



T1600 Core Router Interface Module Reference



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T1600 Core Router Interface Module Reference

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- Requesting Technical Support on page xvi

Documentation and Release Notes

To obtain the most current version of all Juniper Networks® technical documentation, see the product documentation page on the Juniper Networks website at <http://www.juniper.net/techpubs/>.

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Supported Platforms

For the features described in this document, the following platforms are supported:

- TI600

Documentation Conventions

Table 1 on page xiv defines notice icons used in this guide.

Table 1: Notice Icons

Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.
	Tip	Indicates helpful information.
	Best practice	Alerts you to a recommended use or implementation.

Table 2 on page xiv defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents text that you type.	To enter configuration mode, type the configure command: user@host> configure
Fixed-width text like this	Represents output that appears on the terminal screen.	user@host> show chassis alarms No alarms currently active
<i>Italic text like this</i>	- Introduces or emphasizes important new terms. - Identifies guide names. - Identifies RFC and Internet draft titles.	- A policy <i>term</i> is a named structure that defines match conditions and actions. <i>Junos OS CLI User Guide</i> - RFC 1997, <i>BGP Communities Attribute</i>
<i>Italic text like this</i>	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name: [edit] root@# set system domain-name <i>domain-name</i>

Table 2: Text and Syntax Conventions (*continued*)

Convention	Description	Examples
Text like this	Represents names of configuration statements, commands, files, and directories; configuration hierarchy levels; or labels on routing platform components.	- To configure a stub area, include the stub statement at the [edit protocols ospf area area-id] hierarchy level. - The console port is labeled CONSOLE.
< > (angle brackets)	Encloses optional keywords or variables.	stub <default-metric <i>metric</i>>;
(pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	broadcast multicast (<i>string1</i> <i>string2</i> <i>string3</i>)
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	rsvp { # Required for dynamic MPLS only
[] (square brackets)	Encloses a variable for which you can substitute one or more values.	community name members [<i>community-ids</i>]
Indentation and braces ({ })	Identifies a level in the configuration hierarchy.	<pre>[edit] routing-options { static { route default { nexthop <i>address</i>; retain; } } }</pre>
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
GUI Conventions		
Bold text like this	Represents graphical user interface (GUI) items you click or select.	- In the Logical Interfaces box, select All Interfaces. - To cancel the configuration, click Cancel.
> (bold right angle bracket)	Separates levels in a hierarchy of menu selections.	In the configuration editor hierarchy, select Protocols>Ospf .

Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. You can provide feedback by using either of the following methods:

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- E-mail—Send your comments to techpubs-comments@juniper.net. Include the document or topic name, URL or page number, and software version (if applicable).

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or Partner Support Service support contract, or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the *JTAC User Guide* located at <http://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf>.
- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/>.
- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>
- Find product documentation: <http://www.juniper.net/techpubs/>
- Find solutions and answer questions using our Knowledge Base: <http://kb.juniper.net/>
- Download the latest versions of software and review release notes: <http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications: <http://kb.juniper.net/InfoCenter/>
- Join and participate in the Juniper Networks Community Forum: <http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: <https://tools.juniper.net/SerialNumberEntitlementSearch/>

Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Management tool in the CSC at <http://www.juniper.net/cm/>.
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, see <http://www.juniper.net/support/requesting-support.html>.

PART 1

Overview

- [T1600 Interface Modules Support on page 3](#)
- [Network Interface Specifications on page 21](#)

CHAPTER 1

T1600 Interface Modules Support

- [T1600 PICs Supported on page 3](#)
- [T1600 End-of-Life PICs Supported on page 12](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PIC/FPC Compatibility on page 14](#)

T1600 PICs Supported

[Table 3 on page 4](#) through [Table 16 on page 11](#) list the PICs supported by the T1600 router by PIC family.

- [ATM2 IQ PICs on page 3](#)
- [Channelized PICs on page 4](#)
- [DS3 and E3 PICs on page 5](#)
- [Fast Ethernet PICs on page 6](#)
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- [Services PICs on page 10](#)
- [SONET/SDH PICs on page 11](#)

ATM2 IQ PICs

[Table 3 on page 4](#) lists the ATM2 IQ PICs supported by the T1600 router.

Table 3: ATM2 IQ PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"ATM2 E3 IQ PIC (T1600 Router)" on page 65	4	PB-2E3-ATM2	Coaxial: 10 ft (3.05 m) posilock SMB to BNC cable (provided) - Four pairs of Rx and Tx coaxial cables	8.5
"ATM2 OC3/STM1 IQ PIC (T1600 Router)" on page 67	2	PB-2OC3-ATM2-MM PB-2OC3-ATM2-SMIR	• Optical: SC/PC	8.5
"ATM2 OC12/STM4 IQ PICs (T1600 Router)" on page 70				
• ATM2 OC12/STM4 IQ PIC	2	PB-2OC12-ATM2-MM PB-2OC12-ATM2-SMIR	• Optical: SC/PC	8.5
• ATM2 OC12/STM4 IQ PIC	1	PB-1OC12-ATM2-MM PB-1OC12-ATM2-SMIR	• Optical: SC/PC	8.5
"ATM2 OC48/STM16 IQ PIC with SFP (T1600 Router)" on page 73	1	PB-1OC48-ATM2-SFP	• Optical: LC/PC	8.5

Channelized PICs

- [Table 4 on page 4](#) lists the channelized IQ PICs supported by T1600 router.
- [Table 5 on page 5](#) lists the enhanced channelized IQ (IQE) PICs supported by T1600 router.

Table 4: Channelized IQ PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"Channelized DS3 IQ PIC (T1600 Router)" on page 77	4	PB-4CHDS3-QPP	Coaxial Standard DS3 BNC coaxial cable interfaces	8.5
"Channelized OC3 IQ PIC (T1600 Router)" on page 79	1	PB-1CHOC3-SMIR-QPP	• Optical: SC/PC	8.5
"Channelized STM1 IQ PIC (T1600 Router)" on page 81	1	PB-1CHSTM1-SMIR-QPP	• Optical: SC/PC	8.5

Table 5: Channelized Enhanced IQ (IQE) PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"Channelized DS3/E3 Enhanced IQ (IQE) PIC (T1600 Router)" on page 84	4	PB-4CHDS3-E3-IQE-BNC	Coaxial Standard DS3 BNC coaxial cable interfaces	9.3
"Channelized E1/T1 Enhanced IQ (IQE) PIC (T1600 Router)" on page 87	10	PB-1OCHE1-T1-IQE-RJ48	120-ohm RJ-48C connector (female)	9.5
"Channelized OC3/STM1 Enhanced IQ (IQE) PIC with SFP (T1600 Router)" on page 90	2	PB-2CHOC3-STM1-IQE-SFP	Optical: LC/PC	9.3
"Channelized OC12/STM4 Enhanced IQ (IQE) PICs with SFP (T1600 Router)" on page 94				
Channelized OC12/STM4 Enhanced IQ (IQE) PIC with SFP	1	PB-1CHOC12-STM4-IQE-SFP	Optical: LC/PC	9.3
Channelized OC12/STM4 Enhanced IQ (IQE) PIC with SFP (Type 2)	4	PB-4CHOC12-STM4-IQE-SFP	Optical: LC/PC	9.4
Channelized OC12/STM4 Enhanced IQ (IQE) PIC with SFP (Type 3)	4	PC-4CHOC12STM4-IQE-SFP	Optical: LC/PC	10.1
"Channelized OC48/STM16 Enhanced IQ (IQE) PIC with SFP (T1600 Router)" on page 100	1	PB-1CHOC48-STM16-IQE-SFP	Optical: LC/PC	9.4

DS3 and E3 PICs

Table 6 on page 5 lists the DS3 and E3 PICs supported by T1600 router.

Table 6: DS3 and E3 PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"DS3/E3 Enhanced IQ (IQE) PIC (T1600 Router)" on page 105	4	PB-4DS3-E3-IQE-BNC	Coaxial Standard DS3 BNC coaxial cable interfaces	9.3R2

Table 6: DS3 and E3 PICs Supported by the T1600 Router (*continued*)

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"E3 IQ PIC (T1600 Router)" on page 108	4	PB-4E3-QPP	Coaxial Standard DS3 BNC coaxial cable interfaces	8.5

Fast Ethernet PICs

Table 7 on page 6 lists the Fast Ethernet PICs supported by T1600 router.

Table 7: Fast Ethernet PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"Fast Ethernet PIC (T1600 Router)" on page 111	4	PB-4FE-TX	- RJ-45 - Two-pair, Category 5 unshielded twisted-pair - Pinout: MDI noncrossover	8.5

Gigabit Ethernet PICs

- Table 8 on page 6 lists the Gigabit Ethernet PICs supported by T1600 router.
- Table 9 on page 7 lists the Gigabit Ethernet IQ PICs supported by T1600 router.
- Table 10 on page 8 lists the Gigabit Ethernet IQ2 PICs supported by T1600 router.
- Table 11 on page 8 lists the Gigabit Ethernet Enhanced IQ2 PICs supported by T1600 router.

Table 8: Gigabit Ethernet PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"Gigabit Ethernet PICs with SFP (T1600 Router)" on page 114				
Gigabit Ethernet PIC with SFP	1	PB-1GE-SFP	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5

Table 8: Gigabit Ethernet PICs Supported by the T1600 Router (*continued*)

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
Gigabit Ethernet PIC with SFP	2	PB-2GE-SFP	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5
Gigabit Ethernet PIC with SFP	4	PB-4GE-SFP	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5
Gigabit Ethernet PIC with SFP	10	PC-10GE-SFP	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5

Table 9: Gigabit Ethernet IQ

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
Gigabit Ethernet IQ PIC with SFP	1	PB-1GE-SFP-QPP	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5
Gigabit Ethernet IQ PIC with SFP	2	PB-2GE-SFP-QPP	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5

"Gigabit Ethernet IQ PICs with SFP (T1600 Router)" on page 117

Table 10: Gigabit Ethernet IQ2

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"Gigabit Ethernet IQ2 PICs with SFP (T1600 Router)" on page 119				
• Type 1 Gigabit Ethernet IQ2 PIC with SFP	4	PB-4GE-TYPE1-SFP-IQ2	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5
• Type 2 Gigabit Ethernet IQ2 PIC with SFP	8	PB-8GE-TYPE2-SFP-IQ2	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5
• Type 3 Gigabit Ethernet IQ2 PIC with SFP	8	PB-8GE-TYPE3-SFP-IQ2	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	8.5

Table 11: Gigabit Ethernet IQ2E PICs

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"Gigabit Ethernet Enhanced IQ2 (IQ2E) PICs with SFP (T1600 Router)" on page 123				
• Type 1 Gigabit Ethernet Enhanced IQ2 (IQ2E) PIC with SFP	4	PB-4GE-TYPE1-SFP-IQ2E	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	9.4

Table 11: Gigabit Ethernet IQ2E PICs (*continued*)

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
Type 2 Gigabit Ethernet Enhanced IQ2 (IQ2E) PIC with SFP	8	PB-8GE-TYPE2-SFP-IQ2	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	9.4
Type 3 Gigabit Ethernet Enhanced IQ2 (IQ2E) PIC with SFP	8	PB-8GE-TYPE3-SFP-IQ2	- Optical: LC - Copper: RJ-45 - Four-pair, Category 5 shielded twisted-pair connectivity - Pinout: MDI crossover	9.4

10-Gigabit Ethernet PICs

Table 12 on page 9 lists the 10-Gigabit Ethernet PICs supported by T1600 router.

Table 12: 10-Gigabit Ethernet PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"10-Gigabit Ethernet IQ2 PIC with XFP (T1600 Router)" on page 127	1	PC-1XGE-TYPE3-XFP-IQ2	Optical: LC	8.5
"10-Gigabit Ethernet Enhanced IQ2 (IQ2E) PIC with XFP (T1600 Router)" on page 129	1	PC-1XGE-TYPE3-XFP-IQ2E	Optical: LC	9.4
"10-Gigabit Ethernet PIC with XENPAK (T1600 Router)" on page 131	1	PC-1XGE-XENPAK	XENPAK	8.5
"10-Gigabit Ethernet DWDM PIC (T1600 Router)" on page 133	1	PC-1XGE-DWDM-CBAND	Optical: SC	8.5
"10-Gigabit Ethernet DWDM OTN PIC (T1600 Router)" on page 134	1	PC-1XGE-DWDM-OTN	Optical: SC	9.4

Table 12: 10-Gigabit Ethernet PICs Supported by the T1600 Router (*continued*)

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"10-Gigabit Ethernet LAN/WAN PIC with Oversubscription and SFP+ (T1600 Router)" on page 136	10	PD-5-10XGE-SFPP	• Optical: LC	10.1
"10-Gigabit Ethernet LAN/WAN PIC with XFP (T1600 Router)" on page 139	4	PD-4XGE-XFP	• Optical: LC	9.0

40-Gigabit Ethernet PICs

Table 13 on page 10 lists the 40-Gigabit Ethernet PICs supported by T1600 router.

Table 13: 40-Gigabit Ethernet PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
40-Gigabit Ethernet				
"40-Gigabit Ethernet PIC with CFP (T1600 Router)" on page 143	4	PD-1XLE-CFP	Optical: SC	11.4

100-Gigabit Ethernet PICs

Table 14 on page 10 lists the 100-Gigabit Ethernet PICs supported by T1600 router.

Table 14: 100-Gigabit Ethernet PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
"100-Gigabit Ethernet PIC with CFP (T1600 Router)" on page 147	1	PD-1CE-CFP-FPC4 (PIC and FPC) <i>NOTE:</i> This PIC is only available packaged in an assembly with the T1600-FPC4-ES FPC.	• Optical: SC	10.3

Services PICs

Table 15 on page 11 lists the Services PICs supported by T1600 router.

Table 15: Services PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
Services				
“MultiServices PICs (T1600 Router)” on page 151				
• MultiServices 100 PIC	0	PB-MS-100-1	• None	8.5
• MultiServices 400 PIC	0	PB-MS-400-2	• None	8.5
• MultiServices 500 PIC	0	PB-MS-500-3	• None	8.5
“Tunnel Services PIC (T1600 Router)” on page 155				
• Type 1 Tunnel Services PIC	0	PB-TUNNEL-1	• None	8.5
• Type 2 Tunnel Services PIC	0	PB-TUNNEL	• None	8.5
• Type 3 Tunnel Services PIC	0	PC-TUNNEL	• None	8.5
“40-Gigabit Tunnel Services PIC (T1600 Router)” on page 156	0	PD-TUNNEL	• None	8.5

SONET/SDH PICs

Table 16: SONET/SDH PICs Supported by the T1600 Router

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
“SONET/SDH OC3/STM1 Enhanced IQ (IQE) PIC with SFP (T1600 Router)” on page 160	4	PB-4OC3-STM1-IQE-SFP	• Optical: LC	9.3R2
“SONET/SDH OC3/STM1 (Multi-Rate) PICs with SFP (T1600 Router)” on page 163				
• Type 1 SONET/SDH OC3/STM1 (Multi-Rate) PIC with SFP	4	PB-4OC3-1OC12-SON-SFP	• Optical: LC	8.5
• Type 2 SONET/SDH OC3/STM1 (Multi-Rate) PIC with SFP	4	PB-4OC3-1OC12-SON2-SFP	• Optical: LC	8.5
“SONET/SDH OC12/STM4 Enhanced IQ (IQE) PIC with SFP (T1600 Router)” on page 166	1	PB-1OC12-STM4-IQE-SFP	• Optical: LC	9.3

Table 16: SONET/SDH PICs Supported by the T1600 Router (*continued*)

PIC Family and Type	Ports	Model Number	Connectors	First Junos OS Release Support
“SONET/SDH OC12/STM4 (Multi-Rate) PICs with SFP (T1600 Router)” on page 169				
• SONET/SDH OC12/STM4 (Multi-Rate) PIC with SFP	1	PB-1OC12-SON-SFP	• Optical: LC	8.5
• SONET/SDH OC12/STM4 (Multi-Rate) PIC with SFP	4	PB-4OC3-4OC12-SON-SFP	• Optical: LC	8.5
“SONET/SDH OC48c/STM16 PIC with SFP (T1600 Router)” on page 172	4	PC-4OC48-SON-SFP	• Optical: LC	8.5
“SONET/SDH OC48/STM16 Enhanced IQ (IQE) PIC with SFP (T1600 Router)” on page 175	4	PC-4OC48-STM16-IQE-SFP	• Optical: LC	10.4R2
“SONET/SDH OC48/STM16 (Multi-Rate) PIC with SFP (T1600 Router)” on page 179	1	PB-1OC48-SON-B-SFP	• Optical: LC	8.5
“SONET/SDH OC192c/STM64 PIC (T1600 Router)” on page 182	1	PC-1OC192-SON-VSR	• Optical: LC	8.5
“SONET/SDH OC192/STM64 PICs with XFP (T1600 Router)” on page 185	1	PC-1OC192-SON-XFP	• Optical: LC	8.5
“SONET/SDH OC192/STM64 PICs with XFP (T1600 Router)” on page 185	4	PD-4OC192-SON-XFP	• Optical: LC	8.5
“SONET/SDH OC768c/STM256 PIC (T1600 Router)” on page 188	1	PD-1OC768-SON-SR	• Optical: SC	8.5

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 FPCs Supported](#)

T1600 End-of-Life PICs Supported

Table 17 on page 13 lists the end-of-life PICs supported by the T1600 router. The PICs are listed alphabetically by PIC family.

Table 17: End-of-Life PICs Supported in the T1600 Router

PIC Family and Type	Ports	Model Number	Connector
Channelized IQ			
"Channelized OC12 IQ EOL PIC (T1600 Router)" on page 191	1	PE-1CHOC12SMIR-QPP	Optical: SC/PC
DS3/E3			
"DS3 EOL PIC (T1600 Router)" on page 194	4	PB-2DS3	Custom 10 ft (3.05 m) posilock SMB to BNC male cable, separate Rx and Tx (provided)
Services			
"Adaptive Services II EOL PIC (T1600 Router)" on page 195	0	PB-AS2	None
"Adaptive Services II Layer 2 Services EOL PIC (T1600 Router)" on page 198	0	PB-AS2-LAYER2SERVICES	None
"Link Services EOL PIC (T1600 Router)" on page 200	0	PB-LS-4 PB-LS-32 PB-LS-128	None
"Monitoring Services II EOL PIC (T1600 Router)" on page 201	0	PB-PM2	None
"Monitoring Services III EOL PIC (T1600 Router)" on page 203	0	PB-PM3	None
SONET/SDH			
"SONET/SDH OC3c/STM1 EOL PICs (T1600 Router)" on page 204	4	PB-4OC3-SON-MM PB-4OC3-SON-SMIR	Optical: SC/PC
"SONET/SDH OC12c/STM4 EOL PICs (T1600 Router)" on page 207			
• SONET/SDH OC12c/STM4 PIC	1	PB-1OC12-SON-MM	Optical: SC/PC
• SONET/SDH OC12c/STM4 PIC	4	PB-4OC12-SON-MM PB-4OC12-SON-SMIR	Optical: SC/PC
"SONET/SDH OC48c/STM16 EOL PIC with SFP (T1600 Router)" on page 210	1	PB-1OC48-SON-SFP	Optical: LC/PC

Related Documentation • *T1600 PIC Description*

T1600 PIC Combination Limitations

In most cases, you can install PICs of different media types on the same FPC as long as the FPC and the router support those PICs. However, configuration rules might limit certain combinations of PICs on some platforms.

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

If you have different PIC families on a single FPC, review the configuration rules to plan which PICs to install on the FPCs for your router. Consult technical bulletin [PSN-2007-01-023](#) for information about configuration rules for PIC combinations on the Juniper Networks Support site at <https://www.juniper.net/alerts/>.

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

- Install a Junos OS release that supports the combination.
- Install PICs on a different FPC.
- Remove PICs from the affected FPC.

Related Documentation

- *T1600 PIC Description*
- [T1600 PICs Supported on page 3](#)
- *T1600 FPCs Supported*
- [T1600 PIC/FPC Compatibility on page 14](#)

T1600 PIC/FPC Compatibility

The PIC/FPC compatibility matrixes list the current PICs for the T1600 router. For example, Junos OS Release 8.5 is the first release in which the T640-FPC1-E2 supports the ATM2 OC3/STM1 IQ, 2-port PIC.



NOTE: A – indicates that the FPC does not support the PIC.

- [PIC/FPC Compatibility \(Type 1 FPCs and Type 1 PICs\) on page 15](#)
- [PIC/FPC Compatibility \(Type 2 FPCs and Type 2 PICs\) on page 16](#)
- [PIC/FPC Compatibility \(Type 3 FPCs and Type 3 PICs\) on page 18](#)
- [PIC/FPC Compatibility \(Type 4 FPCs and Type 4 PICs\) on page 19](#)

PIC/FPC Compatibility (Type 1 FPCs and Type 1 PICs)

Table 18 on page 15 provides a PIC/FPC compatibility matrix for the current Type 1 PICs for the T1600 router and Type 1 FPCs.



NOTE: A T1600 router in a routing matrix supports Type 1 PICs in Junos OS Release 10.0 and later.

Table 18: T1600 PIC/FPC Compatibility Type 1

Type 1 PIC	PIC Model Number	T640-FPC1-E	T640-FPC1-E2	T640-FPC1-ES
ATM2 IQ PICs				
ATM2 E3 IQ, 4-port	PB-4E3-ATM2	8.5	8.5	–
ATM2 OC3/STM1 IQ, 2-port	PB-2OC3-ATM2-MM	8.5	8.5	–
	PB-2OC3-ATM2-SMIR			
ATM2 OC12/ STM4 IQ, 1-port	PB-1OC12-ATM2-MM	8.5	8.5	–
	PB-1OC12-ATM2-SMIR			
Channelized IQ PICs				
ChDS3 IQ, 4-port	PB-4CHDS3-QPP	8.5	8.5	9.4
ChOC3 IQ, 1-port	PB-1CHOC3-SMIR-QPP	8.5	8.5	9.4
ChSTM1 IQ, 1-port	PB-1CHSTM1-SMIR-QPP	8.5	8.5	9.4
Channelized IQE PICs				
ChDS3/E3 IQE, 4-port	PB-4CHDS3-E3-IQE-BNC	9.3	9.3	9.4
ChE1/T1 IQE, 10-port	PB-1OCHE1-T1-IQE-RJ48	9.5	9.5	9.5
ChOC3/STM1 IQE, 2-port	PB-2CHOC3-STM1-IQE-SFP	9.3	9.3	9.4
ChOC12/STM4 IQE, 1-port	PB-1CHOC12-STM4-IQE-SFP	9.3	9.3	9.4
DS3 and E3 PICs				
DS3/E3 IQE, 4-port	PB-4DS3-E3-IQE-BNC	9.3R2	9.3R2	9.4
E3 IQ, 4-port	PB-4E3-QPP	8.5	8.5	–
Fast Ethernet and Gigabit Ethernet PICs				
Fast Ethernet, 4-port	PB-4FE-TX	8.5	8.5	9.4

Table 18: T1600 PIC/FPC Compatibility Type 1 (*continued*)

Type 1 PIC	PIC Model Number	T640-FPC1-E	T640-FPC1-E2	T640-FPC1-ES
Gigabit Ethernet, 1-port SFP	PB-1GE-SFP	8.5	8.5	9.4
Gigabit Ethernet IQ PICs				
Gigabit Ethernet IQ, 1-port SFP	PB-1GE-SFP-QPP	8.5	8.5	—
Gigabit Ethernet IQ2 PICs				
Gigabit Ethernet IQ2, 4-port SFP	PB-4GE-TYPE1-SFP-IQ2	8.5	8.5	9.4
Gigabit Ethernet IQ2E PICs				
Gigabit Ethernet IQ2E, 4-port SFP	PB-4GE-TYPE1-SFP-IQ2E	9.4	9.4	—
Services PICs				
MultiServices 100	PB-MS-100-1	8.5	8.5	9.4
Tunnel Services	PB-TUNNEL1	8.5	8.5	9.4
SONET/SDH PICs				
OC3/STM1 IQE, 4-port SFP	PB-4OC3-STM1-IQE-SFP	9.3R2	9.3R2	—
OC3c/STM1 (Multi-Rate) 4-port (Type 1)	PB-4OC3-IOC12-SON-SFP	8.5	8.5	9.4
OC12/STM4 IQE, 1-port SFP	PB-IOC12-STM4-IQE-SFP	9.3	9.3	—
OC12c/STM4 (Multi-Rate) 1-port (Type 1)	PB-IOC12-SON-SFP	8.5	8.5	9.4

PIC/FPC Compatibility (Type 2 FPCs and Type 2 PICs)

Table 19 on page 16 provides a PIC/FPC compatibility matrix for the current Type 2 PICs for the T1600 router and Type 2 FPCs.



NOTE: A T1600 router in a routing matrix supports Type 2 PICs in Junos OS Release 10.0 and later.

Table 19: T1600 PIC/FPC Compatibility Type 2

PIC	PIC Model Number	T640-FPC2	T640-FPC2-E	T640-FPC2-E2	T640-FPC2-ES
ATM2 IQ PICs					

Table 19: T1600 PIC/FPC Compatibility Type 2 (*continued*)

PIC	PIC Model Number	T640-FPC2	T640-FPC2-E	T640-FPC2-E2	T640-FPC2-E5
ATM2 OC12/ STM4 IQ, 1-port	PB-1OC12-ATM2-MM PB-1OC12-ATM2-SMIR	8.5	8.5	8.5	—
ATM2 OC48/ STM16 IQ, 1-port SFP	PB-1OC48-ATM2-SFP	8.5	8.5	8.5	—
Channelized IQE PICs					
ChOC12/STM4 IQE, 4-port	PB-4CHOC12-STM4-IQE-SFP	—	9.4	9.4	9.5
ChOC48/STM16 IQE, 1-port	PB-1CHOC48-STM16-IQE-SFP	—	9.4	9.4	9.5
Gigabit Ethernet PICs					
Gigabit Ethernet, 2-port SFP	PB-2GE-SFP	8.5	8.5	8.5	9.5
Gigabit Ethernet, 4-port SFP	PB-4GE-SFP	8.5	8.5	8.5	9.5
Gigabit Ethernet IQ PICs					
Gigabit Ethernet IQ, 2-port SFP	PB-2GE-SFP-QPP	8.5	8.5	8.5	—
Gigabit Ethernet IQ2 PICs					
Gigabit Ethernet IQ2, 8-port SFP (Type 2)	PB-8GE-TYPE2-SFP-IQ2	—	8.5	8.5	9.5
Gigabit Ethernet IQ2E PICs					
Gigabit Ethernet IQ2E, 8-port SFP (Type 2)	PB-8GE-TYPE2-SFP-IQ2E	—	9.4	9.4	—
Services PICs					
MultiServices 400	PB-MS-400-2	—	8.5	8.5	9.5
Tunnel Services	PB-TUNNEL	8.5	8.5	8.5	9.5
SONET/SDH PICs					
OC3c/STM1 (Multi-Rate) 4-port (Type 2)	PB-4OC3-1OC12-SON2-SFP	—	8.5	8.5	—
OC12c/STM4 (Multi-Rate) 4-port (Type 2)	PB-4OC3-4OC12-SON-SFP	—	8.5	8.5	9.5
OC48c/STM16, 1-port SFP	PB-1OC48-SON-SFP	8.5	8.5	8.5	—
OC48/STM16 (Multi-Rate) 4-port (Type 2)	PB-1OC48-SON-B-SFP	—	8.5	8.5	9.5

PIC/FPC Compatibility (Type 3 FPCs and Type 3 PICs)

Table 20 on page 18 provides a PIC/FPC compatibility matrix for the current Type 3 PICs for the T1600 router and Type 3 FPCs.



NOTE: A T1600 router in a routing matrix supports Type 3 PICs in Junos OS Release 9.6R2 and later.

Table 20: T1600 PIC/FPC Compatibility Type 3

Type 3 PIC	PIC Model Number	T640-FPC3	T640-FPC3-E	T640-FPC3-E2	T640-FPC3-ES
Channelized IQE PICs					
ChOC12/STM4 IQE, 4-port	PC-4CHOC12-STM4-IQE-SFP	–	–	–	10.1
Gigabit Ethernet PICs					
Gigabit Ethernet, 10-port SFP	PC-10-GE-SFP	8.5	8.5	8.5	9.0
Gigabit Ethernet IQ2 PICs					
Gigabit Ethernet IQ2, 8-port SFP (Type 3)	PC-8GE-TYPE3-SFP-IQ2	8.5	8.5	8.5	9.0
10-Gigabit Ethernet IQ2, 1-port XFP	PC-1XGE-TYPE3-XFP-IQ2	8.5	8.5	8.5	9.0
Gigabit Ethernet and 10-Gigabit Ethernet IQ2E PICs					
Gigabit Ethernet IQ2E, 8-port SFP (Type 3)	PC-8GE-TYPE3-SFP-IQ2E	9.4	9.4	9.4	9.4
10-Gigabit Ethernet IQ2E, 1-port XFP	PC-1XGE-TYPE3-XFP-IQ2E	9.4	9.4	9.4	9.4
10-Gigabit Ethernet PICs					
10-Gigabit Ethernet, 1-port XENPAK	PC-1XGE-XENPAK with 10GBase-ER and 10GBASE-LR transceivers installed	8.5	8.5	8.5	9.0
	PC-1XGE-XENPAK with 10GBASE-SR and 10GBASE-ZR transceivers installed	8.5	8.5	8.5	9.0

Table 20: T1600 PIC/FPC Compatibility Type 3 (continued)

Type 3 PIC	PIC Model Number	T640-FPC3	T640-FPC3-E	T640-FPC3-E2	T640-FPC3-ES
10-Gigabit Ethernet, 1-port DWDM	PC-1XGE-DWDM-CBAND	8.5	8.5	8.5	9.0
10-Gigabit Ethernet, 1-port DWDM OTN	PC-1XGE-DWDM-OTN	9.4	9.4	9.4	9.4
Services PICs					
MultiServices 500	PC-MS-500-3	–	8.5	8.5	9.3
Tunnel Services	PC-TUNNEL	8.5	8.5	8.5	9.0
SONET/SDH PICs					
OC48/STM16 IQE, 4-port SFP	PC-4OC48-STM16-IQE-SFP in a standalone T1600 router This PIC is not supported in a T1600 router connected to a TX Matrix Plus router.	–	–	–	10.4R2
OC48c/STM16, 4-port SFP	PC-4OC48-SON-SFP	8.5	8.5	8.5	9.0
OC192c /STM64, 1-port	PC-1OC192-SON-VSR	8.5	8.5	8.5	9.0
OC192 /STM64, 1-port XFP	PC-1OC192-SON-XFP	–	8.5	8.5	9.0

PIC/FPC Compatibility (Type 4 FPCs and Type 4 PICs)

Table 21 on page 19 provides a PIC/FPC compatibility matrix for the current Type 4 PICs for the T1600 router and Type 4 FPCs.



NOTE: A T1600 router in a routing matrix supports Type 4 PICs in Junos OS Release 9.6R2 and later.

Table 21: T1600 PIC/FPC Compatibility Type 4

Type 4 PIC	PIC Model Number	T640-FPC4-ES	T1600-FPC4-ES	T640-FPC4-1P-ES
10-Gigabit Ethernet PICs				
10-Gigabit Ethernet, 4-port LAN/WAN XFP	PD-4XGE-XFP	9.0	9.0	9.5

Table 21: T1600 PIC/FPC Compatibility Type 4 (*continued*)

Type 4 PIC	PIC Model Number	T640-FPC4-ES	T1600-FPC4-ES	T640-FPC4-1P-ES
10-Gigabit LAN/WAN with Oversubscription and SFP+	PD-5-10XGE-SFPP	10.1	10.1 <i>NOTE:</i> To support PD-5-10XGE-SFPP, the hardware version of the T1600-FPC4-ES (part number 710-013037) REV 13 or later is required.	10.1
40-Gigabit Ethernet PICs				
40-Gigabit with CFP	PD-1XLE-CFP	—	11.4	11.4
100-Gigabit Ethernet PICs				
100-Gigabit with CFP	PD-ICE-CFP-FPC4 (PIC and FPC) <i>NOTE:</i> This PIC is only available packaged in an assembly with the T1600-FPC4-ES FPC.	—	—	10.3
Services PICs				
40-Gigabit Tunnel Services	PD-TUNNEL	8.5	8.5	9.5
SONET/SDH PICs				
OC192/STM64, 4-port XFP	PD-4OC192-SON-XFP	8.5	8.5	9.5
OC768c/STM256, 1-port	PD-1OC768-SON-SR	8.5	8.5	9.5

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)
 - [T1600 FPCs Supported](#)

CHAPTER 2

Network Interface Specifications

- Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21
- Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
- Gigabit Ethernet 1000BASE Optical Interface Specifications on page 34
- Gigabit Ethernet 1000BASE-T Copper Interface Specifications on page 37
- 10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
- 10-Gigabit Ethernet DWDM Optical Interface Specifications on page 43
- 10-Gigabit Ethernet DWDM Transceiver Wavelengths on page 44
- 100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
- SONET/SDH OC3/STM1 Optical Interface Specifications on page 50
- SONET/SDH OC12/STM4 Optical Interface Specifications on page 52
- SONET/SDH OC48/STM16 Optical Interface Specifications on page 54
- SONET/SDH OC192/STM64 Optical Interface Specifications on page 57
- SONET/SDH OC768/STM256 Optical Interface Specifications on page 60

Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers

Table 22 on page 22 and Table 23 on page 29 list the transceivers supported by ACX, M, MX, and T Series devices.



NOTE: Not all transceivers are supported on all devices. To determine which transceivers are supported in a particular device, see the “Cables and Connectors” section for each PIC, MIC, or line card in the *Interface Module Reference* for your device, or see the [Hardware Compatibility Tool](#).



TIP: You can use the [Hardware Compatibility Tool](#) to find information about the pluggable transceivers supported on your Juniper Networks device.

- [Table 22 on page 22](#) lists the supported Ethernet standards for each transceiver.
- [Table 23 on page 29](#) lists the supported SONET standards for each transceiver.

Some transceivers support monitoring by using the operational mode CLI command **show interfaces diagnostics optics**. To determine which transceivers support monitoring, refer to the “Monitoring Available” column in [Table 22 on page 22](#) and [Table 23 on page 29](#). For a description of the monitoring fields displayed by the transceiver, see *show interfaces diagnostics optics (Gigabit Ethernet, 10-Gigabit Ethernet, 40-Gigabit Ethernet, 100-Gigabit Ethernet, and Virtual Chassis Port)* or *show interfaces diagnostics optics (SONET)*.



CAUTION: If you face a problem running a Juniper Networks device that uses a third-party optic or cable, the Juniper Networks Technical Assistance Center (JTAC) can help you diagnose the source of the problem. Your JTAC engineer might recommend that you check the third-party optic or cable and potentially replace it with an equivalent Juniper Networks optic or cable that is qualified for the device.



NOTE: For XFP transceivers that can support either the 10-Gigabit Ethernet or SONET OC192/STM64 specifications, check the standard supported for the device into which the transceiver is installed. For example, the XFP-10G-E-OC192-IR2 transceiver installed in a 10-Gigabit Ethernet PIC supports the 10GBASE-E standard. However, the XFP-10G-E-OC192-IR2 transceiver installed in a SONET OC192/STM64 PIC supports the SONET OC192/STM64 IR2 standard.

[Table 22 on page 22](#) is organized by transmission speed and then alphabetically by model number.

Table 22: Supported Ethernet Standards

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
Ethernet 10BASE, Fast Ethernet 100BASE, and Gigabit Ethernet 1000BASE Specifications					
SFP-1FE-FX	SFP	LC	No	100BASE-FX	• <i>Fast Ethernet 100BASE-FX Optical Interface Specifications</i>
SFP-1GE-FE-E-T	SFP	RJ-45	No	10/100/1000 BASE-T	• <i>Ethernet 10BASE-T Copper Interface Specifications</i> • <i>Fast Ethernet 100BASE-T Copper Interface Specifications</i> • Gigabit Ethernet 1000BASE-T Copper Interface Specifications on page 37

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
SFP-1GE-LH	SFP	LC	Yes	1000BASE-LH	Gigabit Ethernet 1000BASE Optical Interface Specifications on page 34
SFP-1GE-LX	SFP	LC	Yes	1000BASE-LX 1000BASE-LX10	Gigabit Ethernet 1000BASE Optical Interface Specifications on page 34
SFP-1GE-SX	SFP	LC	Yes	1000BASE-SX	Gigabit Ethernet 1000BASE Optical Interface Specifications on page 34
SFP-1GE-T	SFP	RJ-45	No	1000BASE-T	Gigabit Ethernet 1000BASE-T Copper Interface Specifications on page 37
SFP-FE20KT13R15	SFP	LC	No	100BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-FE20KT15R13	SFP	LC	No	100BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-GE10KT13R14	SFP	LC	Yes	1000BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-GE10KT13R15	SFP	LC	Yes	1000BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-GE10KT14R13	SFP	LC	Yes	1000BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
SFP-GE10KT15R13	SFP	LC	Yes	1000BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-GE40KM	SFP	LC	Yes	1000BASE-EX	Gigabit Ethernet 1000BASE Optical Interface Specifications on page 34
SFP-GE40KT13R15	SFP	LC	Yes	1000BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-GE40KT15R13	SFP	LC	Yes	1000BASE-BX	Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications on page 31
SFP-GE80KCW1470-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications
SFP-GE80KCW1490-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications
SFP-GE80KCW1510-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications
SFP-GE80KCW1530-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications
SFP-GE80KCW1550-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications
SFP-GE80KCW1570-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications
SFP-GE80KCW1590-ET	SFP	LC	Yes	NA	Gigabit Ethernet SFP CWDM Optical Interface Specifications

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
SFP-GE80KCWI610-ET	SFP	LC	Yes	NA	<i>Gigabit Ethernet SFP CWDM Optical Interface Specifications</i>
10-Gigabit Ethernet 10GBASE Specifications					
PC-1XGE-DWDM-CBAND	Fixed	SC	Yes	10-Gigabit Ethernet dense wavelength-division multiplexing (DWDM)	<i>10-Gigabit Ethernet DWDM Optical Interface Specifications on page 43</i> <i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
PC-1XGE-DWDM-OTN	Fixed	SC	Yes	10-Gigabit Ethernet dense wavelength-division multiplexing (DWDM) OTN	<i>10-Gigabit Ethernet DWDM OTN Optical Interface Specifications</i> <i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
SFPP-10G-CT50-ZR	SFP+	LC	Yes	10GBASE-Z	<i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
SFPP-10G-DT-ZRC2	SFP+	LC	Yes	10BASE-Z	<i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
SFPP-10G-ER-OTN	SFP+	LC	Yes	10GBASE-ER	<i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
SFPP-10G-LR-OTN	SFP+	LC	Yes	10GBASE-LR	<i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
SFPP-10G-ZR-OTN-XT	SFP+	LC	Yes	10GBASE-Z	<i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>
SFPP-10GE-ER	SFP+	LC	Yes	10GBASE-ER	<i>10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38</i>

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
SFPP-10GE-LR	SFP+	LC	Yes	10GBASE-LR	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
SFPP-10GE-LRM	SFP+	LC	Yes	10GBASE-LRM	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
SFPP-10GE-SR	SFP+	LC	Yes	10GBASE-SR	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
SFPP-10GE-ZR	SFP+	LC	Yes	10GBASE-Z	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XENPAK-1XGE-ER	XENPAK	SC	Yes	10GBASE-ER	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XENPAK-1XGE-LR	XENPAK	SC	Yes	10GBASE-LR	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XENPAK-1XGE-SR	XENPAK	SC	Yes	10GBASE-SR	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XENPAK-1XGE-ZR EOL (see PSN-2010-02-649)	XENPAK	SC	Yes	10GBASE-Z	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XFP-10G-CBAND-T50-ZR	XFP	LC	Yes	10GBASE-Z 10-Gigabit Ethernet dense wavelength-division multiplexing (DWDM)	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XFP-10G-E-OC192-IR2	XFP	LC	Yes	10GBASE-E	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
XFP-10G-L-OC192-SR1	XFP	LC	Yes	10GBASE-L	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XFP-10G-S	XFP	LC	Yes	10GBASE-S	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
XFP-10G-Z-OC192-LR2	XFP	LC	Yes	10GBASE-Z	10-Gigabit Ethernet 10GBASE Optical Interface Specifications on page 38
40-Gigabit Ethernet 40GBASE Specifications					
CFP-40GBASE-LR4	CFP	SC	Yes	40GBASE-LR4	40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications
QSFP-40G-LX4	QSFP+	LC	Yes	40GBASE-LX4	40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications
QSFP-40GE-LX4	QSFP+	LC	Yes	40GBASE-LX4	40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications
QSFP-40GBASE-ER4	QSFP+	LC	Yes	40GBASE-ER4	40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications
QSFP-40GBASE-LR4	QSFP+	LC	Yes	40GBASE-LR4	40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications
QSFP-40GBASE-SR4	QSFP+	12-fiber MPO	Yes	40GBASE-SR4	40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications
100-Gigabit Ethernet 100GBASE-R Specifications					
CFP-100GBASE-ER4	CFP	LC	Yes	100GBASE-ER4	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
CFP-GEN2-CGE-ER4	CFP	LC	Yes	100GBASE-ER4	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
CFP-100GBASE-LR4	CFP	SC	Yes	100GBASE-LR4	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
CFP-GEN2-100GBASE-LR4	CFP	LC	Yes	100GBASE-LR4	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
CFP-100GBASE-SR10	CFP	24-fiber MPO	Yes NOTE: Optical power monitoring is not supported.	100GBASE-SR10	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
CFP-100GBASE-ZR	CFP	LC	Yes	None	See the Juniper Networks specification in the "100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications" on page 46.
CFP2-100GBASE-LR4	CFP2	LC	Yes	100GBASE-LR4	See the Juniper Networks specification in the "100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications" on page 46.
CFP2-100G-ER4-D	CFP2	LC	Yes	100GBASE-ER4	See the Juniper Networks specification in the "100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications" on page 46.
CFP2-100G-SR10-D3	CFP2	24-fiber MPO	Yes	100GBASE-SR10	See the Juniper Networks specification in the "100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications" on page 46.

Table 22: Supported Ethernet Standards (*continued*)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
CXP-100GBASE-SR10	CXP	24-fiber MPO	Yes	100GBASE-SR10	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
QSFP28-100G-SR4	QSFP28	12-fiber MPO	Yes	100G-SR4	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
QSFP28-100G-LR4	QSFP28	LC	Yes	100G-LR4	100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications on page 46
TCFP2-100G-C	CFP2-ACO	LC/UPC	Yes	100-Gigabit DWDM OTN	100-Gigabit DWDM OTN CFP2-ACO Transceiver Wavelengths

Table 23 on page 29 is organized by transmission speed and then alphabetically by model number.

Table 23: Supported SONET Standards

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
SONET OC3/STM1 Specifications					
SFP-OC3-IR	SFP	LC	Yes	SONET/SDH OC3/STM1 Intermediate Reach	SONET/SDH OC3/STM1 Optical Interface Specifications on page 50
SFP-OC3-LR	SFP	LC	Yes	SONET/SDH OC3/STM1 Long Reach	SONET/SDH OC3/STM1 Optical Interface Specifications on page 50
SFP-OC3-SR	SFP	LC	Yes	SONET/SDH OC3/STM1 Multimode	SONET/SDH OC3/STM1 Optical Interface Specifications on page 50
SONET OC12/STM4 Specifications					
SFP-OC12-IR	SFP	LC	Yes	SONET/SDH OC12/STM4 Intermediate Reach (IR-1)	SONET/SDH OC12/STM4 Optical Interface Specifications on page 52
SFP-OC12-LR	SFP	LC	Yes	SONET/SDH OC12/STM4 Long Reach (LR-1)	SONET/SDH OC12/STM4 Optical Interface Specifications on page 52

Table 23: Supported SONET Standards (continued)

Model Number	Transceiver Type	Connector	Monitoring Available	Standard	Specifications
SFP-OC12-LR2	SFP	LC	Yes	SONET/SDH OC12/STM4 Long Reach (LR-2)	SONET/SDH OC12/STM4 Optical Interface Specifications on page 52
SFP-OC12-SR	SFP	LC	Yes	SONET/SDH OC12/STM4 Short Reach (SR-1)	SONET/SDH OC12/STM4 Optical Interface Specifications on page 52
SONET OC48/STM16 Specifications					
SFP-10C48-IR	SFP	LC	No	SONET/SDH OC48/STM16 Intermediate Reach (IR-1)	SONET/SDH OC48/STM16 Optical Interface Specifications on page 54
SFP-10C48-LR	SFP	LC	Yes	SONET/SDH OC48/STM16 Long Reach (LR-2)	SONET/SDH OC48/STM16 Optical Interface Specifications on page 54
SFP-10C48-SR	SFP	LC	No	SONET/SDH OC48/STM16 Short Reach (SR-1)	SONET/SDH OC48/STM16 Optical Interface Specifications on page 54
SONET OC192/STM64 Specifications					
XFP-10G-E-OC192-IR2	XFP	LC	Yes	SONET/SDH OC192/STM64 Intermediate Reach (IR-2)	SONET/SDH OC192/STM64 Optical Interface Specifications on page 57
XFP-10G-L-OC192-SR1	XFP	LC	Yes	SONET/SDH OC192/STM64 Short Reach (SR-1)	SONET/SDH OC192/STM64 Optical Interface Specifications on page 57
XFP-10G-Z-OC192-LR2	XFP	LC	Yes	SONET/SDH OC192/STM64 Long Reach (LR-2)	SONET/SDH OC192/STM64 Optical Interface Specifications on page 57
SONET OC768/STM256 Specifications					
PD-10C768-SON-SR	Fixed	SC	Yes	SONET/SDH OC768/STM256 Short Reach (SR)	SONET/SDH OC768/STM256 Optical Interface Specifications on page 60

Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications

The bidirectional SFP standards are supported on M Series, MX Series, and T Series routers.

To determine which transceivers support each bidirectional SFP standard, see [“Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21](#). The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

The standards are organized by distance supported.

- [Fast Ethernet 100BASE-BX Bidirectional SFP Optical Interface Specifications on page 31](#)
- [Gigabit Ethernet 1000BASE-BX Bidirectional SFP \(U 13/14 and D 14/13\) Optical Interface Specifications on page 32](#)
- [Gigabit Ethernet 1000BASE-BX Bidirectional SFP \(U 13/15 and D 15/13\) Optical Interface Specifications on page 33](#)
- [Gigabit Ethernet 1000BASE-BX Bidirectional SFP \(40 U 13/15 and D 15/13\) Optical Interface Specifications on page 33](#)

Fast Ethernet 100BASE-BX Bidirectional SFP Optical Interface Specifications

[Table 24 on page 31](#) shows the optical specifications for 100BASE-BX bidirectional SFPs. 100BASE-BX bidirectional interfaces are supported in Junos OS Release 9.6 and later and must be used in pairs.

Table 24: Fast Ethernet 100BASE-BX Bidirectional SFP Optical Interface Specifications

Parameter	100BASE-BX-U	100BASE-BX-D
Pairs with	100BASE-BX-D	100BASE-BX-U
Transceiver model number	SFP-FE20KT13R15	SFP-FE20KT15R13
Rate	100 Mbps	100 Mbps
Optical interface	Single-mode	Single-mode
Transceiver type	SFP	SFP
Standard	100BASE-BX IEEE 802.3-2005	100BASE-BX IEEE 802.3-2005
Maximum distance	9/125 SMF cable: 12.4 miles (20 km)	9/125 SMF cable: 12.4 miles (20 km)
Transmitter wavelength	1260 through 1360 nm	1480 through 1580 nm
Average launch power	–14 through –8 dBm	–14 through –8 dBm

Table 24: Fast Ethernet 100BASE-BX Bidirectional SFP Optical Interface Specifications (*continued*)

Parameter	100BASE-BX-U	100BASE-BX-D
Average receive power	–45 through –8 dBm	–45 through –8 dBm
Receiver saturation	–8 dBm	–8 dBm
Receiver sensitivity	–45 dBm	–45 dBm

Gigabit Ethernet 1000BASE-BX Bidirectional SFP (U 13/14 and D 14/13) Optical Interface Specifications

Table 25 on page 32 shows the optical specifications for 1000BASE-BX bidirectional SFPs. 1000BASE-BX bidirectional interfaces are supported in Junos OS Release 9.0 and later and must be used in pairs.

Table 25: Gigabit Ethernet 1000BASE-BX Bidirectional SFP (U 13/14 and D 14/13) Optical Interface Specifications

Parameter	1000BASE-BX10-U 13/14	1000BASE-BX10-D 14/13
Pairs with	1000BASE-BX10-D 14/13	1000BASE-BX10-U 13/14
Transceiver model number	SFP-GE10KT13R14	SFP-GE10KT14R13
Rate	1000 Mbps	1000 Mbps
Optical interface	Single-mode	Single-mode
Transceiver type	SFP	SFP
Standard	IEEE 802.3-2005	IEEE 802.3-2005
Maximum distance	9/125 SMF cable: 6.2 miles (10 km)	9/125 SMF cable: 6.2 miles (10 km)
Transmitter wavelength	1260 through 1360 nm	1480 through 1500 nm
Average launch power	–9 through –3 dBm	–9 through –3 dBm
Average receive power	–19.5 through –3 dBm	–19.5 through –3 dBm
Receiver saturation	–3 dBm	–3 dBm
Receiver sensitivity	–19.5 dBm	–19.5 dBm

Gigabit Ethernet 1000BASE-BX Bidirectional SFP (U 13/15 and D 15/13) Optical Interface Specifications

Table 27 on page 33 shows the optical specifications for 1000BASE-BX bidirectional SFPs. 1000BASE-BX bidirectional interfaces are supported in Junos OS Release 9.0 and later and must be used in pairs.

Table 26: Gigabit Ethernet 1000BASE-BX Bidirectional SFP (U 13/15 and D 15/13) Optical Interface Specifications

Parameter	1000BASE-BX10-U 13/15	1000BASE-BX10-D 15/13
Pairs with	1000BASE-BX10-D 15/13	1000BASE-BX10-U 13/15
Transceiver model number	SFP-GE10KT13R15	SFP-GE10KT15R13
Rate	1000 Mbps	1000 Mbps
Optical interface	Single-mode	Single-mode
Transceiver type	SFP	SFP
Standard	Multivendor agreement	Multivendor agreement
Maximum distance	9/125 SMF cable: 6.2 miles (10 km)	9/125 SMF cable: 6.2 miles (10 km)
Transmitter wavelength	1270 through 1360 nm	1530 through 1570 nm
Average launch power	–9 through –3 dBm	–9 through –3 dBm
Average receive power	–20 through –3 dBm	–20 through –3 dBm
Receiver saturation	–3 dBm	–3 dBm
Receiver sensitivity	–20 dBm	–20 dBm

Gigabit Ethernet 1000BASE-BX Bidirectional SFP (40 U 13/15 and D 15/13) Optical Interface Specifications

Table 26 on page 33 shows the optical specifications for 1000BASE-BX bidirectional SFPs. 1000BASE-BX bidirectional interfaces are supported in JUNOS 9.0 and later and must be used in pairs.

Table 27: Gigabit Ethernet 1000BASE-BX Bidirectional SFP (40 U 13/15 and D 15/13) Optical Interface Specifications

Parameter	1000BASE-BX40-U 13/15	1000BASE-BX40-D 15/13
Pairs with	1000BASE-BX40-D 15/13	1000BASE-BX40-U 13/15

Table 27: Gigabit Ethernet 1000BASE-BX Bidirectional SFP (40 U 13/15 and D 15/13) Optical Interface Specifications (*continued*)

Parameter	1000BASE-BX40-U 13/15	1000BASE-BX40-D 15/13
Transceiver model number	SFP-GE40KT13R15	SFP-GE40KT15R13
Rate	1000 Mbps	1000 Mbps
Optical interface	Single-mode	Single-mode
Transceiver type	SFP	SFP
Standard	Multivendor agreement	Multivendor agreement
Maximum distance	9/125 SMF cable: 24.9 miles (40 km)	9/125 SMF cable: 24.9 miles (40 km)
Transmitter wavelength	1260 through 1360 nm	1530 through 1570 nm
Average launch power	-3 through 2 dBm	-7 through 2 dBm
Average receive power	-23 through -3 dBm	-23 through -3 dBm
Receiver saturation	-3 dBm	-3 dBm
Receiver sensitivity	-23 dBm	-23 dBm

Related Documentation

- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

Gigabit Ethernet 1000BASE Optical Interface Specifications

To determine which transceivers support each Gigabit Ethernet 1000BASE standard, see “Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21. The “Cables and connectors” section in the description for each DPC, MIC, or PIC lists which standards and transceivers are supported.

The standards are organized by distance supported.

- [Gigabit Ethernet 1000BASE-SX Optical Interface Specifications on page 35](#)
- [Gigabit Ethernet 1000BASE-LX Optical Interface Specifications on page 35](#)
- [Gigabit Ethernet 1000BASE-LX10 Optical Interface Specifications on page 36](#)
- [Gigabit Ethernet 1000BASE-EX Optical Interface Specifications on page 36](#)
- [Gigabit Ethernet 1000BASE-LH Optical Interface Specifications on page 37](#)

Gigabit Ethernet 1000BASE-SX Optical Interface Specifications

Table 28 on page 35 shows the optical interface specifications for the 1000BASE-SX standard.

Table 28: Gigabit Ethernet 1000BASE-SX Optical Interface Specifications

Parameter	1000BASE-SX
Rate	1000 Mbps
Optical interface	Multimode
Maximum distance	62.5/125 MMF cable: 656 ft (200 m) 50/125 MMF cable: 1640 ft (500 m)
Transmitter wavelength	770 through 860 nm
Average launch power	−9.5 through 0 dBm
Average receive power	−17 through 0 dBm
Receiver saturation	0 dBm
Receiver sensitivity	−17 dBm

Gigabit Ethernet 1000BASE-LX Optical Interface Specifications

Table 29 on page 35 shows the optical interface specifications for the 1000BASE-LX standard.

Table 29: Gigabit Ethernet 1000BASE-LX Optical Interface Specifications

Parameter	1000BASE-LX
Rate	1000 Mbps
Optical interface	Multimode and single-mode
Maximum distance	62.5/125 and 50/125 MMF cable: 1804.5 ft (550 m) 9/125 SMF cable: 6.2 miles (10 km)
Transmitter wavelength	1270 through 1355 nm
Average launch power	−11.5 through −3 dBm
Average receive power	−19 through −3 dBm

Table 29: Gigabit Ethernet 1000BASE-LX Optical Interface Specifications (*continued*)

Parameter	1000BASE-LX
Receiver saturation	−3 dBm
Receiver sensitivity	−19 dBm

Gigabit Ethernet 1000BASE-LX10 Optical Interface Specifications

Table 30 on page 36 shows the optical interface specifications for the 1000BASE-LX10 standard.

Table 30: Gigabit Ethernet 1000BASE-LX10 Optical Interface Specifications

Parameter	1000BASE-LX10
Rate	1000 Mbps
Optical interface	Single-mode
Maximum distance	9/125 SMF cable: 6.2 miles (10 km)
Transmitter wavelength	1270 through 1355 nm
Average launch power	−11.5 through −3 dBm
Average receive power	−19 through −3 dBm
Receiver saturation	−3 dBm
Receiver sensitivity	−19 dBm

Gigabit Ethernet 1000BASE-EX Optical Interface Specifications

Table 30 on page 36 shows the optical interface specifications for the 1000BASE-EX standard.

Table 31: Gigabit Ethernet 1000BASE-EX Optical Interface Specifications

Parameter	1000BASE-EX
Rate	1000 Mbps
Optical interface	Single-mode
Maximum distance	9/125 SMF cable: 24.85 miles (40 km)
Transmitter wavelength	1260 through 1360 nm

Table 31: Gigabit Ethernet 1000BASE-EX Optical Interface Specifications (*continued*)

Parameter	1000BASE-EX
Average launch power	–4.5 through 0 dBm
Average receive power	–22.5 through –3 dBm
Receiver saturation	–3 dBm
Receiver sensitivity	–22.5 dBm

Gigabit Ethernet 1000BASE-LH Optical Interface Specifications

Table 32: Gigabit Ethernet 1000BASE-LH Optical Interface Specifications

Parameter	1000BASE-LH
Rate	1000 Mbps
Optical interface	Single-mode
Maximum distance	9/125 SMF cable: 43.5 miles (70 km)
Transmitter wavelength	1460 through 1580 nm
Average launch power	–3 through +3 dBm
Average receive power	–20 through –3 dBm
Receiver saturation	–3 dBm
Receiver sensitivity	–20 dBm

- Related Documentation**
- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

Gigabit Ethernet 1000BASE-T Copper Interface Specifications

The 1000BASE-T copper standard is supported on M Series, MX Series, and T Series routers.

To determine which transceivers support the 1000BASE-T copper standard, see “Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21. The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

Table 33 on page 38 shows the copper interface specifications for the 1000BASE-T standard.

Table 33: 1000BASE-T Copper Interface Specifications

Parameter	1000BASE-T
Rate	1000 Mbps autosensing
Distance	328 ft (100 m)
Cable	Four-pair, Category 5 shielded twisted-pair

- Related Documentation**
- Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21

10-Gigabit Ethernet 10GBASE Optical Interface Specifications

To determine which transceivers support each 10GBASE standard, see “Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21. The “Cables and Connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.



NOTE: Some XFP transceivers can support either the 10-Gigabit Ethernet or SONET/SDH OC192/STM64 specifications. Check the standard supported for the device in which the transceiver is installed. For example, the XFP-10G-E-OC192-IR2 transceiver installed in a 10-Gigabit Ethernet PIC supports the 10GBASE-E standard. However, the XFP-10G-E-OC192-IR2 transceiver installed in a SONET/SDH OC192/STM64 PIC supports the SONET/SDH OC192/STM64 IR2 standard.

The specifications are organized by distance supported.

- 10GBASE-LRM Specifications on page 38
- 10GBASE-S Specifications on page 39
- 10GBASE-L Specifications on page 40
- 10GBASE-E Specifications on page 41
- 10GBASE-Z Specifications on page 41

10GBASE-LRM Specifications

Table 34 on page 39 shows the optical interface specifications for the 10GBASE-LRM standard.

Table 34: 10GBASE-LRM Optical Interface Specifications

Parameter	10GBASE-LRM
Optical interface	Single-mode Multimode
Standard	IEEE 802.3aq—2006
Maximum distance	Single-mode: 9/125 SMF cable: 300 m (984 ft) Multimode: 62.5 /125 MMF cable, 500 MHz-km: 220 m (722 ft) 50/125 MMF cable, 500 MHz-km: 220 m (722 ft) 50/125 MMF cable, 400 MHz-km: 100 m (328 ft)
Transmitter wavelength	1260 through 1355 nm
Average launch power	−6.5 through +0.5 dBm
Average receive power	−8.4 through +0.5 dBm
Overload in OMA	+1.5 dBm
Stressed sensitivity in OMA	−6.5 dBm

10GBASE-S Specifications

Table 35 on page 39 shows the optical interface specifications for the 10GBASE-SR and 10GBASE-SW standards.



NOTE: The XFP-10G-L-OC192-SR1 transceiver supports single-mode fiber and the 10GBASE-L optical interface specifications.

Table 35: 10GBASE-S (10GBASE-SR and 10GBASE-SW) Optical Interface Specifications

Parameter	10GBASE-S
Optical interface	Multimode
Standard	IEEE 802.3ae—2002

Table 35: 10GBASE-S (10GBASE-SR and 10GBASE-SW) Optical Interface Specifications (*continued*)

Parameter	10GBASE-S
Maximum distance	50/125 MMF cable, 400 MHz-km: 66 m (217 ft) 50/125 MMF cable, 500 MHz-km: 82 m (269 ft) 50/125 MMF cable, 2000 MHz-km: 300 m (948 ft) 50/125 MMF cable, 4700 MHz-km: 400 m (1312 ft) 62.5/125 MMF cable, 200 MHz-km: 33 m (108 ft) 62.5/125 MMF cable, 160 MHz-km: 26 m (85 ft)
Transmitter wavelength	840 through 860 nm
Average launch power	−7.3 through −1.0 dBm
Average receive power	−9.9 through −1.0 dBm
Receiver saturation	−1.0 dBm
Receiver sensitivity (max) in OMA	−11.1 dBm

10GBASE-L Specifications

Table 36 on page 40 shows the optical interface specifications for the 10GBASE-LR and 10GBASE-LW standards.

Table 36: 10GBASE-L (10GBASE-LR and 10GBASE-LW) Optical Interface Specifications

Parameter	10GBASE-L
Optical interface	Single-mode
Standard	IEEE 802.3ae—2002
Maximum distance	9/125 SMF cable: 10 km (6.2 miles)
Transmitter wavelength	1260 through 1355 nm
Average launch power	−8.2 through 0.5 dBm
Average receive power	−14.4 through 0.5 dBm
Receiver saturation	0.5 dBm
Receiver sensitivity (max) in OMA	−12.6 dBm

10GBASE-E Specifications

Table 37 on page 41 shows the optical interface specifications for the 10GBASE-ER and 10GBASE-EW standards.

Table 37: 10GBASE-E (10GBASE-ER and 10GBASE-EW) Optical Interface Specifications

Parameter	10GBASE-E
Optical interface	Single-mode
Standard	IEEE 802.3ae—2002
Maximum distance	9/125 SMF cable: 40 km (24.8 miles); distances greater than 30 km (18.6 miles) are considered to be engineered links. NOTE: Any distance greater than 30 km requires engineered links that must be field-tested to verify the conformance of the 10.9 dB channel insertion loss specification. EANSI/TIA/EIA-526-7/Method A1 describes the insertion loss measurement of installed fiber-optic cables.
Transmitter wavelength	1530 through 1565 nm
Average launch power	−4.7 through 4.0 dBm
Average receive power	−15.8 through −1.0 dBm
Receiver saturation	−1.0 dBm
Receiver sensitivity (max) in OMA	−14.1 dBm

10GBASE-Z Specifications

Table 38 on page 41 shows the optical interface specifications for the 10GBASE-ZR and 10GBASE-ZW transceiver.

Table 38: 10GBASE-Z (10GBASE-ZR and 10GBASE-ZW) Optical Interface Specifications

Parameter	10GBASE-Z
Optical interface	Single-mode
Standard	Multivendor
Maximum distance	9/125 SMF cable: 80 km (49.6 miles)

Table 38: 10GBASE-Z (10GBASE-ZR and 10GBASE-ZW) Optical Interface Specifications (*continued*)

Parameter	10GBASE-Z
Transmitter wavelength	1530 through 1565 nm 1528.77 through 1563.86 nm (tunable) for XFP-10G-CBAND-T50-ZR 1528.38 through 1568.77 nm (tunable) for SFPP-10G-CT50-ZR 1528.38 through 1568.77 nm (tunable) for SFPP-10G-DT-ZRC2
Average launch power	0 through 4.0 dBm for XENPAK-1XGE-ZR, XFP-10G-Z-OC192-LR2, and SFPP-10G-ZR-OTN-XT –1.0 through +3.0 dBm for XFP-10G-CBAND-T50-ZR 0 through 4.0 dBm for SFPP-10GE-ZR –1.0 through +3.0 dBm for SFPP-10G-CT50-ZR and SFPP-10G-DT-ZRC2
Average receive power	–25.0 through –7.0 dBm for XENPAK-1XGE-ZR –23.0 through –7.0 dBm for XFP-10G-CBAND-T50-ZR –24.0 through –7.0 dBm for XFP-10G-Z-OC192-LR2 –24.0 through –7.0 dBm for SFPP-10GE-ZR –24.0 through –7.0 dBm for SFPP-10G-CT50-ZR –24.0 through –7.0 dBm (9.95, 10.312, and 10.709 Gbps) for SFPP-10G-DT-ZRC2 –24.0 through –7.0 dBm for SFPP-10G-ZR-OTN-XT
Receiver saturation	–7.0 dBm for XENPAK-1XGE-ZR, XFP-10G-CBAND-T50-ZR, XFP-10G-Z-OC192-LR2, SFPP-10G-CT50-ZR, SFPP-10G-DT-ZRC2, and SFPP-10G-ZR-OTN-XT –8.0 dBm for SFPP-10GE-ZR

Table 38: 10GBASE-Z (10GBASE-ZR and 10GBASE-ZW) Optical Interface Specifications (*continued*)

Parameter	10GBASE-Z
Receiver sensitivity	–25.0 dBm for XENPAK-1XGE-ZR –23.0 dBm for XFP-10G-CBAND-T50-ZR –24.0 dBm for XFP-10G-Z-OC192-LR2 –24.0 dBm for SFPP-10GE-ZR –24.0 dBm for SFPP-10G-CT50-ZR For SFPP-10G-DT-ZRC2: –24.0 dBm (9.95, 10.312, and 10.709 Gbps, BER < 1×10^{-12}, no FEC) –25.0 dBm (11.049 and 11.095 Gbps, BER < 1×10^{-6}, pre-FEC) NOTE: When you use SFPP-10G-DT-ZRC2 in OTU1e (11.049 Gbps) or OTU2e (11.095 Gbps) applications, you must enable forward error correction (FEC) to achieve target receiver sensitivity. To enable FEC mode, use the fec command at the [edit interfaces interface-name otn-options] hierarchy level (see <i>fec</i>). –24.0 dBm for SFPP-10G-ZR-OTN-XT

Related Documentation

- Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21

10-Gigabit Ethernet DWDM Optical Interface Specifications

The 10-Gigabit Ethernet DWDM PIC transceiver is supported on the M320 and T Series routers.

To determine which transceivers support the 10-Gigabit Ethernet DWDM optical interface specification, see “Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21. The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

Table 39 on page 44 shows the optical interface specifications for the 10-Gigabit Ethernet DWDM PIC transceiver.

Table 39: 10-Gigabit Ethernet DWDM LAN Rate Optical Interface Specifications

Parameter	Extra-Long Wavelength Serial DWDM, LAN Rate
Optical interface	Single-mode
Transceiver type	Dense wavelength division multiplexing (DWDM)
Standard	ITU-T G.694.1
Maximum distance	9/125 SMF cable: 49.6 miles (80 km)
Transmitter wavelength	1528.77 through 1563.86 nm, 100-GHz ITU grid
Average launch power	0 through 4.0 dBm
Transmit extinction ratio	9.0 dBm
Average receive power	–24.0 through –7.0 dBm
Receiver saturation	–7.0 dBm
Receiver sensitivity	–24.0 dBm

- Related Documentation**
- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

10-Gigabit Ethernet DWDM Transceiver Wavelengths

Table 40 on page 45 provides the supported wavelengths for the 100-GHz grid and the 50-GHz offset in both THz and nm.

Table 40: Programmable Wavelengths Supported by 10-Gigabit Ethernet DWDM Transceivers

100-GHz Grid		50-GHz Offset		100-GHz Grid		50-GHz Offset	
THz	nm	THz	nm	THz	nm	THz	nm
191.70	1563.86	191.75	1563.45	194.00	1545.32	194.05	1544.92
191.80	1563.04	191.85	1562.63	194.10	1544.52	194.15	1544.12
191.90	1562.23	191.95	1561.82	194.20	1543.73	194.25	1543.33
192.00	1561.41	192.05	1561.01	194.30	1542.93	194.35	1542.53
192.10	1560.60	192.15	1560.20	194.40	1542.14	194.45	1541.74
192.20	1559.79	192.25	1559.38	194.50	1541.34	194.55	1540.95
192.30	1558.98	192.35	1558.57	194.60	1540.55	194.65	1540.16
192.40	1558.17	192.45	1557.76	194.70	1539.76	194.75	1539.37
192.50	1557.36	192.55	1556.95	194.80	1538.97	194.85	1538.58
192.60	1556.55	192.65	1556.15	194.90	1538.18	194.95	1537.79
192.70	1555.74	192.75	1555.34	195.00	1537.39	195.05	1537.00
192.80	1554.94	192.85	1554.53	195.10	1536.60	195.15	1536.21
192.90	1554.13	192.95	1553.73	195.20	1535.82	195.25	1535.42
193.00	1553.32	193.05	1552.92	195.30	1535.03	195.35	1534.64
193.10	1552.52	193.15	1552.12	195.40	1534.25	195.45	1533.85
193.20	1551.72	193.25	1551.31	195.50	1533.46	195.55	1533.07
193.30	1550.91	193.35	1550.51	195.60	1532.68	195.65	1532.28
193.40	1550.11	193.45	1549.71	195.70	1531.89	195.75	1531.50
193.50	1549.31	193.55	1548.91	195.80	1531.11	195.85	1530.72
193.60	1548.51	193.65	1548.11	195.90	1530.33	195.95	1529.94
193.70	1547.71	193.75	1547.31	196.00	1529.55	196.05	1529.16
193.80	1546.91	193.85	1546.51	196.10	1528.77		
193.90	1546.11	193.95	1545.72				

Related Documentation

- [Ethernet DWDM Interface Wavelength Overview](#)
[Configuring the 10-Gigabit or 100-Gigabit Ethernet DWDM Interface Wavelength](#)
- [Network Cable and Transceiver Overview for ACX Series, M Series, and MX Series Routers](#)
- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications

To determine which transceivers support each 100GBASE-R standard, see “[Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers](#)” on page 21. The “Cables and Connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

The specifications are organized by distance supported.



NOTE: The CFP-100GBASE-ZR transceiver is not supported on the T1600 and T4000 routers.

- [100GBASE-SR10 Specifications on page 46](#)
- [100GBASE-SR4 Specifications on page 47](#)
- [100GBASE-LR4 Specifications on page 47](#)
- [100GBASE-ER4 Specifications on page 48](#)
- [Juniper Networks Specifications for CFP-100GBASE-ZR on page 49](#)

100GBASE-SR10 Specifications

Table 41 on page 46 shows the optical interface specifications for the 100GBASE-SR10 standard.

Table 41: 100GBASE-SR10 Optical Interface Specifications

Parameter	100GBASE-SR10
Optical interface	Multimode
Standard	IEEE 802.3ba—2010
Maximum distance	OM3 MMF cable, 100 m (328 ft) OM4 MMF cable, 150 m (492 ft)
Transmitter wavelength per lane	840 through 860 nm
Average launch power per lane	−7.6 through 2.4 dBm
Average receive power per lane	−9.5 through 2.4 dBm

Table 41: 100GBASE-SR10 Optical Interface Specifications (*continued*)

Parameter	100GBASE-SR10
Stressed receiver sensitivity (OMA) per lane (maximum)	−5.4 dBm

100GBASE-SR4 Specifications

Table 42 on page 47 shows the optical interface specifications for the 100GBASE-SR4 standard.

Table 42: 100GBASE-SR4 Optical Interface Specifications

Parameter	100GBASE-SR4
Optical interface	Multimode
Standard	IEEE 802.3bm
Maximum distance	OM3 MMF cable, 70 m (230 feet) OM4 MMF cable, 100 m (328 feet)
Transmitter wavelength per lane	840 through 860 nm
Average launch power per lane	−8.4 through 2.4 dBm
Average receive power per lane	−10.3 through 2.4 dBm
Stressed receiver sensitivity (OMA), each lane (maximum)	−5.2 dBm

100GBASE-LR4 Specifications

Table 43 on page 47 shows the optical interface specifications for the 100GBASE-LR4 standard.

Table 43: 100GBASE-LR4 Optical Interface Specifications

Parameter	100GBASE-LR4
Optical interface	Single-mode
Standard	IEEE 802.3ba-2010
Maximum distance	9/125 SMF cable, 10 km (6.2 miles)

Table 43: 100GBASE-LR4 Optical Interface Specifications (*continued*)

Parameter	100GBASE-LR4
Transmitter wavelength per lane	1294.53 through 1296.59 nm 1299.02 through 1301.09 nm 1303.54 through 1305.63 nm 1308.09 through 1310.19 nm
TX power per lane	minimum: -4.3 dBm (0.37 mW) maximum: 4.5 dBm (2.82 mW)
RX power per lane	minimum: -10.5 dBm (0.09 mW) maximum: 4.5 dBm (2.82 mW)
Total TX power	minimum: 1.7 dBm (1.48 mW) maximum: 10.5 dBm (11.28 mW)
Total RX power	minimum: -4.4 dBm (0.36 mW) maximum: 10.5 dBm (11.28 mW)
Receiver sensitivity (OMA) per lane (maximum)	-8.6 dBm

100GBASE-ER4 Specifications

Table 44 on page 48 shows the optical interface specifications for the 100GBASE-ER4 standard.

Table 44: 100GBASE-ER4 Optical Interface Specifications

Parameter	100GBASE-ER4
Optical interface	Single-mode
Standard	IEEE 802.3ba-2010
Maximum distance	SMF cable, 40 km (24.9 miles)
Transmitter wavelength per lane	1294.53 through 1296.59 nm 1299.02 through 1301.09 nm 1303.54 through 1305.63 nm 1308.09 through 1310.19 nm
Average launch power per lane	-2.9 through 2.9 dBm

Table 44: 100GBASE-ER4 Optical Interface Specifications (*continued*)

Parameter	100GBASE-ER4
Average receive power per lane	–20.9 through 4.5 dBm
Receiver sensitivity (OMA) per lane (maximum)	–21.4 dBm

Juniper Networks Specifications for CFP-100GBASE-ZR

The CFP-100GBASE-ZR transceiver is not specified as part of IEEE 802.3 but is built according to Juniper Networks specifications.

[Table 45 on page 49](#) shows the optical interface specifications for the CFP-100GBASE-ZR transceiver.

Table 45: Juniper Networks Optical Interface Specifications for CFP-100GBASE-ZR

Parameter	CFP-100GBASE-ZR
Optical interface	Single-mode
Standard	Proprietary Dual polarization-quadrature phase shift keying (DP-QPSK) with forward error correction (FEC)
Maximum distance	80 km (49.7 miles) Greater reach possible with link engineering
Line rate	120.579 Gbps
Transmitter frequency / wavelength	193.90 THz (+/-1.8 GHz) / 1546.119 nm
Transmit output power (enabled)	+5 dBm
Transmit output power (disabled)	–40 dBm
Receive frequency / wavelength	193.90 THz (+/-1.8 GHz) / 1546.119 nm
Receive input optical power range	–20 through +5 dBm
Receive input optical power damage threshold	+10 dBm
Receive chromatic dispersion (CD) tolerance	+/-2500 ps/nm
Receive polarization mode dispersion (PMD) tolerance	15 ps (mean DGD)
Receive polarization tracking	50 krad/s

- Related Documentation**
- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

SONET/SDH OC3/STM1 Optical Interface Specifications

The SONET/SDH OC3/STM1 standards are supported on M Series routers, MX Series routers, and T Series routers.

To determine which transceivers support each SONET/SDH OC3/STM1 standard, see [“Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21](#). The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

The specifications are organized by distance supported.

- [SONET/SDH OC3/STM1 Specifications on page 50](#)
- [SONET/SDH OC3/STM1 Intermediate Reach \(IR-1\) Specifications on page 50](#)
- [SONET/SDH OC3/STM1 Long Reach \(LR-1\) Specifications on page 51](#)

SONET/SDH OC3/STM1 Specifications

[Table 46 on page 50](#) shows the multimode SONET/SDH OC3/STM1 optical interface specifications.

Table 46: SONET/SDH OC3/STM1 Multimode Optical Interface Specifications

Parameter	Multimode
Optical interface	Multimode
Maximum distance	MMF cable: 1.2 miles (2 km)
Standard	Multivendor agreement
Transmitter wavelength	1270 through 1380 nm
Average launch power	–20 through –14 dBm
Receiver saturation	–14 dBm
Receiver sensitivity	–30 dBm

SONET/SDH OC3/STM1 Intermediate Reach (IR-1) Specifications

[Table 47 on page 51](#) shows the SONET/SDH OC3/STM1 intermediate reach (IR-1) optical interface specifications.

Table 47: SONET/SDH OC3/STM1 Intermediate Reach Optical Interface Specifications

Parameter	Intermediate Reach (IR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 9.3 miles (15 km)
Standard	Telcordia GR-253
Transmitter wavelength	1261 through 1360 nm
Average launch power	-15 through -8 dBm
Receiver saturation	-8 dBm
Receiver sensitivity	-28 dBm

SONET/SDH OC3/STM1 Long Reach (LR-1) Specifications

Table 48 on page 51 shows the SONET/SDH OC3/STM1 long reach (LR-1) optical interface specifications.

Table 48: SONET/SDH OC3/STM1 Long Reach -1 Optical Interface Specifications

Parameter	Long Reach (LR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 24.85 miles (40 km)
Standard	Telcordia GR-253
Transmitter wavelength	1263 through 1360 nm
Average launch power	-5 through 0 dBm
Receiver saturation	-10 dBm
Receiver sensitivity	-34 dBm

Related Documentation

- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

SONET/SDH OC12/STM4 Optical Interface Specifications

The SONET/SDH OC12/STM4 optical interface standards are supported on M Series routers, MX Series routers, and T Series routers.

To determine which transceivers support each SONET/SDH OC12/STM4 standard, see [“Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21](#). The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

The specifications are organized by distance supported.

- [SONET/SDH OC12/STM4 Short Reach \(SR-1\) Specifications on page 52](#)
- [SONET/SDH OC12/STM4 Intermediate Reach \(IR-1\) Specifications on page 52](#)
- [SONET/SDH OC12/STM4 Long Reach \(LR-1\) Specifications on page 53](#)
- [SONET/SDH OC12/STM4 Long Reach \(LR-2\) Specifications on page 53](#)

SONET/SDH OC12/STM4 Short Reach (SR-1) Specifications

[Table 49 on page 52](#) shows the SONET/SDH OC12/STM4 short reach (SR-1) optical interface specifications.

Table 49: SONET/SDH OC12/STM4 Short Reach (SR-1) Optical Interface Specifications

Parameter	Short Reach (SR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 1.24 miles (2 km)
Standard	Telcordia GR-253
Transmitter wavelength	1261 through 1360 nm
Average launch power	–15 through –8 dBm
Receiver saturation	–8 dBm
Receiver sensitivity	–23 dBm

SONET/SDH OC12/STM4 Intermediate Reach (IR-1) Specifications

[Table 50 on page 53](#) shows the SONET/SDH OC12/STM4 short reach (IR-1) optical interface specifications.

Table 50: SONET/SDH OC12/STM4 Intermediate Reach (IR-1) Optical Interface Specifications

Parameter	Intermediate Reach (IR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 9.3 miles (15 km)
Standard	Telcordia GR-253
Transmitter wavelength	1274 through 1356 nm
Average launch power	-15 through -8 dBm
Receiver saturation	-8 dBm
Receiver sensitivity	-28 dBm

SONET/SDH OC12/STM4 Long Reach (LR-1) Specifications

Table 51 on page 53 shows the SONET/SDH OC12/STM4 short reach (LR-1) optical interface specifications.

Table 51: SONET/SDH OC12/STM4 Long Reach (LR-1) Optical Interface Specifications

Parameter	Long Reach (LR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 24.85 miles (40 km)
Standard	Telcordia GR-253
Transmitter wavelength	1280 through 1335 nm
Average launch power	-3 through +2 dBm
Receiver saturation	-8 dBm
Receiver sensitivity	-28 dBm

SONET/SDH OC12/STM4 Long Reach (LR-2) Specifications

Table 52 on page 54 shows the SONET/SDH OC12/STM4 short reach (LR-2) optical interface specifications.

Table 52: SONET/SDH OC12/STM4 Long Reach (LR-2) Optical Interface Specifications

Parameter	Long Reach (LR-2)
Optical interface	Single-mode
Maximum distance	SMF cable: 49.70 miles (80 km)
Standard	Telcordia GR-253
Transmitter wavelength	1480 through 1580 nm
Average launch power	–3 through 2 dBm
Receiver saturation	–8 dBm
Receiver sensitivity	–28 through –8 dBm

- Related Documentation**
- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

SONET/SDH OC48/STM16 Optical Interface Specifications

The SONET/SDH OC48/STM16 standards are supported on M40e routers, M120 routers, M320 routers, MX Series routers, and T Series routers.

To determine which transceivers support each SONET/SDH OC48/STM16 standard, see “Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21. The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

The specifications are organized by distance supported.

- [SONET/SDH OC48/STM16 Short Reach \(SR-1\) Specifications on page 54](#)
- [SONET/SDH OC48/STM16 Intermediate Reach \(IR-1\) Specifications on page 55](#)
- [SONET/SDH OC48/STM16 Long Reach \(LR-1\) Specifications on page 55](#)
- [SONET/SDH OC48/STM16 Long Reach \(LR-2\) Specifications on page 56](#)

SONET/SDH OC48/STM16 Short Reach (SR-1) Specifications

[Table 53 on page 55](#) shows the SONET/SDH OC48/STM16 short reach (SR-1) optical interface specifications.

Table 53: SONET/SDH OC48/STM16 Short Reach (SR-1) Optical Interface Specifications

Parameter	Short Reach (SR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 1.24 miles (2 km)
Standard	Telcordia GR-253
Transmitter wavelength	1266 through 1360 nm
Average launch power	-10 through -3 dBm
Receiver saturation	-3 dBm
Receiver sensitivity	-18 dBm

SONET/SDH OC48/STM16 Intermediate Reach (IR-1) Specifications

Table 54 on page 55 shows the SONET/SDH OC48/STM16 intermediate reach (IR-1) optical interface specifications.

Table 54: SONET/SDH OC48/STM16 Intermediate Reach (IR-1) Optical Interface Specifications

Parameter	Intermediate Reach (IR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 9.3 miles (15 km)
Standard	Telcordia GR-253
Transmitter wavelength	1260 through 1360 nm
Average launch power	-5 through 0 dBm
Receiver saturation	0 dBm
Receiver sensitivity	-18 dBm

SONET/SDH OC48/STM16 Long Reach (LR-1) Specifications

Table 55 on page 56 shows the SONET/SDH OC48/STM16 long reach (LR-1) optical interface specifications.

Table 55: SONET/SDH OC48/STM16 Long Reach (LR-1) Optical Interface Specifications

Parameter	Long Reach (LR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 28.85 miles (40 km)
Standard	Telcordia GR-253
Transmitter wavelength	1280 through 1335 nm
Average launch power	-2 through +3 dBm
Receiver saturation	-9 dBm
Receiver sensitivity	-28 dBm

SONET/SDH OC48/STM16 Long Reach (LR-2) Specifications

Table 56 on page 56 shows the SONET/SDH OC48/STM16 long reach (LR-2) optical interface specifications.

Table 56: SONET/SDH OC48/STM16 Long Reach (LR-2) Optical Interface Specifications

Parameter	Long Reach (LR-2)
Optical interface	Single-mode
Maximum distance	SMF cable: 49.71 miles (80 km)
Standard	Telcordia GR-253
Transmitter wavelength	1500 through 1580 nm
Average launch power	-2 through +3 dBm
Receiver saturation	-9 dBm
Receiver sensitivity	-28 dBm

Related Documentation

- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

SONET/SDH OC192/STM64 Optical Interface Specifications

The SONET/SDH OC192/STM64 standards are supported on M120 routers, M320 routers, MX Series routers, and T Series routers.

To determine which transceivers support the SONET/SDH OC192/STM64 standard, see “Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21. The “Cables and connectors” section in the description for each MIC or PIC lists which standards and transceivers are supported for that device.

The specifications are organized by distance supported.

- [SONET/SDH OC192/STM64 Very Short Reach \(VSR\) on page 57](#)
- [SONET/SDH OC192/STM64 Short Reach \(SR-1\) on page 57](#)
- [SONET/SDH OC192/STM64 Short Reach \(SR-2\) on page 58](#)
- [SONET/SDH OC192/STM64 Intermediate Reach \(IR-2\) on page 58](#)
- [SONET/SDH OC192/STM64 Long reach \(LR-1\) on page 59](#)
- [SONET/SDH OC192/STM64 Long reach \(LR-2\) on page 59](#)

SONET/SDH OC192/STM64 Very Short Reach (VSR)

[Table 57 on page 57](#) shows the SONET/SDH OC192/STM64 very short reach (VSR) optical interface specifications.

Table 57: SONET/SDH OC192/STM64 Very Short Reach (VSR 1) Optical Interface Specifications

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

SONET/SDH OC192/STM64 Short Reach (SR-1)

[Table 58 on page 58](#) shows the SONET/SDH OC192/STM64 short reach (SR-1) optical interface specifications.

Table 58: SONET/SDH OC192/STM64 Short Reach (SR-1) Optical Interface Specifications

Parameter	Short Reach (SR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 6.21 miles (10 km)
Standard	Telcordia GR-253 OC192 SR1
Transmitter wavelength	1290 nm through 1330 nm
Average launch power	–6 through –1 dBm
Receiver saturation	–1.0 dBm
Receiver sensitivity	–11 dBm

SONET/SDH OC192/STM64 Short Reach (SR-2)

Table 59 on page 58 shows the SONET/SDH OC192/STM64 short reach (SR-2) optical interface specifications.

Table 59: SONET/SDH OC192/STM64 Short Reach (SR-2) Optical Interface Specifications

Parameter	Short Reach (SR-2)
Optical interface	Single-mode
Maximum distance	SMF cable: 15.5 miles (25 km)
Standard	Telcordia GR-253 OC192 SR2
Transmitter wavelength	1530 through 1565 nm
Average launch power	–4 through 0 dBm
Receiver saturation	–3 dBm
Receiver sensitivity	–14 dBm

SONET/SDH OC192/STM64 Intermediate Reach (IR-2)

Table 60 on page 59 shows the SONET/SDH OC192/STM64 Intermediate reach (IR-2) optical interface specifications.

Table 60: SONET/SDH OC192/STM64 Intermediate Reach (IR-2) Optical Interface Specifications

Parameter	Intermediate Reach (IR-2)
Optical interface	Single-mode
Maximum distance	SMF cable: 24.8 miles (40 km) NOTE: Distances greater than 30 km are considered to be engineered links.
Standard	Telcordia GR-253 OC192 IR2
Transmitter wavelength	1530 nm through 1565 nm
Average launch power	-1.0. through 2 dBm
Receiver saturation	-1.0 dBm
Receiver sensitivity	-14 dBm

SONET/SDH OC192/STM64 Long reach (LR-1)

Table 61 on page 59 shows the SONET/SDH OC192/STM64 long reach (LR-1) optical interface specifications.

Table 61: SONET/SDH OC192/STM64 Long Reach (LR-1) Optical Interface Specifications

Parameter	Long Reach (LR-1)
Optical interface	Single-mode
Maximum distance	SMF cable: 49.71 miles (80 km)
Standard	Telcordia GR-253 OC192 LR2
Transmitter wavelength	1530 nm through 1565 nm
Average launch power	6 through 8 dBm
Receiver saturation	-10 dBm
Receiver sensitivity	-22 dBm

SONET/SDH OC192/STM64 Long reach (LR-2)

Table 62 on page 60 shows the SONET/SDH OC192/STM64 long reach (LR-2) optical interface specifications.

Table 62: SONET/SDH OC192/STM64 Long Reach (LR-2) Optical Interface Specifications

Parameter	Long Reach (LR-2)
Optical interface	Single-mode
Maximum distance	SMF cable: 49.71 miles (80 km)
Standard	Telcordia GR-253 OC192 LR2
Transmitter wavelength	1530 nm through 1565 nm
Average launch power	0 through 4 dBm
Receiver saturation	−7 dBm
Receiver sensitivity	−24 dBm

- Related Documentation**
- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

SONET/SDH OC768/STM256 Optical Interface Specifications

The SONET/SDH OC768/STM256 PIC is supported on T640 routers, T1600 routers, and T4000 routers. This PIC has a fixed SONET/SDH OC768/STM256 short reach (SR-1) optical interface.

To determine which transceivers support each SONET/SDH OC768/STM256 standard, see [“Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers” on page 21](#). The “Cables and connectors” section in the description for each PIC lists which standards and transceivers are supported for that device.

[Table 63 on page 60](#) shows the SONET/SDH OC768/STM256 short reach (SR-1) optical interface specifications.

Table 63: SONET/SDH OC768/STM256 Short Reach (SR-1) Optical Interface Specifications

Parameter	Short Reach (SR-1)
Optical interface	Single-mode
Maximum distance	1.24 miles (2 km)
Standard	300-pin multi-source agreement (MSA) ITU G.693 VSR2000–3R2
Transmitter wavelength	1530 through 1565 nm

Table 63: SONET/SDH OC768/STM256 Short Reach (SR-1) Optical Interface Specifications (*continued*)

Parameter	Short Reach (SR-1)
Average launch power	0 through +3 dBm
Receiver saturation	+3 dBm
Receiver sensitivity	−6 dBm

**Related
Documentation**

- [Supported Network Interface Standards by Transceiver for ACX Series, M Series, MX Series, and T Series Routers on page 21](#)

PART 2

PIC Descriptions

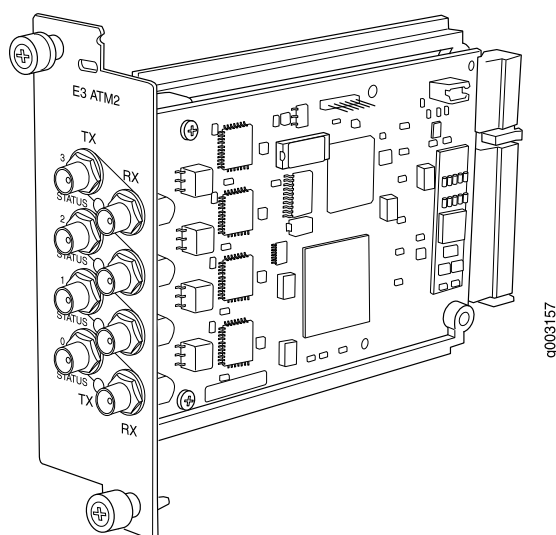
- [ATM2 IQ PIC Descriptions on page 65](#)
- [Channelized IQ PIC Descriptions on page 77](#)
- [Channelized Enhanced IQ \(IQE\) PIC Descriptions on page 83](#)
- [DS3 and E3 PIC Descriptions on page 105](#)
- [Fast Ethernet PIC Descriptions on page 111](#)
- [Gigabit Ethernet PIC Descriptions on page 113](#)
- [Gigabit Ethernet IQ PIC Descriptions on page 117](#)
- [Gigabit Ethernet IQ2 Ethernet PIC Descriptions on page 119](#)
- [Gigabit Ethernet IQ2E PIC Descriptions on page 123](#)
- [10-Gigabit Ethernet PIC Descriptions on page 127](#)
- [40-Gigabit Ethernet PIC Descriptions on page 143](#)
- [100-Gigabit Ethernet PIC Descriptions on page 147](#)
- [Services PIC Descriptions on page 151](#)
- [SONET/SDH PIC Descriptions on page 159](#)
- [End-of-Life PIC Descriptions on page 191](#)

CHAPTER 3

ATM2 IQ PIC Descriptions

- ATM2 E3 IQ PIC (T1600 Router) on page 65
- ATM2 OC3/STM1 IQ PIC (T1600 Router) on page 67
- ATM2 OC12/STM4 IQ PICs (T1600 Router) on page 70
- ATM2 OC48/STM16 IQ PIC with SFP (T1600 Router) on page 73

ATM2 E3 IQ PIC (T1600 Router)

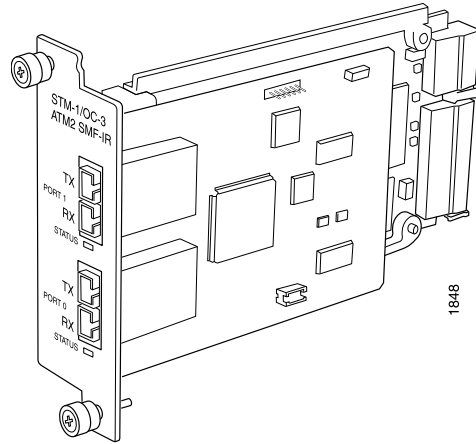


Software release	• Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• Four E3 ports • Power requirement: 0.41 A @ 48 V (20 W) • Fine-grained queuing per logical interface • ATM standards compliant • Model number: PB-4E3-ATM2

Hardware features	• 16-MB SDRAM memory for ATM segmentation and reassembly (SAR) • ATM switch ID • Configurable framing options: • G.751 direct mapping • G.751 with PLCP encapsulation (default) • G.832 ATM direct mapping • Internal and loop timing
Software features	• Per-virtual circuit (VC) and per-virtual path (VP) traffic shaping • Unspecified bit rate (UBR) traffic shaping • Fine-grained variable bit rate (VBR) traffic shaping • Circuit cross-connect (CCC) • ATM Inverse Address Resolution Protocol (ARP), which enables routers to automatically learn the IP address of the router on the far end of an ATM permanent virtual circuit (PVC) • Simple Network Management Protocol (SNMP): • Management Information Base (MIB) 2 (RFC 1213) • ATM MIB (RFC 1695) • SONET MIB • AAL5 encapsulations: • ATM-VC-MUX • ATM-NLPID • ATM-Cisco-LLPID • ATM-SNAP • ATM-CCC-VC-MUX
Cables and connectors	• 10 ft (3.05 m) posilock SMB to BNC (provided) • Four pairs of Rx and Tx coaxial cables
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• Alarm indication signal (AIS) • Frame error • Line code violation • Local and remote loopback • Loss of signal (LOS) • Out of frame (OOF) • Yellow alarm

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

ATM2 OC3/STM1 IQ PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Two OC3 ports - Power requirement: 0.41 A @ 48 V (20 W) - Fine-grained queuing per logical interface - Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 - ATM and SONET/SDH standards compliant - Alarm and event counting and detection - Compatible with well-known ATM switches - ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches - Model number: PB-2OC3-ATM2-MM - Model number: PB-2OC3-STM2-SMIR
Hardware features	- Single 3010 SAR for segmentation and reassembly into 53 byte ATM cells - High-performance parsing of SONET/SDH frames - ASIC-based packet segmentation and reassembly (SAR) management and output port queuing 64 MB SDRAM memory for ATM SAR - Packet buffering, Layer 2 parsing

Software features	• Circuit cross-connect (CCC) for leveraging ATM access networks • User-configurable virtual circuit (VC) and virtual path (VP) support • Support for idle cell or unassigned cell transmission • OAM fault management processes alarm indication signal (AIS), remote defect indication (RDI) cells, and loop cells • Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP • Local and remote loopback • ATM Inverse Address Resolution Protocol (ARP), which enables routers to automatically learn the IP address of the router on the far end of an ATM permanent virtual circuit (PVC) • Simple Network Management Protocol (SNMP): • Management Information Base (MIB) 2 (RFC 1213) • ATM MIB (RFC 1695) • SONET MIB • Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping • Per-VC or per-VP traffic shaping • Support for F4 OAM cells • Support for 16 bit VCI range
Cables and connectors	• Duplex SC/PC connector (RX and TX) • SONET/SDH OC3/STM1 fixed transceivers: • Multimode • Intermediate reach (IR-1) Optical interface specifications—see “SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- Alarm indication signal—line (AIS-L)
- Alarm indication signal—path (AIS-P)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Loss of cell delineation (LOC)
- Loss of frame (LOF)
- Loss of pointer (LOP-P)
- Loss of signal (LOS)
- Payload mismatch (PLM-P)
- Payload unequipped (unequipped STS at path level) (UNEQ-P)
- Remote defect indication—line (RDI-L)
- Remote defect indication—path (RDI-P)
- Error detection:
 - Bit interleaved parity errors B1, B2, B3
 - Errored seconds (ES-S, ES-L, ES-P)
 - Far-end bit errors, remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
 - Far-end bit errors, remote error indication—path (REI-P), far-end path coding violations (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)
 - 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)

Related Documentation

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

ATM2 OC12/STM4 IQ PICs (T1600 Router)

Figure 1: 1-Port ATM2 OC12/STM4 IQ PIC

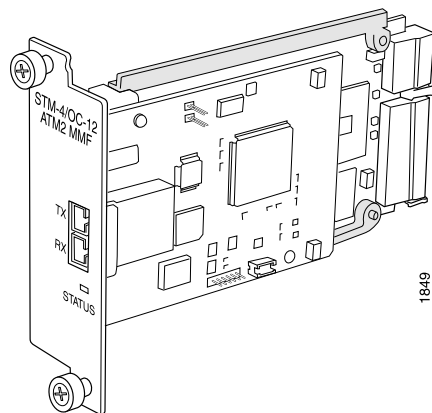
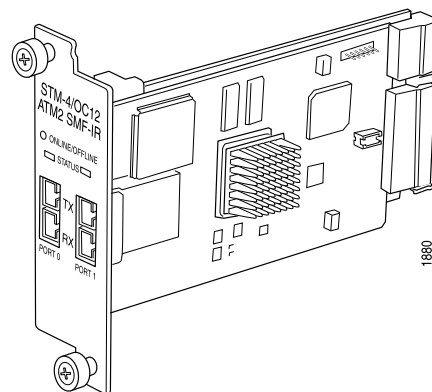


Figure 2: 2-Port ATM2 OC12/STM4 IQ PIC



Software release

- 1-port: Junos OS Release 8.5 and later (Type 1)
- 2-port: Junos OS Release 8.5 and later (Type 2)

For information on which FPCs support this PIC, see [“T1600 PIC/FPC Compatibility”](#) on page 14.

Description

- One or two OC12 ports
- Power requirement: 0.52 A @ 48 V (25 W)
- Fine-grained queuing per logical interface
- Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1
- Complies with ATM and SONET/SDH standards
- Alarm and event counting and detection
- Compatible with well-known ATM switches
- ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches
- Model number for 1-Port ATM2 OC12/STM4 IQ PIC: PB-1OC12-ATM2-MM
Model number for 1-Port ATM2 OC12/STM4 IQ PIC: PB-1OC12-ATM2-SMIR
- Model number for 2-Port ATM2 OC12/STM4 IQ PIC: PB-2OC12-ATM2-MM
Model number for 2-Port ATM2 OC12/STM4 IQ PIC: PB-2OC12-ATM2-SMIR

Hardware features

- ATM2 IQ 1-port OC12 PICs have one 3010 SAR for segmentation and reassembly into 53-byte ATM cells; ATM2 IQ 2-port OC12 PICs have dual 3010 SAR
- High-performance parsing of SONET/SDH frames
- ASIC-based packet segmentation and reassembly (SAR) management and output port queuing
- 64 MB SDRAM memory for ATM SAR
- Packet buffering, Layer 2 parsing

Software features	• Circuit cross-connect for leveraging ATM access networks • User-configurable virtual circuit (VC) and virtual path (VP) support • Support for idle cell or unassigned cell transmission • OAM fault management processes alarm indication signal (AIS), remote defect indication (RDI), and loop cells • Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP • Local and remote loopback • ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC • Simple Network Management Protocol (SNMP): • Management Information Base (MIB) 2 (RFC 1213) • ATM MIB (RFC 1695) • SONET MIB • Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping • Per-VC or per-VP traffic shaping • Support for F4 OAM cells • Support for 16-bit VCI range
Cables and connectors	• Duplex SC/PC connector (Rx and Tx) • SONET/SDH OC12/STM4 fixed transceivers: • Multimode • Intermediate reach (IR-1) Optical interface specifications—see “SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

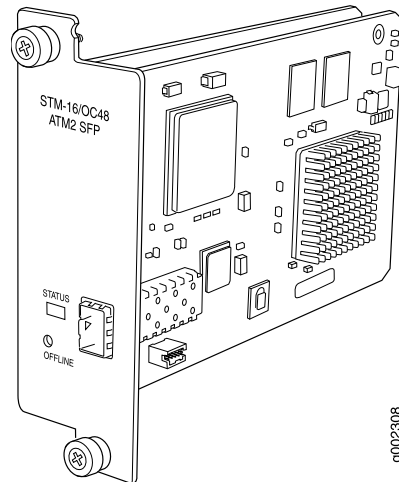
Alarms, errors, and events

- Alarm indication signal—line (AIS-L)
- Alarm indication signal—path (AIS-P)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Loss of cell delineation (LOC)
- Loss of frame (LOF)
- Loss of pointer (LOP-P)
- Loss of signal (LOS)
- Payload mismatch (PLM-P)
- Payload unequipped (unequipped STS at path level) (UNEQ-P)
- Remote defect indication—line (RDI-L)
- Remote defect indication—path (RDI-P)
- Error detection:
 - Bit interleaved parity errors B1, B2, B3
 - Errored seconds (ES-S, ES-L, ES-P)
 - Far-end bit errors, remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
 - Far-end bit errors, remote error indication—path (REI-P), far-end path coding violations (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)
 - 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)

**Related
Documentation**

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

ATM2 OC48/STM16 IQ PIC with SFP (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 2) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- One OC48 port - Power requirements: 0.41 A @ 48 V (20 W) - Intelligent queuing (IQ) PICs support fine-grained queuing per logical interface - Conforms to ANSI T1.105-1991 and T1E1.2/93-020R1 - ATM and SONET/SDH standards compliant - Alarm and event counting and detection - Compatible with well-known ATM switches - ATM switch ID, which displays the switch IP address and local interface name of the adjacent Fore ATM switches - Model number: PB-1OC48-ATM2-SFP
Hardware features	- ATM2 IQ 1-port OC48 PICs have one 3010 SAR for segmentation and reassembly into 53-byte ATM cells. - High-performance parsing of SONET/SDH frames - ASIC-based packet segmentation and reassembly (SAR) management and output port queuing 64-MB SDRAM memory for ATM SAR - Packet buffering, Layer 2 parsing

Software features	• Multiprotocol Label Switching (MPLS) circuit cross-connect for leveraging ATM access networks • User-configurable virtual circuit (VC) and virtual path (VP) support • Support for idle cell or unassigned cell transmission • OAM Fault Management processes Alarm Indication Signal (AIS), Remote Defect Indicator (RDI), and loop cells • Point-to-point and point-to-multipoint mode Layer 2 counters per VC and per VP • Local and remote loopback • ATM Inverse ARP, which enables routers to automatically learn the IP address of the router on the far end of an ATM PVC • Simple Network Management Protocol (SNMP): • Management Information Base (MIB) 2 (RFC 1213) • ATM MIB (RFC 1695) • SONET MIB • Unspecified bit rate (UBR), non-real-time variable bit rate (VBR), and constant bit rate (CBR) traffic shaping • Per-VC or per-VP traffic shaping • Support for F4 OAM cells • Support for 16-bit VCI range
Cables and connectors	• You can install different transceivers on the PIC. • Duplex LC/PC connector (RX and TX) • SONET/SDH OC48/STM16 fiber-optic SFP transceivers: • Multimode (model number: SFP-OC48-SR) • Intermediate reach (IR-1) (model number: SFP-OC48-IR) Optical interface specifications—see “SONET/SDH OC48/STM16 Optical Interface Specifications” on page 54
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- Alarm indication signal—line (AIS-L)
- Alarm indication signal—path (AIS-P)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Loss of cell delineation (LOC)
- Loss of frame (LOF)
- Loss of pointer (LOP-P)
- Loss of signal (LOS)
- Payload mismatch (PLM-P)
- Payload unequipped (unequipped STS at path level) (UNEQ-P)
- Remote defect indication—line (RDI-L)
- Remote defect indication—path (RDI-P)
- Error detection:
 - Bit interleaved parity errors B1, B2, B3
 - Errored seconds (ES-S, ES-L, ES-P)
 - Far-end bit errors, remote error indication—line (REI-L), far-end line coding violations (CV-LFE)
 - Far-end bit errors, remote error indication—path (REI-P), far-end path coding violations (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)
 - 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)

Related Documentation

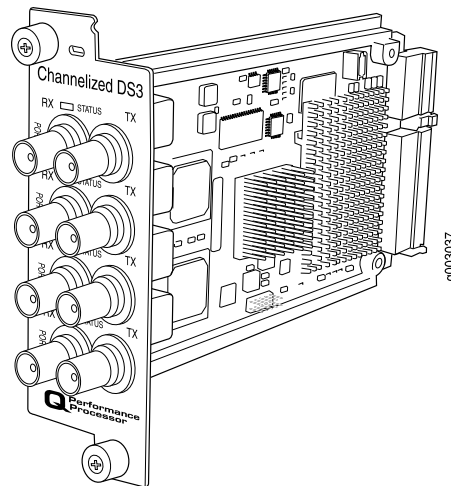
- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

CHAPTER 4

Channelized IQ PIC Descriptions

- [Channelized DS3 IQ PIC \(T1600 Router\) on page 77](#)
- [Channelized OC3 IQ PIC \(T1600 Router\) on page 79](#)
- [Channelized STM1 IQ PIC \(T1600 Router\) on page 81](#)

Channelized DS3 IQ PIC (T1600 Router)

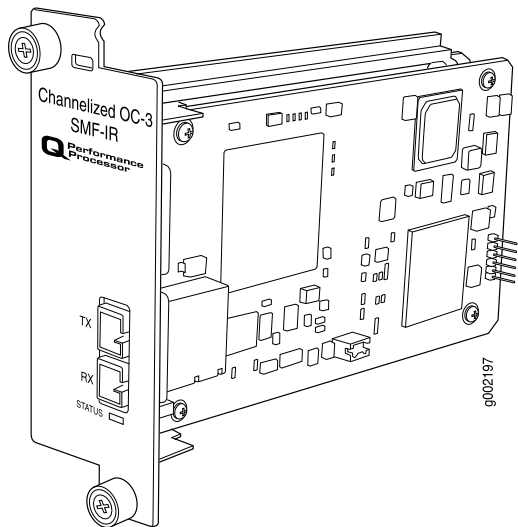


Software release	• Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	• Four DS3 ports • Power requirement: 0.32 A @ 48 V (15.6 W) • Fine-grained queuing per logical interface • Channelization: DS3, DS0 • Model number: PB-4CHDS3-QPP

Hardware features	• Data service unit (DSU) functionality • Subrate and scrambling: • Digital Link/Quick Eagle • Kentrox • Larscom • ADTRAN • Verilink • B3ZS line encoding • M13 or C-bit parity • Full bit error rate test (BERT) • Local and remote loopback testing
Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Simple Network Management Protocol (SNMP): DS1 MIB, DS3 MIB • Dynamic, arbitrary channel configuration • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Frame Relay • High-Level Data Link Control (HDLC) • Point-to-Point Protocol (PPP)
Cables and connectors	• Standard DS3 BNC coaxial cable interfaces
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• Alarm indication signal (AIS) • Excessive zeros (EXZ) • Far-end block error (FEBE) • Frame error • Idle code, Idle received • Line code violation (LCV) • Loss of signal (LOS) • Out of frame (OOF) • Parity bit (P-bit) disagreements • Path parity error • Yellow alarm bit (X-bit) disagreements
Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters

- Related Documentation
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

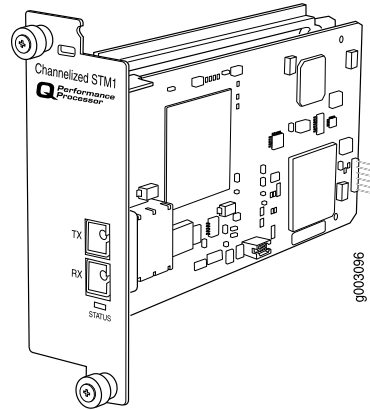
Channelized OC3 IQ PIC (T1600 Router)



Software release	• Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	• One OC3 port • Power requirement: 0.39 A @ 48 V (18.6 W) • Fine-grained queuing per logical interface • Channelization: DS3, DS1, DS0 • Model number: PB-1CHOC3-SMIR-QPP
Hardware features	• Subrate and scrambling: • Digital Link/Quick Eagle • Kentrox • Larscom • ADTRAN • Verilink • Packet buffering, Layer 2 parsing • M13/C-bit parity encoding • DS3 far-end alarm and control (FEAC) channel support • Local and remote loopback testing

Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB • Dynamic, arbitrary channel configuration • Full bit error rate test (BERT) • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Frame Relay • High-Level Data Link Control (HDLC) • Point-to-Point Protocol (PPP)
Cables and connectors	• Duplex SC/PC connector (Rx and Tx) • Single-mode fiber SONET/SDH OC3/STM1 intermediate-reach (IR-1) fiber • Optical interface specifications—see “SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• Alarm indication signal (AIS-L, AIS-P) • Bit error rate signal degrade (BERR-SD), bit error rate signal fail (BERR-SF) • Bit interleaved parity errors B1, B2, B3 • Errored seconds (ES-S, ES-L, ES-P), far-end bit errors REI-L, REI-P (CV-LFE, CV-PFE), Far-end block error (FEBE), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE) • Frame error • Idle code, Idle received • Loss of frame (LOF), loss of pointer (LOP-P), loss of signal (LOS) • Out of frame (OOF) • Payload mismatch (PLM-P), payload unequipped (UNEQ-P) • Parity bit (P-bit) disagreements • Path parity error • Remote defect indication (RDI-L, RDI-P) • Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P) • Yellow alarm bit (X-bit) disagreements
Related Documentation	• <i>T1600 PIC Description</i> • T1600 PIC Combination Limitations on page 14 • T1600 PICs Supported on page 3

Channelized STM1 IQ PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- One STM1 port - Power requirement: 0.39 A @ 48 V (18.6 W) - Fine-grained queuing per logical interface - Channelization: STM1c, fractional E1, framed and unframed DS0 - Model number: PB-1CHSTM1-SMIR-QPP
Hardware features	- Packet buffering, Layer 2 parsing - Local and remote loopback testing
Software features	- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) - SNMP: SONET/SDH MIB, T1/E1 MIB - Dynamic, arbitrary channel configuration - Full bit error rate test (BERT) patterns at E1 and DS0 levels - Encapsulations: - High-Level Data Link Control (HDLC) - Frame Relay - Circuit cross-connect (CCC) - Translational cross-connect (TCC) - Point-to-Point Protocol (PPP)
Cables and connectors	- Duplex SC/PC connector (Rx and Tx) - Single-mode fiber - Intermediate-reach fixed transceiver - Optical interface specifications—see “SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50 NOTE: This PIC supports only SDH.

LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• Alarm indication signal—line (AIS-L) • Alarm indication signal—path (AIS-P) • Bit error rate—signal degrade (BERR-SD) • Bit error rate—signal fail (BERR-SF) • Bit interleaved parity errors B1, B2, B3 (CV-S, CV-L, CV-P) • Loss of frame (LOF) • Loss of pointer (LOP-P) • Loss of signal (LOS) • Payload mismatch (PLM-P) • Payload unequipped (unequipped STS at path level) (UNEQ-P) • Remote defect indication—line (RDI-L) • Remote defect indication—path (RDI-P) Error detection: • Errored seconds (ES-S, ES-L, ES-P) • Far-end bit errors, remote error indication—line (REI-L), far-end line coding violations (CV-LFE) • Far-end bit errors, remote error indication—path (REI-P), far-end path coding violations (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) • Severely errored framing (SEF) • Severely errored framing seconds (SEFS-S) • Severely errored seconds (SES-S, SES-L, SES-P) • Unavailable seconds (UAS-L, UAS-P)
Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters

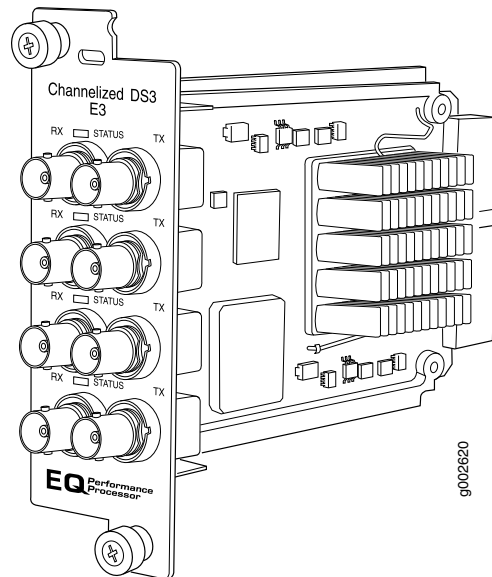
- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

CHAPTER 5

Channelized Enhanced IQ (IQE) PIC Descriptions

- [Channelized DS3/E3 Enhanced IQ \(IQE\) PIC \(T1600 Router\) on page 84](#)
- [Channelized E1/T1 Enhanced IQ \(IQE\) PIC \(T1600 Router\) on page 87](#)
- [Channelized OC3/STM1 Enhanced IQ \(IQE\) PIC with SFP \(T1600 Router\) on page 90](#)
- [Channelized OC12/STM4 Enhanced IQ \(IQE\) PICs with SFP \(T1600 Router\) on page 94](#)
- [Channelized OC48/STM16 Enhanced IQ \(IQE\) PIC with SFP \(T1600 Router\) on page 100](#)

Channelized DS3/E3 Enhanced IQ (IQE) PIC (T1600 Router)



Software release	Junos OS Release 9.3 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Four E3 or Channelized DS3 ports - E3 or Channelized DS3 is configurable on a per-port granularity - DS3 channelization: 4 DS3 channels 112 DS1 channels 1011 DS0 channels - Power requirement: 0.53 A @ 48 V (25.4 W) - Model number: PB-4CHDS3-E3-IQE-BNC
Hardware features	Ports are numbered 0 through 3 top to bottom

Software features

- Maximum transmission units (MTUs) of up to 9000 bytes
- Dynamic, arbitrary channel configuration
- Subrate and scrambling:

NOTE: Only DS3 interfaces supports subrate and scrambling.

- Digital Link/Quick Eagle
- Kentrox
- Larscom
- ADTRAN
- Verilink (subrate: only port A mode)

NOTE: For DS3 interfaces, Verilink does not function if an IQE interface is paired with an IQ interface.

- Data service unit (DSU) functionality
- B3ZS line encoding
- Framing: M13, C-bit parity, framed clear channel
- Full bit error rate test (BERT) for DS0, DS1, and DS3
- ANSI T1.403 FDL
- Internal and loop clocking for DS3 and DS1
- DS3 far end alarm and control (FEAC) channel
- Local line, remote line, and remote playback loopback testing for each DS3 and DS1 channels
- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
- Enhanced fine-grained queuing per logical interface. See the *Class of Service Feature Guide for Routing Devices* for more information about class of service features.
- Simple Network Management Protocol (SNMP): DS1 MIB, DS3 MIB
- Encapsulations:
 - Circuit cross-connect (CCC)
 - Translational cross-connect (TCC)
 - Extended Frame Relay for CCC and TCC
 - Flexible Frame Relay
 - Frame Relay
 - Frame Relay for CCC
 - Frame Relay for TCC
 - Frame Relay port CCC
 - High-Level Data Link Control (HDLC)
 - HDLC framing for CCC
 - HDLC framing for TCC
 - MPLS CCC
 - MPLS TCC
 - Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
 - Point-to-Point Protocol (PPP)
 - PPP for CCC
 - PPP for TCC

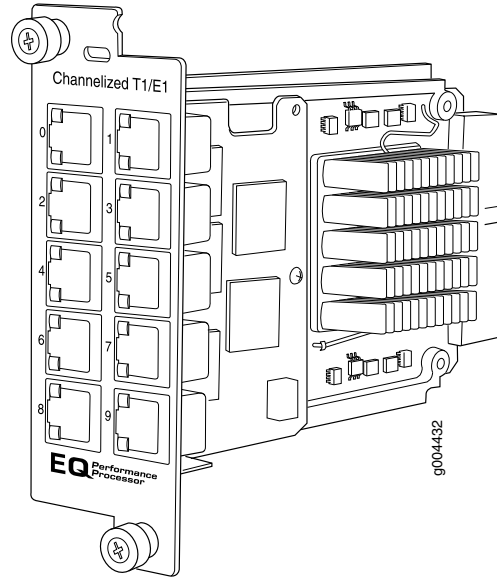
Cables and connectors

- Standard DS3 BNC coaxial cable interfaces

LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• Alarm reporting for error statistics and failure counts • DS1 alarms: • Alarm indication signal (AIS) • Loss of frame (LOF) • Remote alarm indication signal (RAIS) • DS1 error detection: • Bursty errored seconds (BES) • CRC errors • Errored seconds (ES) • Line errored seconds (LES) • Loss of framing seconds (LOFS) • Loss of signal seconds (LOSS) • Severely errored seconds (SES) • Severely errored framing seconds (SEFS) • Unavailable seconds (UAS) • DS3 alarms: • Alarm indication signal (AIS) • Loss of frame (LOF) • Loss of signal (LOS) • Phase lock loop (PLL) • DS3 error detection: • C-bit code violations (CCV) • C-bit errored seconds (CES) • C-bit severely errored framing seconds (CEFS) • CRC errors • Excessive zeros (EXZ) • Far-end block error (FEBE) • Far-end receive failure (FERF) • Line errored seconds (LES) • Parity bit (P-bit) code violations (PCV) • Parity bit (P-bit) errored seconds (PES) • Parity bit (P-bit) severely errored framing seconds (PSES) • Severely errored framing seconds (SEFS) • Unavailable seconds (UAS)
Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

Channelized E1/T1 Enhanced IQ (IQE) PIC (T1600 Router)



Software release	• Junos OS Release 9.5 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• Ten E1 or T1 ports • DS1 and E1 interfaces are selectable on a per-port granularity • E1 channelization per PIC: • 10 E1 channels • 310 DS0 channels • T1 channelization per PIC: • 10 T1 channels • 240 DS0 channels • Power requirement: 0.52 A @ 48 V (24.73 W) • Model number: PB-10CHE1-T1-IQE-RJ48

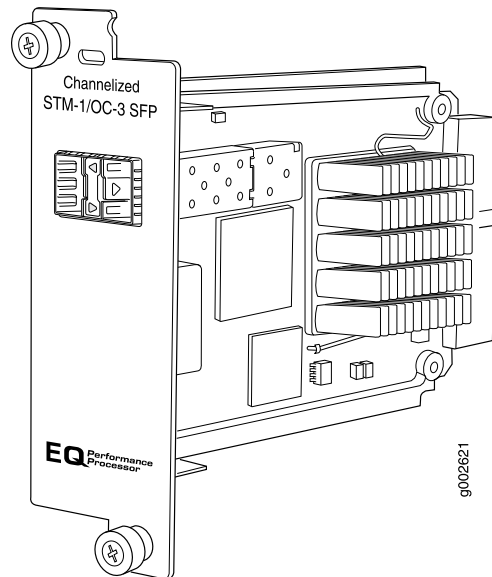
Hardware features	Ports are numbered: • Top row: 0 and 1 from left to right • Second row: 2 and 3 from left to right • Third row: 3 and 4 from left to right • Bottom row: 5 and 6 from left to right
Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Enhanced fine-grained queuing per logical interface. See the <i>Class of Service Feature Guide for Routing Devices</i> for more information about class of service features. • Support sending and receiving in-band loopback codes in both framed and unframed mode: • Framed in-band loopback at CSU • Framed in-band loopback at Smartjack (ANSI) • Unframed in-band loopback at CSU • Unframed in-band loopback at Smartjack (ANSI) • You can configure the following framing modes using the CLI: • T1—SF (D4/superframe), ESF (extended superframe) • E1—G704, G704—no-crc4, unframed • Packet buffering, Layer 2 parsing • Local line, remote line, and remote payload loopback testing; each channel can be looped individually and independently of other channels (DS1/E1 channels) • Simple Network Management Protocol (SNMP): T1 MIB (RFC 1406) • Dynamic, arbitrary channel configuration • Full bit error rate test (BERT) • Clocking: internal and loop (clock recovered from network and use for transmit). Internal timing is the default for channelized T1 ports. The external master clock can be a multiple of 2.048 MHz or 1.544 MHz for E1 or T1 operation. • Line coding: • T1—CLI configurable as AMI or B8ZS • E1—HDB3 • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Extended Frame Relay for CCC and TCC • Flexible Frame Relay • Frame Relay • Frame Relay for CCC • Frame Relay for TCC • Frame Relay port CCC • High-Level Data Link Control (HDLC) • HDLC framing for CCC • HDLC framing for TCC • MPLS CCC • MPLS TCC • Point-to-Point Protocol (PPP) • PPP for CCC • PPP for TCC

- Encapsulations available only for DS0 and DS1:
 - Multilink Frame Relay end-to-end (MLFR FRF.15)
 - Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
 - Multilink PPP (MLPPP)
- Encapsulations available only for DS1:
 - PPP over Frame Relay

Cables and connectors	• 120-ohm RJ-48C connector (female)
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• DS1 alarms: • Alarm indication signal (AIS) • Loss of frame (LOF) • Remote alarm indication signal (RAIS) • 24-hour alarm reporting history maintained for error statistics and failure counts, 15-minute intervals on all errors • DS1 error detection: • Bursty errored seconds (BES) • CRC errors • Errored seconds (ES) • Line errored seconds (LES) • Loss of framing seconds (LOFS) • Loss of signal seconds (LOSS) • Severely errored seconds (SES) • Severely errored framing seconds (SEFS) • Unavailable seconds (UAS)
Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters • Layer 2 per-queue and per-channel packet and byte drop counters

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

Channelized OC3/STM1 Enhanced IQ (IQE) PIC with SFP (T1600 Router)



Software release	Junos OS Release 9.3 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Two OC3 or STM1 ports - SONET or SDH is configurable on a per-port granularity - SONET channelization: 2 OC3 channels 6 DS3 channels 168 DS1 channels 1011 DS0 channels - SDH channelization: 2 STM1 channels (non-concatenated) 6 E3 channels 126 E1 channels 6 DS3 channels (Junos OS Release 10.1 and later) 168 DS1 channels (Junos OS Release 10.1 and later) 1011 DS0 channels - Power requirement: 0.56 A @ 48 V (27.1 W) - Model number: PB-2CHOC3-STM1-IQE-SFP
Hardware features	Ports are numbered 0 and 1 from left to right
Software features	- Dynamic, arbitrary channel configuration - Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) - Enhanced fine-grained queuing per logical interface. See the <i>Class of Service Feature Guide for Routing Devices</i> for more information about class of service features.

- Subrate and scrambling:
 - Digital Link/Quick Eagle
 - Kentrox
 - Larscom
 - ADTRAN
 - Verilink
- Packet buffering, Layer 2 parsing
- M13/C-bit parity encoding
- DS3 far-end alarm and control (FEAC) channel support
- Local line, remote line, and remote payload loopback testing
- Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB
- Full bit error rate test (BERT)
- Encapsulations:
 - Circuit cross-connect (CCC)
 - Translational cross-connect (TCC)
 - Extended Frame Relay for CCC and TCC
 - Flexible Frame Relay
 - Frame Relay
 - Frame Relay for CCC
 - Frame Relay for TCC
 - Frame Relay port CCC
 - High-Level Data Link Control (HDLC)
 - HDLC framing for CCC
 - HDLC framing for TCC
 - MPLS CCC
 - MPLS TCC
 - Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
 - Point-to-Point Protocol (PPP)
 - PPP for CCC
 - PPP for TCC
- Encapsulations available only for DS1:
 - Multilink Frame Relay end-to-end (MLFR FRF.15)
 - Multilink PPP (MLPPP)
 - PPP over Frame Relay

Cables and connectors

- Duplex LC/PC connector (Rx and Tx)
- SONET/SDH OC3/STM1 fiber-optic SFPs:
 - Multimode (model number: SFP-OC3-SR)
 - Intermediate reach (IR-1) (model number: SFP-OC3-IR)
 - Long reach (IR-1) (model number: SFP-OC3-LR)

Optical interface specifications—see [“SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50](#)

LEDs

One tricolor **Status** LED per port:

- Off—Not enabled.
- Green—Online with no alarms or failures.
- Yellow—Online with alarms for remote failures.
- Red—Active with a local alarm; router has detected a failure.

Alarms, errors, and events

- SONET alarms:
 - Alarm indication signal—line (AIS-L)
 - Alarm indication signal—path (AIS-P)
 - Bit error rate—signal degrade (BERR-SD)
 - Bit error rate—signal fail (BERR-SF)
 - Loss of clock (LOC)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of pointer (LOP)
 - Loss of signal (LOS)
 - Payload label mismatch (PLM-P)
 - Remote defect indication—line (RDI-L)
 - Remote defect indication—path (RDI-P)
 - Remote error indication (REI)
 - Payload unequipped (unequipped STS at path level) (UNEQ-P)
 - Virtual container—alarm indication signal (VAIS)
 - Virtual container—loss of clock (VLOC)
 - Virtual container—loss of pointer (VLOP)
 - Virtual container—mismatch (VMIS)
 - Virtual container—remote defect indication (VRDI)
 - Virtual container—unequipped (VUNEQ)
- SDH alarms:
 - Administrative unit alarm indication signal (AU-AIS)
 - Bit error rate signal degrade (BERR-SD)
 - Bit error rate signal fail (BERR-SF)
 - Bit interleaved parity (BIP) error B1, B2, B3
 - Higher order path—alarm indication signal (HP-AIS)
 - Higher order path—far-end receive failure (HP-FERF)
 - Higher order path—payload label mismatch (HP-PLM)
 - Higher order path—loss of pointer (HP-LOP)
 - Higher order path—remote defect indication (HP-RDI)
 - Higher order path—unequipped (HP-UNEQ)
 - Loss of clock (LOC)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of signal (LOS)
 - Multiplex section—alarm indication signal (MS-AIS)
 - Multiplex section—far-end receive failure (MS-FERF)
 - Multiplex section—remote defect indication (MS-RDI)
 - Multiplex section—remote error indication (MS-REI)

- Phase lock loop (PLL)
- Remote error indication (REI)
- Severely errored frame (SEF)
- Tributary unit—alarm indication signal (TU-AIS)
- Tributary unit—loss of clock (TU-LOC)
- Tributary unit—loss of pointer (TU-LOP)
- Tributary unit—mismatch (TU-MIS)
- Tributary unit—remote defect indication (TU-RDI)
- Tributary unit—unequipped (TU-UNEQ)
- DS1 alarms:
 - Alarm indication signal (AIS)
 - Loss of frame (LOF)
 - Remote alarm indication signal (RAIS)
- DS1 error detection:
 - Bursty errored seconds (BES)
 - CRC errors
 - Errored seconds (ES)
 - Line errored seconds (LES)
 - Loss of framing seconds (LOFS)
 - Loss of signal seconds (LOSS)
 - Severely errored seconds (SES)
 - Severely errored framing seconds (SEFS)
 - Unavailable seconds (UAS)
- DS3 alarms:
 - Alarm indication signal (AIS)
 - Loss of frame (LOF)
 - Loss of signal (LOS)
 - Phase lock loop (PLL)
- DS3 error detection:
 - C-bit code violations (CCV)
 - C-bit errored seconds (CES)
 - C-bit severely errored framing seconds (CEFS)
 - CRC errors
 - Excessive zeros (EXZ)
 - Far-end block error (FEBE)
 - Far-end receive failure (FERF)
 - Line errored seconds (LES)
 - Parity bit (P-bit) code violations (PCV)
 - Parity bit (P-bit) errored seconds (PES)
 - Parity bit (P-bit) severely errored framing seconds (PSES)
 - Severely errored framing seconds (SEFS)
 - Unavailable seconds (UAS)

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

Channelized OC12/STM4 Enhanced IQ (IQE) PICs with SFP (T1600 Router)

Figure 3: 1-Port IQE PIC

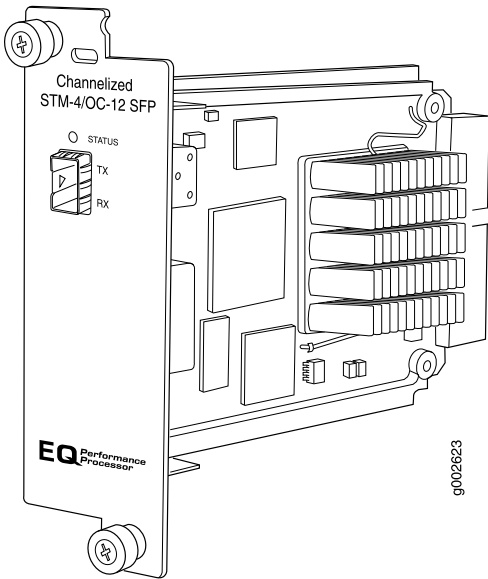


Figure 4: 4-Port IQE PIC (Type 2)

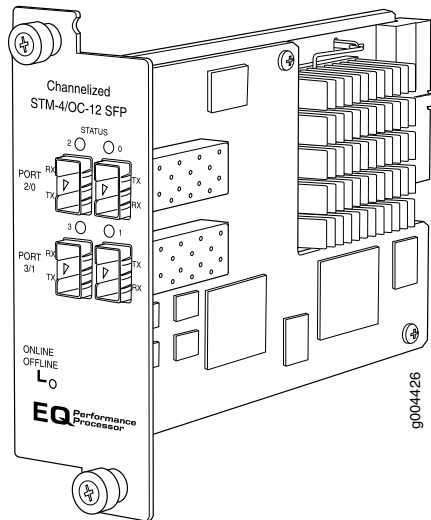
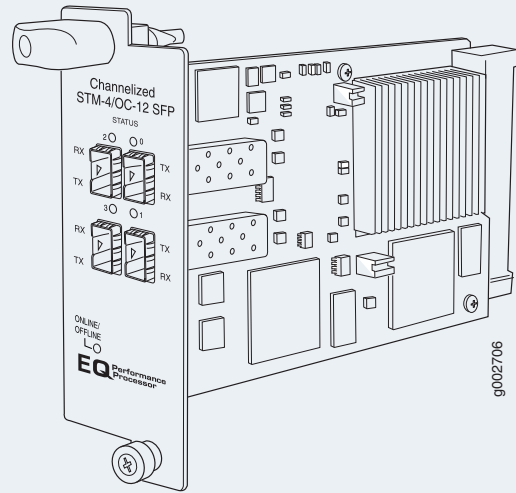


Figure 5: 4-Port IQE PIC (Type 3)



Software release

- 1-port: Junos OS Release 9.3 and later (Type 1)
- 4-port: Junos OS Release 9.4 and later (Type 2)
- 4-port: Junos OS Release 10.1 and later (Type 3)

For information on which FPCs support this PIC, see [“T1600 PIC/FPC Compatibility” on page 14](#).

Description

- One or four OC12/STM4 ports
- SONET or SDH is configurable on a per-port granularity
- SONET channelization (1-port PIC):
 - 1 OC12 channel
 - 4 OC3 channels
 - 12 DS3 channels
 - 336 DS1 channels
 - 1011 DS0 channels
- SDH channelization (1-port PIC):
 - 1 STM4 channel
 - 4 STM1 channels
 - 12 E3 channels
 - 252 E1 channels
 - 12 DS3 channels (Junos OS Release 10.1 and later)
 - 336 DS1 channels (Junos OS Release 10.1 and later)
 - 1011 DS0 channels
- SONET channelization (4-port PIC):
 - 4 OC12 channel
 - 16 OC3 channels
 - 48 DS3 channels
 - 672 DS1 channels
 - 974 DS0 channels
- SDH channelization (4-port PIC):

- 4 STM4 channel
- 16 STM1 channels
- 48 E3 channels
- 504 E1 channels
- 48 DS3 channels (Junos OS Release 10.1 and later)
- 672 DS1 channels (Junos OS Release 10.1 and later)
- 974 DS0 channels
- Power requirement:
 - 1-port: 0.64 A @ -48 V (30.7 W)
 - 4-port: 1.08 A @ -48V (52 W)
- Model number for 1-Port IQE PIC: PB-1CHOC12-STM4-IQE-SFP
Model number for 4-Port IQE PIC: PB-4CHOC12-STM4-IQE-SFP

Hardware features	• 1-port: Port is numbered 0. • 4-port: Ports are numbered: • Top row: 2 and 0 from left to right • Bottom row: 3 and 1 from left to right
Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Enhanced fine-grained queuing per logical interface. See the <i>Class of Service Feature Guide for Routing Devices</i> for more information about class of service features. • Subrate and scrambling: • Digital Link/Quick Eagle • Kentrox • Larscom • ADTRAN • Verilink • Packet buffering, Layer 2 parsing • M13/C-bit parity encoding • DS3 far-end alarm and control (FEAC) channel support • Local line, remote line, and remote payload loopback testing • Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB • Dynamic, arbitrary channel configuration • Full bit error rate test (BERT) • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Extended Frame Relay for CCC and TCC • Flexible Frame Relay • Frame Relay • Frame Relay for CCC • Frame Relay for TCC • Frame Relay port CCC • High-Level Data Link Control (HDLC) • HDLC framing for CCC • HDLC framing for TCC

- MPLS CCC
- MPLS TCC
- Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
- Point-to-Point Protocol (PPP)
- PPP for CCC
- PPP for TCC
- Encapsulations available only for DSI:
 - Multilink Frame Relay end-to-end (MLFR FRF.15)
 - Multilink PPP (MLPPP)
 - PPP over Frame Relay

Cables and connectors	• Duplex LC/PC connector (Rx and Tx); single-mode fiber • SONET/SDH OC12/STM4 fiber-optic SFP transceivers: • Short reach (model number: SFP-OC12-SR) • Intermediate reach (IR-1) (model number: SFP-OC12-IR) • Long reach (LR-1) (model number: SFP-OC12-LR) Optical interface specifications—see “SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52
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LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
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Alarms, errors, and events	• SONET alarms: • Alarm indication signal—line (AIS-L) • Alarm indication signal—path (AIS-P) • Bit error rate—signal degrade (BERR-SD) • Bit error rate—signal fail (BERR-SF) • Loss of frame (LOF) • Loss of light (LOL) • Loss of pointer (LOP) • Loss of signal (LOS) • Payload label mismatch (PLM-P) • Remote defect indication—line (RDI-L) • Remote defect indication—path (RDI-P) • Remote error indication (REI) • Payload unequipped (unequipped STS at path level) (UNEQ-P) • Virtual container—alarm indication signal (VAIS) • Virtual container—loss of pointer (VLOP) • Virtual container—mismatch (VMIS) • Virtual container—remote defect indication (VRDI) • Virtual container—unequipped (VUNEQ) • SDH alarms: • Administrative unit alarm indication signal (AU-AIS)
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- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Bit interleaved parity (BIP) error B1, B2, B3
- Higher order path—alarm indication signal (HP-AIS)
- Higher order path—far-end receive failure (HP-FERF)
- Higher order path—payload label mismatch (HP-PLM)
- Higher order path—loss of pointer (HP-LOP)
- Higher order path—remote defect indication (HP-RDI)
- Higher order path—unequipped (HP-UNEQ)
- Loss of frame (LOF)
- Loss of light (LOL)
- Loss of signal (LOS)
- Multiplex section—alarm indication signal (MS-AIS)
- Multiplex section—far-end receive failure (MS-FERF)
- Multiplex section—remote defect indication (MS-RDI)
- Multiplex section—remote error indication (MS-REI)
- Phase lock loop (PLL)
- Remote error indication (REI)
- Severely errored frame (SEF)
- Tributary unit—alarm indication signal (TU-AIS)
- Tributary unit—loss of pointer (TU-LOP)
- Tributary unit—mismatch (TU-MIS)
- Tributary unit—remote defect indication (TU-RDI)
- Tributary unit—unequipped (TU-UNEQ)
- DS1 alarms:
 - Alarm indication signal (AIS)
 - Loss of frame (LOF)
 - Remote alarm indication signal (RAIS)
- DS1 error detection:
 - Bursty errored seconds (BES)
 - CRC errors
 - Errored seconds (ES)
 - Line errored seconds (LES)
 - Loss of framing seconds (LOFS)
 - Severely errored seconds (SES)
 - Severely errored framing seconds (SEFS)
 - Unavailable seconds (UAS)
- DS3 alarms:
 - Alarm indication signal (AIS)
 - Loss of frame (LOF)
 - Yellow alarm
- DS3 error detection:
 - C-bit code violations (CCV)
 - C-bit errored seconds (CES)
 - C-bit severely errored framing seconds (CEFS)

- CRC errors
- Excessive zeros (EXZ)
- Far-end block error (FEBE)
- Far-end receive failure (FERF)
- Line errored seconds (LES)
- Parity bit (P-bit) code violations (PCV)
- Parity bit (P-bit) errored seconds (PES)
- Parity bit (P-bit) severely errored framing seconds (PSES)
- Severely errored framing seconds (SEFS)
- Unavailable seconds (UAS)

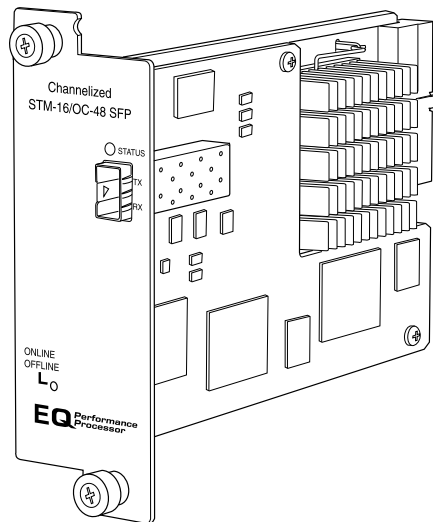
Instrumentation
(counters)

- Layer 2 per-queue and per-channel packet and byte counters

**Related
Documentation**

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

Channelized OC48/STM16 Enhanced IQ (IQE) PIC with SFP (T1600 Router)



Software release	Junos OS Release 9.4 and later (Type 2) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	- One OC48/STM16 port - SONET or SDH is configurable on a per-port granularity - SONET channelization: 4 OC12 channels 16 OC3 channels 48 DS3 channels 672 DS1 channels 975 DS0 channels - SDH channelization: 4 STM4 channels 16 STM1 channels 48 E3 channels 504 E1 channels 48 DS3 channels 672 DS1 channels 975 DS0 channels - Power requirement: 1.10 A @ 48V (53 W) - Model number: PB-1CHOC48-STM16-IQE-SFP
Hardware features	Port is numbered 0.

- Software features
- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
 - Enhanced fine-grained queuing per logical interface. See the *Class of Service Feature Guide for Routing Devices* for more information about class of service features.
 - Subrate and scrambling:
 - Digital Link/Quick Eagle
 - Kentrox
 - Larscom
 - ADTRAN
 - Verilink
 - Packet buffering, Layer 2 parsing
 - M13/C-bit parity encoding
 - DS3 far-end alarm and control (FEAC) channel support
 - Local line, remote line, and remote payload loopback testing
 - Simple Network Management Protocol (SNMP): OC12, OC3 MIB, DS3 MIB, T1 MIB
 - Dynamic, arbitrary channel configuration
 - Full bit error rate test (BERT)
 - Encapsulations:
 - Circuit cross-connect (CCC)
 - Translational cross-connect (TCC)
 - Extended Frame Relay for CCC and TCC
 - Flexible Frame Relay
 - Frame Relay
 - Frame Relay for CCC
 - Frame Relay for TCC
 - Frame Relay port CCC
 - High-Level Data Link Control (HDLC)
 - HDLC framing for CCC
 - HDLC framing for TCC
 - MPLS CCC
 - MPLS TCC
 - Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
 - Point-to-Point Protocol (PPP)
 - PPP for CCC
 - PPP for TCC
 - Encapsulations available only for DS1:
 - Multilink Frame Relay end-to-end (MLFR FRF.15)
 - Multilink PPP (MLPPP)
 - PPP over Frame Relay

- Cables and connectors
- Duplex LC connector (Rx and Tx); single-mode fiber
 - SONET/SDH OC48/STM16 fiber-optic SFP transceivers:
 - Short reach (SR-1) (model number: SFP-1OC48-SR)
 - Intermediate reach (IR-1) (model number: SFP-1OC48-IR)
 - Long reach (LR-1) (model number: SFP-1OC48-LR)
- Optical interface specifications—see [“SONET/SDH OC48/STM16 Optical Interface Specifications” on page 54](#)

LEDs

One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
 - Alarm indication signal—line (AIS-L)
 - Alarm indication signal—path (AIS-P)
 - Bit error rate—signal degrade (BERR-SD)
 - Bit error rate—signal fail (BERR-SF)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of pointer (LOP)
 - Loss of signal (LOS)
 - Payload label mismatch (PLM-P)
 - Remote defect indication—line (RDI-L)
 - Remote defect indication—path (RDI-P)
 - Remote error indication (REI)
 - Payload unequipped (unequipped STS at path level) (UNEQ-P)
 - Virtual container—alarm indication signal (VAIS)
 - Virtual container—loss of pointer (VLOP)
 - Virtual container—mismatch (VMIS)
 - Virtual container—remote defect indication (VRDI)
 - Virtual container—unequipped (VUNEQ)
- SDH alarms:
 - Administrative unit alarm indication signal (AU-AIS)
 - Bit error rate—signal degrade (BERR-SD)
 - Bit error rate—signal fail (BERR-SF)
 - Bit interleaved parity (BIP) error B1, B2, B3
 - Higher order path—alarm indication signal (HP-AIS)
 - Higher order path—far-end receive failure (HP-FERF)
 - Higher order path—payload label mismatch (HP-PLM)
 - Higher order path—loss of pointer (HP-LOP)
 - Higher order path—remote defect indication (HP-RDI)
 - Higher order path—unequipped (HP-UNEQ)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of signal (LOS)
 - Multiplex section—alarm indication signal (MS-AIS)
 - Multiplex section—far-end receive failure (MS-FERF)
 - Multiplex section—remote defect indication (MS-RDI)
 - Multiplex section—remote error indication (MS-REI)
 - Phase lock loop (PLL)
 - Remote error indication (REI)
 - Severely errored frame (SEF)
 - Tributary unit—alarm indication signal (TU-AIS)

- Tributary unit—loss of pointer (TU-LOP)
- Tributary unit—mismatch (TU-MIS)
- Tributary unit—remote defect indication (TU-RDI)
- Tributary unit—unequipped (TU-UNEQ)
- DS1 alarms:
 - Alarm indication signal (AIS)
 - Loss of frame (LOF)
 - Remote alarm indication signal (RAIS)
- DS1 error detection:
 - Bursty errored seconds (BES)
 - CRC errors
 - Errored seconds (ES)
 - Line errored seconds (LES)
 - Loss of framing seconds (LOFS)
 - Severely errored seconds (SES)
 - Severely errored framing seconds (SEFS)
 - Unavailable seconds (UAS)
- DS3 alarms:
 - Alarm indication signal (AIS)
 - Loss of frame (LOF)
 - Yellow alarm
- DS3 error detection:
 - C-bit code violations (CCV)
 - C-bit errored seconds (CES)
 - C-bit severely errored framing seconds (CEFS)
 - CRC errors
 - Excessive zeros (EXZ)
 - Far-end block error (FEBE)
 - Far-end receive failure (FERF)
 - Line errored seconds (LES)
 - Parity bit (P-bit) code violations (PCV)
 - Parity bit (P-bit) errored seconds (PES)
 - Parity bit (P-bit) severely errored framing seconds (PSES)
 - Severely errored framing seconds (SEFS)
 - Unavailable seconds (UAS)

Instrumentation
(counters)

- Layer 2 per-queue and per-channel packet and byte counters

Table 64: PICs Supported in Fourth Slot of T640-FPC2-E and T640-FPC2-E2 with Type 2 IQE PICs

PIC Name	PIC Model Number
Gigabit Ethernet, 2-port SFP	PB-2GE-SFP
Gigabit Ethernet, 4-port SFP	PB-4GE-SFP
Gigabit Ethernet IQ, 2-port SFP	PB-2GE-SFP-QPP
SONET/SDH OC12c/STM4, 4-port with multimode transceivers installed	PB-4OC12-SON-MM
SONET/SDH OC12c/STM4, 4-port with single-mode intermediate reach transceivers installed	PB-4OC12-SON-SMIR
SONET/SDH OC48/STM16, 1-port SFP	PB-1OC48-SON-SFP
Tunnel Services	PB-TUNNEL

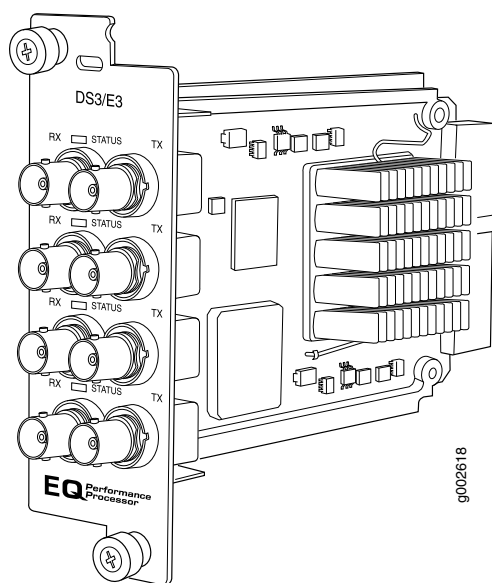
- Related Documentation**
- *T1600 PIC Description*
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

CHAPTER 6

DS3 and E3 PIC Descriptions

- DS3/E3 Enhanced IQ (IQE) PIC (T1600 Router) on page 105
- E3 IQ PIC (T1600 Router) on page 108

DS3/E3 Enhanced IQ (IQE) PIC (T1600 Router)



Software release	• Junos OS Release 9.3R2 and later (Type 1) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	• Four DS3 or E3 ports • DS3 or E3 is configurable on a per-port granularity • Power requirement: 0.51 A @ 48 V (24.7 W) • Model number: PB-4DS3-E3-IQE-BNC
Hardware features	• Ports are numbered 0 through 3 top to bottom

Software features

- Maximum transmission units (MTUs) of up to 9192 bytes
- Subrate and scrambling:

NOTE: Only DS3 interfaces support subrate and scrambling.

- Digital Link/Quick Eagle
- Kentrox
- Larscom
- ADTRAN
- Verilink (subrate: only port A mode)

NOTE: For DS3 interfaces, Verilink does not function if an IQE interface is paired with an IQ interface.

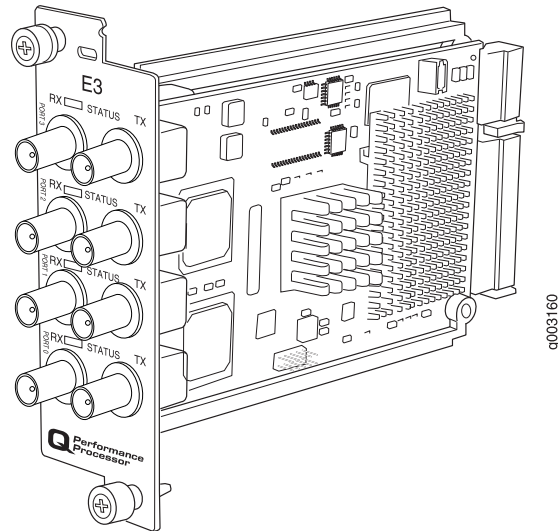
- Data service unit (DSU) functionality
- B3ZS line encoding
- Framing: M13, C-bit parity, framed clear channel
- Full bit error rate test (BERT)
- ANSI T1.403 FDL
- Internal and loop clocking
- DS3 far end alarm and control (FEAC) channel
- Local line, remote line, and remote playback loopback testing
- Simple Network Management Protocol (SNMP): DS3 MIB
- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
- Enhanced fine-grained queuing per logical interface. See the *Class of Service Feature Guide for Routing Devices* for more information about class of service features.
- Encapsulations:
 - Circuit cross-connect (CCC)
 - Translational cross-connect (TCC)
 - Extended Frame Relay for CCC and TCC
 - Flexible Frame Relay
 - Frame Relay
 - Frame Relay for CCC
 - Frame Relay for TCC
 - Frame Relay port CCC
 - High-Level Data Link Control (HDLC)
 - HDLC framing for CCC
 - HDLC framing for TCC
 - MPLS CCC
 - MPLS TCC
 - Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
 - Point-to-Point Protocol (PPP)
 - PPP for CCC
 - PPP for TCC

Cables and connectors

- Standard DS3 BNC coaxial cable interfaces

LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure
Alarms, errors, and events	• DS3 alarms: • Alarm indication signal (AIS) • Loss of frame (LOF) • Loss of signal (LOS) • Phase lock loop (PLL) • DS3 error detection: • C-bit code violations (CCV) • C-bit errored seconds (CES) • C-bit severely errored framing seconds (CEFS) • CRC errors • Excessive zeros (EXZ) • Far-end block error (FEBE) • Far-end receive failure (FERF) • Line errored seconds (LES) • Parity bit (P-bit) code violations (PCV) • Parity bit (P-bit) errored seconds (PES) • Parity bit (P-bit) severely errored framing seconds (PSES) • Severely errored framing seconds (SEFS) • Unavailable seconds (UAS)
Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters
Related Documentation	• <i>T1600 PIC Description</i> • T1600 PIC Combination Limitations on page 14 • T1600 PICs Supported on page 3

E3 IQ PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	- Four E3 ports - Power requirement: 0.38 A @ 48 V (18 W) - Fine-grained queuing per logical interface - Model number: PB-4E3-QPP
Hardware features	- Clear-channel (34.368-Mbps) and subrate E3 - Unframed or ITU G.751 framing - Data service unit (DSU) functionality - Subrate and scrambling: - Digital Link/Quick Eagle - Kentrox - HDB3 line encoding - Full bit error rate test (BERT) - Local and remote loopback testing

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

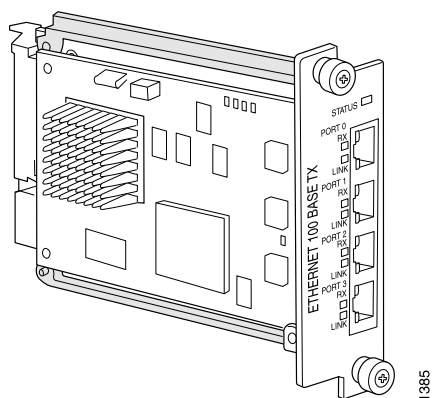
- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

CHAPTER 7

Fast Ethernet PIC Descriptions

- Fast Ethernet PIC (T1600 Router) on page 111

Fast Ethernet PIC (T1600 Router)



Software release	• Junos OS Release 8.5 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• 4 100Base-TX ports • Power requirement: 0.14 A @ 48 V (6.8 W) • Model number: PB-4FE-TX
Hardware features	• High-performance throughput on each port at speeds up to 100 Mbps • Source and destination Media Access Control (MAC) address filtering • RMON EtherStats packet buffering • 802.3 Ethernet standard compliant • MTUs up to 1533 bytes • 1,024 autosensing 802.1q VLANs per port
Software features	• Autosensing full-duplex and half-duplex modes • Virtual Router Redundancy Protocol (VRRP) • 802.1q virtual LANs (VLANs) • Circuit cross-connect (CCC) VLAN

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| Cables and connectors | <p>4-port PIC:</p> <ul style="list-style-type: none">• Connector: Two-pair, Category 5 unshielded twisted-pair connectivity through an RJ-45 connector• Pinout: MDI noncrossover |
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| LEDs | <p>Status LED, one bicolor:</p> <ul style="list-style-type: none">• Off—PIC ports not enabled.• Green—PIC is operating normally.• Red—PIC has an error or failure. <p>4-port PIC—One pair of port LEDs:</p> <ul style="list-style-type: none">• Link LED—If green, the port is online; if there is no light, the port is down.• RX LED—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data. |
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| Related Documentation | <ul style="list-style-type: none">• T1600 PIC Description• T1600 PIC Combination Limitations on page 14• T1600 PICs Supported on page 3 |
|------------------------------|---|

CHAPTER 8

Gigabit Ethernet PIC Descriptions

- Gigabit Ethernet PICs with SFP (T1600 Router) on page 114

Gigabit Ethernet PICs with SFP (T1600 Router)

Figure 6: 1-Port Gigabit Ethernet PIC

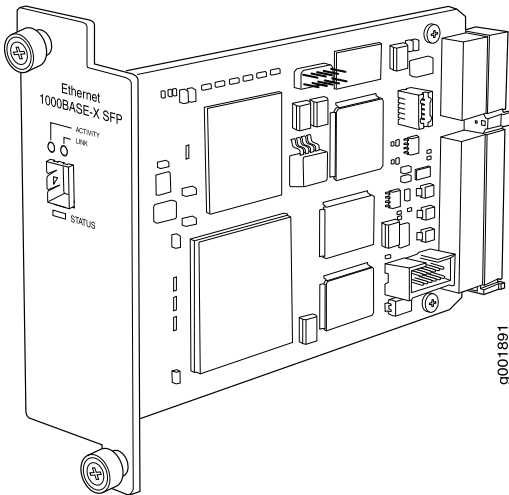


Figure 7: 2-Port Gigabit Ethernet PIC

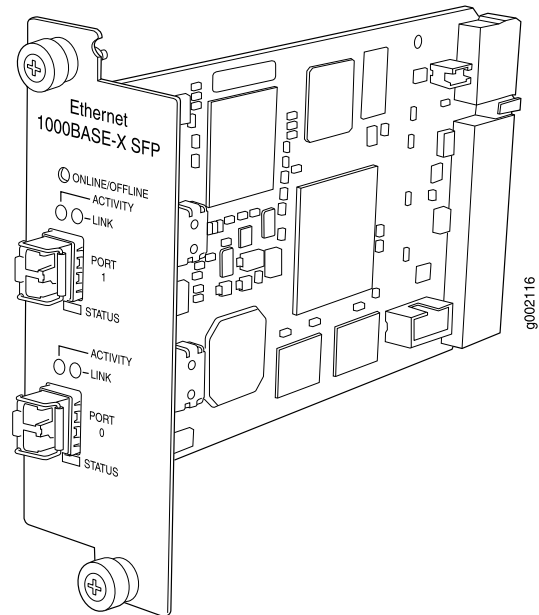


Figure 8: 4-Port Gigabit Ethernet PIC

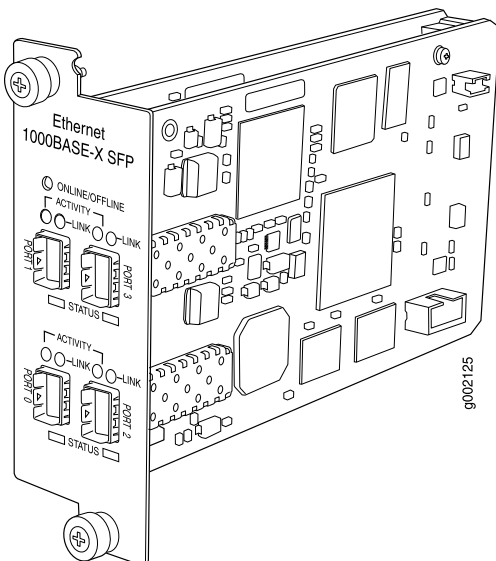
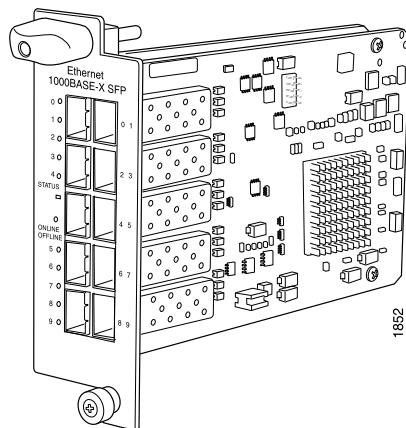


Figure 9: 10-Port Gigabit Ethernet PIC



Software release	• 1-port: Junos OS Release 8.5 and later (Type 1) • 2-port: Junos OS Release 8.5 and later (Type 2) • 4-port: Junos OS Release 8.5 and later (Type 2) • 10-port: Junos OS Release 8.5 and later (Type 3) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• One, two, four, or ten Gigabit Ethernet ports • Power requirement: • 1-port: 0.25 A @ 48 V (11.9 W) • 2-port: 0.25 A @ 48 V (11.9 W) • 4-port: 0.50 A @ 48 V (23.8 W) • 10-port: 0.62 A @ 48 V (29.9 W) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number for 1-Port Gigabit Ethernet PIC: PB-1GE-SFP • Model number for 2-Port Gigabit Ethernet PIC: PB-2GE-SFP • Model number for 4-Port Gigabit Ethernet PIC: PB-4GE-SFP • Model number for 10-Port Gigabit Ethernet PIC: PB-10GE-SFP
Hardware features	• High-performance throughput on each port at speeds up to 1 Gbps • Autonegotiation between Gigabit Ethernet circuit partners • Full-duplex mode • Maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Virtual Router Redundancy Protocol (VRRP) support • 802.1q virtual LANs (VLANs) support • 960 destination MAC filters per port • Optical diagnostics and related alarms on the 2-port, 4-port, and 10-port PICs • 64 source MAC filters per VLAN on the 1-port, 2-port, and 4-port PICs • 1024 source MAC filters per port on the 1-port, 2-port, and 4-port PICs • Flexible Ethernet encapsulation on the 1-port, 2-port, and 4-port PICs • Multiple tag protocol identifiers (TPID) support on the 1-port, 2-port, and 4-port PICs • Source MAC learning on the 1-port, 2-port, and 4-port PICs • MAC accounting and policing—Dynamic local address learning of source MAC addresses on the 1-port, 2-port, and 4-port PICs • Passive monitoring for IPv4 packets on the 10-port PIC for Junos OS Release 11.1 and later. NOTE: The 10-port Gigabit Ethernet PIC with SFP does not support MAC accounting and policing, MAC learning, TPID, or flexible Ethernet encapsulation. The 10-port Gigabit Ethernet PIC supports 64 source MAC filters per port.

Cables and connectors	- You can install any transceiver supported by the PIC. - Fiber-optic SFP transceivers: - Duplex LC/PC connector (Rx and Tx) 1000BASE-LH (model number: SFP-IGE-LH) 1000BASE-LX (model number: SFP-IGE-LX) 1000BASE-SX (model number: SFP-IGE-SX) - Optical interface specifications—see “Gigabit Ethernet 1000BASE Optical Interface Specifications” on page 34 1000BASE-BX (model number pairs: SFP-GE10KT13R14 with SFP-GE10KT14R13, SFP-GE10KT13R15 with SFP-GE10KT15R13, SFP-GE40KT13R15 with SFP-GE40KT15R13)—See “Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications” on page 31 - Copper transceiver: - Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector 1000BASE-T (model number: SFP-IGE-T) - Pinout: MDI crossover - Copper interface specifications—see “Gigabit Ethernet 1000BASE-T Copper Interface Specifications” on page 37 NOTE: Do not install Gigabit Ethernet SFPs in the SONET/SDH port. The port will not recognize the SFP.
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LEDs	Status LED, one bicolor: - Off—PIC is not enabled. - Green—PIC is operating normally. - Red—PIC has an error or failure. Port LEDs, one pair per port: - Link—If green, the port is online; if there is no light, the port is down. - Activity—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data.
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Related Documentation	T1600 PIC Description T1600 PIC Combination Limitations on page 14 T1600 PICs Supported on page 3
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CHAPTER 9

Gigabit Ethernet IQ PIC Descriptions

- Gigabit Ethernet IQ PICs with SFP (T1600 Router) on page 117

Gigabit Ethernet IQ PICs with SFP (T1600 Router)

Figure 10: 1-Port Gigabit Ethernet IQ PIC

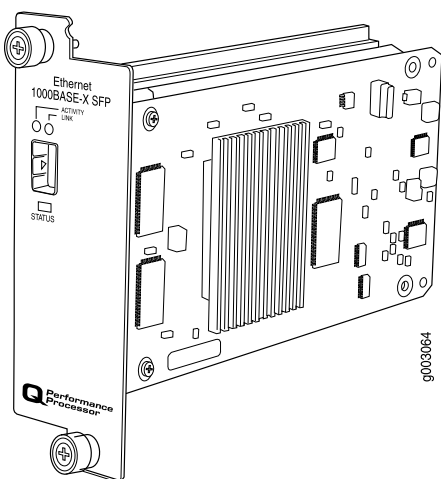
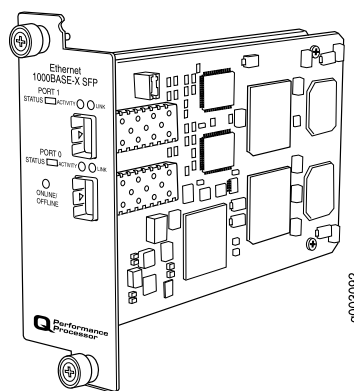


Figure 11: 2-Port Gigabit Ethernet IQ PIC



Software release

- 1-port: Junos OS Release 8.5 and later (Type 1)
- 2-port: Junos OS Release 8.5 and later (Type 2):

For information on which FPCs support this PIC, see [“T1600 PIC/FPC Compatibility” on page 14](#).

Description

- One or two Gigabit Ethernet ports
- Power requirement: 0.46 A @ 48 V (22 W)
- Fine-grained queuing per logical interface
- Model number for 1-Port Gigabit Ethernet IQ PIC: PB-1GESFP-QPP
- Model number for 2-Port Gigabit Ethernet IQ PIC: PB-2GE-SFP-QPP

Hardware features

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

- | | |
|-------------------|---|
| Software features | <ul style="list-style-type: none"> • Optical diagnostics and related alarms • Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Virtual Router Redundancy Protocol (VRRP) support • 802.1q virtual LANs (VLANs) • VLAN stacking and rewriting • Flexible Ethernet encapsulation • MAC policing, accounts, and filters |
|-------------------|---|

- | | |
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| Cables and connectors | <ul style="list-style-type: none"> • You can install any transceiver supported by the PIC. • Fiber-optic small form-factor pluggable (SFP) transceivers: <ul style="list-style-type: none"> • Duplex LC/PC connector (Rx and Tx) • 1000BASE-LH (model number: SFP-IGE-LH) • 1000BASE-LX (model number: SFP-IGE-LX) • 1000BASE-SX (model number: SFP-IGE-SX) • Optical interface specifications—see “Gigabit Ethernet 1000BASE Optical Interface Specifications” on page 34 • 1000BASE-BX (model number pairs: SFP-GE10KT13R14 with SFP-GE10KT14R13, SFP-GE10KT13R15 with SFP-GE10KT15R13, SFP-GE40KT13R15 with SFP-GE40KT15R13)—See “Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications” on page 31 • Copper transceiver: <ul style="list-style-type: none"> • Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector • 1000BASE-T (model number: SFP-IGE-T) • Pinout: MDI crossover • Copper interface specifications—see “Gigabit Ethernet 1000BASE-T Copper Interface Specifications” on page 37 |
|-----------------------|---|

NOTE: Do not install SONET/SDH OC48c/STM16 SFPs in a Gigabit Ethernet port. The port will not recognize the SFP.

- | | |
|------|---|
| LEDs | <p>Status LED, one tricolor:</p> <ul style="list-style-type: none"> • Off—Not enabled. • Green—Online with no alarms or failures. • Yellow—Online with alarms for remote failures. • Red—Active with a local alarm; router has detected a failure. |
|------|---|

NOTE: The green **Status LED** is lit on the 2-port Gigabit Ethernet IQ PIC when at least one port is online.

Port LEDs, one per port:

- Off—Port is down.
- Green—Link is established.

- | | |
|-----------------------|---|
| Related Documentation | <ul style="list-style-type: none"> • T1600 PIC Description • T1600 PIC Combination Limitations on page 14 • T1600 PICs Supported on page 3 |
|-----------------------|---|

CHAPTER 10

Gigabit Ethernet IQ2 Ethernet PIC Descriptions

- Gigabit Ethernet IQ2 PICs with SFP (T1600 Router) on page 119

Gigabit Ethernet IQ2 PICs with SFP (T1600 Router)

Figure 12: 4-Port Gigabit Ethernet IQ2 PIC (Type 1)

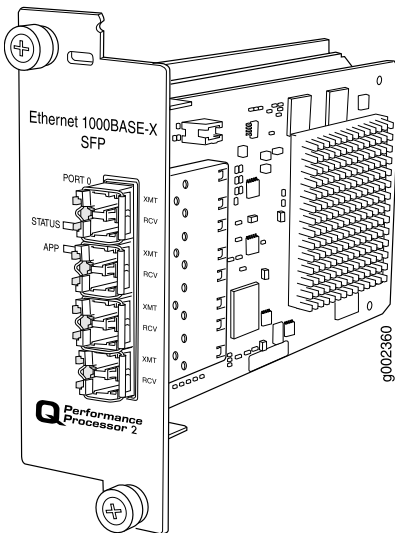


Figure 13: 8-Port Gigabit Ethernet IQ2 PIC (Type 2)

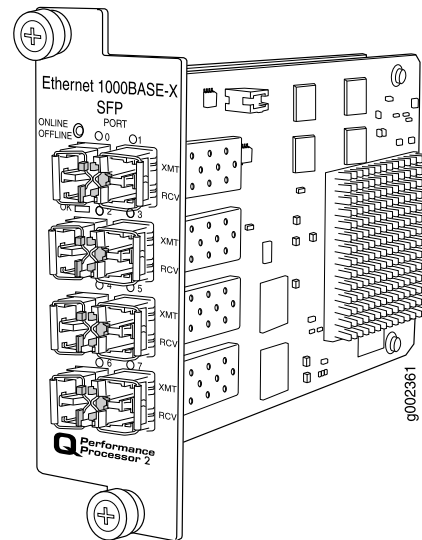
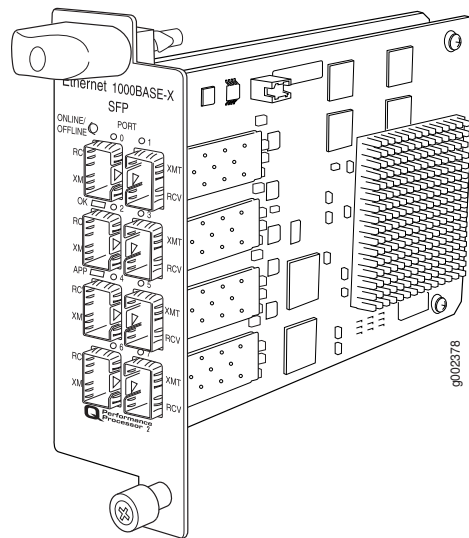


Figure 14: 8-Port Gigabit Ethernet IQ2 PIC (Type 3)



Software release

- 4-port: Junos OS Release 8.5 and later (Type 1)
- 8-port: Junos OS Release 8.5 and later (Type 2)
- 8-port: Junos OS Release 8.5 and later (Type 3)

For information on which FPCs support this PIC, see ["T1600 PIC/FPC Compatibility"](#) on page 14.

Description

- Four or eight Gigabit Ethernet ports
- Power requirement:
 - 4-port: 0.65 A @ 48 V (31 W)
 - 8-port (Type 2): 0.89 A @ 48 V (42.5 W)
 - 8-port (Type 3): 1.25 A @ 48 V (60 W)
- Model number for 4-Port Gigabit Ethernet IQ2 PIC: PB-4GE-TYPE1-SFP-IQ2
- Model number for 8-Port Type 2 Gigabit Ethernet IQ2 PIC: PB-8GE-TYPE2-SFP-IQ2
- Model number for 8-Port Type 3 Gigabit Ethernet IQ2 PIC: PB-8GE-TYPE3-SFP-IQ2

Hardware features

- High-performance throughput: speeds up to 1 Gbps on each port
- Full-duplex mode
- Large maximum transmission units (MTUs) of up to 9192 bytes

- Software features
- Intelligent handling of oversubscribed traffic for Type 1 and Type 2 PICs
 - Optical diagnostics and related alarms
 - Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
 - Virtual Router Redundancy Protocol (VRRP) support
 - Hierarchical shaping
 - Fine-grained queuing and shaping per logical interface at both ingress and egress
 - 802.1q virtual LANs (VLANs)
 - VLAN stacking and rewriting
 - Channels defined by two stacked VLAN tags
 - Multiple tag protocol identifiers (TPID) support
 - IP service for nonstandard TPID and stacked VLAN tags
 - 802.1p rewrite per channel
 - Flexible mapping of channels and scheduler resources at both ingress and egress
 - Flexible Ethernet encapsulation
 - MAC learning, policing, accounting, and filtering

- Cables and connectors
- You can install any transceiver supported by the PIC.
 NOTE: Do not install SONET/SDH SFPs in the Gigabit Ethernet port. The port will not recognize the SFP.
 - Fiber-optic SFP transceivers:
 - Duplex LC/PC connector (Rx and Tx)
 - 1000BASE-LH (model number: SFP-IGE-LH)
 - 1000BASE-LX (model number: SFP-IGE-LX)
 - 1000BASE-SX (model number: SFP-IGE-SX)
 - Optical interface specifications—see [“Gigabit Ethernet 1000BASE Optical Interface Specifications” on page 34](#)
 - 1000BASE-BX (model number pairs: SFP-GE10KT13R14 with SFP-GE10KT14R13, SFP-GE10KT13R15 with SFP-GE10KT15R13, SFP-GE40KT13R15 with SFP-GE40KT15R13)—See [“Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications” on page 31](#)
 - Copper transceiver:
 - Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector
 - 1000BASE-T (model number: SFP-IGE-T)
 - Pinout: MDI crossover
 - Copper interface specifications—see [“Gigabit Ethernet 1000BASE-T Copper Interface Specifications” on page 37](#)

LEDs**OK or Status LED**, one tricolor:

- Off—PIC is offline and it is safe to remove it from the router.
- Green—PIC is operating normally.
- Yellow—PIC is initializing.
- Red—PIC has an error or failure.

APP LED, one bicolor:

- Off—Monitoring application is not running.
- Green—Monitoring application is running under acceptable load.

Port LEDs, one per port:

- Off—Port is not enabled.
- Green—Port is online with no alarms or failures.

**Related
Documentation**

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

Gigabit Ethernet IQ2E PIC Descriptions

- Gigabit Ethernet Enhanced IQ2 (IQ2E) PICs with SFP (T1600 Router) on page 123

Gigabit Ethernet Enhanced IQ2 (IQ2E) PICs with SFP (T1600 Router)

Figure 15: 4-Port Gigabit Ethernet IQ2E PIC (Type 1)

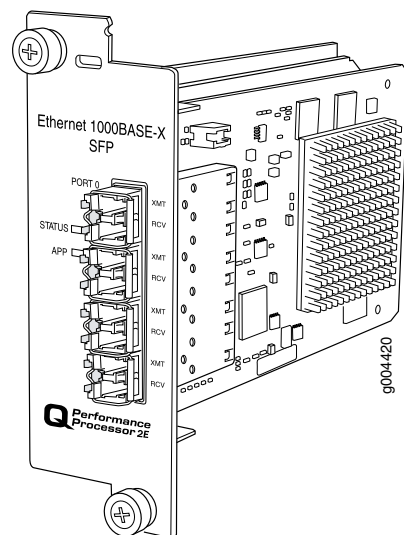


Figure 16: 8-Port Gigabit Ethernet IQ2E PIC (Type 2)

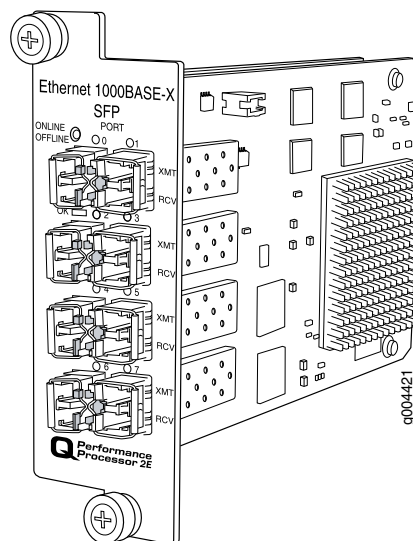
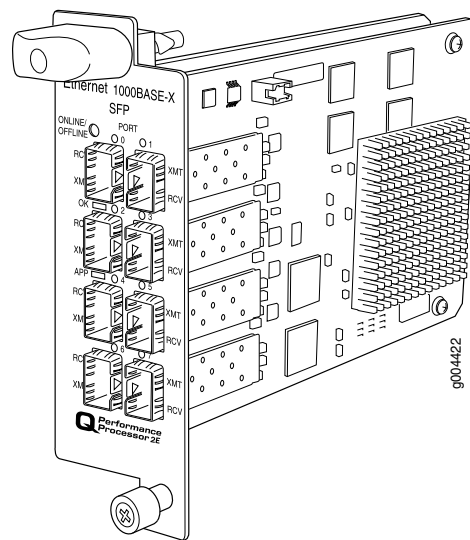


Figure 17: 8-Port Gigabit Ethernet IQ2E PIC (Type 3)



Software release

- 4-port: Junos OS Release 9.4 and later (Type 1)
- 8-port: Junos OS Release 9.4 and later (Type 2)
- 8-port: Junos OS Release 9.4 and later (Type 3)

For information on which FPCs support this PIC, see ["T1600 PIC/FPC Compatibility"](#) on page 14.

Description

- Four or eight Gigabit Ethernet ports
- Power requirement:
 - 4-port: 0.67 A @ 48 V (32 W)
 - 8-port (Type 2): 0.92 A @ 48 V (44 W)
 - 8-port (Type 3): 1.25 A @ 48 V (60 W)
- Model number for 4-Port Gigabit Ethernet Enhanced IQ2 PIC: PB-4GE-TYPE1-SFP-IQ2E
- Model number for 8-Port Type 2 Gigabit Ethernet Enhanced IQ2 PIC: PB-8-GE-TYPE2-SFP-IQ2E
- Model number for 8-Port Type 3 Gigabit Ethernet Enhanced IQ2 PIC: PB-8-GE-TYPE3-SFP-IQ2E

Hardware features

- High-performance throughput: speeds up to 1 Gbps on each port
- Full-duplex mode
- Large maximum transmission units (MTUs) of up to 9192 bytes

Software features	• Intelligent handling of oversubscribed traffic for Type 1 and Type 2 PICs • Optical diagnostics and related alarms • Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Drop statistics reported per queue for each of four priority-based drop profiles • Four levels of strict priorities with priority propagation among scheduling levels • Hierarchical shaping and hierarchical scheduler • Virtual Router Redundancy Protocol (VRRP) support • Fine-grained queuing and shaping per logical interface at both ingress and egress • 802.1q virtual LANs (VLANs) • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Multiple tag protocol identifiers (TPID) support • IP service for nonstandard TPID and stacked VLAN tags • 802.1p rewrite per channel • Flexible mapping of channels and scheduler resources at both ingress and egress • 16,000 schedulers (2,000 schedulers with 8 queues each or 4,000 schedulers with 4 queues each) • Scheduler resources dynamically allocated across ports • Flexible Ethernet encapsulation • MAC learning, policing, accounting, and filtering
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Cables and connectors	• You can install any transceiver supported by the PIC. NOTE: Do not install SONET/SDH SFPs in the Gigabit Ethernet port. The port will not recognize the SFP. • Fiber-optic small form-factor pluggable transceivers (SFPs): • Duplex LC/PC connector (Rx and Tx) • Small form-factor pluggable (SFP) transceivers: • 1000BASE-LH (model number: SFP-1GE-LH) • 1000BASE-LX (model number: SFP-1GE-LX) • 1000BASE-SX (model number: SFP-1GE-SX) • Optical interface specifications—see “Gigabit Ethernet 1000BASE Optical Interface Specifications” on page 34 • 1000BASE-BX (model number pairs: SFP-GE10KT13R14 with SFP-GE10KT14R13, SFP-GE10KT13R15 with SFP-GE10KT15R13, SFP-GE40KT13R15 with SFP-GE40KT15R13)—See “Fast Ethernet and Gigabit Ethernet Bidirectional SFP Optical Interface Specifications” on page 31 • Copper transceiver: • Connector: Four-pair, Category 5 shielded twisted-pair connectivity through an RJ-45 connector • 1000BASE-T (model number: SFP-1GE-T) • Pinout: MDI crossover Copper interface specifications—see “Gigabit Ethernet 1000BASE-T Copper Interface Specifications” on page 37
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LEDs**OK or Status LED**, one tricolor:

- Off—PIC is offline and it is safe to remove it from the router.
- Green—PIC is operating normally.
- Yellow—PIC is initializing.
- Red—PIC has an error or failure.

APP LED, one bicolor:

- Off—Monitoring application is not running.
- Green—Monitoring application is running under acceptable load.

Port LEDs, one per port:

- Off—Port is not enabled.
- Green—Port is online with no alarms or failures.

**Related
Documentation**

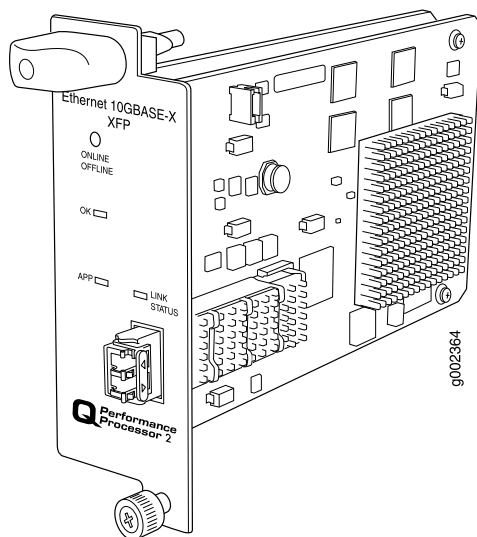
- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

CHAPTER 12

10-Gigabit Ethernet PIC Descriptions

- 10-Gigabit Ethernet IQ2 PIC with XFP (T1600 Router) on page 127
- 10-Gigabit Ethernet Enhanced IQ2 (IQ2E) PIC with XFP (T1600 Router) on page 129
- 10-Gigabit Ethernet PIC with XENPAK (T1600 Router) on page 131
- 10-Gigabit Ethernet DWDM PIC (T1600 Router) on page 133
- 10-Gigabit Ethernet DWDM OTN PIC (T1600 Router) on page 134
- 10-Gigabit Ethernet LAN/WAN PIC with Oversubscription and SFP+ (T1600 Router) on page 136
- 10-Gigabit Ethernet LAN/WAN PIC with XFP (T1600 Router) on page 139

10-Gigabit Ethernet IQ2 PIC with XFP (T1600 Router)



Software release

- Junos OS Release 8.5 and later (Type 3)

For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.

Description

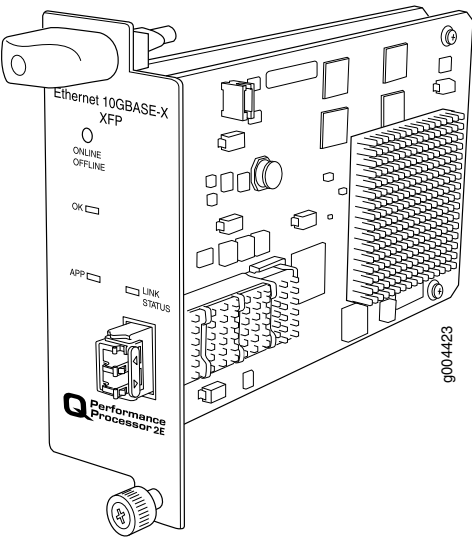
- One 10-Gigabit Ethernet port
- Power requirements: 1.2 A @48 V (56 W)
- Model number: PB-1XGE-TYPE3-XFP-IQ2

Hardware features	• High-performance throughput • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Large maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Configurable WAN-PHY mode options: • loopback • mpls • path-trace • trigger • Virtual Router Redundancy Protocol (VRRP) support • Hierarchical shaping • Fine-grained queueing and shaping per logical interface at both ingress and egress • 802.1q virtual LANs (VLANs) • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Multiple tag protocol identifiers (TPID) support • IP service for nonstandard TPID and stacked VLAN tags • 802.1p rewrite per channel • Flexible mapping of channels and scheduler resources at both ingress and egress • Flexible Ethernet encapsulation • MAC learning, policing, accounting, and filtering
Cables and connectors	• You can install any transceiver supported by the PIC. • Fiber-optic 10-Gigabit small form-factor pluggable (XFP) transceivers: • Duplex LC/PC connector (Rx and Tx) • 10-Gigabit Ethernet XFP transceivers: • 10GBASE-S (model number: XFP-10G-S) • 10GBASE-L (model number: XFP-10G-L-OC192-SR1) • 10GBASE-E (model number: XFP-10G-E-OC192-IR2) • 10GBASE-Z (model number: XFP-10G-Z-OC192-LR2) Optical interface specifications—see “10-Gigabit Ethernet 10GBASE Optical Interface Specifications” on page 38

LEDs	OK LED, one tricolor:
	• Off—PIC is offline and safe to remove from the router. • Green—PIC is operating normally. • Yellow—PIC is initializing. • Red—PIC has an error or failure.
	APP LED, one:
	• Off—Monitoring application is not running. • Green—Monitoring application is running under acceptable load. • Yellow—Monitoring application is overloaded.
	Link status LED, one:
	• Off—Port is down. • Green—Port is online. Link is established.

Related Documentation	• T1600 PIC Description
	• T1600 PIC Combination Limitations on page 14
	• T1600 PICs Supported on page 3

10-Gigabit Ethernet Enhanced IQ2 (IQ2E) PIC with XFP (T1600 Router)



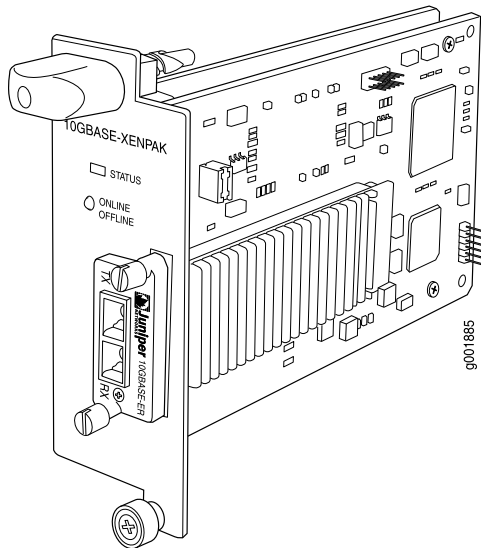
Software release	• Junos OS Release 9.4 and later (Type 3) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• One 10-Gigabit Ethernet port • Power requirements: 1.2 A @48 V (56 W) • Model number: PB-1XGE-TYPE3-XFP-IQ2E

Hardware features	• High-performance throughput • WAN-PHY mode at 9.953 Gbps • LAN-PHY mode at 10.3125 Gbps • Full-duplex mode • Large maximum transmission units (MTUs) of up to 9192 bytes
Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Drop statistics reported per queue for each of four priority-based drop profiles • Four levels of strict priorities with priority propagation among scheduling levels • Hierarchical shaping and hierarchical scheduler • Configurable WAN-PHY mode options: • loopback • mpls • path-trace • trigger • Virtual Router Redundancy Protocol (VRRP) support • Fine-grained queueing and shaping per logical interface at both ingress and egress • 802.1q virtual LANs (VLANs) • VLAN stacking and rewriting • Channels defined by two stacked VLAN tags • Multiple tag protocol identifiers (TPID) support • IP service for nonstandard TPID and stacked VLAN tags • 802.1p rewrite per channel • Flexible mapping of channels and scheduler resources at both ingress and egress • 16,000 schedulers (2,000 schedulers with 8 queues each or 4,000 schedulers with 4 queues each) • Scheduler resources dynamically allocated across ports • Flexible Ethernet encapsulation • MAC learning, policing, accounting, and filtering
Cables and connectors	• You can install any transceiver supported by the PIC. • Fiber-optic 10-Gigabit small form-factor pluggable (XFP) transceivers: • Duplex LC/PC connector (Rx and Tx) • 10-Gigabit Ethernet XFP transceivers: • 10GBASE-S (model number: XFP-10G-S) • 10GBASE-L (model number: XFP-10G-L-OC192-SR1) • 10GBASE-E (model number: XFP-10G-E-OC192-IR2) • 10GBASE-Z (model number: XFP-10G-Z-OC192-LR2) Optical interface specifications—see “10-Gigabit Ethernet 10GBASE Optical Interface Specifications” on page 38

LEDs	OK LED, one tricolor:
	• Off—PIC is offline and safe to remove from the router. • Green—PIC is operating normally. • Yellow—PIC is initializing. • Red—PIC has an error or failure.
	APP LED, one:
	• Off—Monitoring application is not running. • Green—Monitoring application is running under acceptable load. • Yellow—Monitoring application is overloaded.
	Link status LED, one:
	• Off—Port is down. • Green—Port is online. Link is established.

Related Documentation	• T1600 PIC Description
	• T1600 PIC Combination Limitations on page 14
	• T1600 PICs Supported on page 3

10-Gigabit Ethernet PIC with XENPAK (T1600 Router)

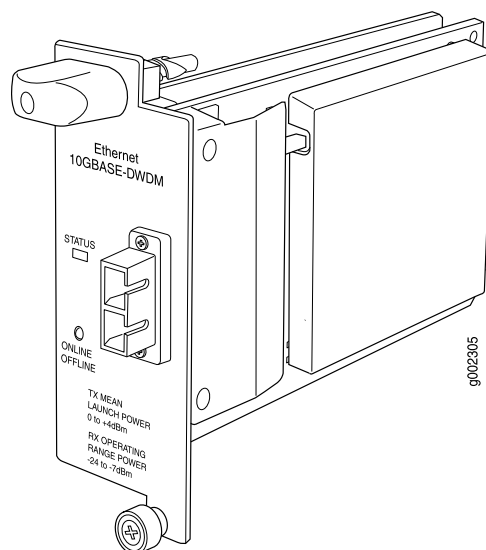


Software release	• Junos OS Release 8.5 and later (Type 3) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• One 10-Gigabit Ethernet port • Power requirement: 0.55 A @ 48 V (26.6 W) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: PC-1XGE-XENPAK

Hardware features	• High-performance throughput at speeds up to 10 Gbps • Full-duplex mode • Maximum transmission units (MTUs) up to 9192 bytes • 64 source MAC address filters • 960 destination MAC filters
Software features	• Virtual Router Redundancy Protocol (VRRP) support • 802.1q virtual LANs (VLANs) support • 802.3ad link aggregation support • RMON EtherStats • Optical diagnostics and related alarms : • Transceiver temperature • Laser bias current • Laser output power • Receive optical power
Cables and connectors	• Duplex SC/PC connector (RX and TX) • 10-Gigabit Ethernet XENPAK transceivers: • 10GBASE-SR, LAN Rate (model number: XENPAK-1XGE-SR) • 10GBASE-LR, LAN Rate (model number: XENPAK-1XGE-LR) • 10GBASE-ER, LAN Rate (model number: XENPAK-1XGE-ER) • 10GBASE-ZR, LAN Rate (model number: XENPAK-1XGE-ZR) EOL (see notification PSN-2010-02-649) Optical interface specifications—see “10-Gigabit Ethernet 10GBASE Optical Interface Specifications” on page 38
LEDs	Status LED, one bicolor: • Off—PIC is not enabled. • Green—PIC is operating normally. • Red—PIC has an error or failure. Port LEDs, one pair: • Link—If green, the port is online; if there is no light, the port is down. • RX—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data.

- Related Documentation**
- *T1600 PIC Description*
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

10-Gigabit Ethernet DWDM PIC (T1600 Router)



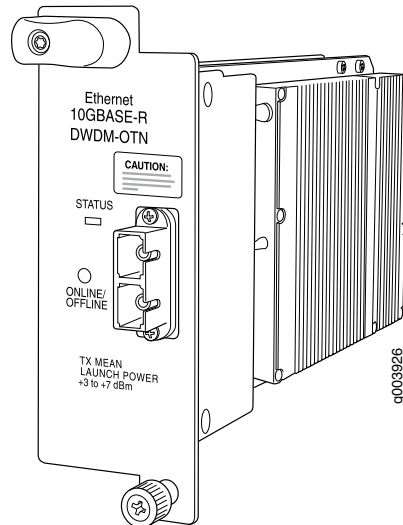
Software release	Junos OS Release 8.5 and later (Type 3) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- One 10-Gigabit Ethernet port - Power requirement: 0.55 A @ 48 V (26.6 W) - Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network - Model number: PB-1XGE-DWDM-CBAND
Hardware features	- C-band ITU-Grid with 100 GHz spacing - High-performance throughput at speeds up to 10 Gbps - Full-duplex mode - Maximum transmission units (MTUs) up to 9192 bytes 64 source MAC address filters 960 destination MAC filters 45 individual wavelengths: 1528.77 nm, 1529.55 nm, 1530.33 nm, 1531.12 nm, 1531.90 nm, 1532.68 nm, 1533.47 nm, 1534.25 nm, 1535.04 nm, 1535.82 nm, 1536.61 nm, 1537.40 nm, 1538.19 nm, 1538.98 nm, 1539.77 nm, 1540.56 nm, 1541.35 nm, 1542.14 nm, 1542.94 nm, 1543.73 nm, 1544.53 nm, 1545.32 nm, 1546.12 nm, 1546.92 nm, 1547.72 nm, 1548.52 nm, 1549.32 nm, 1550.12 nm, 1550.92 nm, 1551.72 nm, 1552.52 nm, 1553.33 nm, 1554.13 nm, 1554.94 nm, 1555.75 nm, 1556.56 nm, 1557.36 nm, 1558.17 nm, 1558.98 nm, 1559.79 nm, 1560.61 nm, 1561.42 nm, 1562.23 nm, 1563.05 nm, 1563.86 nm
Software features	- Enhanced optical monitoring capabilities - CLI configurable wavelength support - Virtual Router Redundancy Protocol (VRRP) support 802.1q virtual LANs (VLANs) support 802.3ad link aggregation support - RMON EtherStats

- | | |
|-----------------------|--|
| Cables and connectors | <ul style="list-style-type: none"> • Duplex SC/PC connector (RX and TX) • Fixed 10-Gigabit Ethernet DWDM transceiver • Optical interface specifications—see “10-Gigabit Ethernet DWDM Optical Interface Specifications” on page 43. |
|-----------------------|--|

- | | |
|------|---|
| LEDs | <p>Status LED, one bicolor:</p> <ul style="list-style-type: none"> • Off—PIC is not enabled. • Green—PIC is operating normally. • Red—PIC has an error or failure. <p>Port LEDs, one pair:</p> <ul style="list-style-type: none"> • Link—If green, the port is online; if there is no light, the port is down. • RX—If flashing green, the port is receiving data; if there is no light, the port might be on but is not receiving data. |
|------|---|

- | | |
|-----------------------|---|
| Related Documentation | <ul style="list-style-type: none"> • T1600 PIC Description • T1600 PIC Combination Limitations on page 14 • T1600 PICs Supported on page 3 |
|-----------------------|---|

10-Gigabit Ethernet DWDM OTN PIC (T1600 Router)

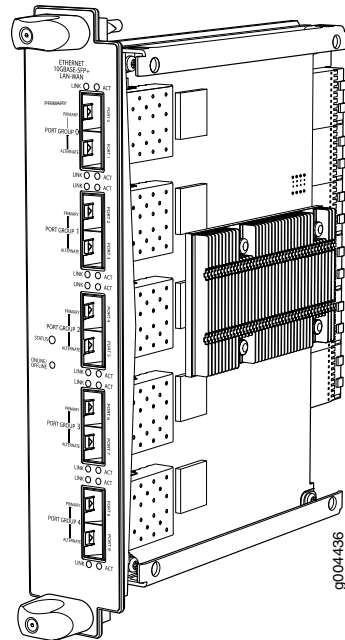


- | | |
|------------------|---|
| Software release | <ul style="list-style-type: none"> • Junos OS Release 9.4 and later (Type 3) <p>For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.</p> |
| Description | <ul style="list-style-type: none"> • One 10-Gigabit Optical Transport Network (OTN) port for transport of 10-Gigabit Ethernet (10GBASE-R) traffic • Power requirement: 0.55 A @ 48 V (26.6 W) • Supports large Ethernet frame sizes for more efficient throughput across the intra-POP network • Model number: PC-1XGE-DWDM-OTN |

Hardware features	• C-band ITU-Grid with 50 GHz spacing • High-performance throughput at speeds up to 10 Gbps • Full-duplex mode • Maximum transmission units (MTUs) up to 9192 bytes • 64 source MAC address filters • 960 destination MAC filters • 89 individual wavelengths
Software features	• Enhanced optical monitoring capabilities • CLI configurable wavelength support • Virtual Router Redundancy Protocol (VRRP) support • 802.1q virtual LANs (VLANs) support • IEEE 802.3ad Link Aggregation • RMON EtherStats
Cables and connectors	• Duplex SC/PC connector (RX and TX) • Fixed transceiver • Dense wavelength division multiplexing (DWDM) optical transport network (OTN) transceiver. Optical interface specifications—see <i>10-Gigabit Ethernet DWDM OTN Optical Interface Specifications</i> and "10-Gigabit Ethernet 10GBASE Optical Interface Specifications" on page 38.
LEDs	Status LED, one bicolor: • Off—PIC is not enabled. • Green—PIC is operating normally. • Red—PIC has an error or is in line-side loopback.

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

10-Gigabit Ethernet LAN/WAN PIC with Oversubscription and SFP+ (T1600 Router)



Software release

- Junos OS Release 10.1 and later (Type 4)

For information about which FPCs support this PIC, see [“T1600 PIC/FPC Compatibility” on page 14](#).

NOTE: In some Juniper Networks documentation, the 10-Gigabit Ethernet LAN/WAN PIC with SFP+ (PD-5-10XGE-SFPP) is referred to as the 10-port 10-Gigabit Oversubscribed Ethernet PIC. In oversubscribed Ethernet mode (default), all 10 ports are enabled and oversubscription is permitted. In line-rate mode, this PIC does not allow oversubscription and supports only 5 ports (0, 2, 4, 6, and 8).

Description

- Ten 10-Gigabit Ethernet SFP+ ports (only ports 0, 2, 4, 6, and 8 are supported in line-rate mode)
- Total bandwidth: 50 Gbps
- Power requirements: 3.3 A @ -48 V (158.4 W)
- Model number: PD-5-10XGE-SFPP

Hardware features

- High-performance throughput:
 - WAN-PHY mode at 9.953 Gbps
 - LAN-PHY mode at 10.3 Gbps
- Full-duplex mode
- Large maximum transmission units (MTUs) of up to 9192 bytes

- Software features
- Two modes of operation: 5 ports in line-rate mode, 10 ports in oversubscribed mode
 - Intelligent handling of oversubscribed traffic
 - Flexible mapping of port-assigned queues and scheduler resources at both ingress and egress
 - Strict-priority queue available on a per-port basis
 - QoS available on a per-port basis
 - Weighted round-robin (WRR)
 - Layer 2 protocol support:
 - Ethernet CCC, Ethernet TCC, Ethernet VPLS
 - VLAN CCC
 - Extended VLAN TCC
 - VLAN VPLS
 - Flexible Ethernet services
 - Layer 3 protocol support
 - IPv4
 - IPv6
 - MPLS
 - VLAN support
 - 4000 VLANs per PIC
 - Flex-VLAN tagging support
 - Interrupt-driven link-down detection
 - Pause frame support
 - Jumbo frame support
 - MAC learning, aging, policing, and filtering
 - Virtual Router Redundancy Protocol (VRRP) support
 - IEEE 802.3ad link aggregation (For routers in a routing matrix, Junos OS Release 11.2 and later is required)
- NOTE:** For PICs that support oversubscription, the PIC must be in line-rate mode to support aggregated Ethernet.
- DSCP rewrite is supported for Junos OS Release 11.4 and later.

- Cables and connectors
- Duplex LC/PC connector (Rx and Tx)
 - 10-Gigabit SFP+ transceivers:
 - 10GBASE-ER (model number: SFPP-10GE-ER) Junos OS Release 12.1 and later
 - 10GBASE-LR (model number: SFPP-10GE-LR)
 - 10GBASE-SR (model number: SFPP-10GE-SR)
 - 10GBASE-ZR (model number: SFPP-10GE-ZR) Junos OS Release 12.3 and later
 - 10GBASE-ZR (model number: SFPP-10G-OTN-XT)
 - Supported in Junos OS Release 12.3R5, 13.2R3, 13.3, and later
 - NESB compliant
 - Dual-rate extended temperature transceiver that supports LAN-PHY and WAN-PHY modes, and OTN rates
 - Optical interface specifications—see [“10-Gigabit Ethernet 10GBASE Optical Interface Specifications” on page 38](#)

LEDs

STATUS LED, one tricolor:

- Off—PIC is offline and safe to remove from the router.
- Green—PIC is operating normally.
- Yellow—PIC is initializing.
- Red—PIC has an error or failure.

Port LEDs, one pair for each port:

- **LINK LED**
 - Off—Port is not enabled.
 - Green—Port is online with no alarms or failures.
 - Red—The router has detected a failure with alarms.
- **ACT LED**
 - Green flashing—Port is sending or receiving packets.
 - Off—No packet activity detected on the port.



CAUTION: A T1600 router with the following power supply configurations and operating conditions can accommodate a maximum of sixteen 10-Gigabit Ethernet LAN/WAN PICs with SFP+ :

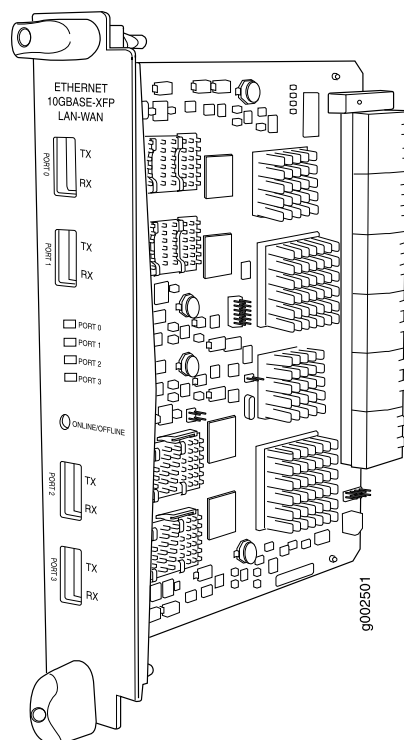
- One or two AC power supplies.
- Two DC power supplies in load-sharing mode with an input voltage between –43 VDC and –72 VDC.
- One DC power supply with an input voltage between –43 VDC and –72 VDC.

However, a router with only one DC power supply with an input voltage between –40 VDC and –43 VDC might not be able to support the maximum number of 10-Gigabit Ethernet LAN/WAN PICs with SFP+. For more information, see technical bulletin [PSN-2010-03-695](#).

**Related
Documentation**

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)

10-Gigabit Ethernet LAN/WAN PIC with XFP (T1600 Router)



Software release	Junos OS Release 9.0 and later (Type 4) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Four 10-Gigabit Ethernet ports - Power requirements: 0.9 A @48 V (43 W) - Model number: PD-4XGE-XFP
Hardware features	- High-performance throughput - WAN-PHY mode at 9.953 Gbps - LAN-PHY mode at 10.3125 Gbps - Full-duplex mode - Large maximum transmission units (MTUs) of up to 9192 bytes

Software features

- Configurable WAN-PHY mode options:
 - loopback
 - mpls
 - path-trace
 - trigger
- Optical diagnostics, monitoring, and alarms supported in Junos OS Release 10.4.
- Flexible Ethernet Services Encapsulation
- 802.1q virtual LANs (VLANs)
- Ethernet OAM 802.1ag continuity check
- Ethernet OAM 802.3ah (remote loopback is not supported for this PIC)
- VLAN stacking
- Channels defined by two stacked VLAN tags
- Multiple tag protocol identifiers (TPID) support
- IP service for nonstandard TPID and stacked VLAN tags
- Passive flow monitoring supported in Junos OS Release 11.2 and later
- MAC learning, accounting, and filtering
- Virtual Router Redundancy Protocol (VRRP) support

Cables and connectors

- You can install any transceiver supported by the PIC.
- Connector: Duplex LC/PC (Rx and Tx)
- Fiber-optic 10-Gigabit small form-factor pluggable (XFP) transceivers:
 - 10GBASE-S (model number: XFP-10G-S)
 - 10GBASE-L (model number: XFP-10G-L-OC192-SR1)
 - 10GBASE-E (model number: XFP-10G-E-OC192-IR2)
 - 10GBASE-Z (model number: XFP-10G-Z-OC192-LR2)
 - Optical interface specifications—see [“10-Gigabit Ethernet 10GBASE Optical Interface Specifications” on page 38](#)
- DWDM Tunable XFP transceivers:
 - 10GBASE-ZR (model number: XFP-10G-CBAND-T50-ZR) supported in Junos OS Release 10.2 and later
 - Optical interface specifications—see [“10-Gigabit Ethernet 10GBASE Optical Interface Specifications” on page 38](#)
 - DWDM supported wavelengths—see [“10-Gigabit Ethernet DWDM Transceiver Wavelengths” on page 44](#)

LEDs

Port LED, one for each port:

- Off—Port is not enabled.
- Green—Port is online with no alarms or failures.
- Yellow—Port is online with alarms for remote failures.
- Red—The router has detected a failure with alarms for local failures.

Alarms Alarms are vendor-specific. Some transceiver vendors might not support every alarm.

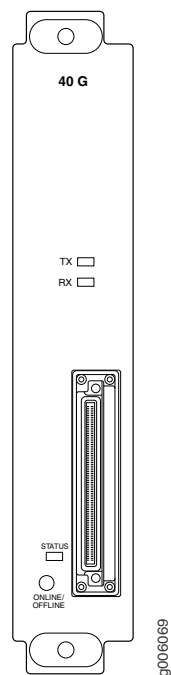
- Input laser power
- Input loss of lock
- Input loss of signal
- Input Rx path
- Output A/D data not ready
- Output CDR (clock data recovery)
- Output laser bias current
- Output laser power
- Output laser safety
- Output Tx path
- Module temperature
- Module MOD_NR (module not ready)
- Module P_DOWN (module down)
- Module unplugged or down
- Wire unplugged or down

- Related Documentation**
- *T1600 PIC Description*
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

40-Gigabit Ethernet PIC Descriptions

- 40-Gigabit Ethernet PIC with CFP (T1600 Router) on page 143

40-Gigabit Ethernet PIC with CFP (T1600 Router)



Software release	• Junos OS Release 11.4 (Type 4) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	• One 40-Gigabit Ethernet port • Power requirement: 1.46 A @ –48 V (70.0 W) • Model number: PD-1XLE-CFP
Hardware features	• Maximum transmission units (MTUs) up to 9192 bytes

Software features

- Media Access Control (MAC) accounting

NOTE: MAC accounting on this PIC is not supported when aggregated Ethernet is configured.

- Source and destination MAC address filtering
- Ethernet OAM 802.3ah (remote loopback is not supported for this PIC)
- Layer 2 filtering and accounting based on Layer 2 headers
- Multiple tag protocol identifiers (TPIDs) used for filtering and counting
- Flexible virtual LAN (VLAN) tagging
- Channels defined by two stacked VLAN tags
- Layer 2 protocols:
 - Flexible Ethernet service
 - Ethernet circuit cross-connect (CCC)
 - Ethernet translational cross-connect (TCC)
 - Ethernet virtual private LAN service (VPLS)
 - VLAN CCC
 - Extended VLAN TCC
 - VLAN VPLS

Layer 3 protocols:

- IPv4
- IPv6
- MPLS
- Optical control features (vendor dependent)
- IEEE 802.3ad Link Aggregation
- Graceful Routing Engine switchover (GRES)

NOTE: The 40-Gigabit Ethernet PIC with CFP does not support Layer 2 egress interface rewrite rules (**egress IEEE802.1P rewrite-rules**).

Cables and connectors

- Duplex SC/PC connector (RX and TX)
- 40-Gigabit Ethernet CFP transceiver: 40GBASE-LR4 (model number: CFP-40GBASE-LR4)
- Optical interface specifications—see *40-Gigabit Ethernet 40GBASE-R Optical Interface Specifications*

LEDs

STATUS LED:

- Green—Online with no alarms or failures
- Yellow—PIC is initializing
- Red—PIC has a remote or local fault
- Off—Not enabled

RX LED:

- Green—Port is receiving data
- Off—Port might be on, but there is a local or remote fault

TX LED:

- Green—Port is transmitting data
- Off—Port might be on, but there is a local fault

Alarms, errors, and events

- Alarm indication signal (AIS)
- Laser bias current high/low alarms and warnings
- Laser Rx power high/low alarms and warnings
- Module not ready alarm
- Module power down alarm
- Module temperature high/low alarms and warnings
- Rx CDR loss of lock alarm
- Rx loss of signal alarm
- Rx not ready alarm
- Tx CDR loss of lock alarm
- Tx data not ready alarm
- Tx laser fault alarm
- Tx not ready alarm

Related Documentation

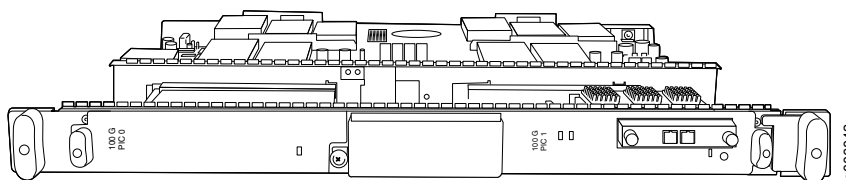
- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

CHAPTER 14

100-Gigabit Ethernet PIC Descriptions

- 100-Gigabit Ethernet PIC with CFP (T1600 Router) on page 147

100-Gigabit Ethernet PIC with CFP (T1600 Router)



Software release

- Junos OS Release 10.3 (Type 4)

The 100-Gigabit Ethernet PIC is available only packaged in an assembly with the T1600-FPC4-ES FPC.

Description

- One 100-Gigabit Ethernet port
- Power requirements for PD-ICE-CFP-FPC4 (PIC and FPC): 9.48 A @48 V (455 W)
- Model number: PD-ICE-CFP-FPC4
- PIC 0 and PIC 1 are connected by a bridge board
- There are two physical interfaces when the 100-Gigabit Ethernet PIC is online. Each physical interface represents one of two internal 50-Gigabit Ethernet Packet Forwarding Engines (PFEs) in the FPC. PFE0 is physical interface 0, PFE1 is physical interface 1.
The following example shows the CLI representation of physical interface. The interface type is **et**, the FPC slot number is **x**, the PIC slot is always **0**, and the ports for the PFEs are **0:0** for PFE0 and **0:1** for PFE1.
 - **et-x/0/0:0**
 - **et-x/0/0:1**
- You must also configure two logical interfaces under each physical interface. The following CLI example shows the logical interfaces.
 - **et-x/0/0:0.0** and **et-x/0/0:0.1**
 - **et-x/0/0:1.0** and **et-x/0/0:1.1**

NOTE: When bringing the PIC online and offline using the **request chassis pic (offline | online) fpc-slot slot-number pic-slot slot-number** command, you must specify **pic-slot slot-number 0**.

NOTE: For more information about CLI commands, see *Ethernet Interfaces Feature Guide for Routing Devices*.

Hardware features	Support for MTUs up to 9192 bytes
Software features	- Media Access Control (MAC) accounting NOTE: MAC accounting on this PIC is not supported when aggregated Ethernet is configured. - Source and destination MAC address filtering - Ethernet OAM 802.3ah (remote loopback is not supported for this PIC) - Layer 2 filtering and accounting based on Layer 2 headers - Multiple tag protocol identifiers (TPIDs) used for filtering and counting - Flexible virtual LAN (VLAN) tagging - Channels defined by two stacked VLAN tags - VLAN-steering - Layer 2 protocols: - Flexible Ethernet service - Ethernet circuit cross-connect (CCC) - Ethernet translational cross-connect (TCC) - Ethernet virtual private LAN service (VPLS) - VLAN CCC - Extended VLAN TCC - VLAN VPLS - Layer 3 protocols: - IPv4 - IPv6 - MPLS - Optical control features (vendor dependent) - IEEE 802.3ad Link Aggregation NOTE: Aggregated Ethernet must be configured on this PIC to support interoperability with 100-Gigabit Ethernet PIC (model number PF-1CGE-CFP) or the 100-Gigabit Ethernet MIC (model number MIC3-3D-1X100GE-CFP) . - Graceful Routing Engine switchover (GRES) - Interoperability with 100-Gigabit Ethernet interfaces from other vendors - Interoperability supported in Junos OS Release 12.1R2 and later with the 100-Gigabit Ethernet PIC (model number PF-1CGE-CFP) and the 100-Gigabit Ethernet MIC (model number MIC3-3D-1X100GE-CFP) NOTE: The 100-Gigabit Ethernet PIC with CFP does not support Layer 2 egress interface rewrite rules (egress IEEE802.1P rewrite rules).

Cables and connectors

- You can install any 100-Gigabit Ethernet CFP transceiver supported by the PIC.
 - 100GBASE-LR4 (model number: CFP-100GBASE-LR4)
 - Duplex SC connector (RX and TX)
 - Junos OS Release 10.3 and later
 - 100GBASE-LR4 (model number: CFP-GEN2-100GBASE-LR4 and part number: 740-047682)
 - Duplex LC connector (RX and TX)
 - Junos OS Release 12.3R5, 13.2R3, 13.3R1, and later releases

NOTE: The “GEN2” optics have been redesigned with newer versions of internal components for reduced power consumption.

- 100GBASE-ER4 (model number: CFP-100GBASE-ER4)
 - Duplex LC connector (RX and TX)
 - Junos OS Release 12.3 and later
- 100GBASE-ER4 (model number: CFP-GEN2-CGE-ER4 and part number: 740-049763)
 - Duplex LC connector (RX and TX)
 - Junos OS Release 12.3R5, 13.2R3, 13.3R1, and later releases

NOTE: The “GEN2” optics have been redesigned with newer versions of internal components for reduced power consumption.

- 100GBASE-SR10 (model number: CFP-100GBASE-SR10)
 - 24-fiber MPO
 - Junos OS Release 12.3 and later
- Optical interface specifications—see [“100-Gigabit Ethernet 100GBASE-R Optical Interface Specifications” on page 46](#)

LEDs

Two tricolor **STATUS** LEDs (**PIC 0** and **PIC 1**):

- Green—Online with no alarms or failures
- Yellow—PIC is initializing
- Red—PIC has a remote or local fault
- Off—PIC is not enabled

RX LED (**PIC 1**):

- Green—Port is receiving data
- Off—Port might be on, but there is a local or remote fault

TX LED (**PIC 1**):

- Green—Port is transmitting data
- Off—Port might be on, but there is a local fault

Alarms, errors, and events

Alarms are vendor-specific. Some transceiver vendors might not support every alarm.

- Alarm indication signal (AIS)
- Laser bias current high/low alarms and warnings
- Laser Rx power high/low alarms and warnings
- Module not ready alarm
- Module power down alarm
- Module temperature high/low alarms and warnings
- Rx CDR loss of lock alarm
- Rx loss of signal alarm
- Rx not ready alarm
- Tx CDR loss of lock alarm
- Tx data not ready alarm
- Tx laser fault alarm
- Tx not ready alarm

Related Documentation

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

CHAPTER 15

Services PIC Descriptions

- [MultiServices PICs \(T1600 Router\) on page 151](#)
- [Tunnel Services PIC \(T1600 Router\) on page 155](#)
- [40-Gigabit Tunnel Services PIC \(T1600 Router\) on page 156](#)

MultiServices PICs (T1600 Router)

Figure 18: MultiServices 100 PIC

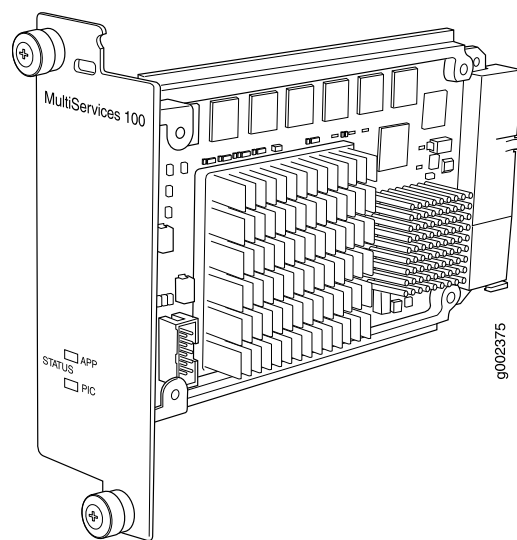


Figure 19: MultiServices 400 PIC

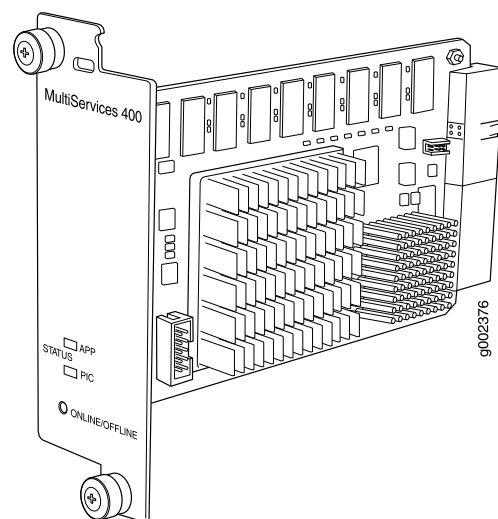
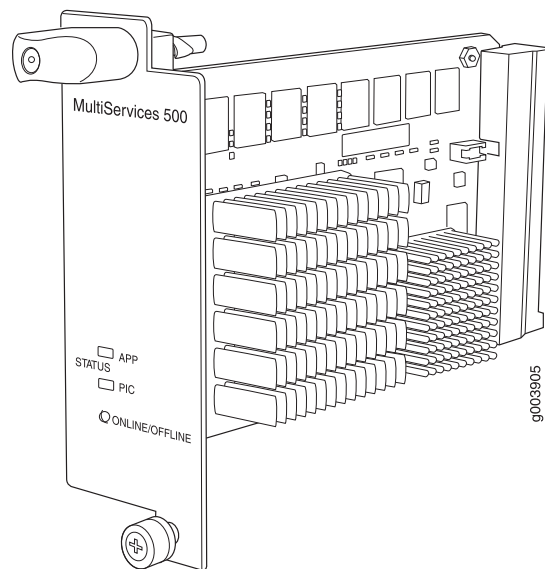


Figure 20: MultiServices 500 PIC



Software release	- MultiServices 100: Junos OS Release 8.5 and later (Type 1) - MultiServices 400: Junos OS Release 8.5 and later (Type 2) - MultiServices 500: Junos OS Release 8.5 and later (Type 3) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Supports tunnel services. This feature is included with the PIC and does not require an individual license. - Individual licenses must be purchased for additional services. - Power requirement: - Type 1: 0.52 A @ 48 V (25 W) - Type 2: 0.69 A @ 48 V (33 W) - Type 3: 0.83 A @ 48 V (40 W) - Model number for Multiservices 100 PIC: PB-MS-100-1 - Model number for Multiservices 400 PIC: PB-MS-400-1 - Model number for Multiservices 500 PIC: PB-MS-500-1
Hardware features	- Active monitoring on: - Type 1: up to 1.6 million flows - Type 2: up to 3.2 million flows - Type 3: up to 3.2 million flows
Software features	- Support for up to 2000 service sets - Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces Depending on your Junos OS Release and individual licenses, software features for this PIC can include the features listed in Table 65 on page 153. For more information about the software features available for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i>.

LEDs	Status LED, one tricolor: • Off—PIC is offline and it is safe to remove it from the chassis. • Green—PIC is operating normally. • Yellow—PIC is initializing. • Red—PIC has an error or failure and no further harm can be done by removing it from the chassis. Application LED, one bicolor: • Off—Service is not running. • Green—Service is running under acceptable load. • Yellow—Service is overloaded.
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Table 65: MultiServices PICs Software Features Supported on the T1600 Router

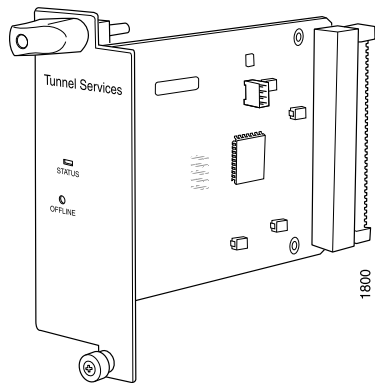
Software Feature	MultiServices 100	MultiServices 400	MultiServices 500
GRE Key	–	–	–
GRE dont-fragment	–	–	–
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks	8.5	8.5	8.5
Network Address Translation (NAT) for IP addresses	8.5	8.5	8.5
Port Address Translation (PAT) for port numbers	8.5	8.5	8.5
IP Security (IPSec) encryption	8.5	8.5	8.5
Active flow monitoring exports cflowd version 5 and version 8 records	8.5	8.5	8.5
Active flow monitoring exports flow monitoring version 9 records, based on RFC 3954	8.5	8.5	8.5
Passive flow monitoring	–	8.5	–
Passive flow collection	–	8.5	–
Flow-tap	8.5	8.5	8.5
Dynamic flow capture	–	8.5	–
Real-time performance monitoring	8.5	8.5	8.5
Link Services	8.5	8.5	8.5

Table 65: MultiServices PICs Software Features Supported on the T1600 Router (*continued*)

Software Feature	MultiServices 100	MultiServices 400	MultiServices 500
Tunnel services:	8.5	8.5	8.5
• IP-IP unicast tunneling • GRE unicast tunneling—Supports GRE fragmentation • Protocol Independent Multicast (PIM) sparse mode unicast tunneling			
Virtual tunnel interface for Layer 3 VPNs	8.5	8.5	8.5
Layer 2 Tunneling Protocol (L2TP)	—	—	—
Voice services:	8.5	8.5	8.5
• Compressed Real-Time Transport Protocol (CRTP)			
Encapsulations:	8.5	8.5	8.5
• Multilink Frame Relay (MLFR) • Multilink Point-to-Point Protocol (MLPP)			

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

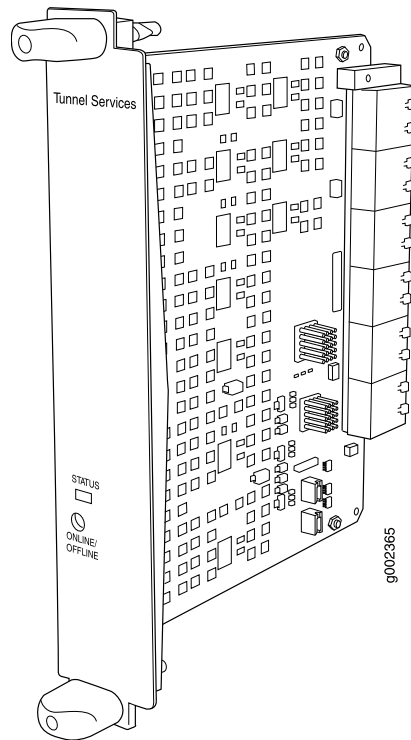
Tunnel Services PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Power requirement: 0.07 A @ 48 V (3.4 W) - Model number for Type 1 Tunnel Services PIC: PB-TUNNEL-1 - Model number for Type 2 Tunnel Services PIC: PB-TUNNEL - Model number for Type 3 Tunnel Services PIC: PC-TUNNEL
Hardware features	- Loopback function that encapsulates and de-encapsulates packets - OC12/STM4 tunneling bandwidth on Type 1 FPC; OC48/STM16 tunneling bandwidth on Type 2 FPC; OC192/STM64 tunneling bandwidth on Type 3 FPC
Software features	For a list of the software features available for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i>. - IP-IP unicast tunneling - GRE unicast tunneling - PIM sparse mode unicast tunneling
LEDs	One tricolor: - Off—Not enabled - Green—Online with no alarms or failures - Yellow—Online with alarms for remote failures - Red—Active with a local alarm; router has detected a failure

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

40-Gigabit Tunnel Services PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Power requirement: 0.07 A @ 48 V (3.4 W) - Model number: PD-TUNNEL
Hardware features	40 gigabit loopback bandwidth that encapsulates and de-encapsulates packets
Software features	For a list of the software features available for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i>. - IP-IP unicast tunneling - GRE unicast tunneling - PIM sparse mode unicast tunneling
LEDs	One tricolor: - Off—Not enabled - Green—Online with no alarms or failures - Yellow—Online with alarms for remote failures - Red—Active with a local alarm; router has detected a failure

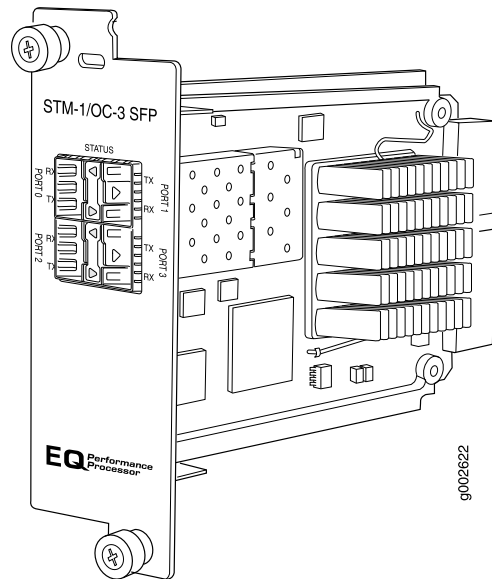
- Related Documentation**
- *T1600 PIC Description*
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

CHAPTER 16

SONET/SDH PIC Descriptions

- [SONET/SDH OC3/STM1 Enhanced IQ \(IQE\) PIC with SFP \(T1600 Router\) on page 160](#)
- [SONET/SDH OC3/STM1 \(Multi-Rate\) PICs with SFP \(T1600 Router\) on page 163](#)
- [SONET/SDH OC12/STM4 Enhanced IQ \(IQE\) PIC with SFP \(T1600 Router\) on page 166](#)
- [SONET/SDH OC12/STM4 \(Multi-Rate\) PICs with SFP \(T1600 Router\) on page 169](#)
- [SONET/SDH OC48c/STM16 PIC with SFP \(T1600 Router\) on page 172](#)
- [SONET/SDH OC48/STM16 Enhanced IQ \(IQE\) PIC with SFP \(T1600 Router\) on page 175](#)
- [SONET/SDH OC48/STM16 \(Multi-Rate\) PIC with SFP \(T1600 Router\) on page 179](#)
- [SONET/SDH OC192c/STM64 PIC \(T1600 Router\) on page 182](#)
- [SONET/SDH OC192/STM64 PICs with XFP \(T1600 Router\) on page 185](#)
- [SONET/SDH OC768c/STM256 PIC \(T1600 Router\) on page 188](#)

SONET/SDH OC3/STM1 Enhanced IQ (IQE) PIC with SFP (T1600 Router)



Software release	4-port: Junos OS Release 9.3R2 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Four OC3 or STM1 ports - SONET or SDH is configurable on a per-port granularity - Power requirement: 0.6 A @ 48 V (28.8 W) - Model number: PB-4OC3-STM1-IQE-SFP
Hardware features	- Top row—ports are numbered 0 and 1 from left to right - Bottom row—ports are numbered 2 and 3 from left to right

Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Enhanced fine-grained queuing per logical interface. See the <i>Class of Service Feature Guide for Routing Devices</i> for more information about class of service features. • Packet buffering, Layer 2 parsing • Local line, remote line, and remote payload loopback testing • Simple Network Management Protocol (SNMP): OC3 MIB • Full bit error rate test (BERT) • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Extended Frame Relay for CCC and TCC • Flexible Frame Relay • Frame Relay • Frame Relay for CCC • Frame Relay for TCC • Frame Relay port CCC • High-Level Data Link Control (HDLC) • HDLC framing for CCC • HDLC framing for TCC • MPLS CCC • MPLS TCC • Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16) • Point-to-Point Protocol (PPP) • PPP for CCC • PPP for TCC
Cables and connectors	• Duplex LC/PC connector (Rx and Tx) • SONET/SDH OC3/STM1 fiber-optic SFP transceivers: • Multimode (model number: SFP-OC3-SR) • Intermediate reach (IR-1) (model number: SFP-OC3-IR) • Long reach (LR-1) (model number: SFP-OC3-LR) Optical interface specifications—see “SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50
LEDs	One tricolor Status LED per port: • Off—Not enabled. • Green—Online with no alarms or failures. • Yellow—Online with alarms for remote failures. • Red—Active with a local alarm; router has detected a failure.

Alarms, errors, and events

SONET alarms:

- Alarm indication signal—line (AIS-L)
- Alarm indication signal—path (AIS-P)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Loss of clock (LOC)
- Loss of frame (LOF)
- Loss of light (LOL)
- Loss of pointer (LOP)
- Loss of signal (LOS)
- Payload label mismatch (PLM-P)
- Phase lock loop (PLL)
- Remote defect indication—line (RDI-L)
- Remote defect indication—path (RDI-P)
- Remote error indication (REI)
- Payload unequipped (unequipped STS at path level) (UNEQ-P)
- Severely errored frames (SEF)
- SDH alarms:
 - Administrative unit alarm indication signal (AU-AIS)
 - Bit error rate signal degrade (BERR-SD)
 - Bit error rate signal fail (BERR-SF)
 - Bit interleaved parity (BIP) error B1, B2, B3
 - Higher order path—alarm indication signal (HP-AIS)
 - Higher order path—far-end receive failure (HP-FERF)
 - Higher order path—payload label mismatch (HP-PLM)
 - Higher order path—loss of pointer (HP-LOP)
 - Higher order path—remote defect indication (HP-RDI)
 - Higher order path—unequipped (HP-UNEQ)
 - Loss of clock (LOC)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of signal (LOS)
 - Multiplex section—alarm indication signal (MS-AIS)
 - Multiplex section—far-end receive failure (MS-FERF)
 - Multiplex section—remote defect indication (MS-RDI)
 - Multiplex section—remote error indication (MS-REI)
 - Phase lock loop (PLL)
 - Remote error indication (REI)
 - Severely errored frames (SEF)
- Error detection:
 - Errored seconds (ES-S, ES-L, ES-P)
 - Severely errored framing seconds (SEFS-S)
 - Severely errored seconds (SES-S, SES-L, SES-P)
 - Unavailable seconds (UAS-L, UAS-P)

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 PIC Combination Limitations on page 14](#)
 - [T1600 PICs Supported on page 3](#)

SONET/SDH OC3/STM1 (Multi-Rate) PICs with SFP (T1600 Router)

Figure 21: SONET/SDH OC3/STM1 (Multi-Rate) PIC (Type 1)

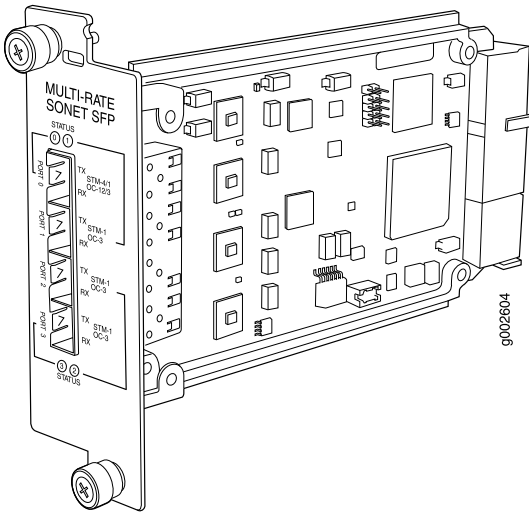
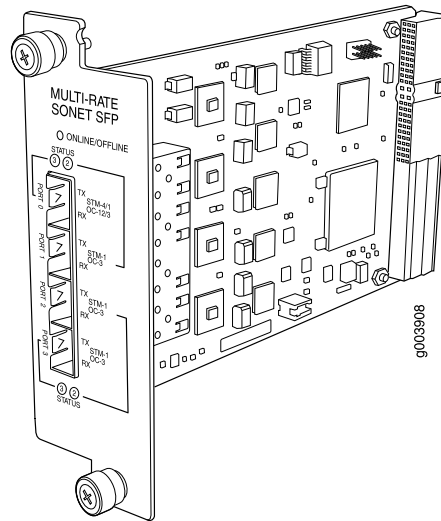


Figure 22: SONET/SDH OC3/STM1 (Multi-Rate) PIC (Type 2)



- Software release**
- 4-port: Junos OS Release 8.5 and later (Type 1)
 - 4-port: Junos OS Release 8.5 and later (Type 2)
- For information on which FPCs support this PIC, see [“T1600 PIC/FPC Compatibility” on page 14](#).

- Description**
- Rate-selectable using one of the following rates:
 - 1-port OC12/STM4
 - 1-port OC12c/STM4c
 - 4-port OC3c/STM1c
 - Power requirement: 0.40 A @ 48 V (19 W)
 - Model number for SONET/SDH OC3/STM1 (Multi-Rate) PIC (Type_1): PB-40C3-1OC12-SON-SFP
 - Model number for SONET/SDH OC3/STM1 (Multi-Rate) PIC (Type_2): PB-40C3-1OC12-SON2-SFP

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

Software features	• Optical diagnostics and related alarms • Per-port SONET/SDH framing • Link aggregation • Alarm and event counting and detection • Dual-router automatic protection switching (APS) • Multiprotocol Label Switching (MPLS) fast reroute • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Frame Relay • High-Level Data Link Control (HDLC) • Point-to-Point Protocol (PPP)
Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing transceivers. • Duplex LC/PC connector (Rx and Tx) • SONET/SDH OC3/STM1 small form-factor pluggable (SFP) transceivers: • Multimode (model number: SFP-OC3-SR) • Intermediate reach (IR-1) (model number: SFP-OC3-IR) • Long reach (LR-1) (model number: SFP-OC3-LR) Optical interface specifications—see “SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50 • SONET/SDH OC12/STM4 small form-factor pluggable (SFP) transceivers: • Short reach (model number: SFP-OC12-SR) • Intermediate reach (IR-1) (model number: SFP-OC312-IR) • Long reach (LR-1) (model number: SFP-OC12-LR) Optical interface specifications—see “SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52 NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

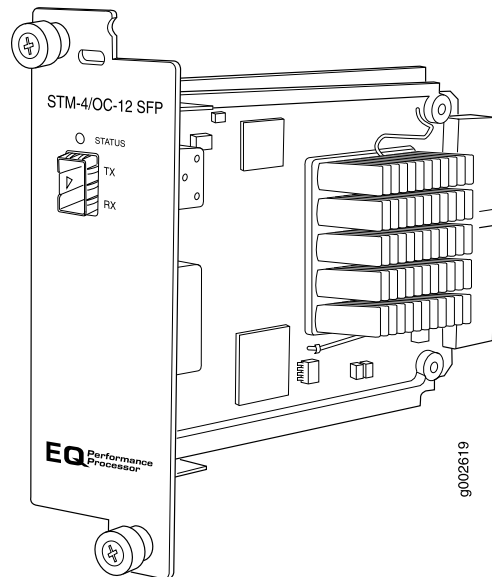
Alarms, errors, and events

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

Related Documentation

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC12/STM4 Enhanced IQ (IQE) PIC with SFP (T1600 Router)



Software release	Junos OS Release 9.3 and later (Type 1) For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- One OC12/STM4 port - SONET or SDH is configurable on a per-port granularity - Power requirement: 0.58 A @ 48 V (27.8 W) - Model number: PB-1OC12-STM4-IQE-SFP
Hardware features	Port is numbered 0.
Software features	- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) - Enhanced fine-grained queuing per logical interface. See the <i>Class of Service Feature Guide for Routing Devices</i> for more information about class of service features. - Packet buffering, Layer 2 parsing - Local line and remote payload loopback testing - Encapsulations: - Circuit cross-connect (CCC) - Translational cross-connect (TCC) - Extended Frame Relay for CCC and TCC - Flexible Frame Relay - Frame Relay - Frame Relay for CCC - Frame Relay for TCC - Frame Relay port CCC - High-Level Data Link Control (HDLC) - HDLC framing for CCC

- HDLC framing for TCC
- MPLS CCC
- MPLS TCC
- Multilink Frame Relay (MLFR) UNI NNI (MFR FRF.16)
- Point-to-Point Protocol (PPP)
- PPP for CCC
- PPP for TCC
- Encapsulations available only for DS1:
 - Multilink Frame Relay end-to-end (MLFR FRF.15)
 - Multilink PPP (MLPPP)
 - PPP over Frame Relay

Cables and connectors

- Duplex LC/PC connector (Rx and Tx)
- SONET/SDH OC12/STM4 fiber-optic SFP transceivers:
 - Short reach (model number: SFP-OC12-SR)
 - Intermediate reach (IR-1) (model number: SFP-OC12-IR)
 - Long reach (LR-1) (model number: SFP-OC12-LR)

Optical interface specifications—see [“SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52](#)

LEDs

One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

- SONET alarms:
 - Alarm indication signal—line (AIS-L)
 - Alarm indication signal—path (AIS-P)
 - Bit error rate signal degrade (BERR-SD)
 - Bit error rate signal fail (BERR-SF)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of pointer (LOP)
 - Loss of signal (LOS)
 - Payload label mismatch (PLM-P)
 - Remote defect indication—line (RDI-L)
 - Remote defect indication—path (RDI-P)
 - Remote error indication (REI)
 - Payload unequipped (unequipped STS at path level) (UNEQ-P)
- SDH alarms:
 - Administrative unit alarm indication signal (AU-AIS)
 - Bit error rate signal degrade (BERR-SD)
 - Bit error rate signal fail (BERR-SF)
 - Bit interleaved parity (BIP) error B1, B2, B3
 - Higher order path—alarm indication signal (HP-AIS)
 - Higher order path—far-end receive failure (HP-FERF)
 - Higher order path—payload label mismatch (HP-PLM)
 - Higher order path—loss of pointer (HP-LOP)
 - Higher order path—remote defect indication (HP-RDI)
 - Higher order path—unequipped (HP-UNEQ)
 - Loss of frame (LOF)
 - Loss of light (LOL)
 - Loss of signal (LOS)
 - Multiplex section—alarm indication signal (MS-AIS)
 - Multiplex section—far-end receive failure (MS-FERF)
 - Multiplex section—remote defect indication (MS-RDI)
 - Multiplex section—remote error indication (MS-REI)
 - Phase lock loop (PLL)
 - Remote error indication (REI)
 - Severely errored frame (SEF)

Instrumentation (counters)

- Layer 2 per-queue and per-channel packet and byte counters

Related Documentation

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC12/STM4 (Multi-Rate) PICs with SFP (T1600 Router)

Figure 23: 1-Port SONET/SDH OC12/STM4 (Multi-Rate) PIC

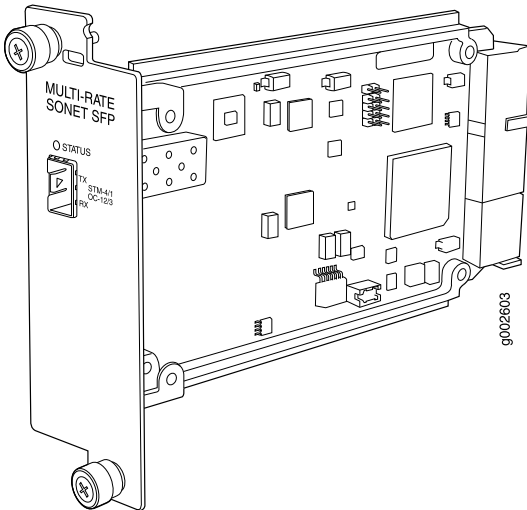
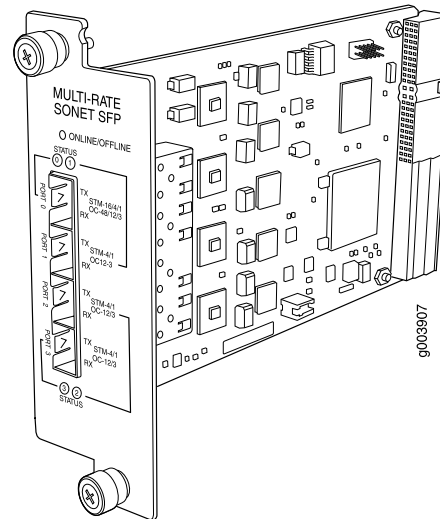


Figure 24: 4-Port SONET/SDH OC12/STM4 (Multi-Rate) PIC



Software release

- 1-port: Junos OS Release 8.5 and later (Type 1)
- 4-port: Junos OS Release 8.5 and later (Type 2)

For information on which FPCs support this PIC, see ["T1600 PIC/FPC Compatibility"](#) on page 14.

Description

- 1-port: Rate-selectable using one of the following rates:
 - 1-port OC3/STM1
 - 1-port OC12/STM4
 - 1-port OC12c/STM4c
- 4-port: Rate-selectable using one of the following rates:
 - 1-port OC12/STM4
 - 1-port OC48/STM16
 - 1-port OC48c/STM16c
 - 4-port OC3c/STM1c
 - 4-port OC12c/STM4c
- Power requirement:
 - 1-port: 0.20 A @ 48 V (9.5 W)
 - 4-port: 0.40 A @ 48 V (19 W)
- Model number for 1-Port SONET/SDH OC12/STM4 (Multi-Rate) PIC: PB-1OC12-SON-SFP
- Model number for 4-Port SONET/SDH OC12/STM4 (Multi-Rate) PIC: PB-4OC3-4OC12-SON-SFP

Hardware features

- Multiplexing and demultiplexing
- Rate policing on input
- Rate shaping on output
- Packet buffering, Layer 2 parsing

Software features	• Optical diagnostics and related alarms • Per-port SONET/SDH framing • Link aggregation • Alarm and event counting and detection • Dual-router automatic protection switching (APS) • Multiprotocol Label Switching (MPLS) fast reroute • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Frame Relay • High-Level Data Link Control (HDLC) • Point-to-Point Protocol (PPP)
Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing transceivers. • Duplex LC/PC connector (Rx and Tx) • SONET/SDH OC3/STM1 small form-factor pluggable (SFP) transceivers: • Multimode (model number: SFP-OC3-SR) • Intermediate reach (IR-1) (model number: SFP-OC3-IR) • Long reach (LR-1) (model number: SFP-OC3-LR) Optical interface specifications—see “SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50 • SONET/SDH OC12/STM4 small form-factor pluggable (SFP) transceivers: • Short reach (model number: SFP-OC12-SR) • Intermediate reach (IR-1) (model number: SFP-OC312-IR) • Long reach (LR-1) (model number: SFP-OC12-LR) Optical interface specifications—see “SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52 NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

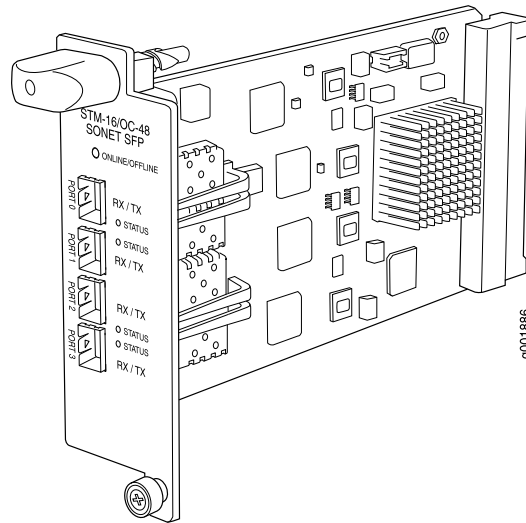
Alarms, errors, and events

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

Related Documentation

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC48c/STM16 PIC with SFP (T1600 Router)



Software release	Junos OS Release 8.5 and later For information on which FPCs support this PIC, see “T1600 PIC/FPC Compatibility” on page 14.
Description	- Four OC48 ports - Power requirement: 0.46 A @ 48 V (22.1 W) - Model number: PC-4OC48-SON-SFP
Hardware features	- Multiplexing and demultiplexing on the 1-port PIC - Rate policing on input - Rate shaping on output - Packet buffering, Layer 2 parsing
Software features	- Optical diagnostics and related alarms - Configuration of SONET or SDH framing on a per-port basis - SONET/SDH framing - Link aggregation - Alarm and event counting and detection - Dual-router automatic protection switching (APS) - Multiprotocol Label Switching (MPLS) fast reroute - Encapsulations: - Circuit cross-connect (CCC) - Translational cross-connect (TCC) - Frame Relay - High-Level Data Link Control (HDLC) - Point-to-Point Protocol (PPP)

Cables and connectors	You can install any transceiver supported by the PIC. For information about installing and removing. • Duplex LC/PC connector (Rx and Tx) • SONET/SDH OC48/STM16 fiber-optic SFP transceivers: • Short reach (SR-1) (model number: SFP-1OC48-SR) • Intermediate reach (IR-1) (model number: SFP-1OC48-IR) • Long reach (LR-1) (model number: SFP-1OC48-LR) Optical interface specifications—see “SONET/SDH OC48/STM16 Optical Interface Specifications” on page 54 NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

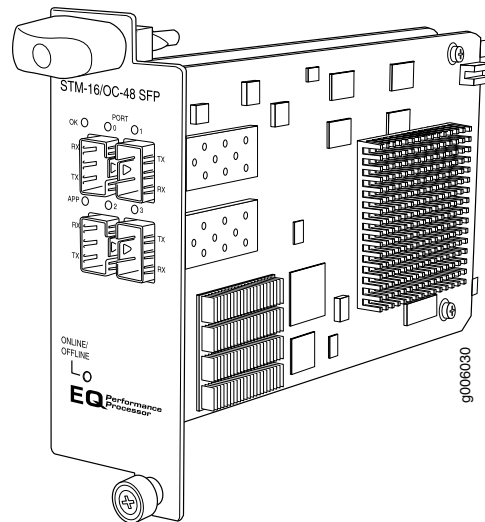
Alarms, errors, and events

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

Related Documentation

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC48/STM16 Enhanced IQ (IQE) PIC with SFP (T1600 Router)



Software release	Junos OS Release 10.4R2 and later (Type 3) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	- Four OC48/STM16 ports - Clear channel functionality - SONET and SDH is configured on a per-port granularity - Power requirement: 1.06 A @ 48 V (51 W) - Weight: 1.6 lb (0.725 kg) - Model number: PC-4OC48-STM16-IQE-SFP
Hardware features	- Ports are numbered: - Top row: 0 and 1 from left to right - Bottom row: 2 and 3 from left to right - Maximum transmission units (MTUs) of up to 9192 bytes

Software features

- Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED)
- Fine-grained egress queuing per logical interface. See the *Class of Service Feature Guide for Routing Devices* for more information about class-of-service features
- Packet buffering
- Local line and remote payload loopback testing
- Optical diagnostics and monitoring
- Clocking options: internal or external/loop mode. Each OC48 transmitter port is configured either in internal or external mode. The default clocking option is internal mode.
- Encapsulations:
 - Extended Frame Relay for circuit cross-connect (CCC) and translational cross-connect (TCC)
 - Flexible Frame Relay
 - Frame Relay
 - Frame Relay for CCC
 - Frame Relay for TCC
 - Frame Relay port CCC
 - High-Level Data Link Control (HDLC)
 - HDLC framing for CCC
 - HDLC framing for TCC
 - MPLS CCC
 - MPLS TCC
 - Point-to-Point Protocol (PPP)
 - PPP for CCC
 - PPP for TCC

Cables and connectors

You can install any transceiver supported by the PIC.

- Duplex LC/PC connector (Rx and Tx)
- SONET/SDH OC48/STM16 small form-factor pluggable (SFP) transceivers:
 - Short reach (SR-1) (model number: SFP-1OC48-SR)
 - Intermediate reach (IR-1) (model number: SFP-1OC48-IR)
 - Long reach (LR-1) (model number: SFP-1OC48-LR)

Optical interface specifications—see [“SONET/SDH OC48/STM16 Optical Interface Specifications” on page 54](#)

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

LEDs

OK LED, one tricolor:

- Off—PIC is offline and safe to remove from the router
- Green—PIC is operating normally
- Yellow—PIC is initializing
- Red—PIC has an error or failure

APP LED, one green per port:

- Off—Service is not running
- Green—Service is running under acceptable load

Port LEDs, one tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events**SONET alarms:**

- Loss of light (LOL)
- Phase lock loop (PLL)
- Loss of frame (LOF)
- Loss of signal (LOS)
- Severely errored frame (SEF)
- Alarm indicator signal—line (AIS-L)
- Alarm indicator signal—path (AIS-P)
- Loss of pointer (LOP)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Remote defect indicator—line (RDI-L)
- Remote defect indicator—path (RDI-P)
- Remote error indicator (REI)
- Unequipped (UNEQ)
- Payload label mismatch—path (PLM-P)

SDH alarms:

- Loss of light (LOL)
- Phase lock loop (PLL)
- Loss of frame (LOF)
- Loss of signal (LOS)
- Severely errored frame (SEF)
- Multiplex-section alarm indicator signal (MS-AIS)
- H Path alarm indicator signal (HP-AIS)
- Loss of pointer (LOP)
- Bit error rate—signal degrade (BERR-SD)
- Bit error rate—signal fail (BERR-SF)
- Multiplex section—far end receive failure (MS-FERF)
- High order path—far end receive failure (HP-FERF)
- Remote error indicator (REI)
- Unequipped (UNEQ)
- High order path—payload label mismatch - Path (HP-PLM)

Optical diagnostics related alarms:

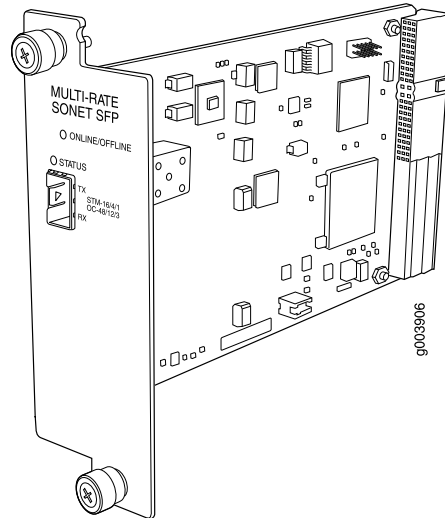
NOTE: Transceivers from some vendors do not support these fields.

- Temperature high/low alarms and warnings
- Supply voltage high/low alarms and warnings
- Tx bias current high/low alarms and warnings
- Tx output power high/low alarms and warnings
- Rx received power high/low alarms and warnings

Related Documentation

- *T1600 PIC Description*
- [T1600 PIC Combination Limitations on page 14](#)

SONET/SDH OC48/STM16 (Multi-Rate) PIC with SFP (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 2) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	- Rate-selectable using one of the following rates: 1-port OC3c/STM1c 1-port OC12/STM4 1-port OC12c/STM4c 1-port OC48/STM16 1-port OC48c/STM16c - Power requirement: 0.20 A @ 48 V (9.5 W) - Model number: PB-1OC48-SON-B-SFP
Hardware features	- Multiplexing and demultiplexing - Rate policing on input - Rate shaping on output - Packet buffering, Layer 2 parsing

Software features

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

Cables and connectors

You can install any transceiver supported by the PIC. For information about installing and removing transceivers.

- Duplex LC/PC connector (Rx and Tx)
- SONET/SDH OC3/STM1 small form-factor pluggable (SFP) transceivers:
 - Multimode (model number: SFP-OC3-SR)
 - Intermediate reach (IR-1) (model number: SFP-OC3-IR)
 - Long reach (LR-1) (model number: SFP-OC3-LR)

Optical interface specifications—see [“SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50](#)

- SONET/SDH OC12/STM4 small form-factor pluggable (SFP) transceivers:
 - Short reach (model number: SFP-OC12-SR)
 - Intermediate reach (IR-1) (model number: SFP-OC312-IR)
 - Long reach (LR-1) (model number: SFP-OC12-LR)

Optical interface specifications—see [“SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52](#)

- SONET/SDH OC48/STM16 fiber-optic SFP transceivers:
 - Short reach (SR-1) (model number: SFP-1OC48-SR)
 - Intermediate reach (IR-1) (model number: SFP-1OC48-IR)
 - Long reach (LR-1) (model number: SFP-1OC48-LR)

Optical interface specifications—see [“SONET/SDH OC48/STM16 Optical Interface Specifications” on page 54](#)

NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the [CLI Explorer](#).

LEDs

One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

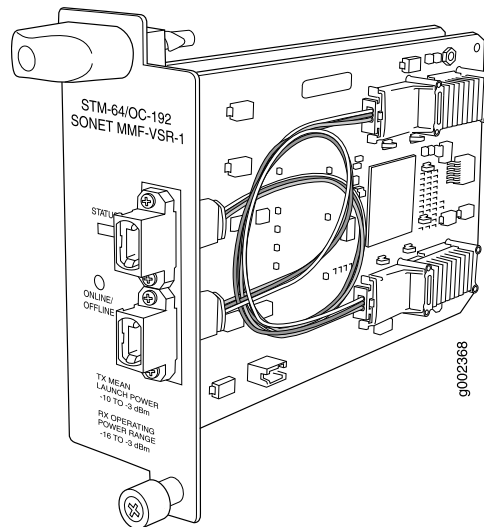
Alarms, errors, and events

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

**Related
Documentation**

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC192c/STM64 PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 3) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	- One OC192 port - Power requirement: 0.45 A @ 48 V (21.6 W) - Model number: PB-1OC192-SON-VSR
Hardware features	- Multiplexing and demultiplexing - Rate policing on input - Rate shaping on output - Packet buffering, Layer 2 parsing
Software features	- SONET/SDH framing - Link aggregation - Alarm and event counting and detection - Dual-router automatic protection switching (APS) - Multiprotocol Label Switching (MPLS) fast reroute - Encapsulations: - Circuit cross-connect (CCC) - Translational cross-connect (TCC) - Frame Relay - High-Level Data Link Control (HDLC) - Point-to-Point Protocol (PPP)

Cables and connectors	• Very short reach (VSR 1): 12-ribbon multimode fiber with MTP connector (Rx and Tx) • SONET/SDH OC192/STM64 very short reach (VSR-1) 1 fixed transceiver: Optical interface specifications—see “SONET/SDH OC192/STM64 Optical Interface Specifications” on page 57 NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

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

Related Documentation

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC192/STM64 PICs with XFP (T1600 Router)

Figure 25: 1-Port SONET/SDH OC192/STM64 PIC

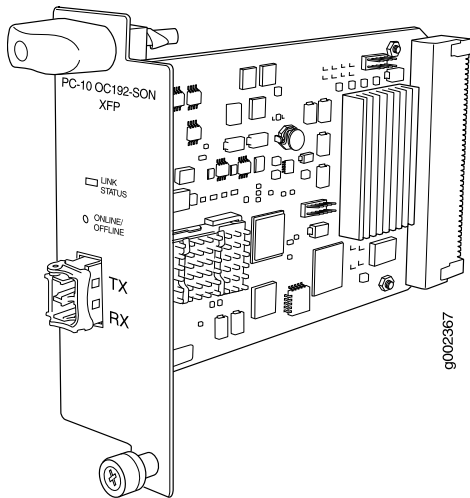
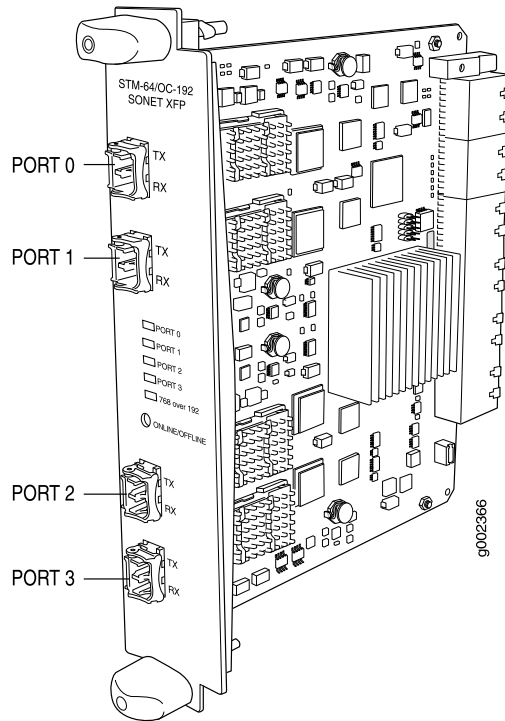


Figure 26: 4-Port SONET/SDH OC192/STM64 PIC



Software release

- 1-port: Junos OS Release 8.5 and later (Type 3)
- 4-port: Junos OS Release 8.5 and later (Type 4)

For information on which FPCs support this PIC, see [“T1600 PIC/FPC Compatibility” on page 14](#).

Description

- One or four OC192 ports
- 4-port OC192 PIC with XFP: four OC192 links can be aggregated into one OC768 link or two OC256 links. The four fiber links should be on the same fiber path or the same fiber.
- Power requirement:
 - 1-port: 0.52 A @ 48 V (25 W)
 - 4-port: 1.11 A @ 48 V (53.1 W)
- Model number: PC-10C192-SON-XFP

Hardware features

- Multiplexing and demultiplexing
- Rate policing on input
- Rate shaping on output
- Packet buffering, Layer 2 parsing

- | | |
|-------------------|--|
| Software features | <ul style="list-style-type: none">• Configuration of SONET or SDH framing on a per-port basis on the 4-port Type 4 PIC• SONET/SDH framing• Link aggregation• Alarm and event counting and detection• Dual-router automatic protection switching (APS)• Multiprotocol Label Switching (MPLS) fast reroute• Encapsulations:<ul style="list-style-type: none">• Circuit cross-connect (CCC)• Translational cross-connect (TCC)• Frame Relay• High-Level Data Link Control (HDLC)• Point-to-Point Protocol (PPP) |
|-------------------|--|

- | | |
|-----------------------|---|
| Cables and connectors | <ul style="list-style-type: none">• Duplex LC connector (Rx and Tx)• SONET/SDH OC192c/STM64 XFP transceivers:<ul style="list-style-type: none">• Short reach (SR-1) (model number: XFP-10G-L-OC192-SR1)• Intermediate reach (IR-1) (model number: XFP-10G-E-OC192-IR2)• Long reach (LR-1) (model number: XFP-10G-Z-OC192-LR2) <p>Optical interface specifications—see “SONET/SDH OC192/STM64 Optical Interface Specifications” on page 57</p> <p>NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the CLI Explorer.</p> |
|-----------------------|---|

- | | |
|------|--|
| LEDs | <p>One tricolor LED per port:</p> <ul style="list-style-type: none">• Off—Not enabled• Green—Online with no alarms or failures• Yellow—Online with alarms for remote failures• Red—Active with a local alarm; router has detected a failure <p>One 768 over 192 LED:</p> <ul style="list-style-type: none">• Off—Not enabled• Green—Online with no alarms or failures• Yellow—Online with alarms for remote failures• Red—Active with a local alarm; router has detected a failure |
|------|--|
-

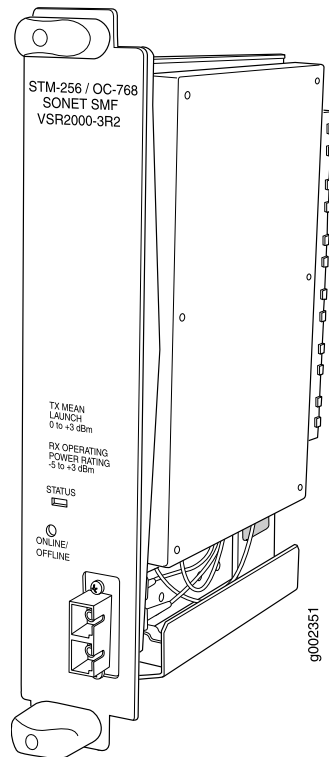
Alarms, errors, and events

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

Related Documentation

- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

SONET/SDH OC768c/STM256 PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 4) For information on which FPCs support this PIC, see "T1600 PIC/FPC Compatibility" on page 14.
Description	- One OC768 port - Power requirement: 1.37 A @ 48 V (65.7 W) - Model number: PD-1OC768-SON-SR
Hardware features	- Multiplexing and demultiplexing - Rate policing on input - Rate shaping on output - Packet buffering, Layer 2 parsing

Software features	• SONET/SDH framing • Link aggregation • Alarm and event counting and detection • Dual-router automatic protection switching (APS) • Multiprotocol Label Switching (MPLS) fast reroute • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Frame Relay • High-Level Data Link Control (HDLC) • Point-to-Point Protocol (PPP) • Optical diagnostics and related alarms • Laser bias • Transmit optical power • Receiver optical power • Laser temperature
Cables and connectors	• Duplex SC/PC connector (Rx and Tx) • SONET/SDH OC768c/STM265 Short reach (SR-1) fixed transceiver Optical interface specifications—see “SONET/SDH OC768/STM256 Optical Interface Specifications” on page 60 NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the request chassis pic offline command in the CLI Explorer.
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events

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

Related Documentation

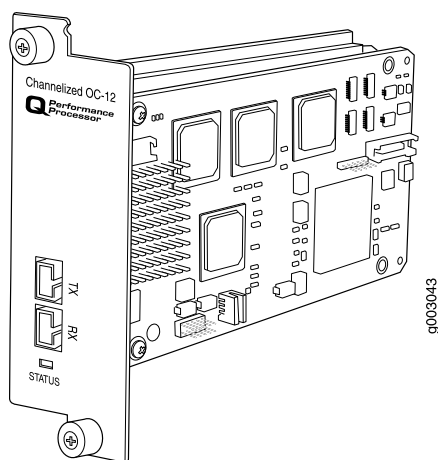
- [T1600 PIC Description](#)
- [T1600 PIC Combination Limitations on page 14](#)
- [T1600 PICs Supported on page 3](#)

CHAPTER 17

End-of-Life PIC Descriptions

- Channelized OC12 IQ EOL PIC (T1600 Router) on page 191
- DS3 EOL PIC (T1600 Router) on page 194
- Adaptive Services II EOL PIC (T1600 Router) on page 195
- Adaptive Services II Layer 2 Services EOL PIC (T1600 Router) on page 198
- Link Services EOL PIC (T1600 Router) on page 200
- Monitoring Services II EOL PIC (T1600 Router) on page 201
- Monitoring Services III EOL PIC (T1600 Router) on page 203
- SONET/SDH OC3c/STM1 EOL PICs (T1600 Router) on page 204
- SONET/SDH OC12c/STM4 EOL PICs (T1600 Router) on page 207
- SONET/SDH OC48c/STM16 EOL PIC with SFP (T1600 Router) on page 210

Channelized OC12 IQ EOL PIC (T1600 Router)



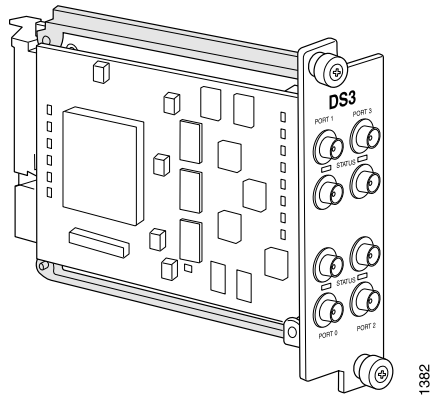
Software release	• Junos OS Release 8.5 and later (Type 1)
Description	• One OC12 port • Power requirement: 0.23 A @ 48 V (10.8 W) • Fine-grained queuing per logical interface • Channelization: OC3, DS3, DS1, DS0

Hardware features	• Subrate and scrambling: • Digital Link/Quick Eagle • Kentrox • Larscom • ADTRAN • Verilink • Packet buffering, Layer 2 parsing • M13/C-bit parity encoding • DS3 far-end alarm and control (FEAC) channel support • Local and remote loopback testing
Software features	• Quality of service (QoS) per channel: weighted round-robin (WRR), random early detection (RED), weighted random early detection (WRED) • Simple Network Management Protocol (SNMP): OC3 MIB, DS3 MIB, T1 MIB • Dynamic, arbitrary channel configuration • Full bit error rate test (BERT) • Encapsulations: • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Frame Relay • High-Level Data Link Control (HDLC) • Point-to-Point Protocol (PPP)
Cables and connectors	• Duplex SC/PC connector (Rx and Tx); single-mode fiber • SONET/SDH OC12 intermediate reach (IR-1) fixed transceivers • Optical interface specifications—see “SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52
LEDs	One tricolor per port: • Off—Not enabled • Green—Online with no alarms or failures • Yellow—Online with alarms for remote failures • Red—Active with a local alarm; router has detected a failure

Alarms, errors, and events	Alarms: • Alarm indication signal—line (AIS-L) • Alarm indication signal—path (AIS-P) • Bit error rate—signal degrade (BERR-SD) • Bit error rate—signal fail (BERR-SF) • Frame error • Idle code, Idle received • Loss of frame (LOF) • Loss of pointer (LOP-P) • Loss of signal (LOS) • Out of frame (OOF) • Payload mismatch (PLM-P) • Payload unequipped (unequipped STS at path level) (UNEQ-P) • Parity bit (P-bit) disagreements • Path parity error • Remote defect indication—line (RDI-L) • Remote defect indication—path (RDI-P) • Yellow alarm bit (X-bit) disagreements Error detection: • Bit interleaved parity errors B1, B2, B3 (CV-S, CV-L, CV-P) • Errored seconds (ES-S, ES-L, ES-P) • Far-end bit errors, remote error indication—line (REI-L), far-end line coding violations (CV-LFE) • Far-end bit errors, remote error indication—path (REI-P), far-end path coding violations (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) • Severely errored framing (SEF) • Severely errored framing seconds (SEFS-S) • Severely errored seconds (SES-S, SES-L, SES-P) • Unavailable seconds (UAS-L, UAS-P)
Instrumentation (counters)	• Layer 2 per-queue and per-channel packet and byte counters

- Related Documentation**
- *T1600 PIC Description*
 - [T1600 End-of-Life PICs Supported on page 12](#)

DS3 EOL PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 1)
Description	- Four DS3 ports - Power requirement: 0.47 A @ 48 V (22.5 W) - Integrated DSU interoperability with leading DSU vendors
Hardware features	- High-performance throughput on each port at speeds up to 44.736 Mbps, full duplex - C-bit framing - B3ZS line encoding - Subrate and scrambling: - Digital Link - Kentrox - Larscom - Per-port rate policing on input - Per-port rate shaping on output - Packet buffering, Layer 2 parsing
Software features	- DS3 functionality: - C-bit framing - B3ZS line encoding - DS3 diagnostics and loopback control - DS3 alarm and event counting and detection - Per-packet counts and byte counts - Local and remote loopback testing, as well as BERT testing per DS3 - DS3 far-end alarm and control (FEAC) channel support - Encapsulations: - High-Level Data Link Control (HDLC) - Frame Relay - Circuit cross-connect (CCC) - Point-to-Point Protocol (PPP)
Cables and connectors	Custom 10-ft (3.05-m) posilock SMB to BNC male cable, separate Rx and Tx (provided)

LEDs

One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

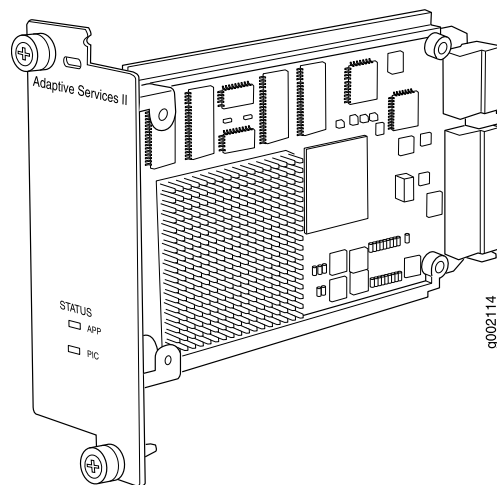
Alarms, errors, and events

- Alarm indication signal (AIS)
- Bit error rate test (BERT) functionality on PIC (you can configure one DS3 channel in BERT mode and configure the remaining channels to transmit and receive normal traffic)
- Equipment failure (does not affect service)
- Far-end block error (FEBE)
- Frame error
- Idle code, Idle received
- Local and remote loopback
- Loss of signal (LOS)
- Out of frame (OOF)
- Parity bit (P-bit) disagreements
- Path parity error
- Yellow alarm bit (X-bit) disagreements

**Related
Documentation**

- [T1600 PIC Description](#)
- [T1600 End-of-Life PICs Supported on page 12](#)

Adaptive Services II EOL PIC (T1600 Router)



Software release

- Junos OS Release 8.5 and later (Type 1)
- Junos OS Release 9.4 and later supports the PB-AS2 PIC on the Enhanced Scaling FPC1 (T640-FPC1-ES).

Description	• Supports tunnel services. This feature is included with the PIC and does not require an individual license. • Individual licenses must be purchased for additional services. • Power requirement: 0.4 A @ 48 V (19 W)
Hardware features	• Support for up to 2000 service sets • Active monitoring on up to 1 million flows • Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces
Software features	Depending on your Junos OS Release and individual licenses, software features for this PIC can include the features listed in Table 66 on page 196 . For more information about the software features available for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i> .
LEDs	Status LED, one tricolor: • Off—PIC is offline and it is safe to remove it from the chassis. • Green—PIC is operating normally. • Yellow—PIC is initializing. • Red—PIC has an error or failure and no further harm can be done by removing it from the chassis. Application LED, one bicolor: • Off—Service is not running. • Green—Service is running under acceptable load. • Yellow—Service is overloaded.

Table 66: Adaptive Services PICs Software Features

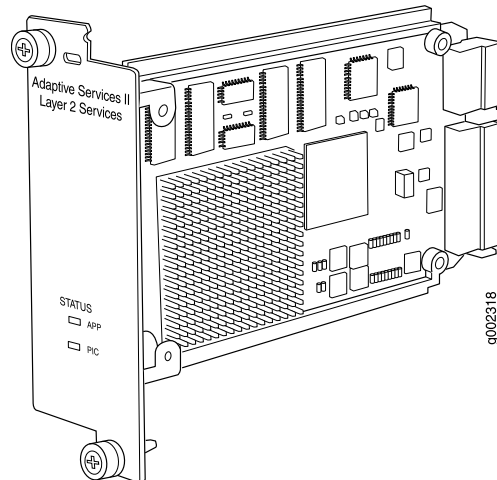
Software Feature	Adaptive Services II PIC	Adaptive Services II Layer 2 Services PIC
GRE Key	—	—
GRE dont-fragment	—	—
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks	8.5	—
Network Address Translation (NAT) for IP addresses	8.5	—
Port Address Translation (PAT) for port numbers	8.5	—
IP Security (IPSec) encryption	8.5	—
Active flow monitoring exports cflowd version 5 and version 8 records	8.5	—
Active flow monitoring exports version 9 records, based on RFC 3954 (IP v4 templates only)	8.5	—

Table 66: Adaptive Services PICs Software Features (*continued*)

Passive flow monitoring	–	–
Passive flow collection	–	–
Flow-tap	8.5	–
Dynamic flow capture	–	–
Real-time performance monitoring	8.5	–
Link Services	8.5	8.5
Tunnel services: • IP-IP unicast tunneling • GRE unicast tunneling—Supports GRE fragmentation • Protocol Independent Multicast (PIM) sparse mode unicast tunneling	8.5	8.5
Virtual tunnel interface for Layer 3 VPNs	8.5	–
Layer 2 Tunneling Protocol (L2TP)	–	–
Voice services: Compressed Real-Time Transport Protocol (CRTP)	8.5	8.5
Encapsulations • Multilink Frame Relay (MLFR) • Multilink Point-to-Point Protocol (MLPP)	8.5	8.5

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 End-of-Life PICs Supported on page 12](#)

Adaptive Services II Layer 2 Services EOL PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 1)
Description	- Supports Layer 2 Service package only. Tunnel services are included with the PIC. Other services require an individual license. - Power requirement: 0.4 A @ 48 V (19 W)
Hardware features	- Support for up to 2000 service sets - Support for MTUs up to 9192 bytes for Gigabit Ethernet and SONET interfaces
Software features	Depending on your Junos OS Release and individual licenses, software features for this PIC can include the features listed in Table 67 on page 198 . For more information about the software features available for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i> .
LEDs	Status LED, one tricolor: - Off—PIC is offline and it is safe to remove it from the chassis. - Green—PIC is operating normally. - Yellow—PIC is initializing. - Red—PIC has an error or failure and no further harm can be done by removing it from the chassis. Application LED, one bicolor: - Off—Service is not running. - Green—Service is running under acceptable load. - Yellow—Service is overloaded.

Table 67: Adaptive Services PICs Software Features

Software Feature	Adaptive Services II PIC	Adaptive Services II Layer 2 Services PIC
GRE Key	—	—

Table 67: Adaptive Services PICs Software Features (*continued*)

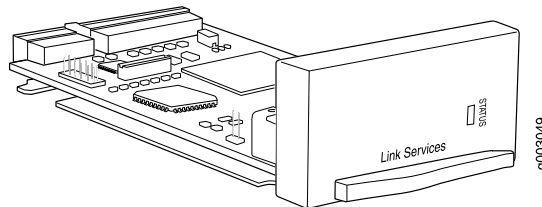
Software Feature	Adaptive Services II PIC	Adaptive Services II Layer 2 Services PIC
GRE dont-fragment	—	—
Stateful firewall with packet inspection: detects SYN attacks, ICMP and UDP floods, and ping-of-death attacks	8.5	—
Network Address Translation (NAT) for IP addresses	8.5	—
Port Address Translation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

Table 67: Adaptive Services PICs Software Features (*continued*)

Software Feature	Adaptive Services II PIC	Adaptive Services II Layer 2 Services PIC
Encapsulations	8.5	8.5
- Multilink Frame Relay (MLFR) - Multilink Point-to-Point Protocol (MLPP)		

- Related Documentation**
- [T1600 PIC Description](#)
 - [T1600 End-of-Life PICs Supported on page 12](#)

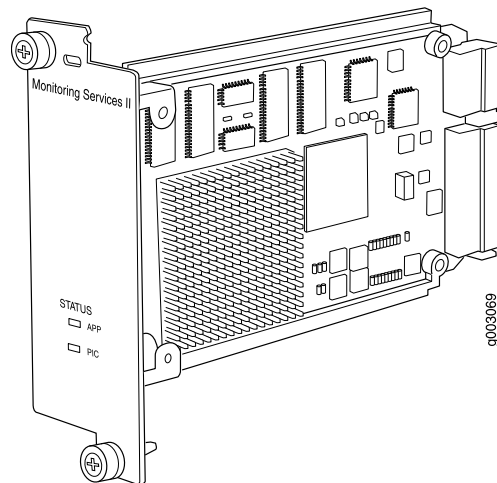
Link Services EOL PIC (T1600 Router)



Software release	Junos OS Release 6.0 and later
Description	- Power requirement: 0.17 A @ 48 V (8 W) - Three versions: 4 multilink bundles, 256 LFI links 32 multilink bundles, 256 LFI links 128 multilink bundles, 256 LFI links - Multilink bonding, link fragmentation and interleaving (LFI), and tunneling
Hardware features	- Rate limiting/policing per multilink bundle - Byte-wise load balancing across multilink bundles - Bonding T1 links enable service ranging from 1.5 Mbps through 12 Mbps - Bonding E1 links enable service ranging from 2 Mbps through 16 Mbps - Loopback function that encapsulates and de-encapsulates packets

Software features	For a list of the software features available for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i>. • Protocol support: • Multilink PPP (MLPPP) • Multilink Frame Relay (MLFR)—FRF.15 and FRF.16 • Link fragmentation and interleaving (LFI)—FRF.12 • LFI over MLPPP • IP-IP unicast tunneling • GRE unicast tunneling • PIM sparse mode unicast tunneling
LEDs	One bicolor: • Off—PIC is offline • Green—PIC is online and at least one configured bundle is operating • Yellow—PIC is online, but no configured bundles are operating
Related Documentation	• T1600 PIC Description • T1600 End-of-Life PICs Supported on page 12

Monitoring Services II EOL PIC (T1600 Router)



Software release	• Junos OS Release 8.5 and later (Type 1)
Description	• Passive traffic monitoring or flow collection services • Power requirement: 0.4 A @ 48 V (19 W) • Monitors IPv4 packets • Support for collecting and exporting cflowd records
Hardware features	• Monitors up to 400,000 packets per second • Support for MTUs up to 4474 bytes for SONET interfaces

Software features For more information about the software features for services PICs, see the *Junos OS Services Interfaces Library for Routing Devices*.

- Load distribution across multiple PICs
- Active monitoring cflowd version 5 support
- Provides start and end times of each export
- Encapsulations:
 - Multilink Frame Relay (MLFR)
 - Multilink Point-to-Point Protocol (MLPP)
- Supports firewall filtering and filter-based forwarding (FBF)

NOTE: Flow collection services are supported.

NOTE: This PIC does not support graceful Routing Engine switchover.

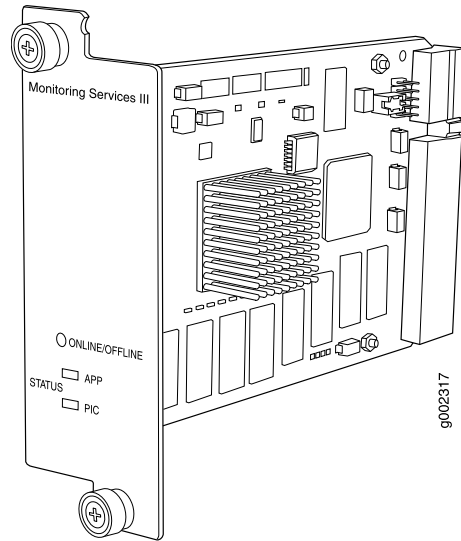
Cables and connectors	• None
------------------------------	--

LEDs	Status LED, one tricolor: • Off—PIC is offline and it is safe to remove it from the chassis. • Green—PIC is operating normally. • Yellow—PIC is initializing. • Red—PIC has an error or failure and no further harm can be done by removing it from the chassis. Application LED, one bicolor: • Off—Flow collector is not running. • Green—Flow collector is running under acceptable load. • Yellow—Flow collector is overloaded.
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Related Documentation

- *T1600 PIC Description*

Monitoring Services III EOL PIC (T1600 Router)



Software release	Junos OS Release 8.5 and later (Type 2)
Description	- Power requirement: 0.4 A @ 48 V (19 W) - Supports dynamic flow capture 2 Gbps of sustained packet bandwidth
Hardware features	Supports MTUs up to 4474 bytes for SONET interfaces
Software features	For more information about the software features for services PICs, see the <i>Junos OS Services Interfaces Library for Routing Devices</i>. Dynamic flow capture
Cables and connectors	None
LEDs	Two status LEDs: PIC and APP PIC LED, one tricolor: - Off—PIC is offline and it is safe to remove it from the chassis. - Green—PIC is operating normally. - Yellow—PIC is initializing. - Red—PIC has an error or failure and no further harm can be done by removing it from the chassis. Application APP LED, one tricolor: - Off—Monitoring application is not running. - Green—Monitoring application is running under acceptable load. - Yellow—Monitoring application is overloaded. - Red—Not used.

Related Documentation

- [T1600 PIC Description](#)

SONET/SDH OC3c/STM1 EOL PICs (T1600 Router)

Figure 27: SONET/SDH OC3c/STM1 PIC (MMF)

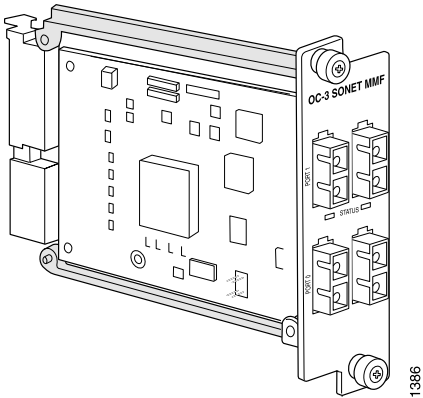
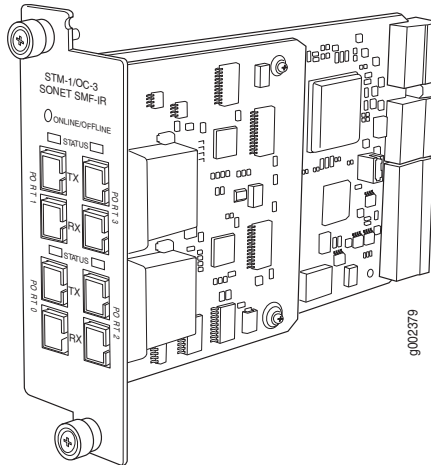


Figure 28: SONET/SDH OC3c/STM1 PIC (SMF-IR)



Software release	• Junos OS Release 8.5 (Type 1 and Type 2) multimode and single-mode intermediate reach • Junos OS Release 9.4 and later supports the PB-4OC3-MM and PB-4OC3-SMIR PICs on the Enhanced Scaling FPC1 (T640-FPC1-ES).
Description	• Four OC3 ports • Power requirement: 0.49 A @ 48 V (23.7 W)
Hardware features	• Multiplexing and demultiplexing • Rate policing on input • Rate shaping on output • Packet buffering, Layer 2 parsing
Software features	• SONET/SDH framing • Link aggregation • Alarm and event counting and detection • Dual-router automatic protection switching (APS) • Multiprotocol Label Switching (MPLS) fast reroute • Encapsulations: • High-Level Data Link Control (HDLC) • Frame Relay • Circuit cross-connect (CCC) • Translational cross-connect (TCC) • Point-to-Point Protocol (PPP)

Cables and connectors

- Duplex SC/PC connector (Rx and Tx)
- SONET/SDH OC3/STM1 fixed transceivers:
 - Multimode
 - Single-mode intermediate reach (IR-1)

Optical interface specifications—see [“SONET/SDH OC3/STM1 Optical Interface Specifications” on page 50](#)

NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the [CLI Explorer](#).

LEDs

One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

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

- Related Documentation**
- *T1600 PIC Description*
 - [T1600 End-of-Life PICs Supported on page 12](#)

SONET/SDH OC12c/STM4 EOL PICs (T1600 Router)

Figure 29: 1-Port SONY/SDH OC12c/STM4 PIC

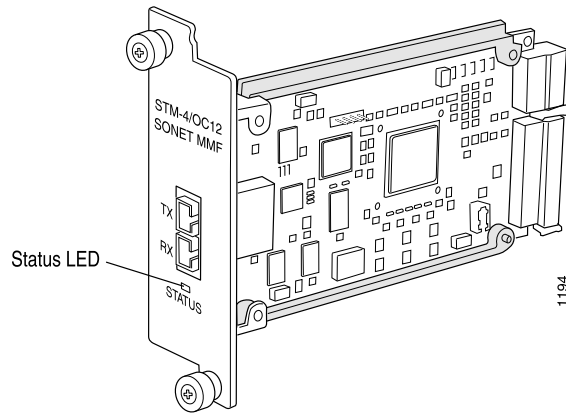
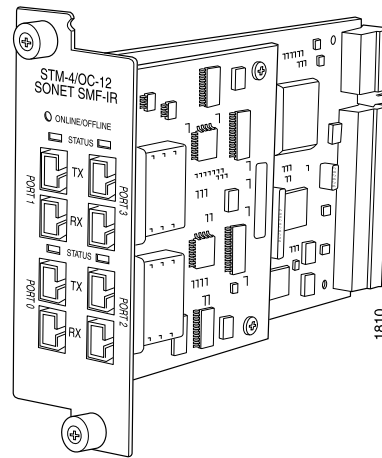


Figure 30: 4-Port SONY/SDH OC12c/STM4 PIC



Software release	- Junos OS Release 8.5 - Junos OS Release 9.4 and later supports the PB-1OC12-SON-MM PIC on the Enhanced Scaling FPC1 (T640-FPC1-ES).
Description	- One or four ports - Power requirement: 0.23 A @ 48 V (10.8 W)
Hardware features	- Multiplexing and demultiplexing - Rate policing on input - Rate shaping on output - Packet buffering, Layer 2 parsing
Software features	- SONET/SDH framing - Link aggregation - Alarm and event counting and detection - Dual-router automatic protection switching (APS) - Multiprotocol Label Switching (MPLS) fast reroute - Encapsulations: - High-Level Data Link Control (HDLC) - Frame Relay - Circuit cross-connect (CCC) - Translational cross-connect (TCC) - Point-to-Point Protocol (PPP)

Cables and connectors

- Duplex SC/PC connector (Rx and Tx)
- SONET/SDH OC12/STM4 fixed transceivers:
 - 1-port and 4-port: Multimode
 - 4-port: Single-mode Intermediate reach (IR-1)

Optical interface specifications—see [“SONET/SDH OC12/STM4 Optical Interface Specifications” on page 52](#)

NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the [CLI Explorer](#).

LEDs

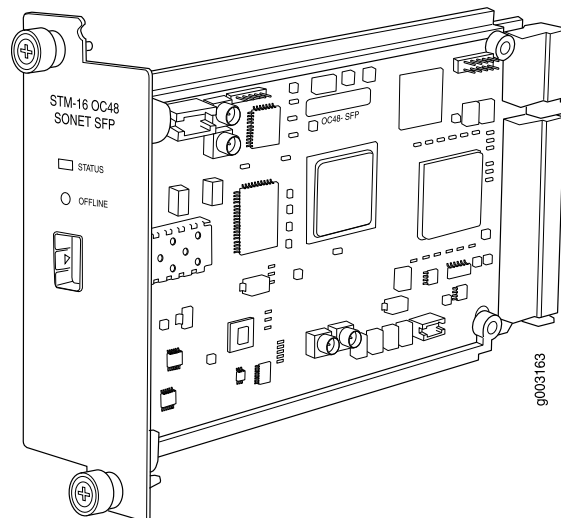
One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

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

- Related Documentation**
- *T1600 PIC Description*
 - [T1600 End-of-Life PICs Supported on page 12](#)

SONET/SDH OC48c/STM16 EOL PIC with SFP (T1600 Router)



Software release	Junos OS Release 8.5
Description	- One OC48 port - Power requirement: 0.33 A @ 48 V (16 W)
Hardware features	- Multiplexing and demultiplexing - Rate policing on input - Rate shaping on output - Packet buffering, Layer 2 parsing
Software features	- SONET/SDH framing - Link aggregation - Alarm and event counting and detection - Dual-router automatic protection switching (APS) - Multiprotocol Label Switching (MPLS) fast reroute - Encapsulations: - High-Level Data Link Control (HDLC) - Frame Relay - Circuit cross-connect (CCC) - Translational cross-connect (TCC) - Point-to-Point Protocol (PPP)

Cables and connectors

- Duplex LC/PC Connector (Rx and Tx)
- SONET/SDH OC48/STM16 fiber-optic SFP transceivers:
 - Short reach (SR-1) (model number: SFP-IOC48-SR)
 - Intermediate reach (IR-1) (model number: SFP-IOC48-IR)
 - Long reach (LR-1) (model number: SFP-IOC48-LR)

Optical interface specifications—see ["SONET/SDH OC48/STM16 Optical Interface Specifications" on page 54](#)

NOTE: To extend the life of the laser, when a PIC is not being actively used with any valid links, take the PIC offline until you are ready to establish a link to another device. For information about taking a PIC offline, see the **request chassis pic offline** command in the [CLI Explorer](#).

LEDs

One tricolor per port:

- Off—Not enabled
- Green—Online with no alarms or failures
- Yellow—Online with alarms for remote failures
- Red—Active with a local alarm; router has detected a failure

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

- Related Documentation**
- *T1600 PIC Description*
 - [T1600 End-of-Life PICs Supported on page 12](#)