0 dBm
Receiver saturation	–14 dBm	–8 dBm	–10 dBm
Receiver sensitivity	–30 dBm	–28 dBm	–34 dBm

Table 40: Optical Interface Support for SONET/SDH OC48/STM16 (Multi-Rate) PICs Configured at an OC12/STM4 Rate

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-1)
Transceiver model number	SFP-OC12-SR	SFP-OC12-IR	SFP-OC12-LR
Optical interface	Single-mode	Single-mode	Single-mode
Transceiver type	SFP	SFP	SFP
Maximum distance	SMF cable: 1.24 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 24.85 miles/40 km
Standard	Telcordia GR-253	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1261 through 1360 nm	1274 through 1356 nm	1280 through 1335 nm
Average launch power	–15 through –8 dBm	–15 through –8 dBm	–3 through +2 dBm
Receiver saturation	–8 dBm	–8 dBm	–8 dBm
Receiver sensitivity	–23 dBm	–28 dBm	–28 dBm

Table 41: Optical Interface Support for SONET/SDH OC48/STM16 (Multi-Rate) PICs Configured at an OC48/STM16 Rate

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-2)
Transceiver model number	SFP-OC48-SR	SFP-OC48-IR	SFP-OC48-LR
Optical interface	Single-mode	Single-mode	Single-mode

Table 41: Optical Interface Support for SONET/SDH OC48/STM16 (Multi-Rate) PICs Configured at an OC48/STM16 Rate *(continued)*

Parameter	Short Reach (SR-1)	Intermediate Reach (IR-1)	Long Reach (LR-2)
Transceiver type	SFP	SFP	SFP
Maximum distance	SMF cable: 1.24 miles/2 km	SMF cable: 9.3 miles/15 km	SMF cable: 49.71 miles/80 km
Standard	Telcordia GR-253	Telcordia GR-253	Telcordia GR-253
Transmitter wavelength	1266 through 1360 nm	1260 through 1360 nm	1500 through 1580 nm
Average launch power	–10 through –3 dBm	–5 through 0 dBm	–2 through +3 dBm
Receiver saturation	–3 dBm	0 dBm	–9 dBm
Receiver sensitivity	–18 dBm	–18 dBm	–28 dBm

SONET/SDH OC192c/STM64 PIC

Software release	■	JUNOS 8.5 and later (Type 3)
Description	■	Two OC192 ports
	■	Power requirement: 0.45 A @ 48 V (21.6 W)
Hardware features	■	Multiplexing and demultiplexing
	■	Rate policing on input
	■	Rate shaping on output
	■	Packet buffering, Layer 2 parsing
Software features	■	SONET/SDH framing
	■	Link aggregation
	■	Alarm and event counting and detection
	■	Dual-router automatic protection switching (APS)
	■	Multiprotocol Label Switching (MPLS) fast reroute
	■	Encapsulations:
		■ High-Level Data Link Control (HDLC)
		■ Frame Relay
		■ Circuit cross-connect (CCC)
		■ Translational cross-connect (TCC)
		■ Point-to-Point Protocol (PPP)

Cables and connectors	■ Very short reach (VSR 1): 12-ribbon multimode fiber with MTP connector (Rx and Tx)
	Optical interface support—See Table 42 on page 100
	NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

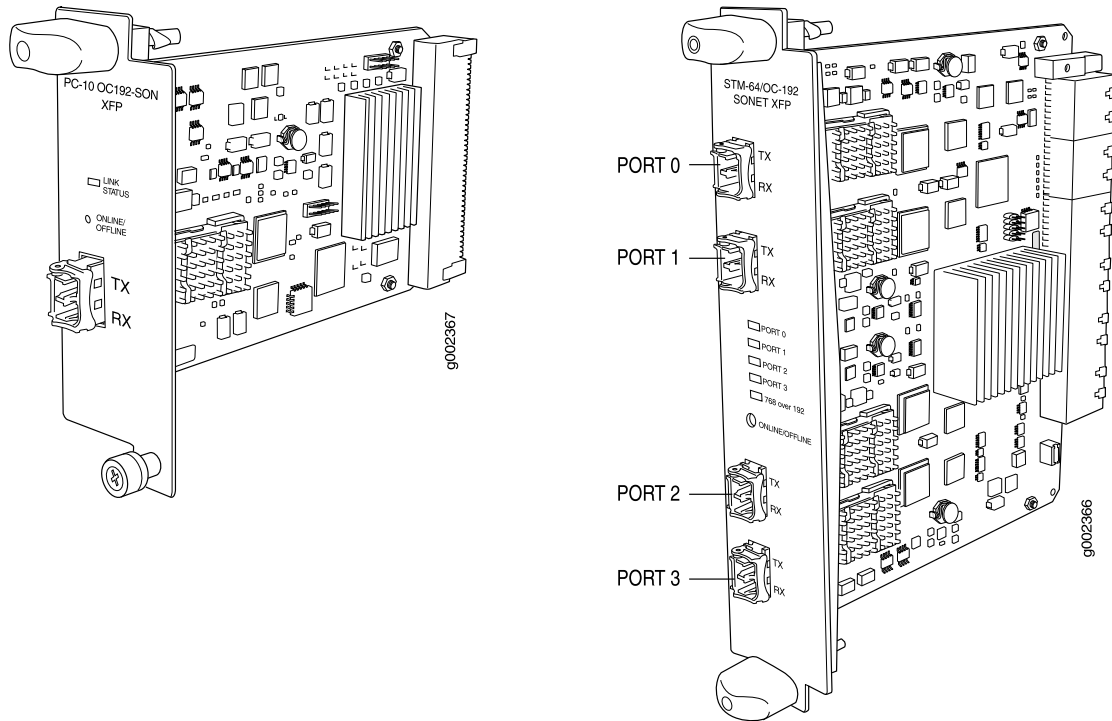|	
Alarms, errors, and events	■ SONET alarms:
	■ Alarm indication signal—line (AIS-L)
	■ Alarm indication signal—path (AIS-P)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (LOP-P)
	■ Loss of signal (LOS)
	■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
	■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
	■ Payload mismatch (path label mismatch) (PLM-P)
	■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
	■ Remote defect indication—line (RDI-L)
	■ Remote defect indication—path (RDI-P)
	■ SDH alarms:
	■ Multiplex section alarm indication signal (MS-AIS)
	■ Administrative unit alarm indication signal (AU-AIS)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (HP-LOP)
	■ Loss of signal (LOS)
	■ Multiplex section remote error indication (MS-REI)
	■ Higher path label mismatch (HP-PLM)
	■ Higher path unequipped (HP-UNEQ)
	■ Multiplex section remote defect indication (MS-RDI)
	■ Higher path remote defect indication (HP-RDI)
	■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 42: Optical Interface Support for the SONET/SDH OC192 PIC

Parameter	Very Short Reach (VSR) 1 Transceiver
Optical interface	Multimode; compatible with 12-ribbon multimode fiber
Transceiver type	Fixed

Table 42: Optical Interface Support for the SONET/SDH OC192 PIC *(continued)*

Parameter	Very Short Reach (VSR) 1 Transceiver
Standard	OIF VSR4-1
Maximum distance	MMF cable: 984.25 feet/300 m
Transmitter wavelength	830 through 860 nm
Average launch power	−10 through −3 dBm
Receiver saturation	−3 dBm
Receiver sensitivity	−16 dBm

SONET/SDH OC192c/STM64 PICs with XFP

Left: 1-port SONET/SDH OC192c/STM64 PIC; Right: 4-port SONET/SDH OC192c/STM64 PIC

Software release	■ 1-port: JUNOS 8.5 and later (Type 3)
	■ 4-port: JUNOS 8.5 and later (Type 4)
Description	■ One or four OC192 ports
	■ 4-port OC192 PIC with XFP: four OC192 links can be aggregated into one OC768 link or two OC256 links. The four fiber links should be on the same fiber path or the same fiber.
	■ Power requirement:
	■ 1-port: 0.52 A @ 48 V (25 W)
	■ 4-port: 1.11 A @ 48 V (53.1 W)
Hardware features	■ Multiplexing and demultiplexing
	■ Rate policing on input
	■ Rate shaping on output
	■ Packet buffering, Layer 2 parsing

Software features	■ Configuration of SONET or SDH framing on a per-port basis on the 4-port Type 4 PIC
	■ SONET/SDH framing
	■ Link aggregation
	■ Alarm and event counting and detection
	■ Dual-router automatic protection switching (APS)
	■ Multiprotocol Label Switching (MPLS) fast reroute
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
Cables and connectors	■ Duplex LC connector (Rx and Tx)
	■ Optical interface support—See Table 43 on page 104
	NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor LED per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure
	One 768 over 192 LED:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

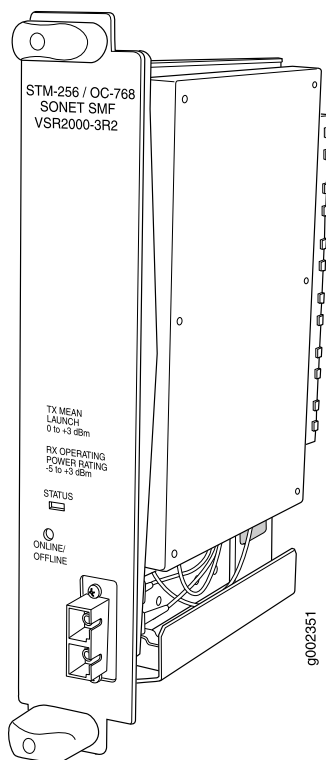|		
Alarms, errors, and events	■	SONET alarms:
		■ Alarm indication signal—line (AIS-L)
		■ Alarm indication signal—path (AIS-P)
		■ Bit error rate signal degrade (BERR-SD)
		■ Bit error rate signal fail (BERR-SF)
		■ Bit interleaved parity (BIP) error B1
		■ Bit interleaved parity (BIP) error B2
		■ Bit interleaved parity (BIP) error B3
		■ Loss of frame (LOF)
		■ Loss of pointer (LOP-P)
		■ Loss of signal (LOS)
		■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
		■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
		■ Payload mismatch (path label mismatch) (PLM-P)
		■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
		■ Remote defect indication—line (RDI-L)
		■ Remote defect indication—path (RDI-P)
	■	SDH alarms:
		■ Multiplex section alarm indication signal (MS-AIS)
		■ Administrative unit alarm indication signal (AU-AIS)
		■ Bit error rate signal degrade (BERR-SD)
		■ Bit error rate signal fail (BERR-SF)
		■ Bit interleaved parity (BIP) error B1
		■ Bit interleaved parity (BIP) error B2
		■ Bit interleaved parity (BIP) error B3
		■ Loss of frame (LOF)
		■ Loss of pointer (HP-LOP)
		■ Loss of signal (LOS)
		■ Multiplex section remote error indication (MS-REI)
		■ Higher path label mismatch (HP-PLM)
		■ Higher path unequipped (HP-UNEQ)
		■ Multiplex section remote defect indication (MS-RDI)
		■ Higher path remote defect indication (HP-RDI)
	■	Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■	Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 43: Optical Interface Support for SONET/SDH OC192 PICs

Parameter	Short reach (SR-1)	Intermediate Reach (IR-2)	Long Reach (LR-2)
Transceiver model number	XFP-10G-L-OC192-SR1	XFP-10G-E-OC192-IR2	XFP-10G-Z-OC192-LR2
Optical interface	Single-mode	Single-mode	Single-mode

Table 43: Optical Interface Support for SONET/SDH OC192 PICs *(continued)*

Parameter	Short reach (SR-1)	Intermediate Reach (IR-2)	Long Reach (LR-2)
Transceiver type	XFP	XFP	XFP
Standard	Telcordia GR-253 OC192 SR1	Telcordia GR-253 OC192 IR2	Telcordia GR-253 OC192 LR2
Maximum distance	SMF cable: 6.21 miles/10 km	SMF cable: 24.8 miles/40 km; distances greater than 30 km are considered to be engineered links.	SMF cable: 49.71 miles/80 km
Transmitter wavelength	1290 nm through 1330 nm	1530 nm through 1565 nm	1530 nm through 1565 nm
Average launch power	−6 through −1 dBm	−1.0. through 2 dBm	0 through 4 dBm
Receiver saturation	−1.0 dBm	−1.0 dBm	−7 dBm
Receiver sensitivity	−11 dBm	−14 dBm	−24 dBm

SONET/SDH OC768c/STM256 PIC

STM-256 / OC-768
SONET SMF
VSR2000-3R2

TX MEAN
LAUNCH
0 to +3 dBm

RX OPERATING
POWER RATING
-5 to +3 dBm

STATUS

ONLINE/
OFFLINE

g002351

Software release	■	JUNOS 8.5 and later (Type 4)

Description	■	One OC768 port
	■	Power requirement: 1.37 A @ 48 V (65.7 W)
	■	Optical interface support—see Table 44 on page 108

Hardware features	■	Multiplexing and demultiplexing
	■	Rate policing on input
	■	Rate shaping on output
	■	Packet buffering, Layer 2 parsing

Software features	■ SONET/SDH framing
	■ Link aggregation
	■ Alarm and event counting and detection
	■ Dual-router automatic protection switching (APS)
	■ Multiprotocol Label Switching (MPLS) fast reroute
	■ Encapsulations:
	■ High-Level Data Link Control (HDLC)
	■ Frame Relay
	■ Circuit cross-connect (CCC)
	■ Translational cross-connect (TCC)
	■ Point-to-Point Protocol (PPP)
	■ Optical diagnostics and related alarms
	■ Laser bias
	■ Transmit optical power
	■ Receiver optical power
	■ Laser temperature
Cables and connectors	■ Duplex SC/PC connector (Rx and Tx)
	■ Optical interface support—see Table 44 on page 108
	NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the *JUNOS System Basics and Services Command Reference*.
LEDs	One tricolor per port:
	■ Off—Not enabled
	■ Green—Online with no alarms or failures
	■ Amber—Online with alarms for remote failures
	■ Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	■ SONET alarms:
	■ Alarm indication signal—line (AIS-L)
	■ Alarm indication signal—path (AIS-P)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (LOP-P)
	■ Loss of signal (LOS)
	■ Far-end bit error: remote error indication—line (REI-L) (CV-LFE)
	■ Far-end bit error: remote error indication—path (REI-P) (CV-PFE)
	■ Payload mismatch (path label mismatch) (PLM-P)
	■ Payload unequipped (unequipped STS at path level) (UNEQ-P)
	■ Remote defect indication—line (RDI-L)
	■ Remote defect indication—path (RDI-P)
	■ SDH alarms:
	■ Multiplex section alarm indication signal (MS-AIS)
	■ Administrative unit alarm indication signal (AU-AIS)
	■ Bit error rate signal degrade (BERR-SD)
	■ Bit error rate signal fail (BERR-SF)
	■ Bit interleaved parity (BIP) error B1
	■ Bit interleaved parity (BIP) error B2
	■ Bit interleaved parity (BIP) error B3
	■ Loss of frame (LOF)
	■ Loss of pointer (HP-LOP)
	■ Loss of signal (LOS)
	■ Multiplex section remote error indication (MS-REI)
	■ Higher path label mismatch (HP-PLM)
	■ Higher path unequipped (HP-UNEQ)
	■ Multiplex section remote defect indication (MS-RDI)
	■ Higher path remote defect indication (HP-RDI)
	■ Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
	■ Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

Table 44: Optical Interface Support for SONET/SDH OC768 PICs

Optical Parameter	Short Reach (SR)
Optical interface	Single-mode
Transceiver type	Fixed

Table 44: Optical Interface Support for SONET/SDH OC768 PICs *(continued)*

Optical Parameter	Short Reach (SR)
Standard	300-pin multi-source agreement (MSA) ITU G.693 VSR2000–3R2
Maximum distance	1.24 miles/2 km
Transmitter wavelength	1530 through 1565 nm
Average launch power	0 through + 3 dBm
Receiver saturation	+ 3 dBm
Receiver sensitivity	–6 dBm

NOTE: The show interfaces diagnostics optics so-X/X/X command has the following tolerances:

■   Laser output power: + /– 1.5 dBm
■   Receiver signal average optical power: + /– 1.5 dBm

Tunnel Services PIC

Software release	■	JUNOS 8.5 and later (Type 1)
	■	JUNOS 8.5 and later (Type 2)
	■	JUNOS 8.5 and later (Type 3)

Description	■	Power requirement: 0.07 A @ 48 V (3.4 W)

Hardware features	■	Loopback function that encapsulates and de-encapsulates packets
	■	OC12/STM4 tunneling bandwidth on Type 1 FPC; OC48/STM16 tunneling bandwidth on Type 2 FPC; OC192/STM64 tunneling bandwidth on Type 3 FPC

Software features		For a list of the software features available for services PICs, see the *JUNOS Services Interfaces Configuration Guide*.
	■	IP-IP unicast tunneling
	■	GRE unicast tunneling
	■	PIM sparse mode unicast tunneling

LEDs		One tricolor:
	■	Off—Not enabled
	■	Green—Online with no alarms or failures
	■	Amber—Online with alarms for remote failures
	■	Red—Active with a local alarm; router has detected a failure

40-Gigabit Tunnel Services PIC

Software release	■	JUNOS 8.5 and later
Description	■	Power requirement: 0.07 A @ 48 V (3.4 W)
Hardware features	■	40 gigabit loopback bandwidth that encapsulates and de-encapsulates packets
Software features		For a list of the software features available for services PICs, see the *JUNOS Services Interfaces Configuration Guide*.
	■	IP-IP unicast tunneling
	■	GRE unicast tunneling
	■	PIM sparse mode unicast tunneling
LEDs		One tricolor:
	■	Off—Not enabled
	■	Green—Online with no alarms or failures
	■	Amber—Online with alarms for remote failures
	■	Red—Active with a local alarm; router has detected a failure

Appendix A
High Availability Features

High availability features include Routing Engine redundancy, graceful Routing Engine switchover (GRES), nonstop bridging, nonstop active routing, graceful restart for routing protocols, Virtual Router Redundancy Protocol (VRRP), and unified in-service software upgrade (ISSU). Some high availability features are not supported by all platforms and all PICs. For information about the first supported JUNOS release for these features by PIC and platform, see the *JUNOS High Availability Configuration Guide*.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. The JUNOS software has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.