



Cisco ACI Auto-Negotiation and Forwarding Error Correction

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New and Changed Information

The following table provides an overview of the significant changes up to the current release. The table does not provide an exhaustive list of all changes or of the new features up to this release.

Table 1: New Features and Changed Behavior in Cisco APIC

Cisco APIC Release	Feature	Description
5.1(3)	Additional auto-negotiation support	All of the switches that support auto-negotiation support additional speeds in the on-enforce mode. The Cisco N9K-C93180YC-EX and N9K-C9364C-GX switches now support the on-enforce mode. Auto-negotiation and forwarding error correction is now supported on 4x10G and 4x25G breakout ports.
5.0(1)	Auto-negotiation	Auto-negotiation enables devices to automatically exchange link information about speed and duplex abilities.
	AUTO-FEC	AUTO-FEC is supported for 10 to 100 Gbps ports.
	KP-FEC	KP-FEC is supported for 4x100 and 400 Gbps ports.
	Additional switches	Additional switches support FEC.
2.2(2e)	RS-FEC	RS-FEC is supported for 25 Gbps ports.
1.3(1g)	Forwarding Error Correction (FEC) was introduced.	--

Auto-Negotiation

About Auto-Negotiation

Auto-negotiation is an optional function of the IEEE 802.3u Fast Ethernet standard that enables devices to automatically exchange information over a link about speed and duplex abilities. Cisco ACI-mode switches support auto-negotiation on these port types:

- 10/25/40/100Gbps on copper passive cables
- 10Gbps native copper ports

You can select from the following auto-negotiation modes:

- **off**: Auto-negotiation is disabled.
- **on**: Auto-negotiation is enabled on RJ45 ports. This is the default.
- **on-enforce**: Auto-negotiation is enabled on copper passive cables. This mode is available beginning with Cisco ACI release 5.0(1).

Auto-negotiation includes the auto-negotiation protocol exchange and link training. 10/40/100Gbps ports support fixed speed auto-negotiation. Ports with 25Gbps direct-attach-cable (DAC) copper cables support speed auto-negotiation, in which the switch advertises both 10Gbps and 25Gbps speeds. In this case, the negotiated speed is the fastest common speed advertised from both peers.

Ports with 25Gbps DAC copper cables support negotiation of forwarding error correction (FEC) as part of the auto-negotiation protocol exchange. Switches advertise their supported FEC modes, and both peers agree upon the best available mode.

Guidelines and Restrictions for Auto-Negotiation

- When auto-negotiation is enabled, it should be enabled on both peers: the Cisco ACI-mode switch and the link partner.
- Auto-negotiation is supported on 4x10Gbps and 4x25Gbps passive (but not active) breakout cables, such as QSFP100G-4SFP25G-CU3M or QSFP40G-4SFP10G-CU3M.
- Auto-negotiation is not supported with any of the QSFP-4x10G-AC transceivers on active copper cables.
- Auto-negotiation on-enforce mode is not supported on the 25G/50G ports on Cisco Nexus 93400LD-H1.
- Auto-negotiation on-enforce mode is not supported on 10G-QSA and 25G-QSA transceivers (applicable for all Cisco Nexus platforms) .
- Auto-negotiation is not supported on 200G and 400G optics.
- Auto-negotiation is not supported on 10G ports unless the port is native 10G copper port. For example, auto-negotiation is not supported on SFP+ ports and QSFP ports with QSAs.

Switch Support for Auto-Negotiation

Table 2: Support in release 5.1(2) and earlier

Switch	AN mode OFF	AN mode ON	AN On-Enforce mode	AN On-Enforce supported speed
N9K-C93180YC-EX	Off	Off	Not supported	N/A
N9K-C93180LC-EX	Off	On	Same as AN ON	100G and 40G passive copper cables
N9K-C93108TC-EX	Off	On	Same as AN ON	1G, 10G, and 100M
N9K-C9348GC-FXP	Off	Off	On	10G and 25G copper cables
N9K-C93108TC-FX	Off	On	Same as AN ON	1G, 10G, and 100M
N9K-C93180YC-FX	Off	Off	On	10G and 25G copper cables
N9K-C9336C-FX2	Off	Off	On	100G and 40G passive copper cables
N9K-C93240YC-FX2	Off	Off	On	10G and 25G copper cables
N9K-C93600CD-GX	Off	Off	Not supported on ports 1-24, supported on ports 25-34	100G, 40G, 4x10G, and 4x25G passive copper cables
N9K-C93360YC-FX2	Off	Off	On	10G, 25G, and 100G copper cables
N9K-C93216TC-FX2	Off	On	Same as AN ON	1G, 10G, 100G, and 100M

Switch	AN mode OFF	AN mode ON	AN On-Enforce mode	AN On-Enforce supported speed
N9K-C9364C-GX	Off	Off	Not supported	N/A

Table 3: Support in release 5.1(3) and later

Switch	AN mode OFF	AN mode ON	AN On-Enforce mode	AN On-Enforce supported speed
N9K-C93180YC-EX	Off	Off	On	10G and 25G
N9K-C93180LC-EX	Off	On	Same as AN ON	40G, 100G, 4x10G, and 4x25G passive copper cables
N9K-C93108TC-EX	Off	On	Same as AN ON	100M, 1G, 10G, 4x10G, and 4x25G
N9K-C9348GC-FXP	Off	On	Same as AN ON	10G, 25G, 4x10G, and 4x25G copper cables
N9K-C9348GC-FX3	Off	On	Same as AN ON	10G, 25G, 4x10G, and 4x25G copper cables
N9K-C93108TC-FX	Off	On	Same as AN ON	100M, 1G, 10G, 4x10G, and 4x25G
N9K-C93180YC-FX	Off	Off	On	10G, 25G, 4x10G, and 4x25G copper cables
N9K-C9336C-FX2	Off	Off	On	10G, 40G, 100G, 4x10G, and 4x25G passive copper cables
N9K-C93240YC-FX2	Off	Off	On	10G, 25G, 100G, 4x10G, and 4x25G copper cables
N9K-C93360YC-FX2	Off	Off	On	10G, 25G, 100G, 4x10G, and 4x25G copper cables
N9K-C93216TC-FX2	Off	On	Same as AN ON	100M, 1G, 10G, 100G, 4x10G, and 4x25G
N9K-C93180YC-FX3	Off	Off	On	10G, 40G, 100G, 4x10G, and 4x25G passive copper cables
N9K-C93108TC-FX3P	Off	On	Supported on ports 1/49 to 52	10G, 40G, 100G, 4x10G, and 4x25G
N9K-C9364C-GX	Off	Off	On	10G, 40G, 100G, 4x10G, and 4x25G passive copper cables
N9K-C93600CD-GX	Off	Off	On	10G, 40G, 100G, 4x10G, and 4x25G passive copper cables



Note In the 3.2 and later releases, auto-negotiation is always turned on for the GLC-TE optic on Cisco Application Centric Infrastructure (ACI), irrespective of the user configuration in the link level policy.

Forwarding Error Correction

About Forwarding Error Correction

Forwarding Error Correction (FEC) is a method of obtaining error control in data transmission over an unreliable or noisy channel in which the source (transmitter) encodes the data in a redundant way using Error Correcting Code, and the destination (receiver) recognizes it and corrects the errors without requiring a retransmission. The supported FEC modes are as follows:

- AUTO-FEC: The switch uses the best FEC mode.
- CL74-FC-FEC: Supports 25 Gbps speed.
- CL91-RS-FEC: Supports 25 and 100 Gbps speeds.
- CONS16-RS-FEC: Supports 25 Gbps speed.
- IEEE-RS-FEC: Supports 25 Gbps speed.
- KP-FEC: Supports 4x100 Gbps (KP1) or 400 Gbps (KP4).
- Disable-FEC: Disables FEC.
- Inherit: The switch uses FEC based on the port transceiver type. This is the default port configuration. See the *Default FEC Support for Switches* section for the inherited FEC mode optic.

The default is "Inherit."

Forwarding Error Correction limitations

These limitations apply to Forwarding Error Correction:

- If you use the IEEE-RS-FEC mode with a Cisco N9K-C93180YC-EX switch and you upgrade from a release earlier than the 15.2(1) release to the 15.2(1) release or later, the Cisco Application Policy Infrastructure Controller (APIC) generates the "unsupported FEC type" fault. This occurs because you could use IEEE-RS-FEC with a Cisco N9K-C93180YC-EX switch in releases earlier than 15.2(1), but you cannot use this combination in the 15.2(1) release or later.
- In AUTO-FEC mode, the retimer ports of specific switches will be in the FC-FEC mode, as IEEE-RS-FEC is not supported in FEC advertising on these ports of those switches. As a result, you can use a cable of only up to 3 meters. A cable that is longer than 3 meters carries the risk of introducing CRC errors with FC-FEC. See the *Ports of switches that do not support AUTO-FEC and IEEE-RS-FEC* table for the affected switches and ports.
- This mode is not supported on the retimer ports of specific switches when used with cables that are greater than 3 meters in length. See the *Ports of switches that do not support AUTO-FEC and IEEE-RS-FEC* table for the affected switches and ports.
- FEC is configurable only on the front port and not on fabric ports.
- SFP-10/25G-CSR does not support the Base-R FEC configuration mode in ACI/NXOS. The default FEC mode for SFP-10/25G-CSR is FC-FEC.

This table lists the ports of switches that do not support AUTO-FEC and IEEE-RS-FEC.

Table 4: Ports of switches that do not support AUTO-FEC and IEEE-RS-FEC

Switch	Ports
N9K-C9336C-FX2	1-6, 33-36
N9K-C93360YC-FX2	97-108
N9K-C93216TC-FX2	97-108
N9K-C93240YC-FX2	49-60
N9K-C93180YC-FX3S	1-54
N9K-C9364C-GX	1-64
N9K-C93600CD-GX	1-24

Switch Support for FC-FEC

Switch	Details
N9K-93180YC-FX	Supported for 25Gbps ports
N9K-93180YC-EX	Supported for 25Gbps ports
N9K-C9348GC-FXP	Supported for 25Gbps ports
N9K-C93240YC-FX2	Supported for 25Gbps ports
N9K-C93360YC-FX2	Supported for 25Gbps ports
N9K-C93600CD-GX	Supported for 25Gbps ports
N9K-C9364C-GX	Supported for 25Gbps ports

Switch Support for CL91-RS-FEC

Switch	Details
	1
N9K-C93180YC-FX	Supported for 100G speed
N9K-C93180YC-EX	Supported for 100G speed
N9K-C93108TC-FX	Supported for 100G speed
N9K-C93108TC-EX	Supported for 100G speed
N9K-C93180LC-EX	Supported for 100G speed
N9K-C9364C	Supported for 100G speed
N9K-C9348GC-FXP	Supported for 100G speed

Switch	Details
	1
N9K-C9336C-FX2	Supported for 100G speed
N9K-C93240YC-FX2	Supported for 100G speed
N9K-C9332C	Supported for 100G speed
N9K-C93360YC-FX2	Supported for 100G speed
N9K-C93216TC-FX2	Supported for 100G speed
N9K-C9316D-GX	Supported for 100G speed
N9K-C93600CD-GX	Supported for 100G speed
N9K-C9364C-GX	Supported for 100G speed
N9K-X9732C-EX (LC)	Supported for 100G speed
N9K-X9736C-FX (LC)	Supported for 100G speed

¹ For QSFP-100G-LR4-S / QSFP-100G-LR4 transceivers, FEC is disabled by default.

Switch Support for CONS16-RS-FEC and IEEE-RS-FEC

Switch	Details
N9K-C93180YC-FX	Supported for 25G speed
N9K-C9348GC-FXP	Supported for 25G speed
N9K-C93240YC-FX2	Supported for 25G speed
N9K-C93360YC-FX2	Supported for 25G speed
N9K-C93180YC-FX3	Supported for 25G speed
N9K-C93600CD-GX	Supported for 25G speed, but only for IEEE-RS-FEC and only on ports 25 to 34

Default FEC Support for Switches

Table 5: EX Switches

Transceiver	Auto-FEC	Inherit
10G	Disable FEC	Disable FEC
25G-CU1,2,3M	FC-FEC (CL74)	FC-FEC (CL74)
25G-CU5M	IEEE-RS-FEC ¹	FC-FEC (CL74)

Transceiver	Auto-FEC	Inherit
25G-optical	FC-FEC (CL74) ²	FC-FEC (CL74)
40G	Disable FEC	Disable FEC
100G	RS-FEC (CL91) ³	RS-FEC (CL91) ³
400G	KP-FEC ⁴	KP-FEC ⁴

¹ On the Cisco N9K-C93180YC-EX switch and platforms with a retimer port, the FEC type is FC-FEC (CL74).

² With the SFP-25G-SR and SFP-25-10G-LR transceivers on switches other than the N9K-C93180YC-EX switch, the FEC type is IEEE-RS-FEC.

³ With the QSFP-100G-LR, QSFP-100G-FR, QSFP-100G-DR, and QSFP-40/100G-SRBD transceivers, FEC is disabled.

⁴ With the 400G optics, KP-FEC is the default FEC and Disable FEC is not supported.

Table 6: FX Switches and Later

Transceiver	Auto-FEC	Inherit
10G	Disable FEC	Disable FEC
25G-CU1,2,3M	FC-FEC (CL74)	FC-FEC (CL74)
25G-CU4M	IEEE-RS-FEC	FC-FEC (CL74)
25G-CU5M	IEEE-RS-FEC	FC-FEC (CL74)
25G-optical	FC-FEC (CL74)	FC-FEC (CL74)
40G	Disable FEC	Disable FEC
100G	RS-FEC (CL91) ¹	RS-FEC (CL91) ¹
400G	KP-FEC	KP-FEC

¹ With the QSFP-100G-LR, QSFP-100G-FR, QSFP-100G-DR, and QSFP-40/100G-SRBD transceivers, FEC is disabled.

Configuration

Configuring Auto-Negotiation Using the GUI

Procedure

-
- Step 1** On the menu bar, click **Fabric > Access Policies**.
 - Step 2** In the **Navigation** pane, expand **Policies > Interface**
 - Step 3** Right click **Link Level** and click **Create Link Level Policy**.
 - Step 4** In the **Create Link Level Policy** dialog box, perform the following actions:

- a) In the **Name** field, enter a name for the policy.
- b) In the **Auto Negotiation** control, choose the desired auto-negotiation mode.

The following modes are available:

- **off**: Auto-negotiation is disabled.
 - **on**: (Default) Auto-negotiation is enabled on RJ45 ports.
 - **on-enforce**: Auto-negotiation is enabled on copper passive cables.
- c) Enter or choose the desired options for the remaining fields in the dialog box.
 - d) Click **Submit**.

Configuring Auto-Negotiation Using the NX-OS Style CLI

This example shows how to configure auto-negotiation on a leaf interface.

Procedure

Step 1 Enter the configure mode.

Example:

```
apicl# configure
```

Step 2 Enter the switch mode.

Example:

```
apicl(config)# leaf 104
```

Step 3 Specify the interface and port.

Example:

```
apicl(config-leaf)# int eth 1/4
```

Step 4 Configure auto-negotiation on the interface.

The options are:

- `no negotiate auto` to disable auto-negotiation
- `negotiate auto` to enable auto-negotiation
- `negotiate on-enforce` to enable auto-negotiation on copper passive cables

Note

The default auto-negotiation mode is `negotiate auto`.

Example:

```
apicl(config-leaf-if)# negotiate on-enforce
```

Step 5 Exit the interface mode.

Example:

```
apic1(config-leaf-if)# exit
```

Configuring FEC Using the GUI

Procedure

- Step 1** On the menu bar, click **Fabric > Access Policies**.
- Step 2** In the **Navigation** pane, expand **Policies > Interface**
- Step 3** Right click **Link Level** and click **Create Link Level Policy**.
- Step 4** In the **Create Link Level Policy** dialog box, perform the following actions:
- In the **Name** field, enter a name for the policy.
 - In the **Forwarding Error Correction** field, choose the desired FEC value.
The default is **Inherit**.
 - Enter or choose the desired options for the remaining fields in the dialog box.
 - Click **Submit**.
- The Link Level Policy is created, and the desired FEC is configured with it.
- Step 5** To verify the configuration, in the **Navigation** pane, click **Policies > Link Level** . The **Work** pane, lists all the policies.
- Step 6** In the **Work** pane, choose the appropriate Link Level Policy, and verify in the **Forwarding Error Correction** column that the desired FEC is displayed.
-

Configuring FEC Using the NX-OS Style CLI

This example shows how to configure forward error correction (FEC) on a leaf switch interface.

Procedure

- Step 1** Enter the configure mode.
- Example:**
- ```
apic1# configure
```
- Step 2** Enter the switch mode.
- Example:**
- ```
apic1(config)# leaf 104
```
- Step 3** Specify the interface and port.
- Example:**
- ```
apic1(config-leaf)# int eth 1/4
```
- Step 4** Configure FEC.
- The options are:

- auto-fec
- cl74-fc-fec
- cl91-rs-fec
- cons16-rs-fec
- disable-fec
- ieee-rs-fec
- inherit
- kp-fec

**Note**

The default forward-error-correction value is `inherit`.

**Example:**

```
apicl(config-leaf-if)# forward-error-correction cl91-rs-fec
```

**Step 5** Exit the interface mode.

**Example:**

```
apicl(config-leaf-if)# exit
```

## Configuring FEC Using the REST API

**Before you begin**

The interface selector is configured.

**Procedure**

Configure RS-FEC policy in a link level policy.

**Example:**

```
<!-- api/policymgr/mo/.xml -->
<polUni>
<infraInfra dn="uni/infra">
 <infraFuncP>
 <infraAccPortGrp name="25G-RS-FEC-PG">
 <infraRsHIfPol tnFabricHIfPolName="RS-FEC-POL"/>
 </infraAccPortGrp>
 </infraFuncP>
 <fabricHIfPol name="RS-FEC-POL" speed="inherit" fecMode="cl91-rs-fec"/>
</infraInfra>
</polUni>
```

The options for `fecMode` are:

- auto-fec
- cl74-fc-fec

- `cl91-rs-fec`
- `cons16-rs-fec`
- `disable-fec`
- `ieee-rs-fec`
- `inherit`
- `kp-fec`

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