



## **M160 Internet Router**

## **PIC Guide**

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This guide provides an overview and description of the Physical Interface Cards (PICs) supported by the Juniper Networks M160 Internet router. The PICs are described alphabetically.

PICs provide the physical connection to various network media types. The PICs are mounted on Flexible PIC Concentrators (FPCs) or Enhanced Flexible PIC Concentrators (Enhanced FPCs), which are inserted into a slot in a router. A PIC occupies a single slot on an FPC. You can install PICs of different media types on the same FPC as long as the FPC and the router support those PICs.

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.



**NOTE:** If you are upgrading an M160 Internet router to JUNOS 6.3 or later and have different PIC types on a single FPC, please consult the most recent technical bulletins about PIC combinations on the Juniper Networks Support site at: <http://www.juniper.net/support/>.

Table 1 lists the features available in all current Services PICs for JUNOS release 7.3.

**Table 1: Services PIC Feature Matrix**

	<b>ASM</b>	<b>AS PIC</b>	<b>AS2 PIC</b>	<b>ES PIC</b>	<b>LS PIC</b>	<b>Monitoring PICs</b>	<b>Tunnel PICs</b>
<b>Model Number</b>	FEB-M7i-SVCS-S	P-AS2, PB-AS, PE-AS	P-AS2, PB-AS2, PE-AS2	P-ES-800, PB-ES-800, PE-ES-800	P-LS-4, PB-LS-4, PE-LS-4, P-LS-32, PB-LS-32, PE-LS-32, P-LS-128, PB-LS-128, PE-LS-128	P-PM, PB-PM, PB-PM2, PE-PM	P-TUNNEL, PB-TUNNEL, PB-TUNNEL-1, PC-TUNNEL, PE-TUNNEL
<b>FPC Type</b>	Integrated	Type 1	Type 1	Type 1	Type 1	Type 1	Type 1, Type 2, Type 3
<b>Platform Support</b>	M7i	M5, M7i, M10, M10i, M20, M40, M40e, M160	M5, M7i, M10, M10i, M20, M40, M40e, M160, M320, T320, T640	M5, M7i, M10, M10i, M20, M40, M40e, M160, M320, T320	M5, M7i, M10, M10i, M20, M40, M40e, M320	M5, M7i, M10, M10i, M20, M40, M40e, M160	M5, M7i, M10, M10i, M20, M40, M40e, M160, M320, T320, T640
<b>Security Services</b>							
Stateful Firewall	X	X	X				

	ASM	AS PIC	AS2 PIC	ES PIC	LS PIC	Monitoring PICs	Tunnel PICs
NAT	X	X	X				
Intrusion Detection System (IDS)	X	X	X				
IPSec	X	X	X	X			
<b>Monitoring Services</b>							
Active Monitoring	X	X	X				
Passive Monitoring						X	
<b>LNS Services</b>							
L2TP LNS	X						
<b>Voice Services</b>							
CRTP	X						
<b>Link Services</b>							
Link Services (FRF.12, FRF.15, FRF.16, LFI, MLPPP)	X	X	X		X		
<b>Tunnel Services</b>							
GRES	X	X	X		X		X
GRES Fragmentation	X	X	X				
Logical Tunnels (LT)	X				X		X
IP-IP	X	X	X		X		X
Multicast Tunnels (MT)	X	X	X		X		X
PIM De-encapsulation (PD)	X	X	X		X		X
PIM Encapsulation (PE)	X	X	X		X		X
Virtual Tunnels (VT)	X	X	X		X		X



**NOTE:** With JUNOS Release 6.3 and later, the M160 router supports Enhanced Flexible PIC Concentrator (FPC) types 2 and 3, which offer additional queue priority levels and next-hop memory, and support all existing type 2 and 3 T-series Physical Interface Cards (PICs). Additionally, the router now supports FPC type 1 and its associated T-series PICs.

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/>.

A single FPC2 has a maximum throughput of 10 Gbps and a single FPC1 has a maximum throughput of 3.2 Gbps. Inserting a combination of PICs with an aggregate higher than that is supported, but constitutes oversubscription.

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You can typically install any combination of PICs on a single Enhanced Flexible PIC Concentrator (FPC). Starting with JUNOS Release 6.2, on M5, M10, M20, M40, M40e, and M160 routers, there are some combinations of PICs that cannot be installed together on the same Enhanced FPC. If you are adding a new type of PIC to an existing configuration, see the most recent at <http://www.juniper.net/alerts>.

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.

For complete information about installing PICs, including installation of small form-factor pluggable transceivers (SFPs), see the *PIC, SFP, and XENPAK Installation Instructions* located at <http://www.juniper.net/techpubs/>.

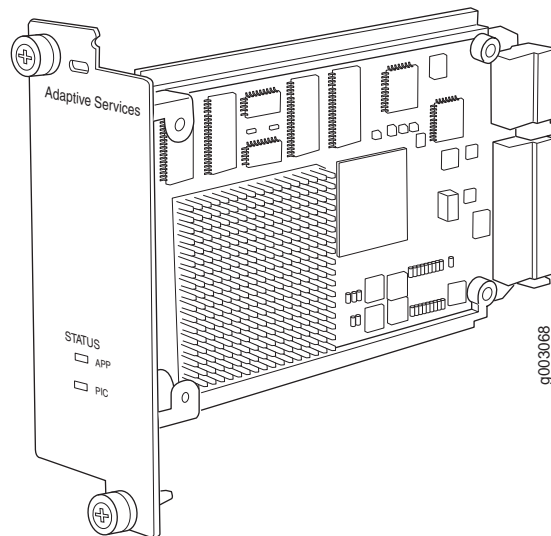
Table 2 lists the PICs supported by the M160 Internet router.

**Table 2: PICs Supported in the M160 Internet Router**

<b>PIC Family and Type</b>	<b>Ports</b>	<b>First JUNOS Support</b>	<b>FPC Support and PIC Slots Required</b>	<b>Page</b>
<b>ATM2 IQ</b>				
ATM2 IQ DS3	4	6.1	FPC1—1 slot	11
ATM2 IQ E3	4	6.1	FPC1—1 slot	13
ATM2 IQ OC3	2	5.5	FPC1—1 slot	15
ATM2 IQ OC12	1	5.5	FPC1—1 slot	18
ATM2 IQ OC12	2	5.5	FPC2—1 slot	18
<b>Channelized</b>				
Channelized OC12	1	4.1	FPC1—1 slot	25
Multichannel DS3	2	5.2	FPC1—1 slot	63
<b>Channelized IQ</b>				
Channelized DS3 IQ	4	5.6	FPC1—1 slot	21
Channelized E1 IQ	10	5.6	FPC1—1 slot	23
Channelized OC12 IQ	1	5.6	FPC1—1 slot	28
Channelized OC3 IQ	1	7.1	1 slot	31
Channelized STM1 IQ	1	5.7	FPC1—1 slot	34
<b>DS3, E1, and T1</b>				
DS3	4	4.1	FPC1—1 slot	36
E1	4	4.1	FPC1—1 slot	38
T1	4	4.1	FPC1—1 slot	75
<b>E3 IQ</b>				
E3 IQ	4	6.1	FPC1—1 slot	41
<b>Ethernet</b>				
Fast Ethernet	4	4.1	FPC1—1 slot	47
Fast Ethernet	8	5.2	FPC1—1 slot	47
Fast Ethernet	48	4.4	FPC2—1 slot	47
Gigabit Ethernet with SFP	1	6.3	FPC1—1 slot	50
Gigabit Ethernet with SFP	2	6.4	FPC2—1 slot	50
Gigabit Ethernet with SFP	4	7.0	FPC2—1 slot	50
10-Gigabit Ethernet	1	5.3	FPC not required	57
<b>Ethernet IQ</b>				
Gigabit Ethernet IQ	1	6.0	FPC1—1 slot	54
Gigabit Ethernet IQ	2	6.1	FPC2—1 slot	54
<b>IP Services</b>				
Adaptive Services	0	6.0	FPC1—1 slot	7

<b>PIC Family and Type</b>	<b>Ports</b>	<b>First JUNOS Support</b>	<b>FPC Support and PIC Slots Required</b>	<b>Page</b>
Adaptive Services II	0	6.4	FPC1—1 slot	9
ES	0	5.3	FPC1—1 slot	45
Monitoring Services	0	5.4	FPC1—1 slot	59
Monitoring Services II	0	6.0	FPC1—1 slot	61
Tunnel Services	0	5.3	FPC2—1 slot	77
<b>Serial</b>				
EIA-530	2	5.6	FPC1—1 slot	43
<b>SONET/SDH</b>				
SONET/SDH OC3c/STM1	4	4.0	FPC1—1 slot	65
SONET/SDH OC12c/STM4	1	4.0	FPC1—1 slot	67
SONET/SDH OC12c/STM4	4	4.0	FPC2—1 slot	67
SONET/SDH OC48c/STM16 with SFP	1	6.1	FPC2—1 slot	69
SONET/SDH OC192c/STM64	1	4.0	FPC not required	72

## Adaptive Services PIC

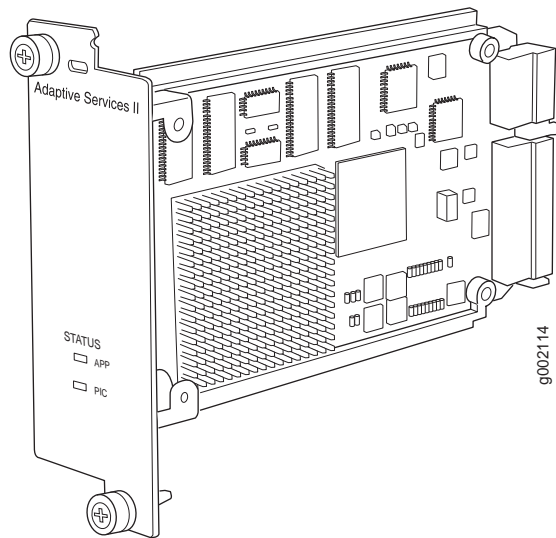


<b>Software release</b>	<ul style="list-style-type: none"> <li>JUNOS 6.0 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>Supports Network Address Translation (NAT), stateful firewall, intrusion detection services (IDS), IPSec, J-Flow accounting, tunnel services, and voice services.</li> </ul> <p><b>NOTE:</b> Individual licenses must be purchased for these features except tunnel services, which is included with the PIC.</p> <ul style="list-style-type: none"> <li>Power requirement: 0.4 A/48 V @ 19 W</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>Throughput speeds up to 500 Mbps of unidirectional traffic or 250 Mbps of bidirectional traffic, determined by packet size</li> <li>Active monitoring on any interface up to 250,000 packets per second</li> <li>Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces</li> </ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Stateful firewall with packet inspection <ul style="list-style-type: none"> <li>■ Detects SYN attacks, ICMP and UDP floods, and ping of death attacks</li> </ul> </li> <li>■ NAT for IP addresses</li> <li>■ Port Address Translation (PAT) for port numbers</li> <li>■ J-Flow accounting exports cflowd version 5 and version 8 records</li> <li>■ Tunnel services: <ul style="list-style-type: none"> <li>■ IP-IP unicast tunneling</li> <li>■ GRE unicast tunneling—supports GRE fragmentation</li> <li>■ PIM sparse mode unicast tunneling</li> <li>■ Virtual loopback tunnel interface for VRF table lookup</li> </ul> </li> <li>■ IPSec encryption</li> </ul> <p><b>NOTE:</b> IPSec is supported in JUNOS release 6.1 and later.</p> <ul style="list-style-type: none"> <li>■ Voice services: <ul style="list-style-type: none"> <li>■ Compressed Real-time Protocol (cRTP)</li> <li>■ Compressed User Datagram Protocol (cUDP)</li> </ul> </li> </ul> <p><b>NOTE:</b> Voice services are supported in JUNOS release 6.3 and later.</p> <ul style="list-style-type: none"> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul> <p><b>NOTE:</b> Extended support for graceful Routing Engine switchover (GRES) has been added for this PIC. To configure GRES, you must be running JUNOS release 7.3 or later.</p>
<b>LEDs</b>	<p>Status LED, one tricolor:</p> <ul style="list-style-type: none"> <li>■ Off—PIC is offline and it is safe to remove it from the chassis.</li> <li>■ Green—PIC is operating normally.</li> <li>■ Amber—PIC is initializing.</li> <li>■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis.</li> </ul> <p>Application LED, one tricolor:</p> <ul style="list-style-type: none"> <li>■ Off—Service is not running.</li> <li>■ Green—Service is running under acceptable load.</li> <li>■ Amber—Service is overloaded.</li> </ul>



Adaptive Services II PIC



Software release	<ul style="list-style-type: none"><li>JUNOS 6.4 and later</li></ul>
Description	<ul style="list-style-type: none"><li>Supports Network Address Translation (NAT), stateful firewall, intrusion detection services (IDS), IPSec, J-Flow accounting, tunnel services, and voice services.</li></ul> <p><b>NOTE:</b> Individual licenses must be purchased for these features except tunnel services, which is included with the PIC.</p> <p><b>NOTE:</b> J-Flow and voice services are not supported on the Adaptive Services II PIC when it is installed in T-series or M320 routing platforms.</p> <ul style="list-style-type: none"><li>Power requirement: 0.4 A/48 V @ 19 W</li></ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
Hardware features	<ul style="list-style-type: none"><li>Support for up to 250 service sets</li><li>Active monitoring on up to 1 million flows</li><li>Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces</li></ul>

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**Software features**

- Stateful firewall with packet inspection
  - Detects SYN attacks, ICMP and UDP floods, and ping of death attacks
- NAT for IP addresses
- Port Address Translation (PAT) for port numbers
- J-Flow accounting exports cflowd version 5 and version 8 records
- Tunnel services:
  - IP-IP unicast tunneling
  - GRE unicast tunneling—supports GRE fragmentation
  - PIM sparse mode unicast tunneling
  - Virtual tunnel interface for Layer 3 VPNs
- IPSec encryption
- Voice services:
  - Compressed Real-Time Protocol (CRTP)
  - Compressed User Datagram Protocol (CUDP)
- Encapsulations:
  - High-level Data Link Control (HDLC)
  - Point-to-Point Protocol (PPP)

**NOTE:** Extended support for graceful Routing Engine switchover (GRES) has been added for this PIC. To configure GRES, you must be running JUNOS release 7.3 or later.

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**LEDs**

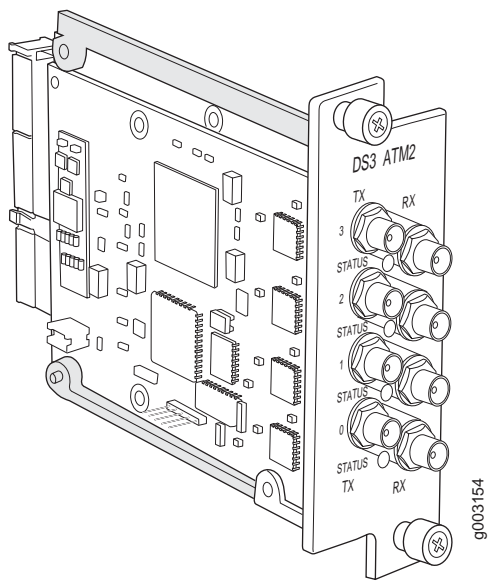
Status LED, one tricolor:

- 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 tricolor:

- Off—Service is not running.
  - Green—Service is running under acceptable load.
  - Amber—Service is overloaded.
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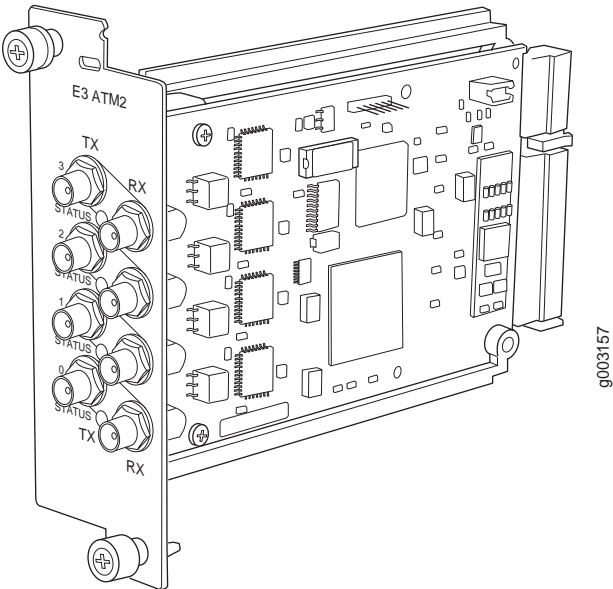
ATM2 IQ DS3 PIC



Software release	■ JUNOS 6.1 and later
Description	<div><div>■ Four DS3 ports</div><div>■ Power requirements: 0.41 A/48 V @ 20.0 W</div><div>■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</div><div>■ ATM standards compliant</div></div> <div><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</div>
Hardware features	<div><div>■ 16-MB SDRAM memory for ATM segmentation and reassembly (SAR)</div><div>■ ATM switch ID</div><div>■ Configurable framing options:<div><div>■ C-bit with ATM direct mapping</div><div>■ C-bit with Physical Layer Convergence Protocol (PLCP) framing (default)</div><div>■ M23 ATM direct mapping</div><div>■ M23 with PLCP framing</div></div></div><div>■ Internal and loop timing</div></div>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Per-virtual circuit (VC) and per-virtual path (VP) traffic shaping</li> <li>■ Unspecified bit rate (UBR) traffic shaping</li> <li>■ Fine-grained variable bit rate (VBR) traffic shaping</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ 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)</li> <li>■ Simple Network Management Protocol (SNMP): <ul style="list-style-type: none"> <li>■ Management Information Base (MIB) 2 (RFC 1213)</li> <li>■ ATM MIB (RFC 1695)</li> <li>■ SONET MIB</li> </ul> </li> <li>■ AAL5 encapsulations: <ul style="list-style-type: none"> <li>■ ATM-VC-MUX</li> <li>■ ATM-NLPID</li> <li>■ ATM-Cisco-LLPID</li> <li>■ ATM-SNAP</li> <li>■ ATM-CCC-VC-MUX</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ 10-ft (3.05-m) posilock SMB to BNC (provided)</li> <li>■ Four pairs of Rx and Tx coaxial cables</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS)</li> <li>■ Far-end Block Error (FEBE)</li> <li>■ Frame Error</li> <li>■ Idle code</li> <li>■ Idle received</li> <li>■ Local and remote loopback</li> <li>■ Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Path parity error</li> <li>■ Yellow alarm</li> </ul>

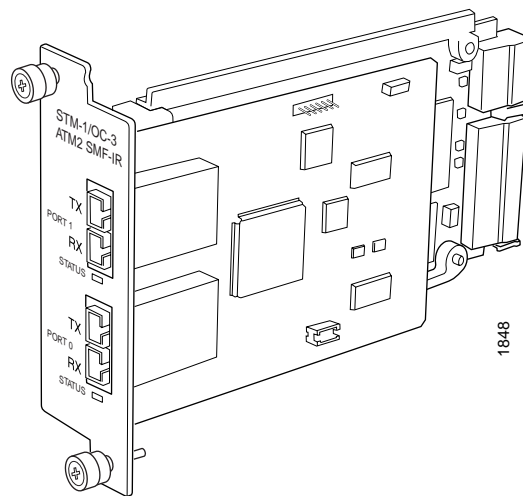
ATM2 IQ E3 PIC



Software release	■ JUNOS 6.1 and later
Description	<div>■ Four E3 ports</div> <div>■ Power requirements: 0.41 A/48 V @ 20.0 W</div> <div>■ Intelligent queuing (IQ) PICs support fine-grained queuing per-logical interface.</div> <div>■ ATM standards compliant</div> <div><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</div>
Hardware features	<div>■ 16-MB SDRAM memory for ATM segmentation and reassembly (SAR)</div> <div>■ ATM switch ID</div> <div>■ Configurable framing options:<div>■ G.751 direct mapping</div><div>■ G.751 with PLCP encapsulation (default)</div><div>■ G.832 ATM direct mapping</div></div> <div>■ Internal and loop timing</div>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Per-virtual circuit (VC) and per-virtual path (VP) traffic shaping</li> <li>■ Unspecified bit rate (UBR) traffic shaping</li> <li>■ Fine-grained variable bit rate (VBR) traffic shaping</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ 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)</li> <li>■ Simple Network Management Protocol (SNMP): <ul style="list-style-type: none"> <li>■ Management Information Base (MIB) 2 (RFC 1213)</li> <li>■ ATM MIB (RFC 1695)</li> <li>■ SONET MIB</li> </ul> </li> <li>■ AAL5 encapsulations: <ul style="list-style-type: none"> <li>■ ATM-VC-MUX</li> <li>■ ATM-NLPID</li> <li>■ ATM-Cisco-LLPID</li> <li>■ ATM-SNAP</li> <li>■ ATM-CCC-VC-MUX</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ 10-ft (3.05-m) posilock SMB to BNC (provided)</li> <li>■ Four pairs of Rx and Tx coaxial cables</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS)</li> <li>■ Frame Error</li> <li>■ Line code violation</li> <li>■ Local and remote loopback</li> <li>■ Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Yellow alarm</li> </ul>

## ATM2 IQ OC3 PIC



<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 5.5 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ Two OC3 ports</li> <li>■ Power requirements: 0.41 A/48 V @ 20 W</li> <li>■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li> <li>■ Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1</li> <li>■ ATM and SONET/SDH standards compliant</li> <li>■ Alarm and event counting and detection</li> <li>■ Compatible with well-known ATM switches</li> <li>■ ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches</li> <li>■ Optical interface support—see Table 3</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ Single 3010 SAR for segmentation and reassembly into 53-byte ATM cells</li> <li>■ High-performance parsing of SONET/SDH frames</li> <li>■ ASIC-based packet segmentation and reassembly (SAR) management and output port queuing</li> <li>■ 64-MB SDRAM memory for ATM SAR</li> <li>■ Packet buffering, Layer 2 parsing</li> </ul>

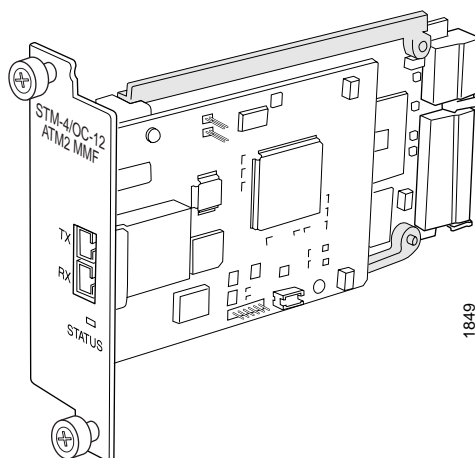
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC) for leveraging ATM access networks</li> <li>■ User-configurable virtual circuit (VC) and virtual path (VP) support</li> <li>■ Support for idle cell or unassigned cell transmission</li> <li>■ OAM fault management processes Alarm Indication Signal (AIS), Remote Defect Indicator (RDI) cells, and loop cells</li> <li>■ Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP</li> <li>■ Local and remote loopback</li> <li>■ 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)</li> <li>■ Simple Network Management Protocol (SNMP): <ul style="list-style-type: none"> <li>■ Management Information Base (MIB) 2 (RFC 1213)</li> <li>■ ATM MIB (RFC 1695)</li> <li>■ SONET MIB</li> </ul> </li> <li>■ Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping</li> <li>■ Per-VC or per-VP traffic shaping</li> <li>■ Support for F4 OAM cells</li> <li>■ Support for 16-bit VCI range</li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (RX and TX)</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Cell Delineation (LoC), Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>



**Table 3: Optical Interface Support for ATM2 IQ OC3 PICs**

<b>PIC Type</b>	<b>Single-mode Intermediate Reach</b>	<b>Multimode</b>
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC/PC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC/PC duplex connector (maximum distance 1.2 miles/2 km)
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 IQ OC12 PIC



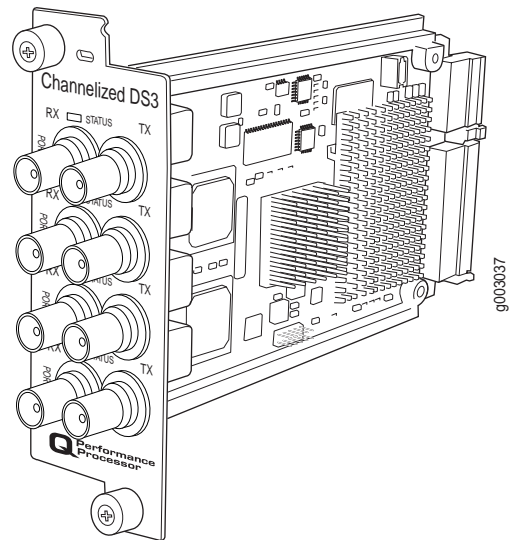
<b>Software release</b>	<ul style="list-style-type: none"> <li>JUNOS 5.5 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>One or two OC12 ports</li> <li>Power requirements: <ul style="list-style-type: none"> <li>1-port: 0.41 A/48 V @ 20 W</li> <li>2-port: 0.52 A/48 V @ 25 W</li> </ul> </li> <li>Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li> <li>Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1</li> <li>ATM and SONET/SDH standards compliant</li> <li>Alarm and event counting and detection</li> <li>Compatible with well-known ATM switches</li> <li>ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches</li> <li>Optical interface support—see Table 4</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>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</li> <li>High-performance parsing of SONET/SDH frames</li> <li>ASIC-based packet segmentation and reassembly (SAR) management and output port queuing</li> <li>64-MB SDRAM memory for ATM SAR</li> <li>Packet buffering, Layer 2 parsing</li> </ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect for leveraging ATM access networks</li> <li>■ User-configurable virtual circuit (VC) and virtual path (VP) support</li> <li>■ Support for idle cell or unassigned cell transmission</li> <li>■ OAM Fault Management processes Alarm Indication Signal (AIS), Remote Defect Indicator (RDI), and loop cells</li> <li>■ Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP</li> <li>■ Local and remote loopback</li> <li>■ ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC</li> <li>■ Simple Network Management Protocol (SNMP): <ul style="list-style-type: none"> <li>■ Management Information Base (MIB) 2 (RFC 1213)</li> <li>■ ATM MIB (RFC 1695)</li> <li>■ SONET MIB</li> </ul> </li> <li>■ Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping</li> <li>■ Per-VC or per-VP traffic shaping</li> <li>■ Support for F4 OAM cells</li> <li>■ Support for 16-bit VCI range</li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (Rx and Tx)</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Cell Delineation (LoC), Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>

**Table 4: Optical Interface Support for ATM2 IQ OC12 PICs**

<b>PIC Type</b>	<b>Single-mode Intermediate Reach</b>	<b>Multimode</b>
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC/PC duplex connector (maximum distance 9.3 miles/15 km)	Multimode with SC/PC duplex connector (maximum distance 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

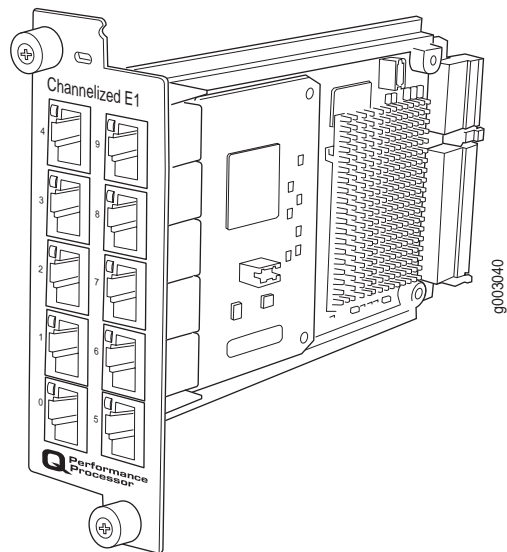
Channelized DS3 IQ PIC



Software release	■ JUNOS 5.6 and later
Description	<div>■ Four DS3 ports</div> <div>■ Power requirement: 0.32 A/48 V @ 15.6 W</div> <div>■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</div> <div>■ Channelization: DS3, DS0</div> <div>NOTE: On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</div>
Hardware features	<div>■ Data Service Unit (DSU) functionality</div> <div>■ Subrate and scrambling:<div>■ Digital Link/Quick Eagle</div><div>■ Kentrox</div><div>■ Larscom</div><div>■ Adtran</div><div>■ Verilink</div></div> <div>■ B3ZS line encoding</div> <div>■ M13 or C-bit parity</div> <div>■ Full Bit Error Rate Testing (BERT)</div> <div>■ Local and remote loopback testing</div>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Quality of Service (QoS) per channel: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>■ Simple Network Management Protocol (SNMP): DS1 MIB, DS3 MIB</li> <li>■ Dynamic, arbitrary channel configuration</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Standard DS3 BNC coaxial cable interfaces</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS)</li> <li>■ Excessive zeros (EXZ)</li> <li>■ Far-end Block Error (FEBE)</li> <li>■ Frame error</li> <li>■ Idle code, Idle received</li> <li>■ Line code violation (LCV)</li> <li>■ Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Parity bit (P-bit) disagreements</li> <li>■ Path parity error</li> <li>■ Yellow alarm bit (X-bits) disagreements</li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Layer 2 per-queue and per-channel packet and byte counters</li> </ul>

Channelized E1 IQ PIC

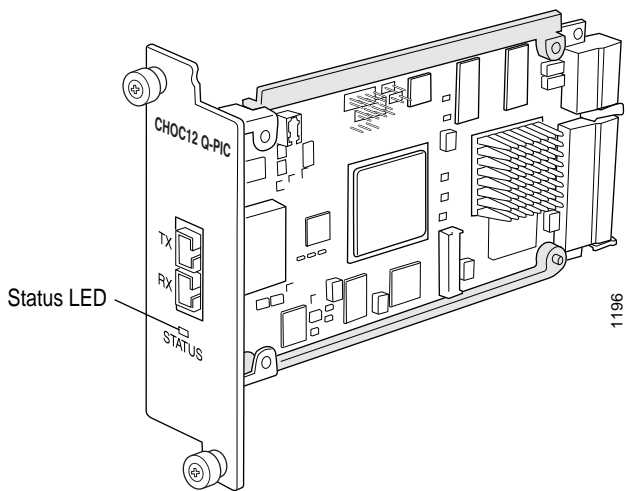


Software release	■ JUNOS 5.6 and later
Description	<div><div>■ Ten E1 ports</div><div>■ Power requirement: 0.15 A/48 V @ 7.2 W</div><div>■ Intelligent queuing (IQ) PICs support fine-grained queuing per-logical interface.</div><div>■ Channelization: E1, DS0</div></div> <div><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</div>
Hardware features	<div><div>■ Data Service Unit (DSU) functionality</div><div>■ Ports configurable as clear channel E1 interfaces with 2.048-Mbps connectivity</div><div>■ Supports unframed E1 G.703 and G.704 framing modes</div><div>■ Supports HDB3 line coding</div><div>■ CRC4 configurable</div><div>■ Local and remote loopback testing</div></div>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Quality of Service (QoS) per channel: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>■ Simple Network Management Protocol (SNMP): E1 MIB, DS0 MIB</li> <li>■ Dynamic, arbitrary channel configuration</li> <li>■ Full Bit Error Rate Testing (BERT)</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ 120 ohm RJ-48C</li> </ul>
<b>LEDs</b>	<p>One bicolor per E1 port:</p> <ul style="list-style-type: none"> <li>■ Off—Port not enabled</li> <li>■ Green—Physical E1 link is up; individual subchannels can be down</li> <li>■ Red—Physical E1 link is down</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS)</li> <li>■ Loss of Frame (LoF)</li> <li>■ Out of Frame (OoF)</li> <li>■ Failed Signal Rate (FSR)</li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Layer 2 per-queue and per-channel packet and byte counters</li> </ul>



Channelized OC12 PIC



Software release	<ul style="list-style-type: none"><li>JUNOS 4.1 and later</li></ul>
Description	<ul style="list-style-type: none"><li>One OC12 port</li><li>Power requirement: 0.23 A/48 V @ 10.8 W</li><li>12 DS3 channels</li><li>Supports IP version 4 (IPv4) unicast and multicast as well as MPLS, Intermediate System-to-Intermediate System (IS-IS), Open Shortest Path First (OSPF), and Border Gateway Protocol (BGP)</li><li>Optical interface support—see Table 5</li></ul>
Hardware features	<ul style="list-style-type: none"><li>ASIC-based, high-performance throughput on all ports</li><li>Integrated DSU functionality with subrate and scrambling support for each DS3 channel</li><li>Class-of-service support for each DS3 channel</li><li>Dual-router SONET automatic protection switching (APS)</li><li>Rate policing on input for each DS3 channel</li><li>Rate shaping output for each DS3 channel</li><li>Packet buffering, Layer 2 parsing</li></ul>

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<b>Software features</b>	<ul style="list-style-type: none"><li>■ M13/C-bit parity encoding</li><li>■ Full instrumentation per DS3 channel</li><li>■ DS3 diagnostics and loopback control</li><li>■ DS3 alarm and event counting and detection</li><li>■ DS3 Far-end Alarm and Control (FEAC) channel support</li><li>■ Encapsulations:<ul style="list-style-type: none"><li>■ High-level Data Link Control (HDLC)</li><li>■ Frame Relay</li><li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li><li>■ Point-to-Point Protocol (PPP)</li></ul></li></ul>
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<b>Cables and connectors</b>	<ul style="list-style-type: none"><li>■ Duplex SC/PC connector (RX and TX); single-mode fiber</li></ul>
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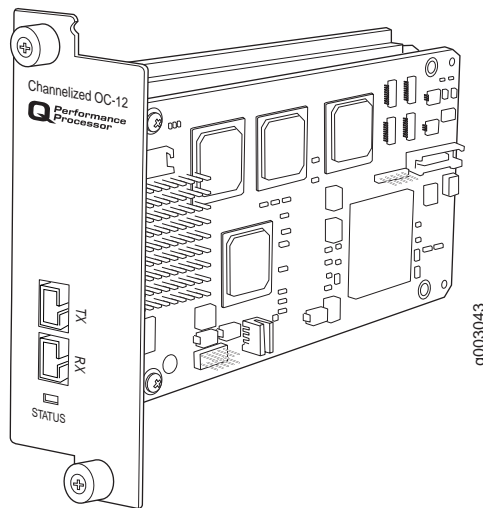
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<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ BERT functionality (you can configure one DS3 channel in BERT mode and configure the remaining channels to transmit and receive normal traffic)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ Equipment failure (Does not affect service)</li> <li>■ 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)</li> <li>■ Frame error</li> <li>■ Idle code, Idle received</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Parity bit (P-bit) disagreements</li> <li>■ Path parity error</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> <li>■ Yellow alarm bit (X-bit) disagreements</li> </ul>

**Table 5: Optical Interface Support for Channelized OC12 PICs**

<b>PIC Type</b>	<b>Single-Mode Intermediate Reach</b>
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC/PC duplex connector (maximum distance 9.3 miles/15 km)
Wavelength	1274 through 1356 nm
Average launch power	–15 through –8 dBm
Receiver saturation	–8 dBm
Receiver sensitivity	–28 dBm

## Channelized OC12 IQ PIC



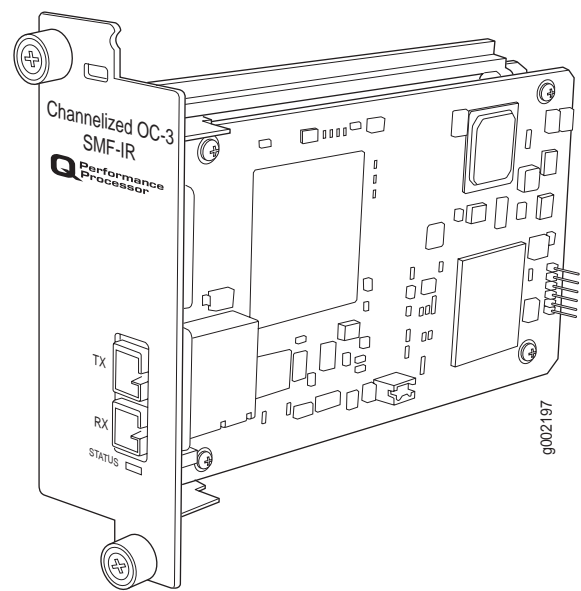
<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 5.6 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ One OC12 port</li> <li>■ Power requirement: 0.23 A/48 V @ 10.8 W</li> <li>■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li> <li>■ Channelization: OC3, DS3, DS1, DS0</li> <li>■ Optical interface support — see Table 6</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ Subrate and scrambling: <ul style="list-style-type: none"> <li>■ Digital Link/Quick Eagle</li> <li>■ Kentrox</li> <li>■ Larscom</li> <li>■ Adtran</li> <li>■ Verilink</li> </ul> </li> <li>■ Packet buffering, Layer 2 parsing</li> <li>■ M13/C-bit parity encoding</li> <li>■ DS3 Far-end Alarm and Control (FEAC) channel support</li> <li>■ Local and remote loopback testing</li> </ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Quality of Service (QoS) per channel: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>■ Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB</li> <li>■ Dynamic, arbitrary channel configuration</li> <li>■ Full Bit Error Rate Testing (BERT)</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (Rx and Tx); single-mode fiber</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Frame error</li> <li>■ Idle code, Idle received</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Parity bit (P-bit) disagreements</li> <li>■ Path parity error</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> <li>■ Yellow alarm bit (X-bit) disagreements</li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Layer 2 per-queue and per-channel packet and byte counters</li> </ul>

**Table 6: Optical Interface Support for Channelized OC12 IQ PICs**

<b>PIC Type</b>	<b>Single-Mode Intermediate Reach</b>
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC/PC duplex connector (maximum distance 9.3 miles/15 km)
Wavelength	1274 through 1356 nm
Average launch power	-15 through -8 dBm
Receiver saturation	-8 dBm
Receiver sensitivity	-28 dBm

Channelized OC3 IQ PIC



Software release	<ul style="list-style-type: none"><li>JUNOS 7.1 and later</li></ul>
Description	<ul style="list-style-type: none"><li>One OC3 port</li><li>Power requirement: 0.39 A/48 V @ 18.6 W</li><li>Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li><li>Channelization: DS3, DS1, DS0</li><li>Optical interface support — see Table 7</li></ul>
Hardware features	<ul style="list-style-type: none"><li>Subrate and scrambling:<ul style="list-style-type: none"><li>Digital Link/Quick Eagle</li><li>Kentrox</li><li>Larscom</li><li>Adtran</li><li>Verilink</li></ul></li><li>Packet buffering, Layer 2 parsing</li><li>M13/C-bit parity encoding</li><li>DS3 Far-end Alarm and Control (FEAC) channel support</li><li>Local and remote loopback testing</li></ul>

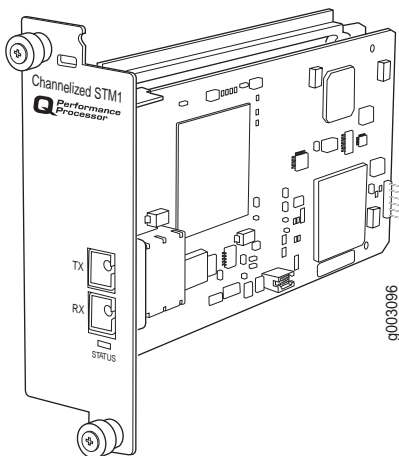
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Quality of Service (QoS) per channel: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>■ Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB</li> <li>■ Dynamic, arbitrary channel configuration</li> <li>■ Full Bit Error Rate Testing (BERT)</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (Rx and Tx); single-mode fiber intermediate-reach fiber</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Frame error</li> <li>■ Idle code, Idle received</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Parity bit (P-bit) disagreements</li> <li>■ Path parity error</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> <li>■ Yellow alarm bit (X-bit) disagreements</li> </ul>



**Table 7: Optical Interface Support for Channelized OC3 IQ PICs**

<b>PIC Type</b>	<b>Single-Mode Intermediate Reach</b>
Optical interface	Single-mode, intermediate reach (Bellcore GR-253 compliant) with SC/PC duplex connector (maximum distance 9.3 miles/15 km)
Wavelength	1274 through 1356 nm
Average launch power	-15 through -8 dBm
Receiver saturation	-8 dBm
Receiver sensitivity	-28 dBm

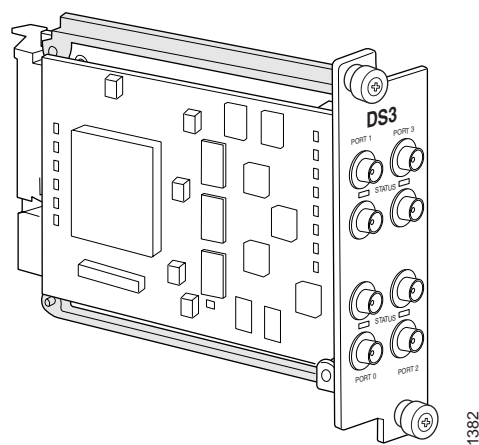
## Channelized STM1 IQ PIC



<b>Software release</b>	<ul style="list-style-type: none"> <li>JUNOS 5.7 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>One STM1 port</li> <li>Power requirement: 0.39 A/48 V @ 18.6 W</li> <li>Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li> <li>Channelization: STM1c, fractional E1, framed and unframed DS0</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>Packet buffering, Layer 2 parsing</li> <li>Local and remote loopback testing</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>Quality of Service (QoS) per channel: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>Simple Network Management Protocol (SNMP): SONET/SDH MIB, T1/E1 MIB</li> <li>Dynamic, arbitrary channel configuration</li> <li>Full Bit Error Rate Testing (BERT) patterns at E1 and DS0 levels</li> <li>Encapsulations: <ul style="list-style-type: none"> <li>High-level Data Link Control (HDLC)</li> <li>Frame Relay</li> <li>Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>MPLS translational cross-connect (TCC)</li> <li>Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>Duplex SC/PC connector (Rx and Tx); single-mode intermediate-reach fiber</li> </ul>

<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Layer 2 per-queue and per-channel packet and byte counters</li> </ul>

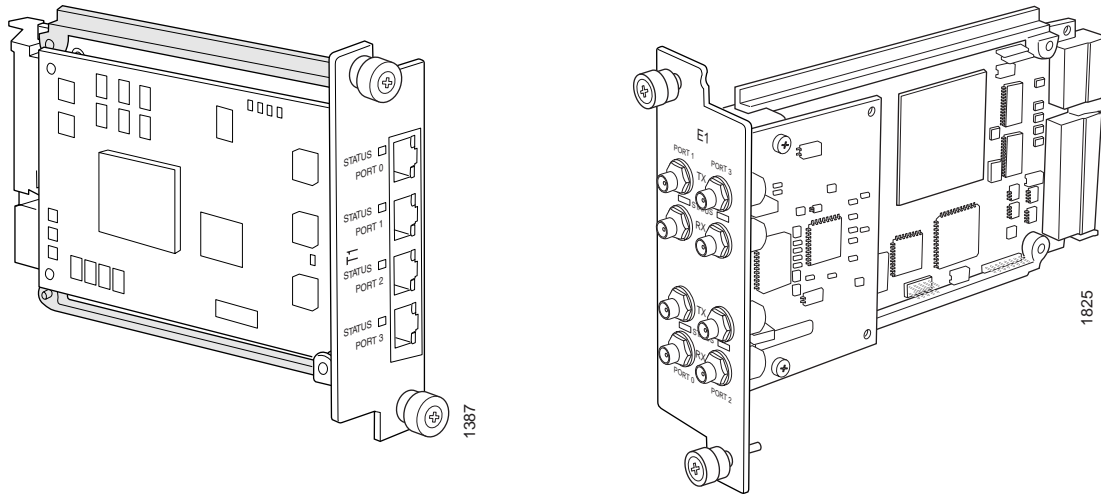
DS3 PIC



Software release	<ul style="list-style-type: none"><li>JUNOS 4.1 and later</li></ul>
Description	<ul style="list-style-type: none"><li>Four DS3 ports</li><li>Power requirement: 0.47 A/48 V @ 22.5 W</li><li>Integrated DSU interoperability with leading DSU vendors</li></ul>
Hardware features	<ul style="list-style-type: none"><li>High-performance throughput on all ports at speeds up to 44.736 Mbps, full duplex</li><li>C-bit framing</li><li>B3ZS line encoding</li><li>Subrate and scrambling:<ul style="list-style-type: none"><li>Digital Link</li><li>Kentrox</li><li>Larscom</li></ul></li><li>Per-port rate policing on input</li><li>Per-port rate shaping on output</li><li>Packet buffering, Layer 2 parsing</li></ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ DS3 functionality: <ul style="list-style-type: none"> <li>■ C-bit framing</li> <li>■ B3ZS line encoding</li> </ul> </li> <li>■ DS3 diagnostics and loopback control</li> <li>■ DS3 alarm and event counting and detection</li> <li>■ Per-packet counts and byte counts</li> <li>■ Local and remote loopback testing, as well as BERT testing per DS3</li> <li>■ DS3 Far-end Alarm and Control (FEAC) channel support</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Custom 10-ft (3.05-m) posilock SMB to BNC male cable, separate Rx and Tx (provided)</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS)</li> <li>■ 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)</li> <li>■ Equipment failure (Does not affect service)</li> <li>■ Far-end Block Error (FEBE)</li> <li>■ Frame error</li> <li>■ Idle code, Idle received</li> <li>■ Local and remote loopback</li> <li>■ Loss of Signal (LoS)</li> <li>■ Out of Frame (OoF)</li> <li>■ Parity bit (P-bit) disagreements</li> <li>■ Path parity error</li> <li>■ Yellow alarm bit (X-bit) disagreements</li> </ul>

## E1 PIC



**Left: E1 RJ-48; Right: E1 coaxial**

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### Software release

- JUNOS 4.1 and later

<b>Description</b>	<ul style="list-style-type: none"> <li>■ Four E1 ports</li> <li>■ Power requirement: 0.08 A/48 V @ 3.74 W</li> <li>■ Two versions: <ul style="list-style-type: none"> <li>■ 4-port, 120-ohm, RJ-48</li> <li>■ 4-port, 75-ohm, coaxial</li> </ul> </li> <li>■ Onboard DSU functionality for E1 connectivity</li> </ul>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ High-performance throughput on all ports at speeds up to 2.048 Mbps, full duplex</li> <li>■ Maximum transmission units (MTUs) of up to 4500 bytes</li> <li>■ Per-interface diagnostics and loopback control</li> <li>■ Per-interface shaping on output</li> <li>■ Per-interface alarm and event counting and detection</li> <li>■ HDB3 line coding</li> <li>■ 4-bit CRC for G.704 framed mode</li> <li>■ Per-port loop timing</li> <li>■ Balanced and unbalanced modes</li> <li>■ Packet buffering, Layer 2 parsing</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Integrated support for G.703 unframed mode and G.704 framed mode with CRC; this feature is user-configurable</li> </ul> <p data-bbox="492 1094 1333 1142"><b>NOTE:</b> The G.704 implementation supports speeds slower than 2.048 Mbps; multiple channels within a single E1 are not supported.</p> <ul style="list-style-type: none"> <li>■ Configurable clock source: Internal or loop</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<p data-bbox="492 1409 623 1434">Two versions:</p> <ul style="list-style-type: none"> <li>■ Four RJ-48 connectors (one per port)</li> <li>■ Custom 10-ft (3.05-m) posilock to BNC male cable, separate Rx and Tx</li> </ul>

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<b>LEDs</b>	<p data-bbox="492 268 703 289">One tricolor per port:</p> <ul style="list-style-type: none"><li data-bbox="511 317 740 338">■ Off—Not enabled</li><li data-bbox="511 365 971 386">■ Green—Online with no alarms or failures</li><li data-bbox="511 413 1029 434">■ Amber—Online with alarms for remote failures</li><li data-bbox="511 462 1154 489">■ Red—Active with a local alarm; router has detected a failure</li></ul>
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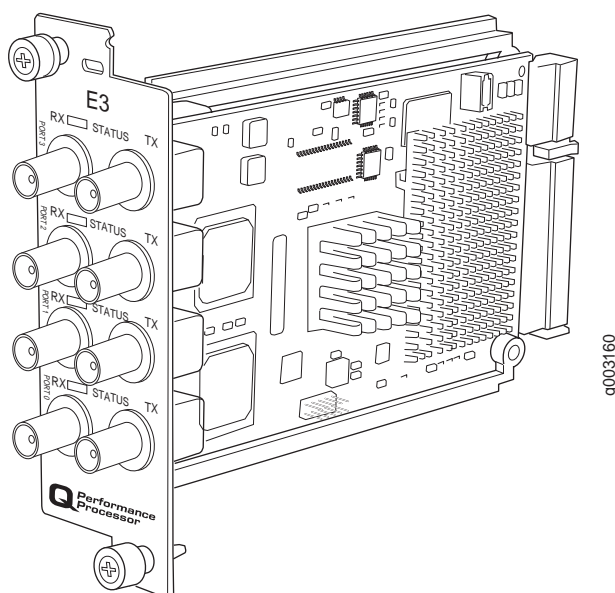
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<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"><li data-bbox="511 506 849 527">■ Alarm Indication Signal (AIS)</li><li data-bbox="511 554 740 575">■ Bipolar Violations</li><li data-bbox="511 602 721 623">■ Excessive Zeros</li><li data-bbox="511 651 963 672">■ Far-end Block Errors (FEBE, E-bit errors)</li><li data-bbox="511 699 963 720">■ Loss of Frame (LoF), Loss of Signal (LoS)</li><li data-bbox="511 747 948 768">■ Local and remote loopback diagnostics</li><li data-bbox="511 795 943 827">■ Yellow alarm bit (X-bit) disagreements</li></ul>
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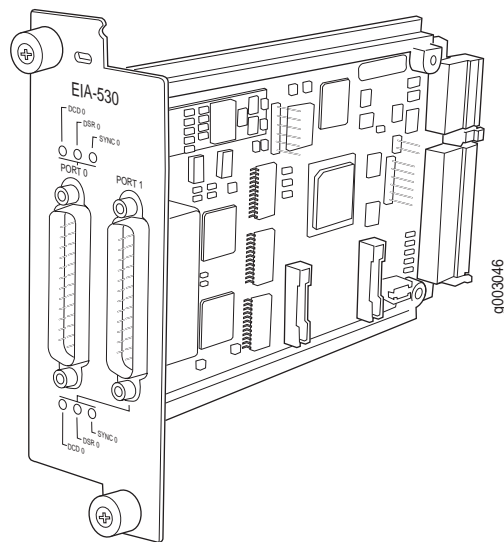
## E3 IQ PIC



<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 6.1 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ Four E3 ports</li> <li>■ Power requirement: 0.38 A/48 V @ 18 W</li> <li>■ Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ Clear-channel (34.368-Mbps) and subrate E3</li> <li>■ Unframed or ITU G.751 framing</li> <li>■ Data Service Unit (DSU) functionality</li> <li>■ Subrate and scrambling:             <ul style="list-style-type: none"> <li>■ Digital Link/Quick Eagle</li> <li>■ Kentrox</li> </ul> </li> <li>■ HDB3 line encoding</li> <li>■ Full Bit Error Rate Testing (BERT)</li> <li>■ Local and remote loopback testing</li> </ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Quality of Service (QoS) per port: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>■ Simple Network Management Protocol (SNMP): E3 MIB, QoS MIB</li> <li>■ Input policing and output shaping</li> <li>■ Provider-side rate limiting</li> <li>■ Full data link connection identifier (DLCI) range with sparse channel numbering</li> <li>■ Per-DLCI queues with weighted deficit round robin and strict priority</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ MPLS translational cross-connect (TCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<p><b>NOTE:</b> Extended support for graceful Routing Engine switchover (GRES) has been added for this PIC. To configure GRES, you must be running JUNOS release 7.3 or later.</p>	
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Standard E3 BNC coaxial cable interfaces</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS)</li> <li>■ Equipment failure (does not affect service)</li> <li>■ Frame error</li> <li>■ Line code violation</li> <li>■ Loss of Signal (LOS)</li> <li>■ Out of Frame (OOF)</li> <li>■ Yellow alarm bit (A-bit) disagreements</li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Layer 2 per-queue packet and byte counters</li> </ul>

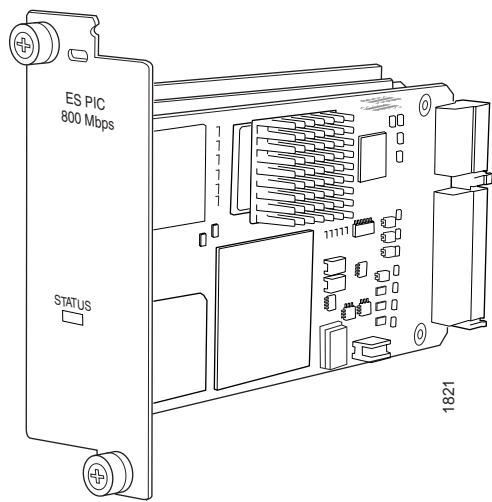
## EIA-530 PIC



<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 5.6 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ Two EIA-530, X.21 or V.35 serial ports</li> <li>■ Power requirement: 0.07 A/48 V @ 3.4 W</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ Configured as Data Terminal Equipment (DTE) ports</li> <li>■ Resynchronization signal</li> <li>■ Receives clock rates up to 16 Mbps</li> <li>■ Local, Data Communications Equipment (DCE) local, and DTE remote loopbacks</li> </ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Supports four queues per port</li> <li>■ Random Early Drop (RED)</li> <li>■ Transmitter Signal Element Timing is looped from the timing received on the Transmitted Signal Element DCE. EIA-530 ports support the ability to invert the Transmit Data Element. The EIA-530 ports support the following rates: <ul style="list-style-type: none"> <li>■ 2.048 Mbps</li> <li>■ 2.341 Mbps</li> <li>■ 2.731 Mbps</li> <li>■ 3.277 Mbps</li> <li>■ 4.09 Mbps</li> <li>■ 5.461 Mbps</li> <li>■ 8.192 Mbps</li> <li>■ 16.384 Mbps</li> </ul> </li> <li>■ V.35 ports support up to 2.048 Mbps</li> <li>■ X.21 ports support up to 10 Mbps</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Two DB-25 male connectors (one per port, included with PIC)</li> <li>■ V.35 requires an EIA-530 to V.35 cable and connects to a V.35 DTE 34-pin Winchester type male cable (one per port)</li> <li>■ X.21 requires an EIA-530 to X.21 cable and connects to a X.21 DTE DB-15 male cable</li> </ul>
<b>LEDs</b>	<p>Three bicolor per port:</p> <ul style="list-style-type: none"> <li>■ Data Set Ready (DSR): <ul style="list-style-type: none"> <li>■ Green—DSR is detected or ignored</li> <li>■ Red—DSR expected but not present</li> </ul> </li> <li>■ Data Carrier Detect (DCD): <ul style="list-style-type: none"> <li>■ Green—DCD is detected or ignored</li> <li>■ Red—DCD expected but not present</li> </ul> </li> <li>■ Resynchronization <ul style="list-style-type: none"> <li>■ Green—Keepalives are being received</li> <li>■ Red—Data Terminal Ready (DTR) toggled from low to high (resynchronization pulses are being sent)</li> </ul> </li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Per-port packet and byte counters</li> <li>■ Resynchronization counters: <ul style="list-style-type: none"> <li>■ Number of resynchronizations initiated</li> <li>■ Time of last resynchronization</li> </ul> </li> </ul>

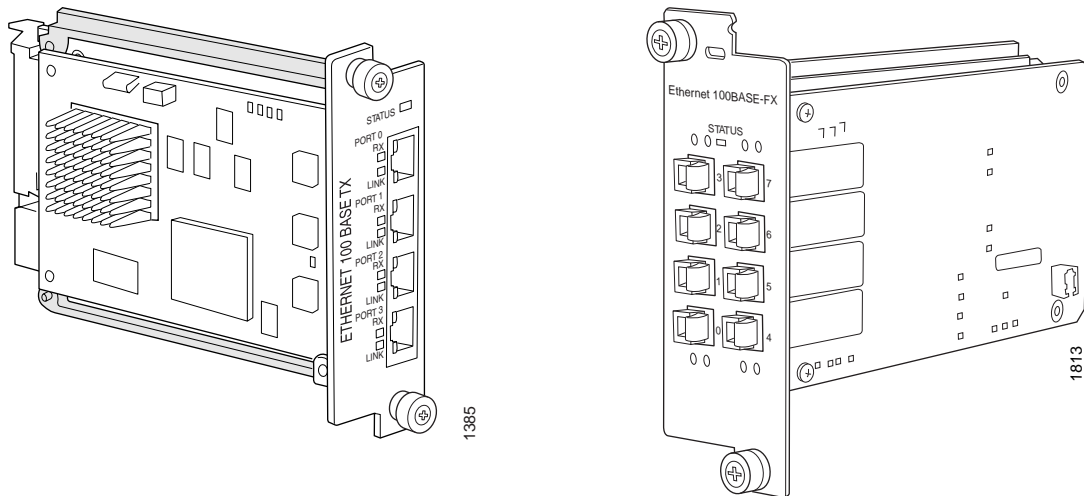
ES PIC



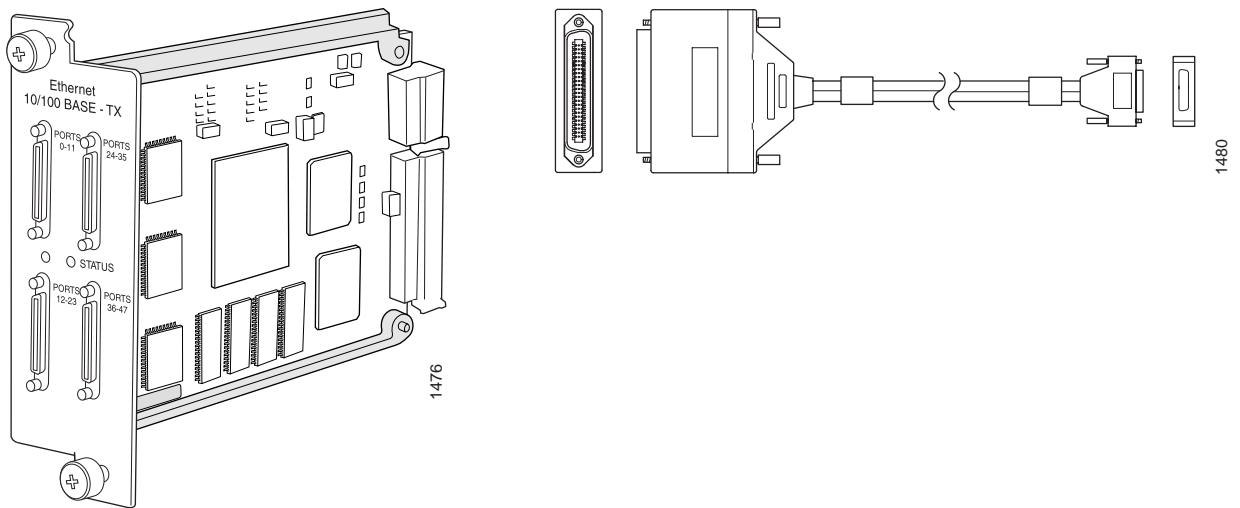
Software release	■ JUNOS 5.3 and later
Description	<div><div>■ High-bandwidth encryption (in accordance with IPSec standards)</div><div>■ Power requirement: 0.21 A/48 V @ 10 W</div><div>■ Support for IPSec encryption, decryption, and key calculation acceleration</div></div> <div><b>NOTE:</b> The ES PIC does not support reassembly and decryption of encrypted packets that were fragmented in an IPSec tunnel.</div>
Hardware features	<div><div>■ Extends the existing security functionality to Internet traffic at high-performance rates</div><div>■ Throughput at 800 Mbps, half duplex</div><div>■ 1000 IPSec tunnels or 2000 IPSec security association (SA) pairs</div><div>■ Supports MTUs of up to 3900 bytes</div></div>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Support for IPv4</li> <li>■ Authentication hash algorithms: MD-5 and SHA-1</li> <li>■ Encryption algorithms: DES, 3-DES, and Null</li> <li>■ Automated key management using Diffie-Hellman key establishment</li> <li>■ Support for pre-shared key management</li> <li>■ Authentication Header and Encapsulating Security Payload (ESP) independently or in bundle mode</li> <li>■ Tunnel mode IPSec encryption and decryption for data traffic</li> <li>■ Transport mode IPSec encryption and decryption for control traffic</li> <li>■ Static and dynamic security associations (SA) supported</li> <li>■ SA lifetime configurable in seconds and kilobytes</li> </ul>
<b>LEDs</b>	<p>One tricolor:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Instrumentation (counters)</b>	<ul style="list-style-type: none"> <li>■ Input and output bytes per tunnel</li> <li>■ Total authentication failures</li> <li>■ Total anti-reply failures</li> <li>■ Total encryption ASIC errors per PIC</li> </ul>

## Fast Ethernet PICs



**Left: 4-Port Fast Ethernet; Right: 8-Port Fast Ethernet**



**Left: 48-Port Fast Ethernet; Right: VHDCI to RJ-21 Cable**

### Software release

- 4-port: JUNOS 4.1 and later
- 8-port: JUNOS 5.2 and later
- 48-port: JUNOS 4.4 and later

<b>Description</b>	<ul style="list-style-type: none"> <li>■ 4 or 48 100Base-T ports; 8 100Base-FX ports</li> <li>■ Power requirements: <ul style="list-style-type: none"> <li>■ 4-port: 0.14 A/48 V @ 6.8 W</li> <li>■ 8-port: 0.26 A/48 V @ 12.5 W</li> <li>■ 48-port: 0.69 A/48 V @ 33.3 W</li> </ul> </li> </ul>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ High-performance throughput on all ports at speeds up to 100 Mbps</li> <li>■ Source and destination Media Access Control (MAC) address filtering</li> <li>■ RMON EtherStats packet buffering</li> <li>■ 802.3 Ethernet standard compliant</li> <li>■ 4-port PICs support MTUs up to 4,500 bytes; 8-port and 48-port PICs support MTUs up to 1,532 bytes</li> <li>■ 4-port PICs support 1,024 802.1Q VLANs per port; 8-port and 48-port PICs support 16 802.1Q VLANs per port</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Auto sensing full-duplex and half-duplex modes</li> <li>■ Virtual Router Redundancy Protocol (VRRP)</li> <li>■ 802.1Q Virtual LANs (VLANs)</li> <li>■ Circuit cross-connect (CCC) VLAN</li> </ul>



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**Cables and connectors**

4-port PICs:

- Connector: Two-pair, category 5 unshielded twisted pair connectivity through an RJ-45 connector
- Pinout: MDI noncrossover

8-port PICs:

- FX optical interface
  - Connector: MT-RJ female
  - Length: 1.24-mile / 2-km reach on 62.5/125 micrometer MMF
  - Wavelength: 1,270 to 1,380 nm
  - Average Launch Power: -20 to -14 dBm
  - Receiver Saturation: -14 dBm
  - Receiver Sensitivity: -34 dBm

48-port PIC:

- VHDCI to RJ-21 cable that connects to an RJ-45 patch panel
- Four VHDCI connectors that each service 12 10/100 ports

**NOTE:** Each of the four connectors on a Fast Ethernet 48-port PIC can support a maximum of approximately 800 Mbps. However, this constitutes oversubscription. Use this PIC only in environments that can support this level of oversubscription.

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**LEDs**

Status LEDs, one bicolor:

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

4-port and 8-port PICs have port LEDs, one pair per port:

- Link—If green, the port is online; no light means the port is down

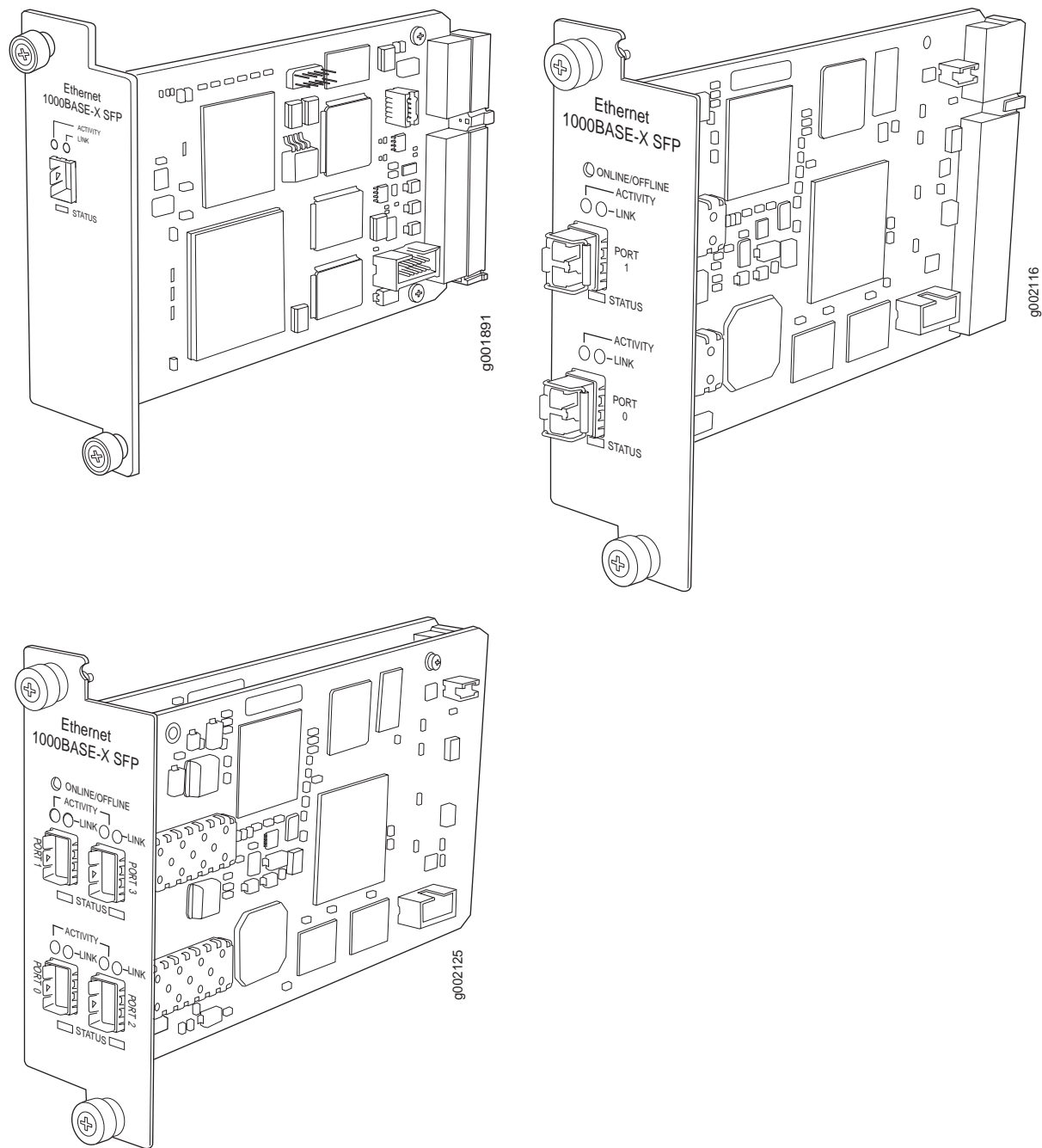
**NOTE:** The Link LED remains lit on the 8-port PIC when the port is down.

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

The 48-port PIC does not have port LEDs. To check port status on a 48-port PIC use the **show interfaces fe-fpc / pic / port**. For more information about this command, see the *JUNOS Operational Mode Command Reference: Interfaces*

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Gigabit Ethernet PIC with SFP



Gigabit Ethernet PICs with SFP: 1-Port, 2-Port, and 4-Port

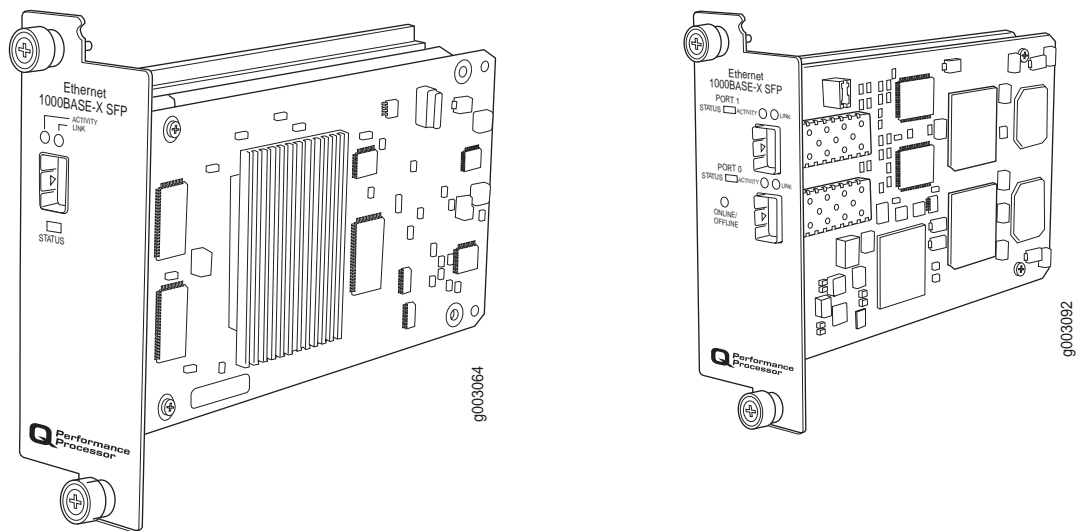
<b>Software release</b>	<ul style="list-style-type: none"> <li>■ 1-port: JUNOS 6.3 and later</li> <li>■ 2-port: JUNOS 6.4 and later</li> <li>■ 4-port: JUNOS 7.0 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ One, two, four, or ten Gigabit Ethernet ports</li> <li>■ Power requirements: <ul style="list-style-type: none"> <li>■ 1-port: 0.15 A/48 V @ 7.3 W</li> <li>■ 2-port: 0.25 A/48 V @ 11.9 W</li> <li>■ 4-port: 0.50 A/48 V @ 23.8 W</li> <li>■ 10-port: 0.62 A/48 V @ 29.9 W</li> </ul> </li> <li>■ Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network</li> <li>■ Optical interface support—see Table 8</li> </ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ High-performance throughput on all ports at speeds up to 1 Gbps</li> <li>■ Autonegotiation between Gigabit Ethernet circuit partners</li> <li>■ Full-duplex mode</li> <li>■ Maximum transmission units (MTUs) of up to 9192 bytes</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Virtual Router Redundancy Protocol (VRRP) support</li> <li>■ 802.1Q virtual LANs (VLANs) support</li> <li>■ 64 source MAC filters per VLAN and 1024 source MAC filters per port</li> <li>■ 960 destination MAC filters per port</li> <li>■ MAC accounting and policing—Dynamic local address learning of source MAC addresses</li> </ul> <p><b>NOTE:</b> MAC accounting and policing is not supported in 10-port Gigabit Ethernet with SFP.</p>

<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ You can use 1000Base-T, 1000Base-SX, 1000Base-LX, and 1000Base-LH SFPs. PICs with multiple ports can use any combination of SFPs.</li> <li>■ SX, LX, and LH SFPs: <ul style="list-style-type: none"> <li>■ Duplex LC/PC connector (Rx and Tx)</li> </ul> </li> <li>■ 1000Base-T SFPs: <ul style="list-style-type: none"> <li>■ Connector: Four-pair, category 5 shielded twisted-pair connectivity through an RJ-45 connector</li> <li>■ Pinout: MDI crossover</li> <li>■ Length: 328-ft/100-m</li> </ul> </li> </ul> <p><b>NOTE:</b> Do not install SONET/SDH OC48c/STM16 SFPs in the Gigabit Ethernet port. The port will not recognize the SFP.</p> <ul style="list-style-type: none"> <li>■ 10-port PIC:</li> <li>■ Duplex LC/PC connector (TX and RX)</li> </ul> <p><b>NOTE:</b> This PIC uses small form-factor pluggables (SFPs) that allow different optical interfaces to be used on the PIC. You can use SX, LX, and LH SFPs. For information about installing and removing SFPs, see the <i>M160 Internet Router Hardware Guide</i>.</p>
<b>LEDs</b>	<p>Status LEDs, one bicolor:</p> <ul style="list-style-type: none"> <li>■ Off—PIC is not enabled</li> <li>■ Green—PIC is operating normally</li> <li>■ Red—PIC has an error or failure</li> </ul> <p>Port LEDs, one pair per port:</p> <ul style="list-style-type: none"> <li>■ Link—If green, the port is online; if there is no light, the port is down</li> <li>■ Activity—If flashing green, the port is receiving data; if there is no light, the port might be on, but is not receiving data</li> </ul>

**Table 8: Optical Interface Support for Gigabit Ethernet PICs with SFP**

<b>PIC Type</b>	<b>SX Transceiver</b>	<b>LX Transceiver</b>	<b>LH Transceiver</b>
Optical interface	656-ft/200-m reach on 62.5/125 micrometer multimode fiber (MMF)  1640-ft/500-m reach on 50/125 micrometer MMF	6.2-mile/10-km reach on 9/125 micrometer single-mode fiber (SMF)  1804.5-ft/550-m reach on 62.5/125 and 50/125 micrometer MMF	49.5-mile/70-km reach on 9/125 micrometer SMF
Wavelength	830 through 860 nm	1275 through 1350 nm	1480 through 1580 nm
Average launch power	-9.5 through -4 dBm	-9.5 through -3 dBm	-3 through +3 dBm
Receiver saturation	0 dBm	-3 dBm	-3 dBm
Receiver sensitivity	-18 dBm	-20.5 dBm	-23 dBm

# Gigabit Ethernet IQ PICs



Left: 1-Port Gigabit Ethernet IQ; Right: 2-Port Gigabit Ethernet IQ

<b>Software release</b>	<ul style="list-style-type: none"><li>1-port: JUNOS 6.0 and later</li><li>2-port: JUNOS 6.1 and later</li></ul>
<b>Description</b>	<ul style="list-style-type: none"><li>One or two Gigabit Ethernet ports</li><li>Power requirements: 0.46 A/48 V @ 22 W</li><li>Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface.</li><li>Optical interface support—see Table 9</li></ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
<b>Hardware features</b>	<ul style="list-style-type: none"><li>High-performance throughput on all ports at speeds up to 1 Gbps</li><li>Full-duplex mode</li><li>Large MTUs of up to 9192 bytes</li></ul>

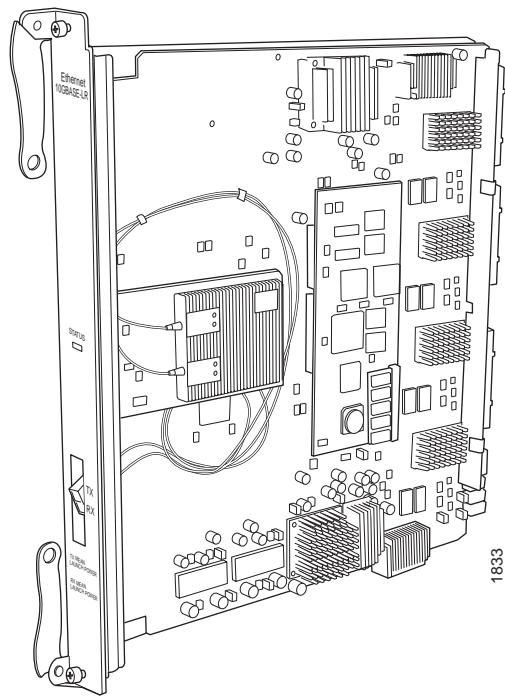
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Quality of Service (QoS) per channel: Weighted Round Robin (WRR), Random Early Drop (RED), Weighted Random Early Drop (WRED)</li> <li>■ Virtual Router Redundancy Protocol (VRRP) support</li> <li>■ 802.1Q Virtual LANs (VLANs)</li> <li>■ VLAN stacking and rewriting</li> <li>■ MAC policing, accounts, and filters</li> </ul>
<b>Cables and connectors</b>	<p><b>NOTE:</b> Extended support for graceful Routing Engine switchover (GRES) has been added for this PIC. To configure GRES, you must be running JUNOS release 7.3 or later.</p> <ul style="list-style-type: none"> <li>■ You can use 1000Base-T, 1000Base-SX, 1000Base-LX, and 1000Base-LH SFPs to install different optical interfaces on the PIC. PICs with multiple ports can use any combination of SFPs.</li> <li>■ SX, LX, and LH small form-factor pluggable transceivers (SFPs): <ul style="list-style-type: none"> <li>■ Duplex LC/PC connector (Rx and Tx)</li> </ul> </li> <li>■ 1000Base-T SFPs: <ul style="list-style-type: none"> <li>■ Connector: Four-pair, category 5 shielded twisted-pair connectivity through an RJ-45 connector</li> <li>■ Pinout: MDI crossover</li> <li>■ Length: 328-ft/100-m</li> </ul> </li> </ul> <p><b>NOTE:</b> Do not install SONET/SDH OC48c/STM16 SFPs in the Gigabit Ethernet port. The port will not recognize the SFP.</p> <ul style="list-style-type: none"> <li>■ Duplex LC/PC connector (Rx and Tx)</li> </ul> <p><b>NOTE:</b> PICs with multiple ports can use any combination of SFPs. For information about installing and removing SFPs, see the <i>M160 Internet Router Hardware Guide</i>.</p>
<b>LEDs</b>	<p>Status LEDs, one tricolor:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul> <p><b>NOTE:</b> The green status LED is lit on the 2-port Gigabit Ethernet IQ PIC when at least one port is online.</p> <p>Port LEDs, one per port:</p> <ul style="list-style-type: none"> <li>■ Off—Port is down</li> <li>■ Green—Link is established</li> </ul>

**Table 9: Optical Interface Support for Gigabit Ethernet IQ PICs**

<b>PIC Type</b>	<b>SX Transceiver</b>	<b>LX Transceiver</b>	<b>LH Transceiver</b>
Optical interface	656-ft/200-m reach on 62.5/125 micrometer multimode fiber (MMF)  1640-ft/500-m reach on 50/125 micrometer MMF	6.2-mile/10-km reach on 9/125 micrometer single-mode fiber (SMF)  1804.5-ft/550-m reach on 62.5/125 and 50/125 micrometer MMF	49.5-mile/70-km reach on 9/125 micrometer SMF
Wavelength	830 through 860 nm	1275 through 1350	1480 through 1580 nm
Average launch power	−9.5 through −4 dBm	−9.5 through −3 dBm	−3 through +3 dBm
Receiver saturation	0 dBm	−3 dBm	−3 dBm
Receiver sensitivity	−18 dBm	−20.5 dBm	−23 dBm



## 10-Gigabit Ethernet PIC



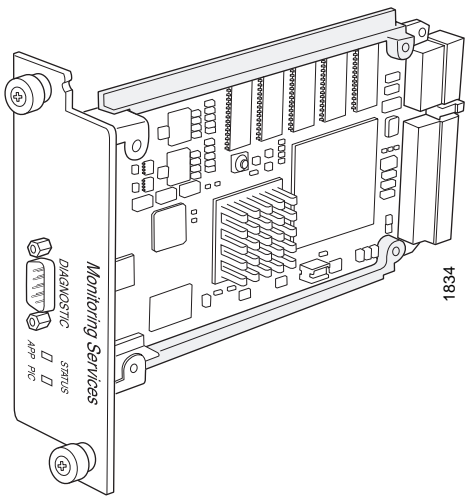
<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 5.3 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ One 10-Gigabit Ethernet port</li> <li>■ Power requirement: 0.74 A/48 V @ 35.5 W</li> <li>■ Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network</li> <li>■ Optical interface support—see Table 10</li> </ul>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ High-performance throughput at speeds up to 10 Gbps</li> <li>■ Full-duplex mode</li> <li>■ Maximum transmission units (MTUs) up to 9192 bytes</li> <li>■ 64 source MAC address filters</li> <li>■ 960 destination MAC filters</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Virtual Router Redundancy Protocol (VRRP) support</li> <li>■ 802.1Q Virtual LANs (VLANs) support</li> <li>■ 802.3ae link aggregation support</li> <li>■ RMON EtherStats</li> </ul>

<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (RX and TX)</li> </ul>
<b>LEDs</b>	<p>Status LEDs, one bicolor:</p> <ul style="list-style-type: none"> <li>■ Off—PIC not enabled</li> <li>■ Green—PIC is operating normally</li> <li>■ Red—PIC has an error or failure</li> </ul> <p>Port LEDs, one pair:</p> <ul style="list-style-type: none"> <li>■ Link—If green, the port is online; if there is no light, the port is down</li> <li>■ RX—If flashing green, the port is receiving data; if there is no light, the port might be on, but is not receiving data</li> </ul>

**Table 10: Optical Interface Support for 10-Gigabit Ethernet PICs**

<b>PIC Type</b>	<b>Long Wavelength Serial (10GBASE-LR), LAN Rate</b>
Optical interface	6.2-mile/10-km reach on micrometer single-mode fiber (SMF) with SC/PC duplex connector
Wavelength	1260 through 1355 nm
Average launch power	−4 through 0.5 dBm
Receiver saturation	0.5 dBm
Receiver sensitivity	−10.5 dBm

Monitoring Services PIC



Software release	<ul style="list-style-type: none"><li>JUNOS 5.4 and later</li></ul>
Description	<ul style="list-style-type: none"><li>Active and passive traffic monitoring</li><li>Power requirement: 0.19 A/48 V @ 9 W</li><li>Monitors IPv4 packets</li><li>Support for collecting and exporting cflowd records</li></ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
Hardware features	<ul style="list-style-type: none"><li>Monitors up to 100,000 packets per second</li><li>Support for MTUs up to 4474 bytes for SONET interfaces</li></ul>
Software features	<ul style="list-style-type: none"><li>Load distribution across multiple PICs</li><li>cflowd version 5 support</li><li>Provides start and end times of each export</li><li>Supports firewall filtering and filter-based forwarding (FBF)</li><li>Encapsulations:<ul style="list-style-type: none"><li>High-level Data Link Control (HDLC)</li><li>Point-to-Point Protocol (PPP)</li></ul></li></ul> <p><b>NOTE:</b> Extended support for graceful Routing Engine switchover (GRES) has been added for this PIC. To configure GRES, you must be running JUNOS release 7.3 or later.</p>

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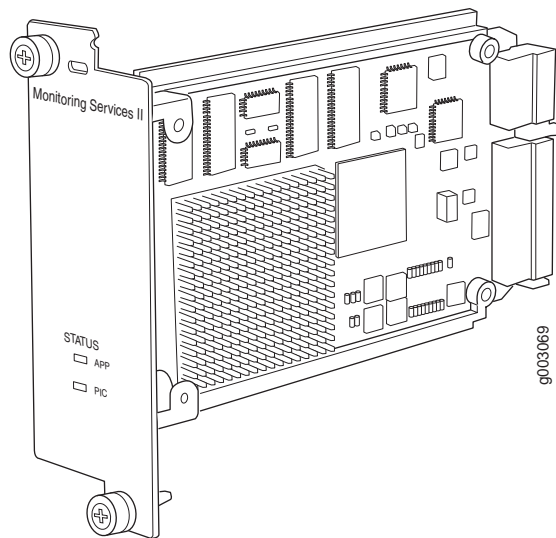
<b>Cables and connectors</b>	■ DB-9 diagnostic serial console port
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<b>LEDs</b>	Status LED, one tricolor: <ul style="list-style-type: none"><li>■ Off—PIC is offline and it is safe to remove it from the chassis</li><li>■ Green—PIC is operating normally</li><li>■ Amber—PIC is initializing</li><li>■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis</li></ul> Application LED, one tricolor: <ul style="list-style-type: none"><li>■ Off—Flow collector is not running</li><li>■ Green—Flow collector is running under acceptable load</li><li>■ Amber—Flow collector is overloaded</li></ul>
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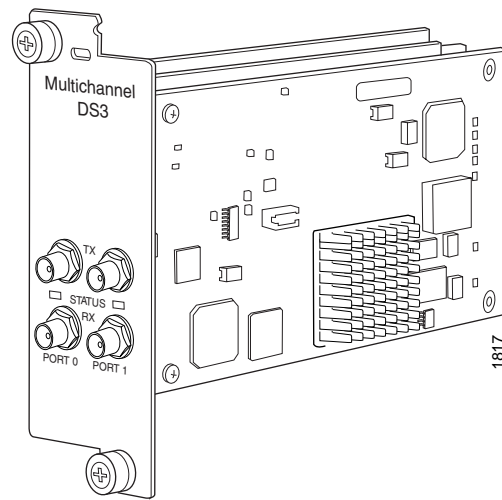
Monitoring Services II PIC



Software release	<ul style="list-style-type: none"><li>JUNOS 6.0 and later</li></ul>
Description	<ul style="list-style-type: none"><li>Passive traffic monitoring or flow collection services</li><li>Power requirement: 0.4 A/48 V @ 19 W</li><li>Monitors IPv4 packets</li><li>Support for collecting and exporting cflowd records</li></ul> <p><b>NOTE:</b> On the M40e routers and above, this PIC requires an enhanced FPC. See the hardware guide for your router for more information.</p>
Hardware features	<ul style="list-style-type: none"><li>Monitors up to 400,000 packets per second</li><li>Support for MTUs up to 4474 bytes for SONET interfaces</li></ul>
Software features	<ul style="list-style-type: none"><li>Load distribution across multiple PICs</li><li>cflowd version 5 support</li><li>Provides start and end times of each export</li><li>Encapsulations:<ul style="list-style-type: none"><li>High-level Data Link Control (HDLC)</li><li>Point-to-Point Protocol (PPP)</li></ul></li><li>Supports firewall filtering and filter-based forwarding (FBF)</li></ul> <p><b>NOTE:</b> Flow collection services are supported in JUNOS 6.2 and later.</p> <p><b>NOTE:</b> This PIC does not support graceful switchover. Graceful switchover can not be configured on routers that this PIC is installed in.</p>

<b>Cables and connectors</b>	■ None
<b>LEDs</b>	<p>Status LED, one tricolor:</p> <ul style="list-style-type: none"><li>■ Off—PIC is offline and it is safe to remove it from the chassis.</li><li>■ Green—PIC is operating normally.</li><li>■ Amber—PIC is initializing.</li><li>■ Red—PIC has an error or failure and no further harm can be done by removing it from the chassis.</li></ul> <p>Application LED, one tricolor:</p> <ul style="list-style-type: none"><li>■ Off—Flow collector is not running.</li><li>■ Green—Flow collector is running under acceptable load.</li><li>■ Amber—Flow collector is overloaded.</li></ul>

## Multichannel DS3 PIC



<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 5.2 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ Two DS3 ports</li> <li>■ Power requirement: 0.31 A/48 V @ 14.9 W</li> <li>■ Supports up to 128 logical customer channels per DS3 port</li> </ul>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ Support for NxT1 by interoperating with the Link Services and Multilink Services PICs, using MLPPP and MLFR protocols</li> <li>■ Onboard DSU functionality</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ Support for four data-link connection identifiers (DLCIs) per logical customer channel</li> <li>■ DS3 alarm and event counting</li> <li>■ DS3 alarm and event detection</li> <li>■ DS3 diagnostics and loopback control</li> <li>■ DS3 framing: M13, C-bit</li> <li>■ T1 framing: super frame (SF) and extended super frame (ESF)</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Custom 10-ft/3.05-m posilock to BNC male cable, separate Rx and Tx</li> </ul>

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<b>LEDs</b>	One tricolor per port: <ul style="list-style-type: none"><li>■ Off—Not enabled</li><li>■ Green—Online with no alarms or failures</li><li>■ Amber—Online with alarms for remote failures</li><li>■ Red—Active with a local alarm; router has detected a failure</li></ul>
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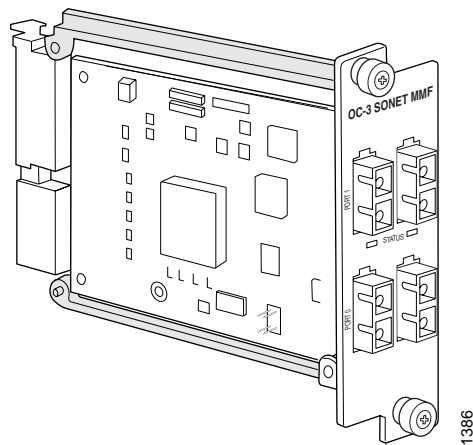
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<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"><li>■ Far-end Block Error (FEBE)</li><li>■ Parity bit (P-bit) disagreements</li><li>■ Path priority error</li><li>■ Alarm Indication Signal (AIS)</li><li>■ Loss of Signal (LoS)</li><li>■ Out of Frame (OoF)</li><li>■ Yellow alarm</li><li>■ AIS Received</li><li>■ Simultaneous BERT functionality</li><li>■ Idle received</li><li>■ Local and remote loopback</li></ul>
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SONET/SDH OC3c/STM1 PIC



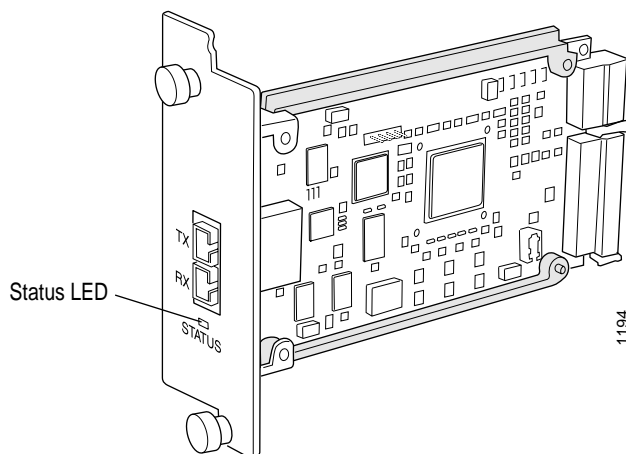
Software release	<ul style="list-style-type: none"><li>JUNOS 4.0 and later</li></ul>
Description	<ul style="list-style-type: none"><li>Four OC3 ports</li><li>Power requirement: 0.49 A/48 V @ 23.7 W</li><li>Optical interface support—see Table 11</li></ul>
Hardware features	<ul style="list-style-type: none"><li>Multiplexing and demultiplexing</li><li>Rate policing on input</li><li>Rate shaping on output</li><li>Packet buffering, Layer 2 parsing</li></ul>
Software features	<ul style="list-style-type: none"><li>SONET/SDH framing</li><li>Alarm and event counting and detection</li><li>Dual-router automatic protection switching (APS)</li><li>Multiprotocol Label Switching (MPLS) fast reroute</li><li>Link aggregation</li><li>Encapsulations:<ul style="list-style-type: none"><li>High-level Data Link Control (HDLC)</li><li>Frame Relay</li><li>Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li><li>Point-to-Point Protocol (PPP)</li></ul></li></ul>
Cables and connectors	<ul style="list-style-type: none"><li>Duplex SC/PC connector (Rx and Tx)</li></ul>

<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>

**Table 11: Optical Interface Support for SONET/SDH OC3c/STM1 PICs**

<b>PIC Type</b>	<b>Single-mode Intermediate Reach</b>	<b>Multimode</b>
Optical interface	Single-mode intermediate reach (Bellcore GR-253 compliant) optical interface (maximum distance 9.3 miles/15 km)	Multimode optical interface (maximum distance 1.2 miles/2 km)
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 OC12c/STM4 PIC



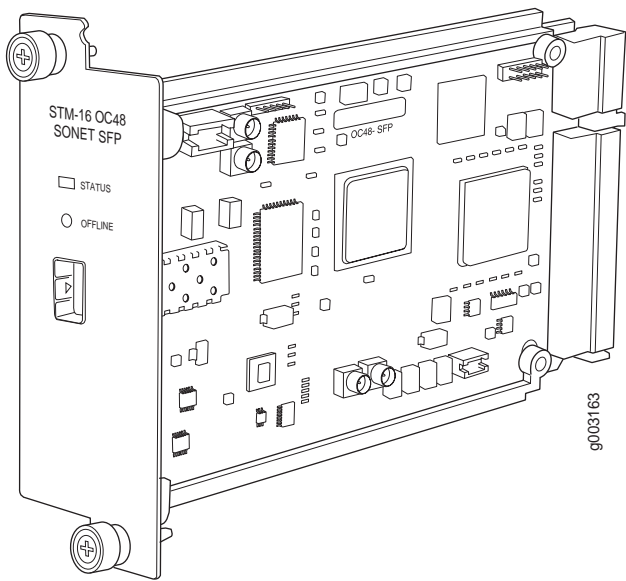
<b>Software release</b>	<ul style="list-style-type: none"> <li>■ JUNOS 4.0 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>■ One or four OC12 ports</li> <li>■ Power requirements: 0.23 A/48 V @ 10.8 W</li> <li>■ Optical interface support—see Table 12</li> </ul>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>■ Multiplexing and demultiplexing</li> <li>■ Rate policing on input</li> <li>■ Rate shaping on output</li> <li>■ Packet buffering, Layer 2 parsing</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>■ SONET/SDH framing</li> <li>■ Alarm and event counting and detection</li> <li>■ Dual-router automatic protection switching (APS)</li> <li>■ Multiprotocol Label Switching (MPLS) fast reroute</li> <li>■ Link aggregation</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (Rx and Tx)</li> </ul>

<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>

**Table 12: Optical Interface Support for SONET/SDH OC12c/STM4 PICs**

<b>PIC Type</b>	<b>Single-mode Intermediate Reach</b>	<b>Multimode</b>
Optical interface	Single-mode intermediate reach (Bellcore GR-253 compliant) optical interface (maximum distance 9.3 miles/15 km)	Multimode optical interface (maximum distance 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

SONET/SDH OC48c/STM16 PIC with SFP



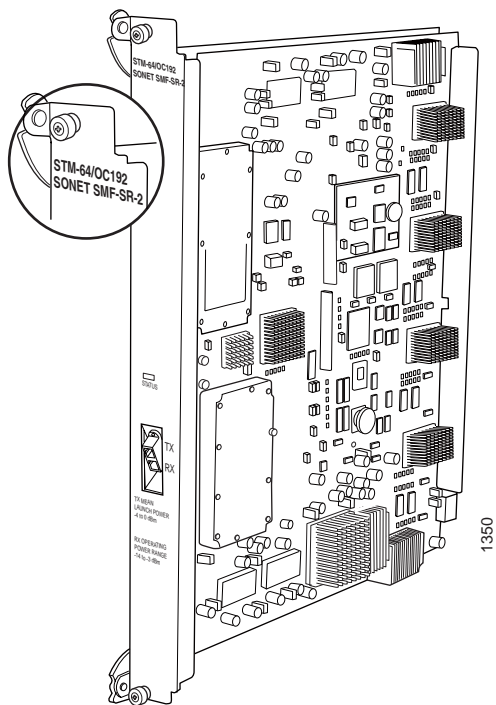
Software release	<ul style="list-style-type: none"><li>JUNOS 6.1 and later</li></ul>
Description	<ul style="list-style-type: none"><li>One OC48 port</li><li>Power requirements: 0.38 A/48 V @ 18 W</li><li>Optical interface support—see Table 13</li></ul> <p><b>NOTE:</b> On the M5, M10, M20, M40, and M160 routers, this PIC requires an Enhanced FPC. See the hardware guide for your router for more information.</p>
Hardware features	<ul style="list-style-type: none"><li>Multiplexing and demultiplexing</li><li>Rate policing on input</li><li>Rate shaping on output</li><li>Packet buffering, Layer 2 parsing</li></ul>

<b>Software features</b>	<ul style="list-style-type: none"> <li>■ SONET/SDH framing</li> <li>■ Alarm and event counting and detection</li> <li>■ Dual-router automatic protection switching (APS)</li> <li>■ Multiprotocol Label Switching (MPLS) fast reroute</li> <li>■ Link aggregation</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<ul style="list-style-type: none"> <li>■ The SONET/SDH OC48c/STM16 PICs with SFP uses small form-factor pluggable transceivers (SFPs) that allow different optical interfaces to be used on the PIC. You can use SR, IR, or LR SFPs. PICs with multiple ports can use any combination of SFPs. For information about installing and removing SFPs, see the <i>M160 Internet Router Hardware Guide</i>.</li> <li>■ Duplex LC/PC connector (Rx and Tx)</li> </ul> <p><b>NOTE:</b> Do not install Gigabit Ethernet SFPs in the SONET/SDH OC48c/STM16 PIC. The PIC will not recognize the SFP.</p>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>

**Table 13: Optical Interface Support for SONET/SDH OC48c/STM16 PICs with SFP**

<b>PIC Type</b>	<b>Single-mode Short Reach (SR)</b>	<b>Single-mode Intermediate Reach (IR)</b>	<b>Single-mode Long Reach (LR)</b>
Optical interface	Single-mode short reach (Bellcore GR-253 compliant) optical interface (maximum distance 1.24 miles/2 km)	Single-mode intermediate reach (Bellcore GR-253 compliant) optical interface (maximum distance 9.3 miles/15 km)	Single-mode long reach (Bellcore GR-253 compliant) optical interface (maximum distance 49.71 miles/80 km); compatible with 1550 nm single-mode LR
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**



<b>Software release</b>	■ JUNOS 4.0 and later
<b>Description</b>	■ One OC192 port ■ Power requirement: 3.0 A/48 V @ 144 W ■ Optical interface support—see Table 14
<b>Hardware features</b>	■ Multiplexing and demultiplexing ■ Rate policing on input ■ Rate shaping on output ■ Packet buffering, Layer 2 parsing

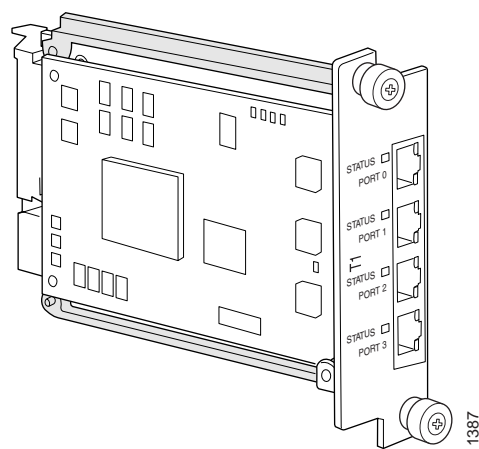


<b>Software features</b>	<ul style="list-style-type: none"> <li>■ SONET/SDH framing</li> <li>■ Alarm and event counting and detection</li> <li>■ Dual-router automatic protection switching (APS)</li> <li>■ Multiprotocol Label Switching (MPLS) fast reroute</li> <li>■ Link aggregation</li> <li>■ Encapsulations: <ul style="list-style-type: none"> <li>■ High-level Data Link Control (HDLC)</li> <li>■ Frame Relay</li> <li>■ Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li> <li>■ Point-to-Point Protocol (PPP)</li> </ul> </li> </ul>
<b>Cables and connectors</b>	<p>Very Short Reach (VSR 1):</p> <ul style="list-style-type: none"> <li>■ 12-ribbon multimode fiber with MTP connector (Rx and Tx)</li> </ul> <p>Short Reach (SR 2) and Long Reach (LR 1):</p> <ul style="list-style-type: none"> <li>■ Duplex SC/PC connector (Rx and Tx)</li> </ul>
<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"> <li>■ Off—Not enabled</li> <li>■ Green—Online with no alarms or failures</li> <li>■ Amber—Online with alarms for remote failures</li> <li>■ Red—Active with a local alarm; router has detected a failure</li> </ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"> <li>■ Alarm Indication Signal (AIS-L, AIS-P)</li> <li>■ Bit Error Rate Signal Degrade (BERR-SD), Bit Error Rate Signal Fail (BERR-SF)</li> <li>■ Bit Interleaved Parity Errors B1, B2, B3 (CV-S, CV-L, CV-P)</li> <li>■ 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)</li> <li>■ Loss of Frame (LoF), Loss of Pointer (LoP-P), Loss of Signal (LoS)</li> <li>■ Payload Mismatch (PLM-P), Payload Unequipped (UNEQ-P)</li> <li>■ Remote Defect Indication (RDI-L, RDI-P)</li> <li>■ 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)</li> </ul>

**Table 14: Optical Interface Support for SONET/SDH OC192 PICs**

<b>PIC Type</b>	<b>Multimode Very Short Reach (VSR 1)</b>	<b>Single-mode Short Reach (SR 2)</b>	<b>Single-mode Long Reach (LR 1)</b>
Optical interface	Multimode, very short reach optical interface (maximum distance 984.25 feet/300 m); compatible with 12-ribbon multimode fiber	Single-mode, short reach (Bellcore GR-253 compliant) optical interface (maximum distance 15.5 miles/25 km); compatible with 1550 nm single-mode SR 2	Single-mode, long reach (Bellcore GR-1377 compliant) optical interface (maximum distance 49.71 miles/80 km); compatible with 1550 nm single-mode LR
Wavelength	830 through 860 nm	1530 through 1565 nm	1530 through 1565 nm
Average launch power	-10 through -3 dBm	-4 through 0 dBm	+ 6 through + 8 dBm
Receiver saturation	-3 dBm	-3 dBm	-10 dBm
Receiver Sensitivity	-16 dBm	-14 dBm	-22 dBm

T1 PIC



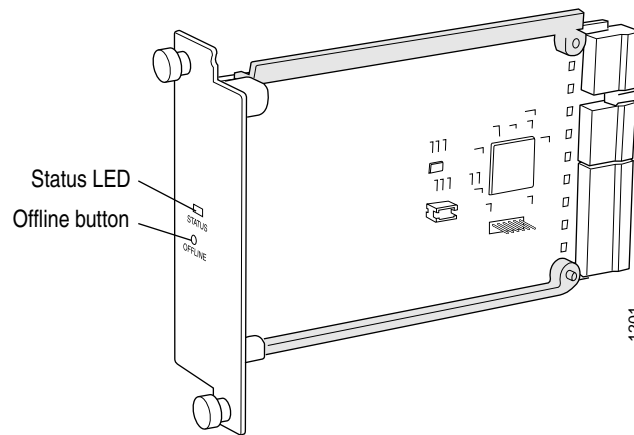
Software release	<ul style="list-style-type: none"><li>JUNOS 4.1 and later</li></ul>
Description	<ul style="list-style-type: none"><li>Four T1 ports</li><li>Power requirement: 0.08 A/48 V @ 3.7 W</li><li>Supports clear channel T1 per port (1.544 Mbps per channel)</li></ul> <p><b>NOTE:</b> The T1 PIC supports attenuation up to -12 dBm.</p>
Hardware features	<ul style="list-style-type: none"><li>Per-port loop timing</li><li>Onboard DSU functionality for T1 connectivity</li></ul>
Software features	<ul style="list-style-type: none"><li>ESF and SF framing</li><li>B8ZS and AMI coding</li><li>ESF CSU counters, WRT impairments, and CRC checking</li><li>Local DS1 line loopback, remote line loopback</li><li>Configurable clock source—Internal or loop</li><li>Encapsulations:<ul style="list-style-type: none"><li>High-level Data Link Control (HDLC)</li><li>Frame Relay</li><li>Multiprotocol Label Switching (MPLS) circuit cross-connect (CCC)</li><li>Point-to-Point Protocol (PPP)</li></ul></li></ul>
Cables and connectors	<ul style="list-style-type: none"><li>100-ohm RJ-48 connector</li></ul>

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<b>LEDs</b>	<p>One tricolor per port:</p> <ul style="list-style-type: none"><li>■ Off—Not enabled</li><li>■ Green—Online with no alarms or failures</li><li>■ Amber—Online with alarms for remote failures</li><li>■ Red—Active with a local alarm; router has detected a failure</li></ul>
<b>Alarms, errors, and events</b>	<ul style="list-style-type: none"><li>■ Alarm Indication Signal (AIS)</li><li>■ Bipolar Violations</li><li>■ Excessive Zeros</li><li>■ Far-end Block Errors (FEBE, E-bit errors)</li><li>■ Loss of Frame (LoF), Loss of Signal (LoS)</li><li>■ Yellow alarm bit (X-bit) disagreements</li></ul>

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## Tunnel Services PIC



<b>Software release</b>	<ul style="list-style-type: none"> <li>JUNOS 5.3 and later</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>Power requirement: 0.07 A/48 V @ 3.4 W</li> </ul>
<b>Hardware features</b>	<ul style="list-style-type: none"> <li>Loopback function that encapsulates and de-encapsulates packets</li> <li>OC48/STM16 tunneling bandwidth</li> </ul>
<b>Software features</b>	<ul style="list-style-type: none"> <li>IP-IP unicast tunneling</li> <li>GRE unicast tunneling</li> <li>PIM sparse mode unicast tunneling</li> </ul>
<b>LEDs</b>	<p>One tricolor:</p> <ul style="list-style-type: none"> <li>Off—Not enabled</li> <li>Green—Online with no alarms or failures</li> <li>Amber—Online with alarms for remote failures</li> <li>Red—Active with a local alarm; router has detected a failure</li> </ul>

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#### *M160 Internet Router PIC Guide*

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13 June 2005—530-013674-01, Rev 1. Minor revision.  
15 January 2005—530-012540-01, Rev 1. Removed Gigabit Ethernet PIC. Added Channelized OC3 IQ PIC and added the PIC Feature Matrix table.  
9 November 2004—530-012312-01. Added 4-port Gigabit Ethernet PIC with SFP.  
11 October 2004—530-012312-01 Revision 2. Clarified description, hardware features, and counters for EIA-530 PIC.  
6 July 2004—530-011628-01 Revision 1.

The information in this document is current as of the date listed in the revision history.

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