



Configuring Power over Ethernet

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Information About PoE

Power over Ethernet Ports

A PoE-capable switch port automatically supplies power to one of these connected devices if the device senses that there is no power on the circuit:

- a Cisco pre-standard powered device (such as a Cisco IP Phone)
- an IEEE 802.3af and IEEE 802.3at-compliant powered device

A powered device can receive redundant power when it is connected to a PoE switch port and to an AC power source. The device does not receive redundant power when it is only connected to the PoE port.

Supported Protocols and Standards

The switch uses these protocols and standards to support PoE:

- CDP with power consumption: The powered switch notifies the device of the amount of power it is consuming. The device does not reply to the power-consumption messages. The device can only supply power to or remove power from the PoE port.
- Cisco intelligent power management: The powered device and the switch negotiate through power-negotiation CDP messages for an agreed-upon power-consumption level. The negotiation allows a high-power Cisco powered device, which consumes more than 7 W, to operate at its highest power mode. The powered device first boots up in low-power mode, consumes less than 7 W, and negotiates to obtain enough power to operate in high-power mode. The device changes to high-power mode only when it receives confirmation from the switch.

High-power devices can operate in low-power mode on switches that do not support power-negotiation CDP.

Cisco intelligent power management is backward-compatible with CDP with power consumption; the switch responds according to the CDP message that it receives. CDP is not supported on third-party powered devices; therefore, the switch uses the IEEE classification to determine the power usage of the device.

- IEEE 802.3af and IEEE 802.3at: The major features of this standard are powered-device discovery, power administration, disconnect detection, and optional powered-device power classification. For more information, see the standard.

Powered-Device Detection and Initial Power Allocation

The device detects a Cisco pre-standard or an IEEE-compliant powered device when the PoE-capable port is in the no-shutdown state, PoE is enabled (the default), and the connected device is not being powered by an AC adaptor.

After device detection, the device determines the device power requirements based on its type:

- The initial power allocation is the maximum amount of power that a powered device requires. The device initially allocates this amount of power when it detects and powers the powered device. As the device receives CDP messages from the powered device and as the powered device negotiates power levels with the device through CDP power-negotiation messages, the initial power allocation might be adjusted.
- The device classifies the detected IEEE device within a power consumption class. Based on the available power in the power budget, the device determines if a port can be powered.

Table 1: IEEE Power Classifications

| Class | Maximum Power Level Required from the Device |
|--------------------------|--|
| 0 (class status unknown) | 15.4 W |
| 1 | 4 W |
| 2 | 7 W |
| 3 | 15.4 W |
| 4 | 30 W (For IEEE 802.3at Type 2 powered devices) |

The device monitors and tracks requests for power and grants power only when it is available. The device tracks its power budget (the amount of power available on the device for PoE). The device performs power-accounting calculations when a port is granted or denied power to keep the power budget up to date.

After power is applied to the port, the device uses CDP to determine the *CDP-specific* power consumption requirement of the connected Cisco powered devices, which is the amount of power to allocate based on the CDP messages. The device adjusts the power budget accordingly. This does not apply to third-party PoE devices. The device processes a request and either grants or denies power. If the request is granted, the device updates the power budget. If the request is denied, the device ensures that power to the port is turned off, generates a syslog message, and updates the LEDs. Powered devices can also negotiate with the device for more power.

With PoE+, powered devices use IEEE 802.3at and LLDP power with media dependent interface (MDI) type, length, and value descriptions (TLVs), Power-via-MDI TLVs, for negotiating power up to 30 W. Cisco

pre-standard devices and Cisco IEEE powered devices can use CDP or the IEEE 802.3at power-via-MDI power negotiation mechanism to request power levels up to 30 W.



Note The initial allocation for Class 0, Class 3, and Class 4 powered devices is 15.4 W. When a device starts up and uses CDP or LLDP to send a request for more than 15.4 W, it can be allocated up to the maximum of 30 W.



Note The CDP-specific power consumption requirement is referred to as the *actual* power consumption requirement in the software configuration guides and command references.

If the device detects a fault caused by an undervoltage, overvoltage, overtemperature, oscillator-fault, or short-circuit condition, it turns off power to the port, generates a syslog message, and updates the power budget and LEDs.

Power Management Modes

The device supports these PoE modes:

- **auto**—The device automatically detects if the connected device requires power. If the device discovers a powered device connected to the port and if the device has enough power, it grants power, updates the power budget, turns on power to the port on a first-come, first-served basis, and updates the LEDs. For LED information, see the hardware installation guide.

If the device has enough power for all the powered devices, they all come up. If enough power is available for all powered devices connected to the device, power is turned on to all devices. If there is not enough available PoE, or if a device is disconnected and reconnected while other devices are waiting for power, it cannot be determined which devices are granted or are denied power.

If granting power would exceed the system power budget, the device denies power, ensures that power to the port is turned off, generates a syslog message, and updates the LEDs. After power has been denied, the device periodically rechecks the power budget and continues to attempt to grant the request for power.

If a device being powered by the device is then connected to wall power, the device might continue to power the device. The device might continue to report that it is still powering the device whether the device is being powered by the device or receiving power from an AC power source.

If a powered device is removed, the device automatically detects the disconnect and removes power from the port. You can connect a nonpowered device without damaging it.

You can specify the maximum wattage that is allowed on the port. If the IEEE class maximum wattage of the powered device is greater than the configured maximum value, the device does not provide power to the port. If you do not specify a wattage, the device delivers the maximum value. Use the **auto** setting on any PoE port. The auto mode is the default setting.

- **static**—The device pre-allocates power to the port (even when no powered device is connected) and guarantees that power will be available for the port. The device allocates the port configured maximum wattage, and the amount is never adjusted through the IEEE class or by CDP messages from the powered device. Because power is pre-allocated, any powered device that uses less than or equal to the maximum wattage is guaranteed to be powered when it is connected to the static port. The port no longer participates in the first-come, first-served model.

However, if the powered-device IEEE class is greater than the maximum wattage, the device does not supply power to it. If the device learns through CDP messages that the powered device is consuming more than the maximum wattage, the device shuts down the powered device.



Note In interface mode, the power consumption of a device cannot exceed the power supplied to the static port.

If you do not specify a wattage, the device pre-allocates the maximum value. The device powers the port only if it discovers a powered device. Use the **static** setting on a high-priority interface.

- **never**—The device disables powered-device detection and never powers the PoE port even if an unpowered device is connected. Use this mode only when you want to make sure that power is never applied to a PoE-capable port, making the port a data-only port.

For most situations, the default configuration (auto mode) works well, providing plug-and-play operation. No further configuration is required. However, perform this task to configure a PoE port for a higher priority, to make it data only, or to specify a maximum wattage to disallow high-power powered devices on a port.

Power Monitoring and Power Policing

When policing of the real-time power consumption is enabled, the device takes action when a powered device consumes more power than the maximum amount allocated, also referred to as the *cutoff-power value*.

When PoE is enabled, the device senses the real-time power consumption of the powered device. The device monitors the real-time power consumption of the connected powered device; this is called *power monitoring* or *power sensing*. The device also polices the power usage with the *power policing* feature.

Power monitoring is backward-compatible with Cisco intelligent power management and CDP-based power consumption. It works with these features to ensure that the PoE port can supply power to the powered device.

The device senses the real-time power consumption of the connected device as follows:

1. The device monitors the real-time power consumption on individual ports.
2. The device records the power consumption, including peak power usage. The device reports the information through the CISCO-POWER-ETHERNET-EXT-MIB.
3. If power policing is enabled, the device polices power usage by comparing the real-time power consumption to the maximum power allocated to the device. The maximum power consumption is also referred to as the *cutoff power* on a PoE port.

If the device uses more than the maximum power allocation on the port, the device can either turn off power to the port, or the device can generate a syslog message and update the LEDs (the port LED is now blinking amber) while still providing power to the device based on the device configuration. By default, power-usage policing is disabled on all PoE ports.

If error recovery from the PoE error-disabled state is enabled, the device automatically takes the PoE port out of the error-disabled state after the specified amount of time.

If error recovery is disabled, you can manually re-enable the PoE port by using the **shutdown** and **no shutdown** interface configuration commands.

4. If policing is disabled, no action occurs when the powered device consumes more than the maximum power allocation on the PoE port, which could adversely affect the device.

Maximum Power Allocation (Cutoff Power) on a PoE Port

When power policing is enabled, the device determines one of the these values as the cutoff power on the PoE port in this order:

1. Manually when you set the user-defined power level that limits the power allowed on the port by using the **power inline auto max** *max-wattage* or the **power inline static max** *max-wattage* interface configuration command
2. Automatically when the device sets the power usage of the device by using CDP power negotiation.

Use the first or second method in the previous list to manually configure the cutoff-power value by entering the **power inline consumption default** *wattage* or the **power inline [auto | static max]** *max-wattage* command.

If you do not manually configure the cutoff-power value, the device automatically determines it by using CDP power negotiation or the device IEEE classification and LLDP power negotiation. If CDP or LLDP are not enabled, the default value of 30 W is applied. However without CDP or LLDP, the device does not allow devices to consume more than 15.4 W of power because values from 15400 to 30000 mW are only allocated based on CDP or LLDP requests. If a powered device consumes more than 15.4 W without CDP or LLDP negotiation, the device might be in violation of the maximum current (*I_{max}*) limitation and might experience an *I_{cut}* fault for drawing more current than the maximum. The port remains in the fault state for a time before attempting to power on again. If the port continuously draws more than 15.4 W, the cycle repeats.



Note When a powered device connected to a PoE+ port restarts and sends a CDP or LLDP packet with a power TLV, the device locks to the power-negotiation protocol of that first packet and does not respond to power requests from the other protocol. For example, if the device is locked to CDP, it does not provide power to devices that send LLDP requests. If CDP is disabled after the device has locked on it, the device does not respond to LLDP power requests and can no longer power on any accessories. In this case, you should restart the powered device.

Power Consumption Values

You can configure the initial power allocation and the maximum power allocation on a port. However, these values are only the configured values that determine when the device should turn on or turn off power on the PoE port. The maximum power allocation is not the same as the actual power consumption of the powered device. The actual cutoff power value that the device uses for power policing is not equal to the configured power value.

When power policing is enabled, the device polices the power usage *at the switch port*, which is greater than the power consumption of the device. When you manually set the maximum power allocation, you must consider the power loss over the cable from the switch port to the powered device. The cutoff power is the sum of the rated power consumption of the powered device and the worst-case power loss over the cable.

We recommend that you enable power policing when PoE is enabled on your device. For example, if policing is disabled and you set the cutoff-power value by using the **power inline auto max 6300** interface configuration command, the configured maximum power allocation on the PoE port is 6.3 W (6300 mW). The device provides power to the connected devices on the port if the device needs up to 6.3 W. If the CDP-power negotiated value or the IEEE classification value exceeds the configured cutoff value, the device does not provide power to the connected device. After the device turns on power on the PoE port, the device does not police the real-time power consumption of the device, and the device can consume more power than the maximum allocated amount, which could adversely affect the device and the devices connected to the other PoE ports.



Note In interface mode, the power consumption of a device cannot exceed the power supplied to the static port. For example, if you configure power supply to the port at 6000 mW (**power inline static6000** interface configuration command), do not configure power consumption by a device at 8000 mW on the same port (**power inline consumption8000** interface configuration command).

Persistent PoE

Persistent PoE provides uninterrupted power to connected devices even when the switch is booting.

How to Configure PoE

Configuring a Power Management Mode on a PoE Port



Note When you make PoE configuration changes, the port being configured drops power. Depending on the new configuration, the state of the other PoE ports, and the state of the power budget, the port might not be powered up again. For example, port 1 is in the auto and on state, and you configure it for static mode. The device removes power from port 1, detects the powered device, and repowers the port. If port 1 is in the auto and on state and you configure it with a maximum wattage of 10 W, the device removes power from the port and then redetects the powered device. The device repowers the port only if the powered device is a class 1, class 2, or a Cisco-only powered device.

Procedure

| | Command or Action | Purpose |
|---------------|---|--|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |
| Step 3 | interface interface-id Example: Device (config)# interface gigabitethernet 1/0/1 Or Device (config)# interface fastethernet 1/0/1 | Specifies the physical port to be configured, and enters interface configuration mode. |

| | Command or Action | Purpose |
|--------|--|--|
| Step 4 | <p>power inline {auto [max <i>max-wattage</i>] never static [max <i>max-wattage</i>]}</p> <p>Example: Device(config-if) # power inline auto</p> | <p>Configures the PoE mode on the port. The keywords have these meanings:</p> <ul style="list-style-type: none"> • auto—Enables powered-device detection. If enough power is available, automatically allocates power to the PoE port after device detection. This is the default setting. • max <i>max-wattage</i>—Limits the power allowed on the port. The range is 4000 to 30000 mW. If no value is specified, the maximum is allowed. • never—Disables device detection, and disable power to the port. <p>Note If a port has a Cisco powered device connected to it, do not use the power inline never command to configure the port. A false link-up can occur, placing the port into the error-disabled state.</p> <ul style="list-style-type: none"> • static—Enables powered-device detection. Pre-allocate (reserve) power for a port before the device discovers the powered device. The device reserves power for this port even when no device is connected and guarantees that power will be provided upon device detection. <p>Note Configure power values in multiples of 100. For example, you can configure 7400 mW, but do not configure 7386 mW or 7421 mW.</p> <p>The device allocates power to a port configured in static mode before it allocates power to a port configured in auto mode.</p> |
| Step 5 | <p>end</p> <p>Example: Device(config-if) # end</p> | <p>Returns to privileged EXEC mode.</p> |
| Step 6 | <p>show power inline [<i>interface-id</i>] module <i>switch-number</i></p> <p>Example: Device# show power inline</p> | <p>Displays PoE status for a device for the specified interface.</p> |

| | Command or Action | Purpose |
|---------------|---|--|
| Step 7 | copy running-config startup-config Example: Device# copy running-config startup-config | (Optional) Saves your entries in the configuration file. |

Configuring Persistent PoE

To configure persistent PoE, perform the following steps:



Note

You will need to configure the **poe-ha** command before connecting the PD, or you will need to manually shut/unshut the port after configuring **poe-ha**.

If you want to reload the switch, ensure that the persistent PoE configuration is first saved. This is necessary to preserve the configuration.

Procedure

| | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |
| Step 3 | interface <i>interface-id</i> Example: Device (config)# interface gigabitethernet 1/0/1 Or Device (config)# interface fastethernet 1/0/1 | Specifies the physical port to be configured, and enters interface configuration mode. |
| Step 4 | power inline port poe-ha Example: Device (config-if)# power inline port poe-ha | Configures persistent PoE. |

| | Command or Action | Purpose |
|--------|--|----------------------------------|
| Step 5 | end Example: Device(config-if)# end | Returns to privileged EXEC mode. |

Budgeting Power for Devices Connected to a PoE Port

When Cisco powered devices are connected to PoE ports, the device uses Cisco Discovery Protocol (CDP) or Link Layer Discovery Protocol (LLDP) to determine the *protocol-specific* power consumption of the devices, and the device adjusts the power budget accordingly. This does not apply to IEEE third-party powered devices. For these devices, when the device grants a power request, the device adjusts the power budget according to the powered-device IEEE classification. If the powered device is a class 0 (class status unknown) or a class 3, the device budgets 15,400 mW for the device, regardless of the CDP-specific amount of power needed. If the powered device reports a higher class than its CDP-specific consumption or does not support power classification (defaults to class 0), the device can power fewer devices because it uses the IEEE class information to track the global power budget.

By using the **power inline consumption** *wattage* interface configuration command, you can override the default power requirement specified by the IEEE classification. The difference between what is mandated by the IEEE classification and what is actually needed by the device is reclaimed into the global power budget for use by additional devices. You can then extend the device power budget and use it more effectively.



Caution

You should carefully plan your device power budget, enable the power monitoring feature, and make certain not to oversubscribe the power supply.



Note

When you manually configure the power budget, you must also consider the power loss over the cable between the device and the powered device.



Note

In interface mode, the power consumption of a device cannot exceed the power supplied to the static port. For example, if you configure power supply to the port at 6000 mW (**power inline static6000** interface configuration command), do not configure power consumption by a device at 8000 mW on the same port (**power inline consumption8000** interface configuration command).

Budgeting Power to All PoE ports

Procedure

| | Command or Action | Purpose |
|--------|----------------------------------|--|
| Step 1 | enable Example: | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |

| | Command or Action | Purpose |
|---------------|---|---|
| | Device> enable | |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |
| Step 3 | no cdp run Example: Device(config)# no cdp run | (Optional) Disables CDP. |
| Step 4 | power inline consumption default <i>wattage</i> Example: Device(config)# power inline consumption default 5000 | Configures the power consumption of powered devices connected to each PoE port. The range for each device is 4000 to 15400 mW (PoE+). The default is 15400 mW. |
| Step 5 | end Example: Device(config)# end | Returns to privileged EXEC mode. |
| Step 6 | show power inline consumption Example: Device# show power inline consumption | Displays the power consumption status. |
| Step 7 | copy running-config startup-config Example: Device# copy running-config startup-config | (Optional) Saves your entries in the configuration file. |

Budgeting Power to a Specific PoE Port

Procedure

| | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |

| | Command or Action | Purpose |
|---------------|---|--|
| Step 3 | no cdp run Example: Device(config)# no cdp run | (Optional) Disables CDP. |
| Step 4 | interface interface-id Example: Device(config)# interface gigabitethernet 1/0/1 Or Device(config)# interface fastethernet 1/0/1 | Specifies the physical port to be configured, and enter interface configuration mode. |
| Step 5 | power inline consumption wattage Example: Device(config-if)# power inline consumption 5000 | Configures the power consumption of a powered device connected to a PoE port on the device. The range for each device is 4000 to 30000 mW (PoE+). The default is 15400 mW (PoE+). |
| Step 6 | end Example: Device(config-if)# end | Returns to privileged EXEC mode. |
| Step 7 | show power inline consumption Example: Device# show power inline consumption | Displays the power consumption data. |
| Step 8 | copy running-config startup-config Example: Device# copy running-config startup-config | (Optional) Saves your entries in the configuration file. |

Configuring Power Policing

By default, the device monitors the real-time power consumption of connected powered devices. You can configure the device to police the power usage. By default, policing is disabled.



Note The power consumption is displayed in units of 0.5 W. For example, if a connected device draws 3.9 W, this feature will display 4.0 W power drawn.

Procedure

| | Command or Action | Purpose |
|---------------|--|--|
| Step 1 | enable Example: Device> enable | Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted. |
| Step 2 | configure terminal Example: Device# configure terminal | Enters global configuration mode. |
| Step 3 | interface <i>interface-id</i> Example: Device(config)# interface gigabitethernet 1/0/1 Or Device(config)# interface fastethernet 1/0/1 | Specifies the physical port to be configured, and enter interface configuration mode. |
| Step 4 | power inline police [action {log errdisable}] Example: Device(config-if)# power inline police | If the real-time power consumption exceeds the maximum power allocation on the port, configures the device to take one of these actions: <ul style="list-style-type: none"> • power inline police—Shuts down the PoE port, turns off power to it, and puts it in the error-disabled state. <p>Note You can enable error detection for the PoE error-disabled cause by using the errdisable detect cause inline-power global configuration command. You can also enable the timer to recover from the PoE error-disabled state by using the errdisable recovery cause inline-power interval <i>interval</i> global configuration command.</p> <ul style="list-style-type: none"> • power inline police action errdisable—Turns off power to the port if the real-time power consumption exceeds the maximum power allocation on the port. • power inline police action log—Generates a syslog message while still providing power to the port. |

| | Command or Action | Purpose |
|---------------|---|---|
| | | If you do not enter the action log keywords, the default action shuts down the port and puts the port in the error-disabled state. |
| Step 5 | exit Example: Device(config-if)# exit | Returns to global configuration mode. |
| Step 6 | Use one of the following: <ul style="list-style-type: none"> • errdisable detect cause inline-power • errdisable recovery cause inline-power • errdisable recovery interval interval Example: Device(config)# errdisable detect cause inline-power Device(config)# errdisable recovery cause inline-power Device(config)# errdisable recovery interval 100 | (Optional) Enables error recovery from the PoE error-disabled state, and configures the PoE recover mechanism variables. By default, the recovery interval is 300 seconds. For interval interval , specifies the time in seconds to recover from the error-disabled state. The range is 30 to 86400. |
| Step 7 | exit Example: Device(config)# exit | Returns to privileged EXEC mode. |
| Step 8 | Use one of the following: <ul style="list-style-type: none"> • show power inline police • show errdisable recovery Example: Device# show power inline police Device# show errdisable recovery | Displays the power monitoring status, and verify the error recovery settings. |
| Step 9 | copy running-config startup-config Example: Device# copy running-config startup-config | (Optional) Saves your entries in the configuration file. |

Monitoring Power Status

Table 2: Show Commands for Power Status

| Command | Purpose |
|--|---|
| show env power | (Optional) Displays the status of the internal power supplies for the switch. |
| show power inline [<i>interface-id</i>] | Displays PoE status for an interface. |
| show power inline police | Displays the power policing data. |



Note Use the `debug ilpower controller` privileged EXEC command to enable debugging of the platform-specific Power over Ethernet (PoE) software module on the switch in long message format. These messages include the Power Controller register reading. Use the `no` form of this command to disable debugging.

Configuration Examples for Configuring PoE

Budgeting Power: Example

When you enter one of the following commands, this caution message appears:

- `[no] power inline consumption default wattage` global configuration command
- `[no] power inline consumption wattage`
interface configuration command

```
%CAUTION: Interface Gi0/1: Misconfiguring the 'power inline consumption/allocation' command
may cause damage to the
switch and void your warranty. Take precaution not to oversubscribe the power supply. It
is recommended to enable power
policing if the switch supports it. Refer to documentation.
```

Feature Information for PoE

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use the Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

| Feature Name | Releases | Feature Information |
|--------------|--------------------------------|------------------------------|
| PoE | Cisco IOS Release 15.2(7)E1 | This feature was introduced. |

