



## **E Series™ Broadband Services Routers**

# **E120 and E320 Module Guide**

*Release 10.3.x*

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This guide provides an overview and description of the line modules (LMs), switch route processor (SRP) modules, switch fabric modules (SFMs), and input/output adapters (IOAs) available for the Juniper Networks E120 and E320 Broadband Services Routers.



**NOTE:** A release may support multiple versions of a module or IOA. For information, see *Software Compatibility* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.

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Table 1 on page 3 lists the modules and IOAs supported by the router.

This book also contains the following appendixes:

- IOA Protocol Support on page 53
- Module and Slot Combinations on page 75
- Module Name Cross-Reference Information on page 79
- Product Reclamation and Recycling Program on page 81

For more information about E120 routers, E320 routers, modules, and IOAs, refer to the following books:

- Module installation and maintenance—*E120 and E320 Hardware Guide*
- Managing routers—*JUNOS System Basics Configuration Guide*
- Configuring modules—*JUNOS Link Layer Configuration Guide*

**Table 1: Modules and IOAs**

| Module/IOA Type             | Module Label               | First JUNOS <sup>e</sup> Support | Page |
|-----------------------------|----------------------------|----------------------------------|------|
| <b>Line Module</b>          |                            |                                  |      |
| LM-4                        | ES2<br>4G<br>LM            | 7.0.1                            | 5    |
| LM-10 Uplink                | ES2<br>10G<br>UPLINK<br>LM | 7.2.0                            | 7    |
| LM-10                       | ES2<br>10G LM              | 8.0.0                            | 9    |
| LM-10 ADV                   | ES2<br>10G ADV LM          | 10.1.0                           | 11   |
| <b>SRP Module</b>           |                            |                                  |      |
| SRP-100                     | SRP-100                    | 7.0.1                            | 12   |
| SRP-120                     | SRP-120                    | 8.2.0                            | 14   |
| SRP-320                     | SRP-320                    | 7.3.0                            | 16   |
| <b>SFM Module</b>           |                            |                                  |      |
| SFM-100                     | SFM-100                    | 7.0.1                            | 18   |
| SFM-120                     | SFM-120                    | 8.2.0                            | 19   |
| SFM-320                     | SFM-320                    | 7.3.0                            | 20   |
| <b>Gigabit Ethernet IOA</b> |                            |                                  |      |
| GE-4 IOA                    | ES2-S1<br>GE-4<br>IOA      | 7.0.1                            | 21   |
| GE-8 IOA                    | ES2-S1<br>GE-8<br>IOA      | 7.2.0                            | 25   |
| GE-20 IOA                   | ES2-S3<br>GE-20<br>IOA     | 9.0.0                            | 29   |
| 10GE IOA                    | ES2-S1<br>10GE<br>IOA      | 7.0.1                            | 33   |
| 10GE PR IOA                 | ES2-S2<br>10GE PR<br>IOA   | 7.2.0                            | 36   |
| <b>OC3/STM1 ATM IOA</b>     |                            |                                  |      |

**Table 1: Modules and IOAs** *(continued)*

| Module/IOA Type          | Module Label                        | First JUNOS <sup>e</sup> Support | Page |
|--------------------------|-------------------------------------|----------------------------------|------|
| OC3/STM1-8 ATM IOA       | ES2-S1<br>OC3-8<br>STM1<br>ATM IOA  | 7.0.1                            | 40   |
| <b>OC12/STM4 ATM IOA</b> |                                     |                                  |      |
| OC12/STM4-2 ATM IOA      | ES2-S1<br>OC12-2<br>STM4<br>ATM IOA | 7.0.1                            | 42   |
| <b>OC12/STM4 POS IOA</b> |                                     |                                  |      |
| OC12/STM4-2 POS IOA      | ES2-S1<br>OC12-2<br>STM4<br>POS IOA | 7.0.1                            | 44   |
| <b>OC48/STM16 IOA</b>    |                                     |                                  |      |
| OC48/STM16 POS IOA       | ES2-S1<br>OC48<br>STM16<br>POS IOA  | 7.0.1                            | 46   |
| <b>Redundancy IOA</b>    |                                     |                                  |      |
| REDUND IOA               | ES2-S1<br>REDUND<br>IOA             | 7.0.1                            | 48   |
| <b>Service IOA</b>       |                                     |                                  |      |
| SERVICE IOA              | ES2-S1<br>SERVICE<br>IOA            | 7.0.1                            | 49   |
| <b>SRP IOA</b>           |                                     |                                  |      |
| SRP IOA                  | SRP IOA                             | 7.0.1                            | 50   |

## LM-4 Line Module

|   |  |
|---|--|
| <b>Module label</b>                         | ES2 4G LM  |
| <b>Number of ports</b>                      | ■ Not applicable   |
| <b>Software release</b>                     | ■ First supported: 7.0.1   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 176 W maximum</li> <li>■ Acts as frame forwarding engines for the physical interfaces</li> <li>■ Responsible for processing data traffic</li> <li>■ Pairs with IOAs to process data from different types of network connections</li> </ul>  |
| <b>Type</b>                                 | ■ FFA ASIC   |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Supports a line rate of 128-byte packets on IOAs</li> <li>■ The 100-Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4).</li> <li>■ The 320-Gbps switch fabric allocates 10 Gbps of overall bandwidth to each line module slot. The line interface on the ES2 4G LM when installed in a 320 Gbps fabric configuration is 3.9 Gbps; you can achieve this rate with random packet sizes in the range 64–1518 bytes or a mixture of packet sizes that represent Internet mix traffic (IMIX).</li> <li>■ See <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> for more information.</li> </ul> |
| <b>Software features</b>                    | ■ Not applicable   |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>            | ■ Not applicable   |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)</li> <li>■ Can only back up another ES2 4G LM</li> </ul>   |
| <b>Port redundancy support</b>              | ■ Not applicable   |
| <b>Cables and connectors</b>                | ■ Not applicable   |
| <b>LEDs</b>                                 | <p>When lit, LED indicates:</p> <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> <li>■ ONLINE (green)—Online with no alarms or errors</li> <li>■ REDUN (green)—Redundant card available</li> </ul>   |

**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
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## LM-10 Uplink Line Module

|   |  |
|---|--|
| <b>Module label</b>                         | ES2 10G UPLINK LM  |
| <b>Number of ports</b>                      | ■ Not applicable   |
| <b>Software release</b>                     | ■ First supported: 7.2.0   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 150 W maximum</li> <li>■ Acts as frame forwarding engines for the physical interfaces</li> <li>■ Processes up to 10 Gb of data traffic</li> <li>■ Pairs with ES2–S2 10GE PR IOA only</li> <li>■ In a SRP-100 configuration, it must be installed in a turbo slot only (slot 2 or slot 4) <ul style="list-style-type: none"> <li>■ If you install the line module in a slot other than slot 2 or slot 4, it will be disabled</li> <li>■ If you install a LM-10 Uplink module next to a configured line module that is already installed in slot 3 or slot 5, the LM-10 Uplink module will be disabled</li> <li>■ If you install a line module in slot 3 or slot 5 next to a previously installed LM-10 Uplink module, the non-LM-10 Uplink module will be disabled</li> </ul> </li> <li>■ In a SRP-120 and SRP-320 configuration, it can be installed in any slot</li> </ul> |
| <b>Type</b>                                 | ■ IXP network processor  |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Supports a line rate of 128-byte frames on IOAs</li> <li>■ The 100-Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4).</li> <li>■ The 120-Gbps and 320-Gbps switch fabrics allocate 10 Gbps of overall bandwidth to each line module slot.</li> <li>■ See <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> for more information.</li> </ul>   |
| <b>Software features</b>                    | ■ Not applicable   |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>            | ■ Not applicable   |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)</li> <li>■ Can only back up another ES2 10G UPLINK LM</li> </ul>   |
| <b>Port redundancy support</b>              | ■ Not applicable   |
| <b>Cables and connectors</b>                | ■ Not applicable   |

**LEDs**

When lit, LED indicates:

- OK (green)—Self-test passed
- FAIL (red)—Failure detected
- ONLINE (green)—Online with no alarms or errors
- REDUN (green)—Redundant card available

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**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
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## LM-10 Line Module

|   |   |
|---|---|
| <b>Module label</b>                         | ES2 10G LM  |
| <b>Number of ports</b>                      | ■ Not applicable  |
| <b>Software release</b>                     | ■ First supported: 8.0.0  |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 198 W maximum</li> <li>■ Acts as frame forwarding engines for the physical interfaces</li> <li>■ Processes up to 10 Gb of data traffic</li> <li>■ Pairs with ES2–S2 10GE PR IOA and ES2–S1 GE-8 IOA</li> <li>■ In a SRP-100 configuration, it must be installed in a turbo slot only (slot 2 or slot 4) <ul style="list-style-type: none"> <li>■ If you install the line module in a slot other than slot 2 or slot 4, it will be disabled</li> <li>■ If you install the LM-10 module next to a configured line module that is already installed in slot 3 or slot 5, the LM-10 module will be disabled</li> <li>■ If you install a line module in slot 3 or slot 5 next to a previously installed LM-10 module, the non-LM-10 module will be disabled</li> </ul> </li> <li>■ In a SRP-120 and SRP-320 configuration, it can be installed in any slot</li> </ul> |
| <b>Type</b>                                 | ■ TFA ASIC  |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Supports a line rate of 128-byte frames on IOAs</li> <li>■ The 100-Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4).</li> <li>■ The 120-Gbps and 320-Gbps switch fabrics allocate 10 Gbps of overall bandwidth to each line module slot.</li> <li>■ See <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> for more information.</li> </ul>  |
| <b>Software features</b>                    | ■ Not applicable  |
| <b>Line module compatibility</b>            | ■ Not applicable  |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>   |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)</li> <li>■ Can only back up another ES2 10G LM</li> </ul>   |
| <b>Port redundancy support</b>              | ■ Not applicable  |
| <b>Cables and connectors</b>                | ■ Not applicable  |

**LEDs**

When lit, LED indicates:

- OK (green)—Self-test passed
- FAIL (red)—Failure detected
- ONLINE (green)—Online with no alarms or errors
- REDUN (green)—Redundant card available

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**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
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## LM-10 ADV Line Module

|   |   |
|---|---|
| <b>Module label</b>                         | ES2 10G ADV LM  |
| <b>Number of ports</b>                      | ■ Not applicable  |
| <b>Software release</b>                     | ■ First supported: 10.1.0   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 190 W maximum</li> <li>■ Acts as frame forwarding engines for the physical interfaces</li> <li>■ Processes up to 10 Gb of data traffic</li> <li>■ Pairs with ES2-S2 10GE PR IOA, ES2-S1 REDUND IOA, ES2-S3 GE-20 IOA, and ES2-S1 GE-8 IOA</li> <li>■ In an SRP-320 configuration, it can be installed in any slot</li> </ul>   |
| <b>Type</b>                                 | ■ TFA ASIC  |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Supports a line rate of 128-byte frames on IOAs</li> <li>■ The 100-Gbps switch fabric allocates 3.4 Gbps of overall bandwidth to each regular line module slot and 10 Gbps of overall bandwidth to each of the turbo slots (slot 2 and slot 4).</li> <li>■ The 320-Gbps switch fabrics allocate 10 Gbps of overall bandwidth to each line module slot.</li> <li>■ See <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> for more information.</li> </ul> |
| <b>Software features</b>                    | ■ Not applicable  |
| <b>Line module compatibility</b>            | ■ Not applicable  |
| <b>SRP module compatibility</b>             | ■ SRP-320   |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)</li> <li>■ Can back up another ES2 10G ADV LM or ES2 10G LM</li> </ul>  |
| <b>Port redundancy support</b>              | ■ Not applicable  |
| <b>Cables and connectors</b>                | ■ Not applicable  |
| <b>LEDs</b>                                 | <p>When lit, LED indicates:</p> <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> <li>■ ONLINE (green)—Online with no alarms or errors</li> <li>■ REDUN (green)—Redundant card available</li> </ul>  |
| <b>Alarms, errors, and events</b>           | ■ See <i>Monitoring Modules</i> in <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> .  |

## SRP-100 Module

|   |   |
|---|---|
| <b>Module label</b>                         | SRP-100   |
| <b>IOA label</b>                            | SRP IOA   |
| <b>Number of IOA ports</b>                  | ■ Not applicable  |
| <b>Software release</b>                     | ■ First supported: 7.0.1  |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 75 W maximum</li> <li>■ Switch route processor (100 Gbps)</li> <li>■ Performs system management, route table calculations and maintenance, forwarding table computations, statistics processing, configuration storage, and other control plane functions</li> <li>■ Has 2 GB of memory</li> <li>■ Works with the SFM-100 module to create a switch fabric</li> <li>■ Uses a PCMCIA nonvolatile storage (NVS) card to store the system's software and configuration files</li> <li>■ Must be installed only with SRP-100 module and SFM-100 modules</li> </ul> |
| <b>Capability</b>                           | ■ Not applicable  |
| <b>Software features</b>                    | ■ Not applicable  |
| <b>Model compatibility</b>                  | ■ E320 router   |
| <b>Line module compatibility</b>            | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> <li>■ ES2 10G LM</li> <li>■ ES2 10G ADV LM (only in turbo slots)</li> </ul>  |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ Cannot use with SRP-120 module or SFM-120 module</li> <li>■ Cannot use with SRP-320 module or SFM-320 module</li> </ul>  |
| <b>Line module redundancy compatibility</b> | ■ Yes ( ES2-S1 REDUND IOA must be installed in either slot 0 or slot 11)  |
| <b>Module redundancy support</b>            | ■ 1:1 redundancy  |
| <b>Port redundancy support</b>              | ■ Not applicable  |
| <b>Cables and connectors</b>                | ■ Not applicable  |

**LEDs**

Board-level LEDs:

- OK (green)—Self-test passed
- FAIL (red)—Failure detected
- ONLINE (green)—Online with no alarms or errors
- REDUN (green)—Module is the spare system controller, is up, and is ready to take the role of the online system controller. When LED is not lit, module is not acting as the spare system controller.
- PA (green)—Power source on source A
- PB (green)—Power source on source B
- FO (green)—Fan OK
- FF (red)—Fan failure
- LK (green)—Ethernet link up
- AC (green)—Blinks when there is Ethernet activity (traffic) on link

Flash Card Port LEDs:

- 0 (green)—When lit, indicates slot is busy
- 1 (green)—When lit, indicates slot is busy

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**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
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## SRP-120 Module

|                                  |  |
|----------------------------------|--|
| <b>Module label</b>              | SRP-120  |
| <b>IOA label</b>                 | SRP IOA  |
| <b>Number of IOA ports</b>       | ■ Not applicable   |
| <b>Software release</b>          | ■ First supported: 8.2.0   |
| <b>Description</b>               | <ul style="list-style-type: none"> <li>■ 140 W maximum</li> <li>■ Switch route processor (120 Gbps)</li> <li>■ Performs system management, route table calculations and maintenance, forwarding table computations, statistics processing, configuration storage, and other control plane functions</li> <li>■ Has 4 GB of memory</li> <li>■ Works with the SFM-120 module to create a switch fabric <ul style="list-style-type: none"> <li>■ The 120-Gbps fabric allocates 10 Gbps of overall bandwidth to each line module slot.</li> </ul> </li> <li>■ Uses an ATA flash card to store the system's software and configuration files <ul style="list-style-type: none"> <li>■ Two flash cards are required for operation</li> </ul> </li> <li>■ Must be installed only with SRP-120 module and SFM-120 modules</li> </ul> |
| <b>Capability</b>                | ■ Not applicable   |
| <b>Software features</b>         | ■ Not applicable   |
| <b>Model compatibility</b>       | ■ E120 router  |
| <b>Line module compatibility</b> | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> <li>■ ES2 10G LM</li> </ul>   |
| <b>SRP module compatibility</b>  | <ul style="list-style-type: none"> <li>■ SRP-120</li> <li>■ Cannot use with SRP-100 module or SFM-100 module</li> <li>■ Cannot use with SRP-320 module or SFM-320 module</li> </ul>  |
| <b>Module redundancy support</b> | ■ 1:1 redundancy   |
| <b>Port redundancy support</b>   | ■ Not applicable   |
| <b>Cables and connectors</b>     | ■ Not applicable   |

**LEDs**

Board-level LEDs:

- OK (green)—Self-test passed
- FAIL (red)—Failure detected
- ONLINE (green)—Online with no alarms or errors
- REDUN (green)—Module is the spare system controller, is up, and is ready to take the role of the online system controller. When LED is not lit, module is not acting as the spare system controller.
- PA (green)—Power source on source A
- PB (green)—Power source on source B
- FO (green)—Fan OK
- FF (red)—Fan failure
- LK (green)—Ethernet link up
- AC (green)—Blinks when there is Ethernet activity (traffic) on link

Flash Card Port LEDs:

- 0 (green)—When lit, indicates slot is busy
- 1 (green)—When lit, indicates slot is busy

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**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
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## SRP-320 Module

|                                  |  |
|----------------------------------|--|
| <b>Module label</b>              | SRP-320  |
| <b>IOA label</b>                 | SRP IOA  |
| <b>Number of IOA ports</b>       | ■ Not applicable   |
| <b>Software release</b>          | ■ First supported: 7.3.0   |
| <b>Description</b>               | <ul style="list-style-type: none"> <li>■ 140 W maximum</li> <li>■ Switch route processor (320 Gbps)</li> <li>■ Performs system management, route table calculations and maintenance, forwarding table computations, statistics processing, configuration storage, and other control plane functions</li> <li>■ Has 4 GB of memory</li> <li>■ Works with the SFM-320 module to create a switch fabric <ul style="list-style-type: none"> <li>■ The 320-Gbps fabric allocates 10 Gbps of overall bandwidth to each line module slot.</li> </ul> </li> <li>■ Uses an ATA flash card to store the system's software and configuration files <ul style="list-style-type: none"> <li>■ Two flash cards are required for operation</li> </ul> </li> <li>■ Must be installed only with SRP-320 module and SFM-320 modules</li> </ul> |
| <b>Capability</b>                | ■ Not applicable   |
| <b>Software features</b>         | ■ Not applicable   |
| <b>Model compatibility</b>       | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b> | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> <li>■ ES2 10G LM</li> <li>■ ES2 10G ADV LM</li> </ul>   |
| <b>SRP module compatibility</b>  | <ul style="list-style-type: none"> <li>■ SRP-320</li> <li>■ Cannot use with SRP-100 module or SFM-100 module</li> <li>■ Cannot use with SRP-120 module or SFM-120 module</li> </ul>  |
| <b>Module redundancy support</b> | ■ 1:1 redundancy   |
| <b>Port redundancy support</b>   | ■ Not applicable   |
| <b>Cables and connectors</b>     | ■ Not applicable   |



**LEDs**

Board-level LEDs:

- OK (green)—Self-test passed
- FAIL (red)—Failure detected
- ONLINE (green)—Online with no alarms or errors
- REDUN (green)—Module is the spare system controller, is up, and is ready to take the role of the online system controller. When LED is not lit, module is not acting as the spare system controller.
- PA (green)—Power source on source A
- PB (green)—Power source on source B
- FO (green)—Fan OK
- FF (red)—Fan failure
- LK (green)—Ethernet link up
- AC (green)—Blinks when there is Ethernet activity (traffic) on link

Flash Card Port LEDs:

- 0 (green)—When lit, indicates slot is busy
- 1 (green)—When lit, indicates slot is busy

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**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
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## SFM-100 Module

|   |   |
|---|---|
| <b>Module label</b>                         | SFM-100   |
| <b>IOA label</b>                            | ■ Not applicable  |
| <b>Number of IOA ports</b>                  | ■ Not applicable  |
| <b>Software release</b>                     | ■ First supported: 7.0.1  |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 40 W maximum</li> <li>■ Switch fabric module (100 Gbps)</li> <li>■ Works with the SRP-100 module to create a switch fabric</li> <li>■ Must be installed only with SRP-100 module and SFM-100 modules</li> </ul>  |
| <b>Capability</b>                           | ■ Not applicable  |
| <b>Software features</b>                    | ■ Not applicable  |
| <b>Model compatibility</b>                  | ■ E320 router   |
| <b>Line module compatibility</b>            | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> <li>■ ES2 10G ADV LM (only in turbo slots)</li> </ul>  |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ Cannot use with SRP-320 module or SFM-320 module</li> </ul>   |
| <b>Line module redundancy compatibility</b> | ■ Yes ( ES2-S1 REDUND IOA must be installed in either slot 0 or slot 11)  |
| <b>Module redundancy support</b>            | ■ N + 1 redundancy  |
| <b>Port redundancy support</b>              | ■ Not applicable  |
| <b>Cables and connectors</b>                | ■ Not applicable  |
| <b>LEDs</b>                                 | <p>When lit, LED indicates:</p> <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> <li>■ ONLINE (green)—Online with no alarms or errors</li> <li>■ REDUN (green)—N + 1 redundancy is enabled; 2 SRPs and 3 SFMs must be installed and working. When LED is unlit, one of the five fabric slices is down or not installed; N + 1 redundancy is not enabled.</li> </ul> <p><b>NOTE:</b> When REDUN LED is on, the module may be removed without interrupting service.</p> |
| <b>Alarms, errors, and events</b>           | ■ See <i>Monitoring Modules</i> in <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> .  |

## SFM-120 Module

|                                   |   |
|-----------------------------------|---|
| <b>Module label</b>               | SFM-120   |
| <b>IOA label</b>                  | ■ Not applicable  |
| <b>Number of IOA ports</b>        | ■ Not applicable  |
| <b>Software release</b>           | ■ First supported: 8.2.0  |
| <b>Description</b>                | <ul style="list-style-type: none"> <li>■ 95 W maximum</li> <li>■ Switch fabric module (120 Gbps)</li> <li>■ Works with the SRP-120 module to create a switch fabric               <ul style="list-style-type: none"> <li>■ The 120-Gbps fabric allocates 10 Gbps of overall bandwidth to each line module slot.</li> </ul> </li> <li>■ Must be installed only with SRP-120 module and SFM-120 modules</li> </ul>  |
| <b>Capability</b>                 | ■ Not applicable  |
| <b>Software features</b>          | ■ Not applicable  |
| <b>Model compatibility</b>        | ■ E120 router   |
| <b>Line module compatibility</b>  | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> </ul>  |
| <b>SRP module compatibility</b>   | <ul style="list-style-type: none"> <li>■ SRP-120</li> <li>■ Cannot use with SRP-100 module or SFM-100 module</li> <li>■ Cannot use with SRP-320 module or SFM-320 module</li> </ul>   |
| <b>Module redundancy support</b>  | ■ N + 1 redundancy  |
| <b>Port redundancy support</b>    | ■ Not applicable  |
| <b>Cables and connectors</b>      | ■ Not applicable  |
| <b>LEDs</b>                       | <p>When lit, LED indicates:</p> <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> <li>■ ONLINE (green)—Online with no alarms or errors</li> <li>■ REDUN (green)—N + 1 redundancy is enabled; 2 SRPs and 3 SFMs must be installed and working. When LED is unlit, one of the five fabric slices is down or not installed; N + 1 redundancy is not enabled.</li> </ul> <p><b>NOTE:</b> When REDUN LED is on, the module may be removed without interrupting service.</p> |
| <b>Alarms, errors, and events</b> | ■ See <i>Monitoring Modules</i> in <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> .  |

## SFM-320 Module

|                                   |   |
|-----------------------------------|---|
| <b>Module label</b>               | SFM-320   |
| <b>IOA label</b>                  | ■ Not applicable  |
| <b>Number of IOA ports</b>        | ■ Not applicable  |
| <b>Software release</b>           | ■ First supported: 7.3.0  |
| <b>Description</b>                | <ul style="list-style-type: none"> <li>■ 95 W maximum</li> <li>■ Switch fabric module (320 Gbps)</li> <li>■ Works with the SRP-320 module to create a switch fabric <ul style="list-style-type: none"> <li>■ The 320-Gbps fabric allocates 10 Gbps of overall bandwidth to each line module slot.</li> </ul> </li> <li>■ Must be installed only with SRP-320 module and SFM-320 modules</li> </ul>  |
| <b>Capability</b>                 | ■ Not applicable  |
| <b>Software features</b>          | ■ Not applicable  |
| <b>Model compatibility</b>        | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>  |
| <b>Line module compatibility</b>  | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> </ul>  |
| <b>SRP module compatibility</b>   | <ul style="list-style-type: none"> <li>■ SRP-320</li> <li>■ Cannot use with SRP-100 module or SFM-100 module</li> </ul>   |
| <b>Module redundancy support</b>  | ■ N + 1 redundancy  |
| <b>Port redundancy support</b>    | ■ Not applicable  |
| <b>Cables and connectors</b>      | ■ Not applicable  |
| <b>LEDs</b>                       | <p>When lit, LED indicates:</p> <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> <li>■ ONLINE (green)—Online with no alarms or errors</li> <li>■ REDUN (green)—N + 1 redundancy is enabled; 2 SRPs and 3 SFMs must be installed and working. When LED is unlit, one of the five fabric slices is down or not installed; N + 1 redundancy is not enabled.</li> </ul> <p><b>NOTE:</b> When REDUN LED is on, the module may be removed without interrupting service.</p> |
| <b>Alarms, errors, and events</b> | ■ See <i>Monitoring Modules</i> in <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> .  |

## GE-4 IOA

|   |   |
|---|---|
| <b>IOA label</b>                            | ES2-S1 GE-4 IOA   |
| <b>Number of IOA ports</b>                  | ■ 4   |
| <b>Software release</b>                     | ■ First supported: 7.0.1  |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 21 W maximum</li> <li>■ Half-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.</li> <li>■ Uses either optical or copper SFPs. <ul style="list-style-type: none"> <li>■ The optical transceivers are 1000Base-SX, 1000Base-LX, and 1000Base-ZX compliant.</li> <li>■ The copper transceivers are 1000Base-T compliant.</li> </ul> </li> <li>■ Single-strand SFPs can be used. These SFPs work in pairs and require a matching SFP at the opposite end of the Ethernet connection. For example, an SFP rated at TX 1310, RX 1550 must be paired with an SFP rated TX 1550, RX 1310 with the same maximum operating range. See the following corresponding table (Single-strand SFPs Pairing) for more information.</li> </ul> |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Ethernet (IEEE 802.3x)</li> <li>■ 1000Base-SX/LX/ZX</li> </ul>   |
| <b>Software features</b>                    | ■ See “Ethernet IOAs” on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.  |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>  |
| <b>Line module compatibility</b>            | ■ ES2 4G LM   |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>   |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>   |
| <b>Port redundancy support</b>              | ■ Not applicable  |
| <b>Cables and connectors (copper SFP)</b>   | ■ Maximum range is 100 meters on CAT5 cable.  |

**Cables and connectors  
(multimode [SX] )**

- Up to four LC-style fiber-optic connectors
- Transmit power:
  - min: -9.5 dBm
  - max: -3 dBm
- Receive input power:
  - min: -20 dBm
  - max: 0 dBm
- See the following corresponding table (SX Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [LX])**

- Up to four LC-style fiber-optic connectors
- Transmit power:
  - min: -9.5 dBm
  - max: -3 dBm
- Receive input power:
  - min: -20 dBm
  - max: -3 dBm
- See the following corresponding table (LX Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode LX40)**

- Up to four LC-style fiber-optic connectors
- Transmit power:
  - min: -4.5 dBm
  - max: 0 dBm
- Receive input power:
  - min: -35 dBm
  - max: -22.5 dBm
- See the following corresponding table (LX40 Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [ZX] )**

- Up to four LC-style fiber-optic connectors
- Transmit power:
  - min: -2 dBm
  - max: 3 dBm
- Receive input power:
  - min: -22 dBm
  - max: -3 dBm
- See the following corresponding table (ZX Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

When lit, LED indicates:

- OK (green)—Physical link is connected properly and is functioning properly
- FAIL (red)—Failure detected
- Port LEDs:
  - LK (green)—Ethernet link is up
  - ACT (green)—Blinks when there is Ethernet traffic being received

**Alarms, errors, and events**

- See *Monitoring Ethernet Interfaces* in *JUNOS Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

**Table 2: SX Fiber Optic Cabling**

| Fiber Type   | Minimal Modal Bandwidth at 850 nm (MHz*km) | Maximum Operating Range (meters) |
|--------------|--|----------------------------------|
| 62.5 microns | 160  | 220 (656.17 ft)                  |
|              | 200  | 275 (902.23 ft)                  |
| 50 microns   | 400  | 500 (1640.42 ft)                 |
|              | 500  | 550 (1804.46 ft)                 |

**Table 3: LX Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 9 microns  | 1310                    | 10 (6.2 miles)                       |

**Table 4: LX40 Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 9 microns  | 1310                    | 40 (24.85 miles)                     |

**Table 5: ZX Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 10 microns | 1550                    | 70 (43.5 miles)                      |

**Table 6: Single-strand SFPs Pairing**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b>   | <b>Maximum Operating Range (kilometers)</b>                       |
|-------------------|--|---|
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1550</li> <li>■ Pairs with TX 1550 / RX 1310</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1550 / RX 1310</li> <li>■ Pairs with TX 1310, RX 1550</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1490</li> <li>■ Pairs with TX 1490 / RX 1310</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1490 / RX 1310</li> <li>■ Pairs with TX 1310, RX 1490</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1550</li> <li>■ Pairs with TX 1550 / RX 1310</li> </ul> | 40 (24.85 miles), matching SFP must have the same operating range |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1550, RX 1310</li> <li>■ Pairs with TX 1310 / RX 1550</li> </ul> | 40 (24.85 miles), matching SFP must have the same operating range |



## GE-8 IOA

|   |  |
|---|--|
| <b>IOA label</b>                            | ES2-S1 GE-8 IOA  |
| <b>Number of IOA ports</b>                  | ■ 8  |
| <b>Software release</b>                     | ■ First supported: 7.2.0   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 32 W maximum</li> <li>■ Gigabit Ethernet</li> <li>■ Half-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths</li> <li>■ Uses either optical or copper SFPs. <ul style="list-style-type: none"> <li>■ The optical transceivers are 1000Base-SX, 1000Base-LX, and 1000Base-ZX compliant.</li> <li>■ The copper transceivers are 1000Base-T compliant.</li> </ul> </li> <li>■ Single-strand SFPs can be used. These SFPs work in pairs and require a matching SFP at the opposite end of the Ethernet connection. For example, an SFP rated at TX 1310, RX 1550 must be paired with an SFP rated TX 1550, RX 1310 with the same maximum operating range. See the following corresponding table (Single-strand SFPs Pairing) for more information.</li> </ul> |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Ethernet (IEEE 802.3z)</li> <li>■ 1000Base-SX/LX/ZX</li> </ul>  |
| <b>Software features</b>                    | ■ See “Ethernet IOAs” on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>            | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G LM</li> <li>■ ES2 10G ADV LM</li> </ul>  |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>  |
| <b>Port redundancy support</b>              | ■ Not applicable   |
| <b>Cables and connectors (copper SFP)</b>   | ■ Maximum range is 100 meters on CAT5 cable.   |

**Cables and connectors  
(multimode [SX])**

- One LC full duplex connector
- Transmit power:
  - min: -9.5 dBm
  - max: -3 dBm
- Receive input power:
  - min: -20 dBm
  - max: 0 dBm
- See the following corresponding table (SX Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [LX])**

- One LC full duplex connector
- Transmit power:
  - min: -9.5 dBm
  - max: -3 dBm
- Receive input power:
  - min: -20 dBm
  - max: -3 dBm
- See the following corresponding table (LX Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode LX40)**

- One LC full duplex connector
- Transmit power:
  - min: -4.5 dBm
  - max: 0 dBm
- Receive input power:
  - min: -35 dBm
  - max: -22.5 dBm
- See the following corresponding table (LX40 Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [ZX])**

- One LC full duplex connector
- Transmit power:
  - min: -2 dBm
  - max: 3dBm
- Receive input power:
  - min: -22 dBm
  - max: -3 dBm
- See the following corresponding table (ZX Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

Board-level LEDs:

- OK (green)—IOA is online and is functioning properly
- FAIL (red)—Failure detected

Port LEDs:

- LK (green)—Ethernet link is up
- ACT (green)—Blinks when Ethernet traffic is being received

**Alarms, errors, and events**

- See *Monitoring Ethernet Interfaces* in *JUNOS Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

**Table 7: SX Fiber Optic Cabling**

| Fiber Type   | Minimal Modal Bandwidth at 850 nm (MHz*km) | Maximum Operating Range (meters) |
|--------------|--|----------------------------------|
| 62.5 microns | 160  | 220 (656.17 ft)                  |
|              | 200  | 275 (902.23 ft)                  |
| 50 microns   | 400  | 500 (1640.42 ft)                 |
|              | 500  | 550 (1804.46 ft)                 |

**Table 8: LX Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 9 microns  | 1310                    | 10 (6.2 miles)                       |

**Table 9: LX40 Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 9 microns  | 1310                    | 40 (24.85 miles)                     |

**Table 10: ZX Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 10 microns | 1550                    | 70 (43.5 miles)                      |

**Table 11: Single-strand SFPs Pairing**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b>   | <b>Maximum Operating Range (kilometers)</b>                       |
|-------------------|--|---|
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1550</li> <li>■ Pairs with TX 1550 / RX 1310</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1550 / RX 1310</li> <li>■ Pairs with TX 1310, RX 1550</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1490</li> <li>■ Pairs with TX 1490 / RX 1310</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1490 / RX 1310</li> <li>■ Pairs with TX 1310, RX 1490</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1550</li> <li>■ Pairs with TX 1550 / RX 1310</li> </ul> | 40 (24.85 miles), matching SFP must have the same operating range |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1550, RX 1310</li> <li>■ Pairs with TX 1310 / RX 1550</li> </ul> | 40 (24.85 miles), matching SFP must have the same operating range |

## GE-20 IOA

|                                  |  |
|----------------------------------|--|
| <b>IOA label</b>                 | ES2-S3 GE-20 IOA   |
| <b>Number of IOA ports</b>       | ■ 20   |
| <b>Software release</b>          | ■ First supported: 9.0.0   |
| <b>Description</b>               | <ul style="list-style-type: none"> <li>■ 92 W maximum</li> <li>■ Full-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths</li> <li>■ Uses either optical or copper SFPs. <ul style="list-style-type: none"> <li>■ The optical transceivers are 1000Base-SX, 1000Base-LX, and 1000Base-ZX compliant.</li> <li>■ The copper transceivers are 1000Base-T compliant and require a ferrite core to be attached around the Ethernet cable. Note that a ferrite bead is not required for a Finisar transceiver (FCLF8522P2BTL-J1).</li> </ul> </li> <li>■ Single-strand SFPs can be used. These SFPs work in pairs and require a matching SFP at the opposite end of the Ethernet connection. For example, an SFP rated at TX 1310, RX 1550 must be paired with an SFP rated TX 1550, RX 1310 with the same maximum operating range. See the following corresponding table (Single-strand SFPs Pairing) for more information.</li> <li>■ In a 100 Gbps fabric configuration, the E320 router can accommodate up to 2 combinations of ES2 10G LMs and ES2-S3 GE-20 IOAs. You must install a combination in either of the turbo slots (slot 2 or slot 4). The 100 Gbps allocates 10 Gbps of overall bandwidth to each of these slots.</li> <li>■ In a 120 Gbps fabric configuration, the E120 router can accommodate up to 6 combinations of ES2 10G LMs and ES2-S3 GE-20 IOAs. You can install a combination in any of the line module slots, each of which are allocated 10 Gbps of overall bandwidth.</li> <li>■ In a 320 Gbps fabric configuration, the E320 router can accommodate up to 12 combinations of ES2 10G LMs and ES2-S3 GE-20 IOAs. You can install a combination in any of the line module slots, each of which are allocated 10 Gbps of overall bandwidth.</li> </ul> |
| <b>Capability</b>                | <ul style="list-style-type: none"> <li>■ Ethernet (IEEE 802.3x)</li> <li>■ 1000Base-SX/LX/ZX</li> </ul>  |
| <b>Software features</b>         | ■ See “Ethernet IOAs” on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>       | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b> | <ul style="list-style-type: none"> <li>■ ES2 10G LM</li> <li>■ ES2 10G ADV LM</li> </ul>   |
| <b>SRP module compatibility</b>  | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |

|   |  |
|---|--|
| <b>Line module redundancy compatibility</b>     | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 10G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 10G LM and ES2-S1 REDUND IOA combination.</li> </ul>  |
| <b>Port redundancy support</b>                  | <ul style="list-style-type: none"> <li>■ Not applicable</li> </ul>   |
| <b>Cables and connectors (copper SFP)</b>       | <ul style="list-style-type: none"> <li>■ Maximum range is 100 meters on CAT5 cable.</li> </ul>   |
| <b>Cables and connectors (multimode [SX])</b>   | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -9.5 dBm</li> <li>■ max: -3 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -20 dBm</li> <li>■ max: 0 dBm</li> </ul> </li> <li>■ See the following corresponding table (SX Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul>      |
| <b>Cables and connectors (single-mode [LX])</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -9.5 dBm</li> <li>■ max: -3 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -20 dBm</li> <li>■ max: -3 dBm</li> </ul> </li> <li>■ See the following corresponding table (LX Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul>     |
| <b>Cables and connectors (single-mode LX40)</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -4.5 dBm</li> <li>■ max: 0 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -35 dBm</li> <li>■ max: -22.5 dBm</li> </ul> </li> <li>■ See the following corresponding table (LX40 Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |
| <b>Cables and connectors (single-mode [ZX])</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -2 dBm</li> <li>■ max: 3dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -22 dBm</li> <li>■ max: -3 dBm</li> </ul> </li> <li>■ See the following corresponding table (ZX Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul>         |

**LEDs**

Board-level LEDs:

- OK (green)—Physical link is connected properly and is functioning properly
- FAIL (red)—Failure detected

Port LEDs:

- LK (green)—Ethernet link is up
- ACT (green)—Blinks when there is Ethernet traffic being received

**Alarms, errors, and events**

- See *Monitoring Ethernet Interfaces* in *JUNOS Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.

**Table 12: SX Fiber Optic Cabling**

| Fiber Type   | Minimal Modal Bandwidth at 850 nm (MHz*km) | Maximum Operating Range (meters) |
|--------------|--|----------------------------------|
| 62.5 microns | 160  | 220 (656.17 ft)                  |
|              | 200  | 275 (902.23 ft)                  |
| 50 microns   | 400  | 500 (1640.42 ft)                 |
|              | 500  | 550 (1804.46 ft)                 |

**Table 13: LX Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 9 microns  | 1310                    | 10 (6.2 miles)                       |

**Table 14: LX40 Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 9 microns  | 1310                    | 40 (24.85 miles)                     |

**Table 15: ZX Fiber Optic Cabling**

| Fiber Type | Nominal Wavelength (nm) | Maximum Operating Range (kilometers) |
|------------|-------------------------|--------------------------------------|
| 10 microns | 1550                    | 70 (43.5 miles)                      |

**Table 16: Single-strand SFPs Pairing**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b>   | <b>Maximum Operating Range (kilometers)</b>                       |
|-------------------|--|---|
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1550</li> <li>■ Pairs with TX 1550 / RX 1310</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1550 / RX 1310</li> <li>■ Pairs with TX 1310, RX 1550</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1490</li> <li>■ Pairs with TX 1490 / RX 1310</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1490 / RX 1310</li> <li>■ Pairs with TX 1310, RX 1490</li> </ul> | 10 (6.2 miles), matching SFP must have the same operating range   |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1310, RX 1550</li> <li>■ Pairs with TX 1550 / RX 1310</li> </ul> | 40 (24.85 miles), matching SFP must have the same operating range |
| 9 microns         | <ul style="list-style-type: none"> <li>■ TX 1550, RX 1310</li> <li>■ Pairs with TX 1310 / RX 1550</li> </ul> | 40 (24.85 miles), matching SFP must have the same operating range |



## 10GE IOA

|   |   |
|---|---|
| <b>IOA label</b>                              | ES2-S1 10GE IOA   |
| <b>Number of IOA ports</b>                    | ■ 1   |
| <b>Software release</b>                       | ■ First supported: 7.0.1  |
| <b>Description</b>                            | <ul style="list-style-type: none"> <li>■ 40 W maximum</li> <li>■ Full-height module</li> <li>■ Uses a range of 10-gigabit small form-factor pluggable (XFP) transceivers to support different modes and cable lengths.</li> </ul>   |
| <b>Capability</b>                             | <ul style="list-style-type: none"> <li>■ Ethernet (IEEE 802.3ae)</li> <li>■ 10Gb Base-SR/LR/ER/ZR</li> <li>■ Port can operate in full duplex mode with an average data rate of 3.4 Gbps</li> </ul>  |
| <b>Software features</b>                      | ■ See “Ethernet IOAs” on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.  |
| <b>Model compatibility</b>                    | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>  |
| <b>Line module compatibility</b>              | ■ ES2 4G LM   |
| <b>SRP module compatibility</b>               | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>   |
| <b>Line module redundancy compatibility</b>   | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>   |
| <b>Port redundancy support</b>                | ■ Not applicable  |
| <b>Cables and connectors (multimode [SR])</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -7.3 dBm</li> <li>■ max: -1.0 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -9.9 dBm</li> <li>■ max: -1.0 dBm</li> </ul> </li> <li>■ See the following corresponding table (SR Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |

|   |   |
|---|---|
| <b>Cables and connectors<br/>(single-mode [LR])</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -8.2 dBm</li> <li>■ max: 0.5 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -14.4 dBm</li> <li>■ max: 0.5 dBm</li> </ul> </li> <li>■ See the following corresponding table (LR Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul>  |
| <b>Cables and connectors<br/>(single-mode [ER])</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -4.7 dBm</li> <li>■ max: 4.0 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -15.8 dBm</li> <li>■ max: -1.0 dBm</li> </ul> </li> <li>■ See the following corresponding table (ER Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |
| <b>Cables and connectors<br/>(single-mode [ZR])</b> | <ul style="list-style-type: none"> <li>■ One LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: 0 dBm</li> <li>■ max: 4 dBm</li> </ul> </li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -24.0 dBm</li> <li>■ max: -7.0 dBm</li> </ul> </li> <li>■ See the following corresponding table (ZR Fiber Optic Cabling) for cabling requirements.</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul>      |
| <b>LEDs</b>   | <p>Board-level LEDs:</p> <ul style="list-style-type: none"> <li>■ OK (green)—Physical link is connected properly and is functioning properly</li> <li>■ FAIL (red)—Failure detected</li> </ul> <p>Port LEDs:</p> <ul style="list-style-type: none"> <li>■ LK (green)—Ethernet link is up</li> <li>■ ACT (green)—Blinks when there is Ethernet traffic being received</li> </ul>   |
| <b>Alarms, errors, and events</b>                   | <ul style="list-style-type: none"> <li>■ See <i>Monitoring Ethernet Interfaces</i> in <i>JUNOS Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces</i>.</li> </ul>   |

**Table 17: SR Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Minimal Modal Bandwidth at 850 nm (MHz*km)</b> | <b>Maximum Operating Range (meters)</b> |
|-------------------|---|---|
| 62.5 microns      | 160   | 26 (85.3 ft)                            |
|                   | 200   | 33 (108.27 ft)                          |
| 50 microns        | 400   | 66 (216.54 ft)                          |
|                   | 500   | 82 (269.03 ft)                          |
|                   | 2000  | 300 (984.25 ft)                         |

**Table 18: LR Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b> | <b>Maximum Operating Range (kilometers)</b> |
|-------------------|--------------------------------|---|
| 9 microns         | 1310                           | 10 (6.2 miles)                              |

**Table 19: ER Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b> | <b>Maximum Operating Range (kilometers)</b> |
|-------------------|--------------------------------|---|
| 9 microns         | 1550                           | 40 (24.85 miles)                            |

**Table 20: ZR Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b> | <b>Maximum Operating Range (kilometers)</b> |
|-------------------|--------------------------------|---|
| 9 microns         | 1550                           | 80 (49.6 miles)                             |

## 10GE PR IOA

|   |  |
|---|--|
| <b>IOA label</b>                            | ES2-S2 10GE PR IOA   |
| <b>Number of IOA ports</b>                  | <ul style="list-style-type: none"> <li>■ 2</li> <li>■ 1 active, 1 redundant</li> </ul>   |
| <b>Software release</b>                     | <ul style="list-style-type: none"> <li>■ First supported: 7.2.0</li> </ul>   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 48 W maximum</li> <li>■ Full-height module</li> <li>■ Uses a range of 10-gigabit small form-factor pluggable (XFP) transceivers to support different modes and cable lengths.</li> <li>■ Pairs only with ES2 10G UPLINK LM, ES2 10G LM, and ES2 10G ADV LM to provide 10-Gigabit Ethernet operation through a single line interface</li> <li>■ In a 100 Gbps configuration, the E320 router can accommodate up to two ES2 10G UPLINK LM and ES2-S2 10GE PR IOA combinations. You must install a combination in either of the turbo slots (slot 2 or slot 4).</li> <li>■ In a 100 Gbps configuration, the E320 router can accommodate up to two ES2 10G LM and ES2-S2 10GE PR IOA combinations</li> <li>■ In a 120 Gbps configuration, the E120 router can accommodate up to six ES2 10G UPLINK LM and ES2-S2 10GE PR IOA combinations. You can install a combination in any of the line module slots.</li> <li>■ In a 320 Gbps configuration, the E320 router can accommodate up to twelve ES2 10G UPLINK LM and ES2-S2 10GE PR IOA combinations. You can install a combination in any of the line module slots.</li> <li>■ In a 320 Gbps configuration, the E320 router can accommodate up to twelve ES2 10G LM and ES2-S2 10GE PR IOA combinations</li> </ul> |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Ethernet (IEEE 802.3ae)</li> <li>■ 10Gb Base-SR/LR/ER/ZR</li> <li>■ Port can operate in full duplex mode with an average data rate of 10 Gbps</li> </ul>  |
| <b>Software features</b>                    | <ul style="list-style-type: none"> <li>■ See “Ethernet IOAs” on page 53 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.</li> </ul>   |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>            | <ul style="list-style-type: none"> <li>■ ES2 10G UPLINK LM</li> <li>■ ES2 10G LM</li> <li>■ ES2 10G ADV LM</li> </ul>  |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Not applicable</li> </ul>   |
| <b>Port redundancy support</b>              | <ul style="list-style-type: none"> <li>■ Yes</li> </ul>  |

**Cables and connectors  
(multimode [SR])**

- One LC full duplex connector
- Transmit power:
  - min: -7.3 dBm
  - max: -1.0 dBm
- Receive input power:
  - min: -9.9 dBm
  - max: -1.0 dBm
- See the following corresponding table (SR Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [LR])**

- One LC full duplex connector
- Transmit power:
  - min: -8.2 dBm
  - max: 0.5 dBm
- Receive input power:
  - min: -14.4 dBm
  - max: 0.5 dBm
- See the following corresponding table (LR Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [ER])**

- One LC full duplex connector
- Transmit power:
  - min: -4.7 dBm
  - max: 4.0 dBm
- Receive input power:
  - min: -15.8 dBm
  - max: -1.0 dBm
- See the following corresponding table (ER Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode [ZR])**

- One LC full duplex connector
- Transmit power:
  - min: 0 dBm
  - max: 4 dBm
- Receive input power:
  - min: -24.0 dBm
  - max: -7.0 dBm
- See the following corresponding table (ZR Fiber Optic Cabling) for cabling requirements.
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

Board-level LEDs:

- OK (green)—IOA online and is functioning properly
- FAIL (red)—Failure detected

Port LEDs:

- LK (green)—Ethernet link is up
- ACT (green)—Blinks when Ethernet traffic is being received

Port labels:

- W—Working port
- P—Protect port (LK blinks when active cable is attached even though it is not the active working port)

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**Alarms, errors, and events**

- See *Monitoring Ethernet Interfaces* in *JUNOS Physical Layer Configuration Guide, Chapter 5, Configuring Ethernet Interfaces*.
-

**Table 21: SR Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Minimal Modal Bandwidth at 850 nm (MHz*km)</b> | <b>Maximum Operating Range (meters)</b> |
|-------------------|---|---|
| 62.5 microns      | 160   | 26 (85.3 ft)                            |
|                   | 200   | 33 (108.27 ft)                          |
| 50 microns        | 400   | 66 (216.54 ft)                          |
|                   | 500   | 82 (269.03 ft)                          |
|                   | 2000  | 300 (984.25 ft)                         |

**Table 22: LR Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b> | <b>Maximum Operating Range (kilometers)</b> |
|-------------------|--------------------------------|---|
| 9 microns         | 1310                           | 10 (6.2 miles)                              |

**Table 23: ER Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b> | <b>Maximum Operating Range (kilometers)</b> |
|-------------------|--------------------------------|---|
| 9 microns         | 1550                           | 40 (24.85 miles)                            |

**Table 24: ZR Fiber Optic Cabling**

| <b>Fiber Type</b> | <b>Nominal Wavelength (nm)</b> | <b>Maximum Operating Range (kilometers)</b> |
|-------------------|--------------------------------|---|
| 9 microns         | 1550                           | 80 (49.6 miles)                             |

## OC3/STM1-8 ATM IOA

|   |  |
|---|--|
| <b>IOA label</b>                            | ES2-S1 OC3-8 STM1 ATM IOA  |
| <b>Number of IOA ports</b>                  | ■ 8  |
| <b>Software release</b>                     | ■ First supported: 7.0.1   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 50 W maximum</li> <li>■ Half-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.</li> </ul>  |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ OC3/STM1</li> <li>■ ATM</li> </ul>  |
| <b>Software features</b>                    | ■ See “OCx/STMx ATM IOAs” on page 65 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>            | ■ ES2 4G LM  |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b> | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>  |
| <b>Port redundancy support</b>              | ■ Not applicable   |
| <b>Cables and connectors (multimode)</b>    | <ul style="list-style-type: none"> <li>■ Up to eight LC full duplex connectors</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -20 dBm</li> <li>■ max: -14 dBm</li> </ul> </li> <li>■ Center wavelength: 1310 nm</li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -30 dBm</li> <li>■ max: -14 dBm</li> </ul> </li> <li>■ Rated for 2 km (1.2 miles) over 62.5-micron core cable with an optical loss of 0-9 dB or 50-micron core cable with an optical loss of 7 dB</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |



**Cables and connectors****(single-mode intermediate [IR-1])**

- Up to eight LC full duplex connectors
- Transmit power:
  - min: -15 dBm
  - max: -8 dBm
- Center wavelength: 1310 nm
- Receive input power:
  - min: -34 dBm
  - max: -7 dBm
- Rated for 15 km (9.3 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors****(single-mode long reach [LR-1])**

- Up to eight LC full duplex connectors
- Transmit power:
  - min: -3 dBm
  - max: 2 dBm
- Center wavelength: 1310 nm
- Receive input power:
  - min: -28 dBm
  - max: -7 dBm
- Rated for 40 km (24.9 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

## Board-level LEDs:

- OK (green)—Physical link is connected properly and is functioning properly
- FAIL (red)—Failure detected

## Port LEDs:

- ALM—Bi-color LED:
  - Yellow: Local loss of signal exists
  - Red: Remote loss of signal exists
- OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

**Alarms, errors, and events**

- See *Monitoring SONET/SDH Interfaces in JUNOS Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

## OC12/STM4-2 ATM IOA

|   |  |
|---|--|
| <b>IOA label</b>  | ES2-S1 OC12-2 STM4 ATM IOA   |
| <b>Number of IOA ports</b>                                  | ■ 2  |
| <b>Software release</b>                                     | ■ First supported: 7.0.1   |
| <b>Description</b>  | <ul style="list-style-type: none"> <li>■ 40 W maximum</li> <li>■ Half-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.</li> </ul>  |
| <b>Capability</b>   | <ul style="list-style-type: none"> <li>■ OC12/STM4</li> <li>■ ATM</li> </ul>   |
| <b>Software features</b>                                    | ■ See “OCx/STMx ATM IOAs” on page 65 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>                                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>                            | ■ ES2 4G LM  |
| <b>SRP module compatibility</b>                             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b>                 | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>  |
| <b>Port redundancy support</b>                              | ■ Not applicable   |
| <b>Cables and connectors (single-mode short reach [SR])</b> | <ul style="list-style-type: none"> <li>■ Up to two LC full duplex connectors</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -15 dBm</li> <li>■ max: -8 dBm</li> </ul> </li> <li>■ Center wavelength: 1310 nm</li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -28 dBm</li> <li>■ max: -7 dBm</li> </ul> </li> <li>■ Rated for 2 km (1.24 miles) of 9-micron core cable</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |

**Cables and connectors****(single-mode intermediate [IR-1])**

- Up to two LC full duplex connectors
- Transmit power:
  - min: -15 dBm
  - max: -8 dBm
- Center wavelength: 1310 nm
- Receive input power:
  - min: -28 dBm
  - max: -7 dBm
- Rated for 15 km (9.3 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors****(single-mode long reach [LR-1])**

- Up to two LC full duplex connectors
- Transmit power:
  - min: -3 dBm
  - max: 2 dBm
- Center wavelength: 1310 nm
- Receive input power:
  - min: -28 dBm
  - max: -7 dBm
- Rated for 40 km (24.9 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

## Board-level LEDs:

- OK (green)—Physical link is connected properly and is functioning properly
- FAIL (red)—Failure detected

## Port LEDs:

- ALM—Bi-color LED:
  - Yellow: Local loss of signal exists
  - Red: Remote loss of signal exists
- OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

**Alarms, errors, and events**

- See *Monitoring SONET/SDH Interfaces in JUNOS Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

## OC12/STM4-2 POS IOA

|   |  |
|---|--|
| <b>IOA label</b>  | ES2-S1 OC12-2 STM4 POS IOA   |
| <b>Number of IOA ports</b>                                  | ■ 2  |
| <b>Software release</b>                                     | ■ First supported: 7.0.1   |
| <b>Description</b>  | <ul style="list-style-type: none"> <li>■ 30 W maximum</li> <li>■ Half-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Uses a range of small form-factor pluggable (SFP) transceivers to support different modes and cable lengths.</li> </ul>  |
| <b>Capability</b>   | <ul style="list-style-type: none"> <li>■ OC12/STM4</li> <li>■ POS</li> </ul>   |
| <b>Software features</b>                                    | ■ See “OCx/STMx POS IOAs” on page 68 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>                                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>                            | ■ ES2 4G LM  |
| <b>SRP module compatibility</b>                             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Module redundancy support</b>                            | ■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)   |
| <b>Line module redundancy compatibility</b>                 | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>  |
| <b>Port redundancy support</b>                              | ■ Not applicable   |
| <b>Cables and connectors (single-mode short reach [SR])</b> | <ul style="list-style-type: none"> <li>■ Up to two LC full duplex connectors</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -15 dBm</li> <li>■ max: -8 dBm</li> </ul> </li> <li>■ Center wavelength: 1310 nm</li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -28 dBm</li> <li>■ max: -7 dBm</li> </ul> </li> <li>■ Rated for 2 km (1.24 miles) of 9-micron core cable</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |

**Cables and connectors  
(single-mode intermediate [IR-1])**

- Up to two LC full duplex connectors
- Transmit power:
  - min: -15 dBm
  - max: -8 dBm
- Center wavelength: 1310 nm
- Receive input power:
  - min: -28 dBm
  - max: -7 dBm
- Rated for 15 km (9.3 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode long reach [LR-1])**

- Up to two LC full duplex connectors
- Transmit power:
  - min: -3 dBm
  - max: 2 dBm
- Center wavelength: 1310 nm
- Receive input power:
  - min: -28 dBm
  - max: -7 dBm
- Rated for 40 km (24.9 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

## Board-level LEDs:

- OK (green)—Physical link is connected properly and is functioning properly
- FAIL (red)—Failure detected

## Port LEDs:

- ALM—Bi-color LED:
  - Yellow: Local loss of signal exists
  - Red: Remote loss of signal exists
- OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

**Alarms, errors, and events**

- See *Monitoring SONET/SDH Interfaces* in *JUNOS Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

## OC48/STM16 POS IOA

|   |  |
|---|--|
| <b>IOA label</b>  | ES2-S1 OC48 STM16 POS IOA  |
| <b>Number of IOA ports</b>                                    | ■ 1  |
| <b>Software release</b>                                       | ■ First supported: 7.0.1   |
| <b>Description</b>  | <ul style="list-style-type: none"> <li>■ 30 W maximum</li> <li>■ Half-height module</li> <li>■ See “Module and Slot Combinations” on page 75 for more information on combining IOAs in a slot.</li> <li>■ Unchannelized, concatenated OC48/STM16 for POS</li> </ul>  |
| <b>Capability</b>   | <ul style="list-style-type: none"> <li>■ OC48/STM16</li> <li>■ HDLC framing</li> </ul>   |
| <b>Software features</b>                                      | ■ See “OCx/STMx POS IOAs” on page 68 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>                                    | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>                              | ■ ES2 4G LM  |
| <b>SRP module compatibility</b>                               | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b>                   | <ul style="list-style-type: none"> <li>■ Can be paired with an ES2 4G LM.</li> <li>■ Must be installed in the same redundancy group as an ES2 4G LM and ES2-S1 REDUND IOA combination.</li> </ul>  |
| <b>Module redundancy support</b>                              | ■ Yes (Redundancy IOA must be installed in either slot 0 or slot 11)   |
| <b>Port redundancy support</b>                                | ■ Not applicable   |
| <b>Cables and connectors (single-mode short reach [SR-1])</b> | <ul style="list-style-type: none"> <li>■ Up to one LC full duplex connector</li> <li>■ Transmit power: <ul style="list-style-type: none"> <li>■ min: -10 dBm</li> <li>■ max: -3 dBm</li> </ul> </li> <li>■ Center wavelength: 1310 nm</li> <li>■ Receive input power: <ul style="list-style-type: none"> <li>■ min: -18 dBm</li> <li>■ max: -3 dBm</li> </ul> </li> <li>■ Rated for 2 km (1.2 miles) of 9-micron core cable</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul> |

**Cables and connectors  
(single-mode intermediate [IR-1])**

- Up to one LC full duplex connector
- Transmit power:
  - min: -5 dBm
  - max: 0 dBm
- Center wavelength: 1266 through 1310 nm
- Receive input power:
  - min: -18 dBm
  - max: -0 dBm
- Rated for 15 km (9.3 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**Cables and connectors  
(single-mode long reach [LR-2])**

- Up to one LC full duplex connector
- Transmit power:
  - min: -2 dBm
  - max: 3 dBm
- Center wavelength: 1550 through 1580 nm
- Receive input power:
  - min: -28 dBm
  - max: -9 dBm
- Rated for 80 km (24.9 miles) of 9-micron core cable
- See *E120 and E320 Hardware Guide, Chapter 5, Cabling the Router* for more information.

**LEDs**

Board-level LEDs:

- OK (green)—Physical link is connected properly and is functioning properly
- FAIL (red)—Failure detected

Port LEDs:

- ALM—Bi-color LED:
  - Yellow: Local loss of signal exists
  - Red: Remote loss of signal exists
- OK (green)—SONET is up and port is functioning properly. If not lit, a problem exists.

**Alarms, errors, and events**

- See *Monitoring SONET/SDH Interfaces* in *JUNOS Physical Layer Configuration Guide, Chapter 3, Configuring Unchannelized OCx/STMx Interfaces*.

## Redundancy IOA

|   |  |
|---|--|
| <b>IOA label</b>                            | ES2-S1 REDUND IOA  |
| <b>Number of IOA ports</b>                  | ■ 0  |
| <b>Software release</b>                     | ■ First supported: 7.0.1   |
| <b>Description</b>                          | <ul style="list-style-type: none"> <li>■ 10 W maximum</li> <li>■ Full-height module</li> <li>■ Provides redundancy for line modules</li> <li>■ Inserted in slot 0 and 11 only</li> </ul>   |
| <b>Capability</b>                           | <ul style="list-style-type: none"> <li>■ Provides switchover when a line module fails</li> <li>■ Provides N + 1 redundancy for line modules</li> <li>■ When inserted in slot 0, provides redundancy for a failed line module in slots 1–5. When inserted in slot 11, provides redundancy for a failed line module in slots 12–16.</li> </ul> |
| <b>Software features</b>                    | ■ See <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> .  |
| <b>Model compatibility</b>                  | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>            | <ul style="list-style-type: none"> <li>■ ES2 4G LM</li> <li>■ ES2 10G UPLINK LM</li> <li>■ ES2 10G LM</li> <li>■ ES2 10G ADV LM</li> </ul>   |
| <b>SRP module compatibility</b>             | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Line module redundancy compatibility</b> | ■ Not applicable   |
| <b>Port redundancy support</b>              | ■ Not applicable   |
| <b>Cables and connectors</b>                | ■ Not applicable   |
| <b>LEDs</b>                                 | <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> </ul>   |
| <b>Alarms, errors, and events</b>           | ■ See <i>Monitoring Modules</i> in <i>JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules</i> .   |



## Service IOA

|                                   |  |
|-----------------------------------|--|
| <b>IOA label</b>                  | ES2-S1 SERVICE IOA   |
| <b>Number of IOA ports</b>        | ■ 0  |
| <b>Software release</b>           | ■ First supported: 7.0.1   |
| <b>Description</b>                | <ul style="list-style-type: none"> <li>■ 10 W maximum</li> <li>■ Full-height module</li> <li>■ Provides tunnel server functionality</li> <li>■ Pairs with associated line module to receive data from and transmit data to other line modules with ingress and egress ports</li> </ul>   |
| <b>Capability</b>                 | <ul style="list-style-type: none"> <li>■ Tunnelling</li> <li>■ Provides support for: <ul style="list-style-type: none"> <li>■ Distance Vector Multicast Routing Protocol (DVMRP) tunnels, also known as IP-in-IP tunnels</li> <li>■ Generic Routing Protocol (GRE) tunnels</li> <li>■ IP packet reassembly for tunnels</li> <li>■ MPLS over GRE</li> </ul> </li> </ul> |
| <b>Software features</b>          | ■ See “Service IOA” on page 71 for information about the layer 2 and layer 3 protocols and applications that this module combination supports.   |
| <b>Model compatibility</b>        | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>   |
| <b>Line module compatibility</b>  | ■ ES2 4G LM  |
| <b>SRP module compatibility</b>   | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>  |
| <b>Module redundancy support</b>  | ■ Not applicable   |
| <b>Port redundancy support</b>    | ■ Not applicable   |
| <b>Cables and connectors</b>      | ■ Not applicable   |
| <b>LEDs</b>                       | <ul style="list-style-type: none"> <li>■ OK (green)—Self-test passed</li> <li>■ FAIL (red)—Failure detected</li> <li>■ ONLINE (green)—Online with no alarms or errors</li> </ul>   |
| <b>Alarms, errors, and events</b> | ■ See <i>Monitoring Tunnel-Service Interfaces</i> in <i>JUNOS Physical Layer Configuration Guide, Chapter 6, Managing Tunnel-Service and IPSec-Service Interfaces</i> .  |

## SRP IOA

|                                  |   |
|----------------------------------|---|
| <b>Module label</b>              | SRP IOA   |
| <b>IOA label</b>                 | <ul style="list-style-type: none"> <li>■ Not applicable</li> </ul>  |
| <b>Number of IOA ports</b>       | <ul style="list-style-type: none"> <li>■ 3</li> </ul>   |
| <b>Software release</b>          | <ul style="list-style-type: none"> <li>■ First supported: 7.0.1</li> </ul>  |
| <b>Description</b>               | <ul style="list-style-type: none"> <li>■ 15 W maximum</li> <li>■ Pairs with SRP module</li> <li>■ Interfaces with the SRP modules through the system's midplane.</li> </ul>   |
| <b>Capability</b>                | <ul style="list-style-type: none"> <li>■ Ethernet (IEEE 802.3)</li> <li>■ 10/100Base-T</li> <li>■ RS-232</li> <li>■ Auxiliary port allows access to debug ports on a specific processor (SRP module, LM).</li> <li>■ External clock input accepts T1 or E1 signaling. You must configure the interface for T1 or E1. No additional configuration for a specific framing mode is required (for example, SF/ESF).</li> <li>■ The BNC connector has a 75-Ohm load impedance.</li> <li>■ T1 inputs must be converted from a balanced 100-Ohm signal to an unbalanced 75-Ohm signal by using a balun.</li> <li>■ The minimum signal amplitude at the BNC connector is 400mV peak.</li> </ul> |
| <b>Software features</b>         | <ul style="list-style-type: none"> <li>■ Not applicable</li> </ul>  |
| <b>Model compatibility</b>       | <ul style="list-style-type: none"> <li>■ E320 router</li> <li>■ E120 router</li> </ul>  |
| <b>Line module compatibility</b> | <ul style="list-style-type: none"> <li>■ Not applicable</li> </ul>  |
| <b>SRP module compatibility</b>  | <ul style="list-style-type: none"> <li>■ SRP-100</li> <li>■ SRP-120</li> <li>■ SRP-320</li> </ul>   |
| <b>Port redundancy support</b>   | <ul style="list-style-type: none"> <li>■ Not applicable</li> </ul>  |
| <b>Cables and connectors</b>     | <ul style="list-style-type: none"> <li>■ Terminal blocks</li> <li>■ Two dual-purpose BNC connectors (primary and secondary) for BITS timing clock sources (E1 or T1); 75-ohm E1 2.048-Mbps/T1 1.544-Mbps inputs terminating with a 120/75 ohm or 100/75 ohm balun</li> <li>■ One 10/100Base-T Ethernet management port with an RJ-45 connector</li> <li>■ Two RS-232 ports with DB-9 connectors for direct command line interface (CLI) and debug access</li> <li>■ See <i>E120 and E320 Hardware Guide, Chapter 5, Cabling the Router</i> for more information.</li> </ul>   |
| <b>LEDs</b>                      | <ul style="list-style-type: none"> <li>■ None</li> </ul>  |

**Alarms, errors, and events**

- See *Monitoring Modules* in *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*.
-



## Appendix A

# IOA Protocol Support

This appendix lists the layer 2 and layer 3 protocols and applications that IOAs support in combination with the listed LM. IOAs are identified by their physical labels. See Table 1 on page 3 for a list of IOAs and their identifying labels.

The designation “not yet fully qualified” that appears in some tables in this appendix indicates that support for the protocol or application on the specified IOA has not yet been fully qualified by Juniper Networks. If you use a feature before it has been fully qualified, it is your responsibility to ensure that it operates correctly in your targeted configuration.

This appendix contains the following sections:

- Ethernet IOAs on page 53
- OCx/STMx ATM IOAs on page 65
- OCx/STMx POS IOAs on page 68
- Service IOA on page 71

## Ethernet IOAs

**Table 25: Ethernet IOAs with ES2 4G LM**

| Protocol or Application  | ES2-S1 GE-4 IOA (with ES2 4G LM) | ES2-S1 GE-8 IOA (with ES2 4G LM) | ES2-S1 10GE IOA (with ES2 4G LM) |
|--|----------------------------------|----------------------------------|----------------------------------|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | Yes                              | Yes                              | Yes                              |
| APS/MSP  | No                               | No                               | No                               |
| ATM  | No                               | No                               | No                               |
| BERT   | No                               | No                               | No                               |
| BFD  | Yes                              | Yes                              | No                               |
| BGP  | Yes                              | Yes                              | Yes                              |
| BGP/MPLS VPNs  | Yes                              | Yes                              | Yes                              |
| Bridged Ethernet   | No                               | No                               | No                               |

**Table 25: Ethernet IOAs with ES2 4G LM** *(continued)*

| Protocol or Application                                     | ES2–S1 GE-4 IOA (with ES2 4G LM)      | ES2–S1 GE-8 IOA (with ES2 4G LM)      | ES2–S1 10GE IOA (with ES2 4G LM)      |
|---|---------------------------------------|---------------------------------------|---------------------------------------|
| Bridged IP  | No                                    | No                                    | No                                    |
| Cisco HDLC  | No                                    | No                                    | No                                    |
| DHCP external server  | Yes                                   | Yes                                   | Yes                                   |
| DHCP local server   | Yes                                   | Yes                                   | Yes                                   |
| DHCPv6 local server   | Yes                                   | Yes                                   | Yes                                   |
| DVMRP and GRE support—access side                           | Yes                                   | Yes                                   | Yes                                   |
| DVMRP and GRE support—server side                           | Yes (over shared tunnel server ports) | Yes (over shared tunnel server ports) | Yes (over shared tunnel server ports) |
| Dynamic interfaces  | Yes                                   | Yes                                   | Yes                                   |
| Ethernet raw mode encapsulation in Martini layer 2 circuits | Yes                                   | Yes                                   | Yes                                   |
| F4 OAM and F5 OAM (ATM administration)                      | No                                    | No                                    | No                                    |
| FDL (facilities data link)                                  | No                                    | No                                    | No                                    |
| Firewall  | No                                    | No                                    | No                                    |
| Frame Relay   | No                                    | No                                    | No                                    |
| ICR   | Yes                                   | Yes                                   | Yes                                   |
| IEEE 802.3ad link aggregation                               | Yes                                   | Yes                                   | No                                    |
| IP  | Yes                                   | Yes                                   | Yes                                   |
| IP multicast  | Yes                                   | Yes                                   | Yes                                   |
| IP reassembly for tunneled packets                          | Yes                                   | Yes                                   | Yes                                   |
| IPSec   | No                                    | No                                    | No                                    |
| IPv6  | Yes                                   | Yes                                   | Yes                                   |
| IPv6 multicast  | Yes                                   | Yes                                   | Yes                                   |
| IPv6 neighbor discovery                                     | Yes                                   | Yes                                   | Yes                                   |
| IS-IS   | Yes                                   | Yes                                   | Yes                                   |
| J-Flow Statistics   | Yes                                   | Yes                                   | Yes                                   |

**Table 25: Ethernet IOAs with ES2 4G LM** (continued)

| Protocol or Application  | ES2-S1 GE-4 IOA (with ES2 4G LM)  | ES2-S1 GE-8 IOA (with ES2 4G LM)  | ES2-S1 10GE IOA (with ES2 4G LM) |
|--|---|---|----------------------------------|
| L2TP/IPSec   | No  | No  | No                               |
| L2TP over MPLS   | Yes   | Yes   | Yes                              |
| LAC support—access side  | Yes   | Yes   | Yes                              |
| LAC support—peer side  | Yes   | Yes   | Yes                              |
| LNS support—peer side  | Yes   | Yes   | Yes                              |
| Local loopback   | No  | No  | No                               |
| MDL (maintenance data link)  | No  | No  | No                               |
| Mobile IP home agent   | Yes (not yet fully qualified)   | Yes   | Yes (not yet fully qualified)    |
| MPLS   | Yes   | Yes   | Yes                              |
| MPLS L2VPNs over the LAGs configured between customer edge (CE) and provider edge (PE) devices | Yes   | Yes   | Yes                              |
| Multilink Frame Relay  | No  | No  | No                               |
| Multilink PPP  | Yes (with fragmentation and reassembly; over MPL2TP on shared tunnel-server port; dynamic only) | Yes (with fragmentation and reassembly; over MPL2TP on shared tunnel-server port; dynamic only) | No                               |
| Network Address Translation (NAT)  | No  | No  | No                               |
| NBMA (multipoint ATM)  | No  | No  | No                               |
| OSPF   | Yes   | Yes   | Yes                              |
| Packet Mirroring   | Yes   | Yes   | Yes                              |
| Packet over SONET  | No  | No  | No                               |
| PPP  | Yes   | Yes   | Yes                              |
| PPPoE  | Yes   | Yes   | Yes                              |
| Remote loopback  | No  | No  | No                               |
| RIP  | Yes   | Yes   | Yes                              |
| Subscriber interfaces (static)   | Yes   | Yes   | Yes                              |
| Subscriber interfaces (dynamic)  | Yes   | Yes   | Yes                              |

**Table 25: Ethernet IOAs with ES2 4G LM** *(continued)*

| Protocol or Application  | ES2-S1 GE-4 IOA (with ES2 4G LM)        | ES2-S1 GE-8 IOA (with ES2 4G LM)        | ES2-S1 10GE IOA (with ES2 4G LM) |
|--|---|---|----------------------------------|
| S-VLAN subinterface with an untagged C-VLAN ID in Martini circuits | Yes                                     | Yes                                     | Yes                              |
| Transparent bridging   | Yes                                     | Yes                                     | Yes                              |
| Tunnel-server ports  | Yes (shared only)                       | Yes (shared only)                       | Yes (shared only)                |
| Unified ISSU   | Yes (IOA must be Revision 3 and higher) | Yes (IOA must be Revision 3 and higher) | No                               |
| VPLS (network interfaces)  | Yes                                     | Yes                                     | Yes                              |
| VPLS (virtual core interfaces)                                     | Yes                                     | Yes                                     | Yes                              |
| VRRP   | Yes                                     | Yes                                     | Yes                              |

**Table 26: Ethernet IOAs with ES2 10G Uplink LM**

| Protocol or Application  | ES2-S2 10GE PR IOA (with ES2 10G Uplink LM) |
|--|---|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | Yes   |
| APS/MSP  | No  |
| ATM  | No  |
| BERT   | No  |
| BFD  | Yes   |
| BGP  | Yes   |
| BGP/MPLS VPNs  | Yes   |
| Bridged Ethernet   | No  |
| Bridged IP   | No  |
| Cisco HDLC   | No  |
| DHCP external server   | Yes   |
| DHCP local server  | Yes   |
| DHCPv6 local server  | Yes   |
| DVMRP and GRE support—access side                                    | Yes   |
| DVMRP and GRE support—server side                                    | No  |



**Table 26: Ethernet IOAs with ES2 10G Uplink LM** *(continued)*

| Protocol or Application                                     | ES2-S2 10GE PR IOA (with ES2 10G Uplink LM) |
|---|---|
| Dynamic interfaces  | No  |
| Ethernet raw mode encapsulation in Martini layer 2 circuits | Yes   |
| F4 OAM and F5 OAM (ATM administration)                      | No  |
| FDL (facilities data link)                                  | No  |
| Firewall  | No  |
| Frame Relay   | No  |
| ICR   | No  |
| IEEE 802.3ad link aggregation                               | No  |
| IP  | Yes   |
| IP multicast  | Yes   |
| IP reassembly for tunneled packets                          | No  |
| IPSec   | No  |
| IPv6  | Yes   |
| IPv6 multicast  | Yes   |
| IPv6 neighbor discovery                                     | Yes   |
| IS-IS   | Yes   |
| J-Flow Statistics   | No  |
| L2TP/IPSec  | No  |
| L2TP over MPLS  | Yes   |
| LAC support—access side                                     | No  |
| LAC support—peer side                                       | Yes   |
| LNS support—peer side                                       | Yes   |
| Local loopback  | No  |
| MDL (maintenance data link)                                 | No  |
| Mobile IP home agent  | No  |
| MPLS  | Yes (LER only)                              |
| Multilink Frame Relay                                       | No  |

**Table 26: Ethernet IOAs with ES2 10G Uplink LM** *(continued)*

| Protocol or Application  | ES2-S2 10GE PR IOA (with ES2 10G Uplink LM) |
|--|---|
| Multilink PPP  | No  |
| Network Address Translation (NAT)                                  | No  |
| NBMA (multipoint ATM)  | No  |
| OSPF   | Yes   |
| Packet Mirroring   | No  |
| Packet over SONET  | No  |
| PPP  | No  |
| PPPoE  | No  |
| Remote loopback  | No  |
| RIP  | Yes   |
| Subscriber interfaces (static)                                     | No  |
| Subscriber interfaces (dynamic)                                    | No  |
| S-VLAN subinterface with an untagged C-VLAN ID in Martini circuits | Yes   |
| Transparent bridging   | No  |
| Tunnel-server ports  | No  |
| Unified ISSU   | Yes (IOA must be Revision 2 and higher)     |
| VPLS (network interfaces)  | No  |
| VPLS (virtual core interfaces)                                     | No  |
| VRRP   | No  |

**Table 27: Ethernet IOAs with ES2 10G LM**

| Protocol or Application  | ES2-S1 GE-8 IOA (with ES2 10G LM) | ES2-S3 GE-20 IOA (with ES2 10G LM) | ES2-S2 10GE PR IOA (with ES2 10G LM) |
|--|-----------------------------------|------------------------------------|--------------------------------------|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | Yes                               | Yes                                | Yes                                  |
| APS/MSP  | No                                | No                                 | No                                   |
| ATM  | No                                | No                                 | No                                   |

**Table 27: Ethernet IOAs with ES2 10G LM** (continued)

| Protocol or Application                                     | ES2-S1 GE-8 IOA (with ES2 10G LM)   | ES2-S3 GE-20 IOA (with ES2 10G LM)  | ES2-S2 10GE PR IOA (with ES2 10G LM)  |
|---|---|---|---|
| BERT  | No  | No  | No  |
| BFD   | Yes   | No  | No  |
| BGP   | Yes   | Yes   | Yes   |
| BGP/MPLS VPNs   | Yes   | Yes   | Yes   |
| Bridged Ethernet  | No  | No  | No  |
| Bridged IP  | No  | No  | No  |
| Cisco HDLC  | No  | No  | No  |
| DHCP external server  | Yes   | Yes   | Yes   |
| DHCP local server   | Yes   | Yes   | Yes   |
| DHCPv6 local server   | Yes   | Yes   | Yes   |
| DVMRP and GRE support—access side                           | Yes   | Yes   | Yes   |
| DVMRP and GRE support—server side                           | No  | No  | No  |
| Dynamic interfaces  | Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information) | Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information) | Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information) |
| Ethernet raw mode encapsulation in Martini layer 2 circuits | Yes   | Yes   | Yes   |
| F4 OAM and F5 OAM (ATM administration)                      | No  | No  | No  |
| FDL (facilities data link)                                  | No  | No  | No  |
| Firewall  | No  | No  | No  |
| Frame Relay   | No  | No  | No  |
| ICR   | No  | No  | No  |
| IEEE 802.3ad link aggregation                               | Yes   | Yes   | No  |
| IP  | Yes   | Yes   | Yes   |
| IP multicast  | Yes   | Yes   | Yes   |

**Table 27: Ethernet IOAs with ES2 10G LM** (continued)

| Protocol or Application  | ES2-S1 GE-8 IOA (with ES2 10G LM) | ES2-S3 GE-20 IOA (with ES2 10G LM) | ES2-S2 10GE PR IOA (with ES2 10G LM) |
|--|-----------------------------------|------------------------------------|--------------------------------------|
| IP reassembly for tunneled packets   | No                                | No                                 | No                                   |
| IPSec  | No                                | No                                 | No                                   |
| IPv6   | Yes                               | Yes                                | Yes                                  |
| IPv6 multicast   | Yes                               | Yes                                | Yes                                  |
| IPv6 neighbor discovery  | Yes                               | Yes                                | Yes                                  |
| IS-IS  | Yes                               | Yes                                | Yes                                  |
| J-Flow Statistics  | Yes                               | Yes                                | Yes                                  |
| L2TP/IPSec   | No                                | No                                 | No                                   |
| L2TP over MPLS   | Yes                               | Yes                                | Yes                                  |
| LAC support—access side  | Yes                               | Yes                                | Yes                                  |
| LAC support—peer side  | Yes                               | Yes                                | Yes                                  |
| LNS support—peer side  | Yes                               | Yes                                | Yes                                  |
| Local loopback   | No                                | No                                 | No                                   |
| MDL (maintenance data link)  | No                                | No                                 | No                                   |
| Mobile IP home agent   | No                                | No                                 | No                                   |
| MPLS   | Yes                               | Yes                                | Yes                                  |
| MPLS L2VPNs over the LAGs configured between customer edge (CE) and provider edge (PE) devices | Yes                               | Yes                                | Yes                                  |
| Multilink Frame Relay  | No                                | No                                 | No                                   |
| Multilink PPP  | No                                | No                                 | No                                   |
| Network Address Translation (NAT)  | No                                | No                                 | No                                   |
| NBMA (multipoint ATM)  | No                                | No                                 | No                                   |
| OSPF   | Yes                               | Yes                                | Yes                                  |
| Packet Mirroring   | Yes                               | Yes                                | Yes                                  |
| Packet over SONET  | No                                | No                                 | No                                   |

**Table 27: Ethernet IOAs with ES2 10G LM** (continued)

| Protocol or Application  | ES2-S1 GE-8 IOA (with ES2 10G LM)       | ES2-S3 GE-20 IOA (with ES2 10G LM) | ES2-S2 10GE PR IOA (with ES2 10G LM)    |
|--|---|------------------------------------|---|
| PPP  | Yes                                     | Yes                                | Yes                                     |
| PPPoE  | Yes                                     | Yes                                | Yes                                     |
| Remote loopback  | No                                      | No                                 | No                                      |
| RIP  | Yes                                     | Yes                                | Yes                                     |
| Subscriber interfaces (static)                                     | Yes                                     | Yes                                | Yes                                     |
| Subscriber interfaces (dynamic)                                    | Yes                                     | Yes                                | Yes                                     |
| S-VLAN subinterface with an untagged C-VLAN ID in Martini circuits | Yes                                     | Yes                                | Yes                                     |
| Transparent bridging   | No                                      | No                                 | No                                      |
| Tunnel-server ports  | No                                      | No                                 | No                                      |
| Unified ISSU   | Yes (IOA must be Revision 3 and higher) | Yes                                | Yes (IOA must be Revision 2 and higher) |
| VPLS (network interfaces)  | No                                      | No                                 | No                                      |
| VPLS (virtual core interfaces)                                     | No                                      | No                                 | No                                      |
| VRRP   | No                                      | No                                 | No                                      |

**Table 28: Ethernet IOAs with ES2 10G ADV LM**

| Protocol or Application  | ES2-S1 GE-8 IOA (with ES2 10G ADV LM) | ES2-S3 GE-20 IOA (with ES2 10G ADV LM) | ES2-S2 10GE PR IOA (with ES2 ADV 10G LM) |
|--|---------------------------------------|--|--|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | Yes                                   | Yes                                    | Yes                                      |
| APS/MSP  | No                                    | No                                     | No                                       |
| ATM  | No                                    | No                                     | No                                       |
| BERT   | No                                    | No                                     | No                                       |
| BFD  | Yes                                   | No                                     | No                                       |
| BGP  | Yes                                   | Yes                                    | Yes                                      |
| BGP/MPLS VPNs  | Yes                                   | Yes                                    | Yes                                      |

**Table 28: Ethernet IOAs with ES2 10G ADV LM** *(continued)*

| Protocol or Application                                     | ES2-S1 GE-8 IOA (with ES2 10G ADV LM)   | ES2-S3 GE-20 IOA (with ES2 10G ADV LM)  | ES2-S2 10GE PR IOA (with ES2 ADV 10G LM)  |
|---|---|---|---|
| Bridged Ethernet  | No  | No  | No  |
| Bridged IP  | No  | No  | No  |
| Cisco HDLC  | No  | No  | No  |
| DHCP external server  | Yes   | Yes   | Yes   |
| DHCP local server   | Yes   | Yes   | Yes   |
| DHCPv6 local server   | Yes   | Yes   | Yes   |
| DVMRP and GRE support—access side                           | Yes   | Yes   | Yes   |
| DVMRP and GRE support—server side                           | No  | No  | No  |
| Dynamic interfaces  | Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information) | Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information) | Yes (except dynamic VLAN subinterfaces based on agent-circuit-identifier information) |
| Ethernet raw mode encapsulation in Martini layer 2 circuits | Yes   | Yes   | Yes   |
| F4 OAM and F5 OAM (ATM administration)                      | No  | No  | No  |
| FDL (facilities data link)                                  | No  | No  | No  |
| Firewall  | No  | No  | No  |
| Frame Relay   | No  | No  | No  |
| ICR   | No  | No  | No  |
| IEEE 802.3ad link aggregation                               | Yes   | Yes   | No  |
| IP  | Yes   | Yes   | Yes   |
| IP multicast  | Yes   | Yes   | Yes   |
| IP reassembly for tunneled packets                          | No  | No  | No  |
| IPSec   | No  | No  | No  |
| IPv6  | Yes   | Yes   | Yes   |
| IPv6 multicast  | Yes   | Yes   | Yes   |

**Table 28: Ethernet IOAs with ES2 10G ADV LM** *(continued)*

| Protocol or Application  | ES2-S1 GE-8 IOA (with ES2 10G ADV LM) | ES2-S3 GE-20 IOA (with ES2 10G ADV LM) | ES2-S2 10GE PR IOA (with ES2 ADV 10G LM) |
|--|---------------------------------------|--|--|
| IPv6 neighbor discovery  | Yes                                   | Yes                                    | Yes                                      |
| IS-IS  | Yes                                   | Yes                                    | Yes                                      |
| J-Flow Statistics  | Yes                                   | Yes                                    | Yes                                      |
| L2TP/IPSec   | No                                    | No                                     | No                                       |
| L2TP over MPLS   | Yes                                   | Yes                                    | Yes                                      |
| LAC support—access side  | Yes                                   | Yes                                    | Yes                                      |
| LAC support—peer side  | Yes                                   | Yes                                    | Yes                                      |
| LNS support—peer side  | Yes                                   | Yes                                    | Yes                                      |
| Local loopback   | No                                    | No                                     | No                                       |
| MDL (maintenance data link)  | No                                    | No                                     | No                                       |
| Mobile IP home agent   | No                                    | No                                     | No                                       |
| MPLS   | Yes                                   | Yes                                    | Yes                                      |
| MPLS L2VPNs over the LAGs configured between customer edge (CE) and provider edge (PE) devices | Yes                                   | Yes                                    | Yes                                      |
| Multilink Frame Relay  | No                                    | No                                     | No                                       |
| Multilink PPP  | No                                    | No                                     | No                                       |
| Network Address Translation (NAT)  | No                                    | No                                     | No                                       |
| NBMA (multipoint ATM)  | No                                    | No                                     | No                                       |
| OSPF   | Yes                                   | Yes                                    | Yes                                      |
| Packet Mirroring   | Yes                                   | Yes                                    | Yes                                      |
| Packet over SONET  | No                                    | No                                     | No                                       |
| PPP  | Yes                                   | Yes                                    | Yes                                      |
| PPPoE  | Yes                                   | Yes                                    | Yes                                      |
| Remote loopback  | No                                    | No                                     | No                                       |
| RIP  | Yes                                   | Yes                                    | Yes                                      |
| Subscriber interfaces (static)   | Yes                                   | Yes                                    | Yes                                      |

**Table 28: Ethernet IOAs with ES2 10G ADV LM** *(continued)*

| Protocol or Application  | ES2-S1 GE-8 IOA (with ES2 10G ADV LM)   | ES2-S3 GE-20 IOA (with ES2 10G ADV LM) | ES2-S2 10GE PR IOA (with ES2 ADV 10G LM) |
|--|---|--|--|
| Subscriber interfaces (dynamic)                                    | Yes                                     | Yes                                    | Yes                                      |
| S-VLAN subinterface with an untagged C-VLAN ID in Martini circuits | Yes                                     | Yes                                    | Yes                                      |
| Transparent bridging   | No                                      | No                                     | No                                       |
| Tunnel-server ports  | No                                      | No                                     | No                                       |
| Unified ISSU   | Yes (IOA must be Revision 3 and higher) | Yes                                    | Yes (IOA must be Revision 2 and higher)  |
| VPLS (network interfaces)  | No                                      | No                                     | No                                       |
| VPLS (virtual core interfaces)                                     | No                                      | No                                     | No                                       |
| VRRP   | No                                      | No                                     | No                                       |



## OCx/STMx ATM IOAs

**Table 29: OCx/STMx ATM IOA**

| Protocol or Application  | ES2–S1 OC3–8 STM1 ATM IOA             | ES2–S1 OC12–2 STM4 ATM IOA            |
|--|---------------------------------------|---------------------------------------|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | Yes                                   | Yes                                   |
| APS/MSP  | No                                    | No                                    |
| ATM  | Yes                                   | Yes                                   |
| BERT   | No                                    | No                                    |
| BFD  | Yes                                   | No                                    |
| BGP  | Yes                                   | Yes                                   |
| BGP/MPLS VPNs  | Yes                                   | Yes                                   |
| Bridged Ethernet   | Yes                                   | Yes                                   |
| Bridged IP   | Yes                                   | Yes                                   |
| Cisco HDLC   | No                                    | No                                    |
| DHCP external server   | Yes                                   | Yes                                   |
| DHCP local server  | Yes                                   | Yes                                   |
| DVMRP and GRE support—access side                                    | Yes                                   | Yes                                   |
| DVMRP and GRE support—server side                                    | Yes (over shared tunnel server ports) | Yes (over shared tunnel server ports) |
| Dynamic interfaces   | Yes                                   | Yes                                   |
| F4 OAM and F5 OAM (ATM administration)                               | Yes                                   | Yes                                   |
| FDL (facilities data link)   | No                                    | No                                    |
| Firewall   | No                                    | No                                    |
| Frame Relay  | No                                    | No                                    |
| ICR  | No                                    | No                                    |
| IEEE 802.3ad link aggregation  | No                                    | No                                    |
| IP   | Yes                                   | Yes                                   |
| IP multicast   | Yes                                   | Yes                                   |
| IP reassembly for tunneled packets                                   | Yes                                   | Yes                                   |

**Table 29: OCx/STMx ATM IOA** *(continued)*

| Protocol or Application           | ES2–S1 OC3–8 STM1 ATM IOA | ES2–S1 OC12–2 STM4 ATM IOA |
|-----------------------------------|---------------------------|----------------------------|
| IPSec                             | No                        | No                         |
| IPv6                              | Yes                       | Yes                        |
| IPv6 multicast                    | Yes                       | Yes                        |
| IPv6 neighbor discovery           | Yes                       | Yes                        |
| IS-IS                             | Yes                       | Yes                        |
| J-Flow Statistics                 | Yes                       | Yes                        |
| L2TP/IPSec                        | No                        | No                         |
| L2TP over MPLS                    | Yes                       | Yes                        |
| LAC support—access side           | Yes                       | Yes                        |
| LAC support—peer side             | Yes                       | Yes                        |
| LNS support—peer side             | Yes                       | Yes                        |
| Local loopback                    | No                        | No                         |
| MDL (maintenance data link)       | No                        | No                         |
| Mobile IP home agent              | No                        | No                         |
| MPLS                              | Yes                       | Yes                        |
| Multilink Frame Relay             | No                        | No                         |
| Multilink PPP                     | No                        | No                         |
| Network Address Translation (NAT) | No                        | No                         |
| NBMA (multipoint ATM)             | No                        | No                         |
| OSPF                              | Yes                       | Yes                        |
| Packet Mirroring                  | Yes                       | Yes                        |
| Packet over SONET                 | No                        | No                         |
| PPP                               | Yes                       | Yes                        |
| PPPoE                             | Yes                       | Yes                        |
| Remote loopback                   | No                        | No                         |
| RIP                               | Yes                       | Yes                        |
| Subscriber interfaces (static)    | Yes                       | Yes                        |

**Table 29: OCx/STMx ATM IOA** *(continued)*

| Protocol or Application         | ES2–S1 OC3–8 STM1 ATM IOA | ES2–S1 OC12–2 STM4 ATM IOA |
|---------------------------------|---------------------------|----------------------------|
| Subscriber interfaces (dynamic) | Yes                       | Yes                        |
| Transparent bridging            | Yes                       | Yes                        |
| Tunnel-server ports             | Yes (shared only)         | Yes (shared only)          |
| Unified ISSU                    | Yes                       | Yes                        |
| VPLS (network interfaces)       | Yes                       | Yes                        |
| VPLS (virtual core interfaces)  | Yes                       | Yes                        |
| VRRP                            | No                        | No                         |

## OCx/STMx POS IOAs

**Table 30: OCx/STMx POS IOA**

| Protocol or Application  | ES2–S1 OC48 STM16 POS IOA  | ES2–S1 OC12–2 STM4 POS IOA   |
|--|--|--|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | Yes  | Yes  |
| APS/MSP  | No   | No   |
| ATM  | No   | No   |
| BERT   | No   | No   |
| BFD  | No   | No   |
| BGP  | Yes  | Yes  |
| BGP/MPLS VPNs  | Yes  | Yes  |
| Bridged Ethernet   | No   | No   |
| Bridged IP   | No   | No   |
| Cisco HDLC   | Yes  | Yes  |
| DHCP external server   | Yes (for POS uplink interfaces; POS access interfaces not yet fully qualified) | Yes (for POS uplink interfaces; POS access interfaces not yet fully qualified) |
| DHCP local server  | Yes (for POS access interfaces; not yet fully qualified)                       | Yes (for POS access interfaces; not yet fully qualified)                       |
| DVMRP and GRE support—access side                                    | Yes  | Yes  |
| DVMRP and GRE support—server side                                    | Yes  | Yes (over shared tunnel server ports)  |
| Dynamic interfaces   | No   | No   |
| F4 OAM and F5 OAM (ATM administration)                               | No   | No   |
| FDL (facilities data link)   | No   | No   |
| Firewall   | No   | No   |
| Frame Relay  | No   | No   |
| ICR  | No   | No   |
| IEEE 802.3ad link aggregation  | No   | No   |
| IP   | Yes  | Yes  |
| IP multicast   | Yes  | Yes  |

**Table 30: OCx/STMx POS IOA** *(continued)*

| Protocol or Application            | ES2–S1 OC48 STM16 POS IOA | ES2–S1 OC12–2 STM4 POS IOA |
|------------------------------------|---------------------------|----------------------------|
| IP reassembly for tunneled packets | Yes                       | Yes                        |
| IPSec                              | No                        | No                         |
| IPv6                               | Yes                       | Yes                        |
| IPv6 multicast                     | Yes                       | Yes                        |
| IPv6 neighbor discovery            | No                        | No                         |
| IS-IS                              | Yes                       | Yes                        |
| J-Flow Statistics                  | Yes                       | Yes                        |
| L2TP/IPSec                         | No                        | No                         |
| L2TP over MPLS                     | Yes                       | Yes                        |
| LAC support—access side            | No                        | No                         |
| LAC support—peer side              | Yes                       | Yes                        |
| LNS support—peer side              | Yes                       | Yes                        |
| Local loopback                     | No                        | No                         |
| MDL (maintenance data link)        | No                        | No                         |
| Mobile IP home agent               | No                        | No                         |
| MPLS                               | Yes                       | Yes                        |
| Multilink Frame Relay              | No                        | No                         |
| Multilink PPP                      | No                        | No                         |
| Network Address Translation (NAT)  | No                        | No                         |
| NBMA (multipoint ATM)              | No                        | No                         |
| OSPF                               | Yes                       | Yes                        |
| Packet Mirroring                   | No                        | No                         |
| Packet over SONET                  | Yes                       | Yes                        |
| PPP                                | Yes                       | Yes                        |
| PPPoE                              | No                        | No                         |
| Remote loopback                    | No                        | No                         |
| RIP                                | Yes                       | Yes                        |

**Table 30: OCx/STMx POS IOA** *(continued)*

| Protocol or Application         | ES2-S1 OC48 STM16 POS IOA | ES2-S1 OC12-2 STM4 POS IOA |
|---------------------------------|---------------------------|----------------------------|
| Subscriber interfaces (static)  | Yes                       | Yes                        |
| Subscriber interfaces (dynamic) | No                        | No                         |
| Transparent bridging            | No                        | No                         |
| Tunnel-server ports             | Yes (shared only)         | Yes (shared only)          |
| Unified ISSU                    | Yes                       | Yes                        |
| VPLS (network interfaces)       | No                        | No                         |
| VPLS (virtual core interfaces)  | Yes                       | Yes                        |
| VRRP                            | No                        | No                         |

## Service IOA

**Table 31: Service IOA**

| Protocol or Application  | ES2-S1 SERVICE IOA                       |
|--|--|
| Accepts traffic destined for GRE tunnels or DVMRP (IP-in-IP) tunnels | No                                       |
| APS/MSP  | No                                       |
| ATM  | No                                       |
| BERT   | No                                       |
| BFD  | No                                       |
| BGP  | Yes                                      |
| BGP/MPLS VPNs  | Yes                                      |
| Bridged Ethernet   | No                                       |
| Bridged IP   | No                                       |
| Cisco HDLC   | No                                       |
| DHCP external server   | No                                       |
| DHCP local server  | No                                       |
| DVMRP and GRE support—access side                                    | No                                       |
| DVMRP and GRE support—server side                                    | Yes (over dedicated tunnel server ports) |
| Dynamic interfaces   | No                                       |
| F4 OAM and F5 OAM (ATM administration)                               | No                                       |
| FDL (facilities data link)   | No                                       |
| Firewall   | No                                       |
| Frame Relay  | No                                       |
| ICR  | No                                       |
| IEEE 802.3ad link aggregation  | No                                       |
| IP   | Yes                                      |
| IP multicast   | No                                       |
| IP reassembly for tunneled packets                                   | Yes                                      |
| IPSec  | No                                       |

**Table 31: Service IOA** *(continued)*

| Protocol or Application           | ES2-S1 SERVICE IOA                                    |
|-----------------------------------|---|
| IPv6                              | No  |
| IPv6 multicast                    | Yes   |
| IPv6 neighbor discovery           | No  |
| IS-IS                             | Yes   |
| J-Flow Statistics                 | Yes   |
| L2TP/IPSec                        | No  |
| LAC support—access side           | No  |
| LAC support—peer side             | No  |
| LNS support—peer side             | Yes   |
| Local loopback                    | No  |
| MDL (maintenance data link)       | No  |
| Mobile IP home agent              | Yes   |
| MPLS                              | Yes   |
| Multilink Frame Relay             | No  |
| Multilink PPP                     | Yes (with fragmentation and reassembly; dynamic only) |
| Network Address Translation (NAT) | No  |
| NBMA (multipoint ATM)             | No  |
| OSPF                              | Yes   |
| Packet Mirroring                  | No  |
| Packet over SONET                 | No  |
| PPP                               | No  |
| PPPoE                             | No  |
| Remote loopback                   | No  |
| RIP                               | Yes   |
| Subscriber interfaces (static)    | Yes (over GRE tunnels only)                           |
| Subscriber interfaces (dynamic)   | Yes (over GRE tunnels only)                           |
| Transparent bridging              | No  |



**Table 31: Service IOA** *(continued)*

| Protocol or Application        | ES2-S1 SERVICE IOA   |
|--------------------------------|----------------------|
| Tunnel-server ports            | Yes (dedicated only) |
| Unified ISSU                   | Yes                  |
| VPLS (network interfaces)      | No                   |
| VPLS (virtual core interfaces) | Yes                  |
| VRRP                           | No                   |



## Appendix B

# Module and Slot Combinations

This appendix lists module and IOA slot combinations and contains the following sections:

- Module Combinations on page 75
- IOA Slot Combinations on page 76

### Module Combinations

Line modules can only be paired with specific IOA, SFM, and SRP modules. See Table 32 on page 75 for valid combinations.

**Table 32: Module Combinations**

| Modules   | ES2 4G LM | ES2 10G UPLINK LM | ES2 10G LM | ES2 10G ADV LM |
|---|-----------|-------------------|------------|----------------|
| <b>SRP Modules</b>                                |           |                   |            |                |
| SRP-100   | √         | √                 | √          | –              |
| This module is only supported in the E320 router. |           |                   |            |                |
| SRP-120   | √         | √                 | √          | √              |
| This module is only supported in the E120 router. |           |                   |            |                |
| SRP-320   | √         | √                 | √          | √              |
| <b>SFM Modules</b>                                |           |                   |            |                |
| SFM-100   | √         | √                 | √          | √              |
| This module is only supported in the E320 router. |           |                   |            |                |
| SFM-120   | √         | √                 | √          | –              |
| This module is only supported in the E120 router. |           |                   |            |                |

**Table 32: Module Combinations** (continued)

| Modules                | ES2 4G LM | ES2 10G UPLINK LM | ES2 10G LM | ES2 10G ADV LM |
|------------------------|-----------|-------------------|------------|----------------|
| SFM-320                | √         | √                 | √          | –              |
| <b>IOA Modules</b>     |           |                   |            |                |
| ES2-S1 GE-4            | √         | –                 | –          | –              |
| ES2-S1 GE-8            | √         | –                 | √          | √              |
| ES2-S3 GE-20           | –         | –                 | √          | √              |
| ES2-S1 10GE            | √         | –                 | –          | –              |
| ES2-S2 10GE PR         | –         | √                 | √          | √              |
| ES2-S1 OC3-8 STM1 ATM  | √         | –                 | –          | –              |
| ES2-S1 OC12-2 STM4 ATM | √         | –                 | –          | –              |
| ES2-S1 OC12-2 STM4 POS | √         | –                 | –          | –              |
| ES2-S1 OC48 STM16 POS  | √         | –                 | –          | –              |
| ES2-S1 REDUND          | √         | √                 | √          | √              |
| ES2-S1 SERVICE         | √         | –                 | –          | –              |

## IOA Slot Combinations

Depending on the software release and IOA type, you must install IOAs in certain slots and bays combined with other IOAs in the same slot:

- You must insert some IOAs only in the upper bay or right bay (Adapter 0) of each IOA module slot. If you insert one of these IOAs into a lower bay or left bay (Adapter 1) slot, the line module diagnostics fail, an error message states that the bottom slot is not supported for the currently installed software release, and the slot is disabled.
- If you insert an unrecognized IOA, such as an IOA that is not supported by a particular software release, the line module diagnostics fail, an error is generated, and the slot is disabled.
- If you remove an IOA and replace it with a different IOA in the same slot, an error message states the mismatch and the slot is disabled.
- Full-height IOAs take up the entire slot (both Adapter 0 and Adapter 1).

For information about working with modules and IOAs, see *JUNOS System Basics Configuration Guide, Chapter 6, Managing Modules*. See Table 33 on page 77 for currently available IOAs and the bays in which you may insert them.

**Table 33: IOA Locations and Combinations**

| IOA                                 | Upper/Right Bay<br>(Adapter 0)                          | Lower/Left Bay<br>(Adapter 1) | Both Bays<br>Concurrently | Combined with<br>Other IOAs in<br>Same Slot  | Hot-Swapping<br>Support |
|-------------------------------------|---|-------------------------------|---------------------------|--|-------------------------|
| ES2-S1 GE-4                         | Yes   | Yes                           | No                        | No   | Yes                     |
| ES2-S1 GE-8                         | Yes   | Yes                           | Yes                       | Yes (GE-8 when paired with ES2 4G LM or ES2 10G LM; GE-8, OC3/STM1, and OC12/STM4 IOAs when paired with ES2 4G LM) | Yes                     |
| ES2-S3 GE-20<br>(Full-height IOA)   | Yes   | Not applicable                | Not applicable            | Not applicable   | No                      |
| ES2-S1 10GE<br>(Full-height IOA)    | Yes   | Not applicable                | Not applicable            | Not applicable   | No                      |
| ES2-S2 10GE PR<br>(Full-height IOA) | Yes   | Not applicable                | Not applicable            | Not applicable   | No                      |
| ES2-S1 OC3-8 STM1<br>ATM            | Yes   | Yes                           | Yes                       | Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)  | Yes                     |
| ES2-S1 OC12-2 STM4<br>ATM           | Yes   | Yes                           | Yes                       | Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)  | Yes                     |
| ES2-S1 OC12-2 STM4<br>POS           | Yes   | Yes                           | Yes                       | Yes (GE-8, OC3/STM1, and OC12/STM4 IOAs only)  | Yes                     |
| ES2-S1 OC48 STM16<br>POS            | Yes   | Yes                           | No                        | No   | Yes                     |
| ES2-S1 SERVICE<br>(Full-height IOA) | Yes   | Not applicable                | Not applicable            | Not applicable   | No                      |
| ES2-S1 REDUND                       | Yes<br><br>(Full-height IOA;<br>slots 0 and 11<br>only) | Not applicable                | Not applicable            | Not applicable   | No                      |



## Appendix C

# Module Name Cross-Reference Information

- Module Name Cross-Reference Information on page 79

## Module Name Cross-Reference Information

Use Table 34 on page 79 to find the label name, software display name, and model number of a module.

**Table 34: Module Naming Reference**

| Label Name          | Software Display Name | Model Number    |
|---------------------|-----------------------|-----------------|
| <b>SRP Modules</b>  |                       |                 |
| SRP IOA             | SRP-IOA               | ES2-SRP-IOA     |
| SRP-100             | SRP-100               | ES2-100G-SRP    |
| SRP-120             | SRP-120               | ES2-120G-SRP    |
| SRP-320             | SRP-320               | ES2-320G-SRP    |
| <b>SFM Modules</b>  |                       |                 |
| SFM-100             | SFM-100               | ES2-100G-SFM    |
| SFM-120             | SFM-120               | ES2-120G-SFM    |
| SFM-320             | SFM-320               | ES2-320G-SFM    |
| <b>Line Modules</b> |                       |                 |
| ES2 4G LM           | LM-4                  | ES2-4GS1-MOD    |
| ES2 10G UPLINK LM   | LM-10 Uplink          | ES2-10GUPS2-MOD |
| ES2 10G LM          | LM-10                 | ES2-10GACS3-MOD |
| ES2 10G ADV LM      | LM-10 S               | ES2-10GACS4-MOD |
| <b>IOAs</b>         |                       |                 |
| ES2-S1 GE-4 IOA     | GE-4 IOA              | ES2-GE4S1-IOA   |

**Table 34: Module Naming Reference** *(continued)*

| Label Name                 | Software Display Name | Model Number     |
|----------------------------|-----------------------|------------------|
| ES2-S1 GE-8 IOA            | GE-8 IOA              | ES2-GE8S1-IOA    |
| ES2-S3 GE-20 IOA           | GE-20 IOA             | ES2-GE20S3-IOA   |
| ES2-S1 10GE IOA            | 10GE IOA              | ES2-10GES1-IOA   |
| ES2-S2 10GE PR IOA         | 10GE PR IOA           | ES2-10GES2-IOA   |
| ES2-S1 OC3-8 STM1 ATM IOA  | OC3/STM1-8 ATM IOA    | ES2-8OC3AS1-IOA  |
| ES2-S1 OC12-2 STM4 ATM IOA | OC12/STM4-2 ATM IOA   | ES2-2OC12AS1-IOA |
| ES2-S1 OC12-2 STM4 POS IOA | OC12/STM4-2 POS IOA   | ES2-2OC12PS1-IOA |
| ES2-S1 OC48 STM16 POS IOA  | OC48/STM16 POS IOA    | ES2-OC48PS1-IOA  |
| ES2-S1 REDUND IOA          | REDUNDANCY IOA        | ES2-REDUNDS1-IOA |
| ES2-S1 SERVICE IOA         | SERVICE IOA           | ES2-SERVS1-IOA   |



## Appendix D

# Product Reclamation and Recycling Program

- Product Reclamation and Recycling Program on page 81

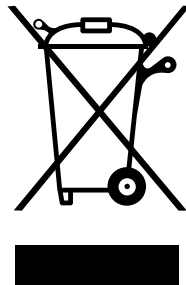
## Product Reclamation and Recycling Program

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Juniper Networks is committed to environmentally responsible behavior. As part of this commitment, we continually work to comply with environmental standards such as the European Union's *Waste Electrical and Electronic Equipment* (WEEE) Directive and *Restriction of Hazardous Substances* (RoHS) Directive.

These directives and other similar regulations from countries outside the European Union regulate electronic waste management and the reduction or elimination of specific hazardous materials in electronic products. The WEEE Directive requires electrical and electronics manufacturers to provide mechanisms for the recycling and reuse of their products. The RoHS Directive restricts the use of certain substances that are commonly found in electronic products today. Restricted substances include heavy metals, including lead, and polybrominated materials. The RoHS Directive, with some exemptions, applies to all electrical and electronic equipment.

In accordance with Article 11(2) of Directive 2002/96/EC (WEEE), products put on the market after 13 August 2005 are marked with the following symbol or include it in their documentation: a crossed-out wheeled waste bin with a bar beneath.



Juniper Networks provides recycling support for our equipment worldwide to comply with the WEEE Directive. For recycling information, go to <http://www.juniper.net/environmental>, and indicate the type of Juniper Networks equipment that you wish to dispose of and the country where it is currently located, or contact your Juniper Networks account representative.

Products returned through our reclamation process are recycled, recovered, or disposed of in a responsible manner. Our packaging is designed to be recycled and should be handled in accordance with your local recycling policies.



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