Power over Ethernet

Power over Ethernet

Power over Ethernet (PoE) is a technique for delivering DC power to devices over copper Ethernet cabling, eliminating the need for separate power supplies and outlets. Using PoE can improve flexible options for placing Ethernet end devices, and reduce the time and expense of installing electrical cabling.

PoE is supported on two Cisco Catalyst IE3100 Rugged Series Switch models beginning in the Cisco IOS XE 17.15.x release: IE-3100-4P2S-E and IE-3100-8P2C-E.

For details of PoE support, see PoE Support for Cisco Catalyst IE3100 Rugged Series Switches , on page 1 in this guide.

An IE3100 PoE-capable switch port automatically supplies power to one of these connected devices if the switch senses that there is no power in the circuit:

- An IEEE standard powered device, such as a new Cisco IP phone.
- An IEEE 802.3af-compliant powered device, which can receive up to 15.4 W of DC power
- An IEEE 802.3at-compliant powered device, which can receive up to 30 W of DC power

PoE Support for Cisco Catalyst IE3100 Rugged Series Switches

The following table lists the Cisco Catalyst IE3100 Rugged Series Switches that are supported for PoE.

Switch Model	Supported Ports	PoE Budget
IE-3100-4P2S-E	Up to 30 W PoE+ output on 4 downlink ports	120 W
IE-3100-8P2C-E	Up to 30 W PoE+ output on 8 downlink ports	240 W

These switches support the following PoE features in the Cisco IOS XE 17.15.x release:

- **PoE power policing:** When power policing is enabled, the device polices power usage by comparing the real-time power consumption with the maximum power allocated to the device.

  For more information, see the section Power Monitoring and Power Policing.

- **Perpetual PoE:** Perpetual PoE provides uninterrupted power to a connected powered device even when the power sourcing equipment switch is booting.

  For more information, see the section Configuring Perpetual PoE and Fast POE.

- **Fast PoE:** Fast PoE enables the quick start of PoE power after a system power loss and recovery. If Fast PoE is enabled, the status of the PoE ports is stored in flash memory so that if there is a power loss and recovery, ports can be powered on as quickly as possible.

  For more information, see the section Configure Perpetual PoE and Fast PoE.

- **PoE Foldback:** PoE Foldback is the process in which the system shuts down PoE devices when the primary power source fails, and the standby power source that takes over is of a lower VDC than the primary power source. When the input VDC decreases because the standby source provides a lower VDC, the PoE budget will be reduced. When this happens the switch first shuts down low-priority devices.

  If the switch still lacks power, it shuts down high-priority devices in descending order of port number. You can configure port priority using the **power inline port priority** CLI command.

  For more information, see PoE Foldback, on page 8 and Configure Port Priority, on page 12.

- **PoE Boost:** IE3200, IE3300, and IE3400 DIN rail platforms require an external 54V DC power supply for PoE operation. IE3100 PoE integrates a boost power supply that can take 12V or 24V to create 54V for PoE applications. The IE3100 can provide PoE power from 9.6V to 60V.

  For more information, see the section PoE Boost.

Powered-Device Detection and Initial Power Allocation

The switch detects 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 powered by an AC adapter.

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

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

Table 1: Power Consumption Classes and Power Levels

Power Consumption Class	Maximum Power Level Required from Device
0 (class status unknown)	15.4 W
1	4 W

Power Consumption Class	Maximum Power Level Required from Device
2	7 W
3	15.4 W
4	30 W

IE-3100-4P2S-E and IE-3100-8P2C-E support power consumption classes 1 through 4 (4 W to 30 W).

1-Event Classification

The PoE+ standard (802.3at) uses 2-event classification. This enables the PD to classify itself and receive up to 30W, based on the advertised class, even before the link comes up. By default, 2-event classification is in effect on all interfaces.

The PoE standard (802.3af) uses 1-event classification. If a PD supports only 1-event classification, then the interface on which the PD is connected should be explicitly configured for 1-Event classification. If an interface is configured with 1-event classification, and if the PD returns a value of Class 1, 2, or 3, then the switch provides Class 1, 2, or 3 power, respectively. If the PD returns a value of Class 4, then Class 3 power is provided initially (15.4W is allocated to the PD during start-up, and the PD can renegotiate for more power through CDP/LLDP).

Use the **power inline port 1-event** command to configure 1-event classification. For example:

```
IE3100-8P2C#configure terminal
IE3100-8P2C(config)#interface gigabitEthernet 1/3
IE3100-8P2C(config-if)#power inline port 1-event
IE3100-8P2C(config-if)#
```

Power Budget

The switch monitors and tracks requests for power and grants power only when it is available. The switch tracks the power budget (the amount of power available on the device for PoE). The switch also 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 switch uses Cisco Discovery Protocol to determine the Cisco Discovery Protocol-specific power consumption requirement of the connected Cisco powered devices, which is the amount of power to allocate based on the Cisco Discovery Protocol messages. The switch adjusts the power budget accordingly. Note that Cisco Discovery Protocol does not apply to third-party PoE devices. The switch processes a request, and either grants or denies power. If the request is granted, the switch updates the power budget. If the request is denied, the switch ensures that the power to the port is turned off, generates a syslog message, and updates the LEDs. Powered devices can also negotiate with the switch for more power.

Note The Cisco Discovery Protocol-specific power consumption requirement is referred to as the actual power consumption requirement in the Cisco Catalyst Switches software configuration guides and command references.

With PoE+, powered devices use IEEE 802.3bt and Link Layer Discovery Protocol (LLDP) power with medium-dependent interface (MDI) type, length, and value descriptions (TLVs) and power-via-MDI TLVs, for negotiating power up to 30 W. Cisco IEEE powered devices can use CDP or the IEEE 802.3 at power-via-MDI power-negotiation mechanism to request power levels up to 30 W.

If the PD does not support LLDP, you can configure with either static or 2-event classification to receive required power according to the PD specification.

If the switch 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

To configure the overall PoE budget of DIN rail switches, use the global configuration command **power inline wattage max <watts for primary PSU> <watts for secondary PSU>**. Limiting the PoE budget prevents overdrawing power and exceeding the capacity of the power source.

The ranges for **power inline wattage max <watts for primary PSU>** and **power inline wattage max <watts for secondary PSU>** depend on the voltage for primary and secondary PSUs, as shown in the following table.

Table 2: Input Voltage Range and Max Wattage

Input Voltage Range	Max PoE Budget Range	Default Total PoE Budget
9.6V < Input Voltage <= 18V	4W to 31W	4W
18V < Input Voltage <= 44V	4W to 90W	31W
44V < Input Voltage <= 52.5V	4W to 120W	120W
52.5V < Input Voltage <= 60V	4W to 120W (IE3100-4P2S) / 240W (IE3100-8P2C)	120W (IE3100-4P2S) / 125W (IE3100-8P2C)

Note The switch also needs power, so it is suggested that you reserve 20 watts for the switch. The power budget for PoE would then be the total power of the PSU minus 20 watts. For example, if the PSU can provide 170W of power, the maximum PoE budget you should configure is 150W.

See the Datasheet for actual IE3100 power consumption for switch operation. The 20W referenced here is just an example.

Note For cases where VDC is in range of 18V - 44V, the IE3100 assumes a PSU with 50W capacity. The PoE budget is ~20W less than 50W. Cisco sells a PSU with 50W capacity and outputs 24VDC.

PoE has the following power-management modes:

- **Auto:** The auto mode is the default setting. The switch automatically detects if the connected device requires power. If the switch discovers a powered device connected to the port, and if the switch has enough power, it grants power, updates the power budget, and turns on power to the port on a first-come, first-served basis, and updates the LEDs. For LED information, see the Cisco Catalyst IE3100 Rugged Series Switches Hardware Installation Guide.

  If the switch has enough power for all the powered devices, they all come up. If enough power is available for all the powered devices connected to the switch, power is turned on to all the devices. If enough PoE

is not available, 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 exceeds the system's power budget, the switch denies power, ensures that power to the port is turned off, generates a syslog message, and updates the LEDs. After power is denied, the switch periodically rechecks the power budget and continues to attempt to grant the request for power.

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

If a powered device is removed, the switch 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 switch does not provide power to the port. If the switch powers a powered device, but the powered device later requests, through Cisco Discovery Protocol or LLDP messages, more than the configured maximum value, the switch removes power to the port. The power that was allocated to the powered device is reclaimed into the global power budget. If you do not specify a wattage, the switch delivers the maximum value. Use the auto setting on any PoE port.

- **Static:** The switch preallocates power to the port (even when no powered device is connected) and guarantees that power will be available for the port. The switch allocates the port-configured maximum wattage, and the amount is never adjusted through the IEEE class or by Cisco Discovery Protocol messages from the powered device. Because power is preallocated, 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's IEEE class is greater than the maximum wattage, the switch does not supply power to it. If the switch learns through Cisco Discovery Protocol messages that the powered device is consuming more than the maximum wattage, the switch shuts down the powered device.

  If you do not specify a wattage, the switch preallocates the maximum value. The switch powers the port only if it discovers a powered device.

- **Never:** The switch 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, configure a PoE port to specify 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 switch takes action when a powered device consumes more power than the maximum amount allocated, which is also referred to as the *cutoff-power value*.

When PoE is enabled, the switch senses and monitors the real-time power consumption of the connected powered device. This is called *power monitoring* or *power sensing*. The switch 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 a powered device.

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

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

   If the powered device uses more than the maximum power allocation on the port, the switch can either turn off the power to the port, or can generate a syslog message while still providing power to the device based on the device configuration. By default, power-usage policing is disabled on all the PoE ports.

   If error recovery from the PoE error-disabled state is enabled, the switch 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.

   If policing is disabled, the powered device can draw a maximum power based on what is allocated by the switch. If the powered device consumes more than what is allocated, the port hits an Imax error and enters a fault condition.

Power Consumption Values

You can configure the initial power allocation and the maximum power allocation on a port. However, these values are 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*, where the power consumption is greater than that requested by 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, for a Class 1 device, 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 the 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.

Monitoring Power Status

Use the following **show** commands to monitor and verify the PoE configuration.

Table 3: show Commands for Power Status

Command	Description
show power inline *interface-id* **detail**	Shows detailed PoE output of the interface.
show power inline consumption	Shows the PoE power allocated to devices connected to the interface.
show power inline police *interface-id* **detail**	Shows detailed PoE policing information of the interface.
show power inline priority	Shows PoE priority level configured on the interface(s).

The following is example output for **show power inline**:

```
IE3100_POE_4P2S#show power inline

Available:120.0(w)  Used:76.2(w)  Remaining:43.8(w)

Interface Admin  Oper       Power   Device              Class Max
                            (Watts)
--------- ------ ---------- ------- ------------------- ----- ----
Gi1/3     auto   on         15.4    Ieee PD             3     30.0
Gi1/4     static on         30.0    Ieee PD             3     30.0
Gi1/5     auto   on         15.4    Ieee PD             3     30.0
Gi1/6     auto   on         15.4    Ieee PD             3     30.0
--------- ------ ---------- ---------- ---------- ------ -----
Totals:          4    on    76.2

IE3100_POE_4P2S#

IE3100_POE_4P2S#show power inline consumption

Interface  Consumption      Admin
           Configured    Consumption (Watts)
---------- -----------  -------------------

Gi1/3         YES               15.4
Gi1/4          NO                0.0
Gi1/5          NO                0.0
Gi1/6          NO                0.0
IE3100_POE_4P2S#
IE3100_POE_4P2S#

IE3100_POE_4P2S#show power inline police

Available:120.0(w)  Used:76.2(w)  Remaining:43.8(w)

Interface Admin  Oper       Admin      Oper       Cutoff Oper
          State  State      Police     Police     Power  Power
--------- ------ ---------- ---------- ---------- ------ -----
Gi1/3     auto   on         none       n/a        n/a    13.2
Gi1/4     static on         none       n/a        n/a    13.0
Gi1/5     auto   on         none       n/a        n/a    13.2
Gi1/6     auto   on         none       n/a        n/a    13.0
```

```
--------- ------ ---------- ---------- ---------- ------ -----
Totals:                                             52.4

IE3100_POE_4P2S#

IE3100_POE_4P2S#show power inline police gigabitEthernet 1/3

Available:120.0(w)  Used:76.2(w)  Remaining:43.8(w)

Interface Admin  Oper       Admin      Oper       Cutoff Oper
          State  State      Police     Police     Power  Power
--------- ------ ---------- ---------- ---------- ------ -----
Gi1/3     auto   on         none       n/a        n/a    13.2
IE3100_POE_4P2S#

IE3100_POE_4P2S#show power inline priority

Interface  Admin  Oper       Admin
           State  State      Priority
---------- ------ ---------- ----------

Gi1/3      auto   on         low
Gi1/4      static on         high
Gi1/5      auto   on         low
Gi1/6      auto   on         low
IE3100_POE_4P2S#
```

PoE Foldback

If the primary power source fails, and the standby power source is providing less VDC input than the primary, the Cisco Catalyst IE3100 Rugged Series Switch shuts down PoE devices, based on port priority. This process is called PoE Foldback and is enabled when you configure the wattages of the external connected power supplies. Use the **power inline wattage max <watts for primary PSU> <watts for secondary PSU>** command to configure the wattages for primary and secondary power supplies. For details about this command, see Power Management Modes, on page 4.

Note If the power supplies are of same voltage, then their power rating should also be the same. If both the power supplies have the same voltage and same power rating, then both PSUs can handle the power in the switch redundantly and PoE Foldback is not required. However, if the two PSUs have the same voltage but a different power rating, then PoE Foldback is not triggered and the switch might reload. In this case the switch detects a power supply switchover based on the incoming voltage change. Because the voltage is same, the assumption is that the power supplies are the same wattage. Note that PSUs with the same voltage but different wattage is not a supported option.

When PoE Foldback is in effect, if power from the higher power supply fails, the switch shuts down power to ports with low-priority. If the switch still lacks power then the high-priority ports are shut down in descending order of port number. It does so until power consumption returns to normal.

By default, all powered devices are low priority, but you can configure high priority ports using the **power inline port priority** CLI command. However, you must change priority before the port has been powered on. If the port is powered on, you must switch it off, change priority, and then switch the port back on.

If the power is restored or a new power supply is added, the switch powers on the devices on a first-come-first-serve basis.

See the section Configure Port Priority, on page 12 for more information.

Configuring PoE+

This section provides instructions for configuring PoE+ on Cisco Catalyst IE3100 Rugged Series Switches.

Configure a Power Management Mode on a PoE Port

When you make PoE configuration changes, the port that is 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 or class 2.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. 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 gigabitethernet1/3`	Specifies the physical port to be configured, and enters interface configuration mode.
Step 4	**power inline** {**auto** [**max** *max-wattage*] | **consumption** *wattage* | **never** | **static** [**max** *max-wattage*] } **Example:** `Device(config-if)# power inline static`	Configures the PoE mode on the port. The following are the keywords: • **auto**: Enables detection of powered devices. If enough power is available, automatically allocates power to the PoE port after device detection. This is the default setting. • **consumption** *wattage*: Sets the PoE consumption (in milliwatts) to override the amount of power specified by the IEEE classification for the device. • **max** *max-wattage*: Limits the power allowed on the port. If no value is specified, the maximum is allowed. • **never**: Disables device detection and power to the port.

	Command or Action	Purpose
		• **static**: Enables detection of powered devices. Preallocates (reserve) power for a port before the switch discovers the powered device. The switch reserves power for this port even when no device is connected, and guarantees that power will be provided upon device detection. The device allocates power to a port configured in static mode before it allocates power to a port configured in auto mode.
Step 5	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode, and returns to privileged EXEC mode.
Step 6	**show power inline** [*interface-id*] [**detail**]] **Example:** `Device# show power inline`	Displays the PoE status for a device, for the specified interface.
Step 7	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configure 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.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. 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 gigabitethernet1/3`	Specifies the physical port to be configured, and enters interface configuration mode.

	Command or Action	Purpose
Step 4	**power inline police** [**action** {**log** | **errdisable**}] **Example:** `Device(config-if)# power inline police`	Configures the device to take one of these actions if the real-time power consumption exceeds the maximum power allocation on the port: • **power inline police**: Shuts down the PoE port, turns off the power to it, and puts it in the error-disabled state. **Note** You can enable error detection for the PoE error-disabled state 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** *interval* global configuration command. • **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. 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`	Exits interface configuration mode, and returns to global configuration mode.
Step 6	Use one of the following: • **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 recovery mechanism variables. By default, the recovery interval is 300 seconds. **interval** *interval*: Specifies the time in seconds, to recover from the error-disabled state. The range is 30 to 86400.
Step 7	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.
Step 8	Use one of the following: • **show power inline police**	Displays the power-monitoring status, and verifies the error recovery settings.

	Command or Action	Purpose
	• **show errdisable recovery** **Example:** `Device# show power inline police` `Device# show errdisable recovery`	
Step 9	**copy running-config startup-config** **Example:** `Device# copy running-config startup-config`	(Optional) Saves your entries in the configuration file.

Configure Port Priority

By default, all the ports on the switch are low-priority. Low-priority ports are the first to be shut down under PoE Foldback, the process in which the switch shuts down ports when the power budget is low or a power supply goes out.

However, you can configure ports to be high-priority. You may want to do so for ports assigned to critical powered devices. A port configured as static is treated as high priority for PoE Foldback. You also can configure a high-priority port to a low-priority port.

Note The system treats any port configured as static as high-priority.

To configure the priority level of the port, complete the following steps.

Before you begin

Make sure that the port that you want to configure is turned off.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**power inline port priority {low | high}** **Example:** `Device# power inline port priority high`	Configures the priority level of the port.