Configuring Power Over Ethernet

This chapter contains the following sections:

Power over Ethernet

About Power over Ethernet

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

- A Cisco pre-standard powered device (such as a Cisco IP Phone or a Cisco Aironet Access Point)
- An IEEE 802.3af-compliant powered device
- An IEEE 802.3at-compliant powered device

When Cisco powered devices are connected to PoE ports, the switch uses the Cisco Discovery Protocol (CDP) to determine the CDP-specific power consumption of the devices. The switch adjusts the power budget accordingly. This does not apply to IEEE third-party powered devices. For these devices, when the switch grants a power request, the switch 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 switch 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 switch can power fewer devices because it uses the IEEE class information to track the global power budget.

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.

After the switch detects a powered device, the switch determines the device power requirements and then grants or denies power to the device. The switch can also sense the real-time power consumption of the device by monitoring and policing the power usage.

About Universal Power over Ethernet

Cisco Universal Power over Ethernet (Cisco UPoE) is a Cisco proprietary technology that extends the IEEE 802.at PoE standard. This feature provides the capability to source up to 60 W of power over a standard Ethernet cabling infrastructure (Class D or better) by using the spare pair of an RJ-45 cable (wires 4,5,7,8) with the signal pair (wires 1,2,3,6). Power on the spare pair is enabled when the switch port and end device mutually identify themselves as Cisco UPoE-capable using CDP or LLDP and the end device requests for power to be enabled on the spare pair. When the spare pair is powered, the end device can negotiate up to 60 W of power from the switch using CDP or LLDP.

If the end device is PoE-capable on both signal and spare pairs but does not support the CDP or LLDP extensions that are required for Cisco UPoE, a 4-pair forced mode configuration automatically enables power on both signal and spare pairs from the switch port.

You can configure Link Layer Discovery Protocol (LLDP) and Cisco Discovery Protocol (CDP) used for Universal Power over Ethernet (UPoE) on the Cisco Nexus 93108TC-FX3P switch. This switch is a Power Source Equipment (PSE) and can support UPoE to the connected power devices.

To address the UPoE requirements, we introduced a new Type, Length, and Value (TLV) in LLDP and CDP specific to the 4-Pair Power over Ethernet (PoE) functionality. This approach is simple and is resilient to packet loss and latency. It is mandatory for any power device requiring UPoE to implement this TLV and enable it administratively or by default.

Table 1: PoE Types and Port Combinations

System PSU Configuration	PSU Power	UPoE (60 W)		PoE+ (30 W)		PoE (15 W)
Combined	1900 W High Line	32	OR	48	OR	48
	1900 W Low Line	32		48		48
	1100 W	26		48		48
Redundant	1900 W High Line	21		43		48
	1900 W Low Line	15		30		48
	1100 W	8		16		32

Supported Protocols and Standards

The switch uses these protocols and standards to support PoE:

- CDP with power consumption—The powered device notifies the switch of the amount of power it is consuming. The switch does not reply to the power-consumption messages. The switch can only supply power to or remove power from the PoE port.

  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—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.
- IEEE 802.3at—The PoE+ standard increases the maximum power that can be drawn by a powered device from 15.4 W per port to 30 W per port.
- The Cisco UPoE feature provides the capability to source up to 60 W of power (2 x 30 W) over both signal and spare pairs of the RJ-45 Ethernet cable by using the Layer-2 power negotiation protocols such as CDP or LLDP. An LLDP and CDP request of 30 W and higher in presence of the 4-wire Cisco Proprietary spare-pair power TLV can provide power on the spare pair.

Powered-Device Detection and Initial Power Allocation

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

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

- A Cisco pre-standard powered device does not provide its power requirement when the switch detects it, so a switch allocates 15.4 W as the initial allocation for power budgeting.

  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. As the switch receives CDP messages from the powered device and as the powered device negotiates power levels with the switch through CDP 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. Table 1: IEEE Power Classifications, on page 2 lists these levels.

Table 2: IEEE Power Classifications

Class	Maximum Power Level Required from the Switch
0 (class status unknown)	15.4 W
1	4 W
2	7 W
3	15.4 W
4	30 W PoE+ devices only
5	45 W
6	60 W

The switch monitors and tracks requests for power and grants power only when it is available. The switch tracks its power budget (the amount of power available on the switch for PoE). The switch 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 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 switch adjusts the power budget accordingly. This 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 power to the port is turned off and generates a syslog message. Powered devices can also negotiate with the switch 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-MDA 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.

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 switch detects a fault that is 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.

The PoE feature operates the same if the switch is a vPC pair. The power budget is per-switch and independent of any other switch in the vPC domain.

Power Management Modes

The switch supports these PoE modes:

- **auto**—The switch automatically detects if the connected device requires power. If the switch discovers a powered device that is connected to the port and if the switch has enough power, it grants power, updates the power budget, turns on power to the port on a first-come, first-served basis.

  If the switch has enough power for all the powered devices, they all come up. If enough power is available for all powered devices that are connected to the switch, power is turned on to all devices. If there is not enough power available to 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 switch denies power, ensures that power to the port is turned off, and generates a syslog message. After power has been denied, the switch periodically rechecks the power budget and continues to attempt to grant the request for power.

  If a device being powered by the switch, is then connected to wall power, the switch might continue to power the device. The switch might continue to report that it is still powering the device 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 CDP 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. The auto mode is the default setting.

- **static**—The switch pre-allocates 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 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 switch does not supply power to it. If the switch learns through CDP messages that the powered device needs 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. 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.

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, also referred to as the cutoff-power value.

When PoE is enabled, the switch senses the real-time power consumption of the powered device. The switch 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 the 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 on individual ports.
2. The switch records the power consumption, including peak power usage. The switch reports the information through the CISCO-POWER-ETHERNET-EXT-MIB.

If the device uses more than the maximum power allocation on the port, power is removed from the port and the switch puts that port into the pwr-deny state.

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 switch 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 switch uses for power policing is not equal to the configured power value.

When power policing is enabled, the switch polices the power usage at the switch port, which is greater than the power consumption of the device. When you are 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 switch. 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 switch 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 switch does not provide power to the connected device. But, if the negotiated power is less than 6.3W, the switch turns on power on the PoE port without policing the real-time power consumption of the device. The device can consume more power than the maximum allocated amount, which could adversely affect the switch and the devices that are connected to the other PoE ports.

- If a power supply is removed and replaced by a new power supply with less power and the switch does not have enough power for the powered devices, the switch denies power to the PoE ports with low priority in descending order of the port numbers. If the switch still does not have enough power, the switch then denies power to the PoE ports with high priority in descending order of the port numbers.
- If the new power supply supports more power than the previous one and the switch now has more power available, the switch grants power to the PoE ports in static mode in ascending order of the port numbers. If it still has power available, the switch then grants power to the PoE ports in auto mode in ascending order of the port numbers.

Guidelines and Limitations for PoE and UPoE

The following are the guidelines and limitations for Power over Ethernet:

- Carefully plan your switch power budget and make certain not to oversubscribe the power supply.
- When you manually configure the power budget, you must also consider the power loss over the cable between the switch and the powered device.
- By using the **power inline auto | static max** interface configuration command, you can override the default power requirement that is specified by the IEEE classification. The difference between what is mandated by the IEEE classification and what is needed by the device is reclaimed into the global power budget for use by other devices. You can then extend the switch power budget and use it more effectively.
- UPoE support is limited to the Cisco Nexus 93180TC-FX3 switch in ToR mode.
- A minimum of 1100 W PSU power is required to enable the UPoE feature on Cisco Nexus switches.

How to Configure PoE

Configuring a Power Management Mode on a PoE 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.

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 switch 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 switch removes power from the port and then redetects the powered device. The switch repowers the port only if the powered device is a class 1, class 2, or a Cisco-only powered device.

This configuration supports UPoE bringup using LLDP. Negotiation with CDP requires no specific configuration other than the general default PoE or CDP configuration.

Once feature PoE is enabled and the interface is in an `admin up` state, the switch starts browsing for a PD device to supply power. By default, UPoE is enabled on ports 1 to 48. Through interface level commands, PoE can be disabled or different PoE parameters can be configured. Feature PoE can be enabled only if the switch has a 1100-W PSU minimum.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**feature poe** **Example:** `switch(config)# feature poe`	Enables Power over Ethernet.
Step 3	**feature lldp** **Example:** `switch(config)# feature lldp`	Enables the LLDP feature for LLDP and UPoE negotiation with the **lldp tlv-select four-wire-power-management** command for Cisco 4-wire power via MDI TLV for LLDP-UPoE.
Step 4	**interface** *interface-id* **Example:** `switch(config)# interface ethernet1/1`	Specifies the physical port to be configured, and enters interface configuration mode.
Step 5	**power inline {auto [max** *max-wattage*] **never | static [max** *max-wattage*]**}** **Example:**	Configures the PoE mode on the port. The keywords have these meanings:

	Command or Action	Purpose
	`switch(config-if)# power inline auto`	• **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** *max-wattage*: Limits the power that is allowed on the port. The range for Cisco UPoE ports is 4000-60000 mW. If no value is specified the maximum is allowed. • **never**: Disables device detection, and disable power to the port. **Note** If a port has a Cisco powered device that is 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. • **static**: Enables powered-device detection. Preallocate (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.
Step 6	**end** **Example:** `switch(config-if)# end`	Returns to privileged EXEC mode.
Step 7	**show power inline** [*interface-id*] **Example:** `switch# show power inline`	Displays PoE status for a switch or for the specified interface.

Budgeting Power for Devices Connected to a PoE Port

When Cisco powered devices are connected to PoE ports, the switch uses Cisco Discovery Protocol (CDP) to determine the CDP-specific power consumption of the devices, and the switch adjusts the power budget accordingly. This does not apply to IEEE third-party powered devices. For these devices, when the switch grants a power request, the switch 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 switch 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 switch can power fewer devices because it uses the IEEE class information to track the global power budget.

By using the **power inline auto | static max** interface configuration command, you can override the default power requirement that is 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 other devices. You can then extend the switch power budget and use it more effectively.

Note You should carefully plan your switch 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 switch and the powered device.

Configuring Power Policing

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

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**interface** *interface-id* **Example:** `switch(config)# interface ethernet 1/1`	Specifies the physical port to be configured and enters interface configuration mode.
Step 3	**power inline police action** [**log** |**errdisable**] *interface-id* **Example:** `switch(config-if)# power inline police action log`	If the real-time power consumption exceeds the maximum power allocation on the port, configures the switch to take one of these actions: • **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 and removes the power to the port.
Step 4	**exit** **Example:**	Returns to global configuration mode.

	Command or Action	Purpose
	`switch(config-if)# exit`	
Step 5	**exit** **Example:** `switch# exit`	Returns to privileged EXEC mode.
Step 6	Use the following: **Example:** `switch# show power inline police`	• **show power inline police** Displays the power monitoring status.

Monitoring Power Status

Table 3: Show Commands for Interfaces

Command	Purpose
show environment power	Displays the status of the internal power supplies of the switch
show power inline *interface-id*	Displays PoE status of all the PoE ports in the switch. If *interface-id* is specified, the PoE details of the specific port are displayed.
show power inline police	Displays the power policing data.

Disabling UPoE on a Port

Use this procedure to disable power to a port.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enter global configuration mode.
Step 2	**interface** *type slot/port* **Example:** `switch(config)# interface ethernet 1/1`	Use this command to identify the port on which you want to disable device detection.
Step 3	**power inline never** **Example:** `switch(config-if)# power inline never`	Disables device detection and disables power to the port.

Disabling PoE/UPoE on a Switch

This procedure describes the steps to disable PoE or UPoE in a switch.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enter global configuration mode.
Step 2	**no lldp tlv-select four-wire-power-management** **Example:** `switch(config)# no lldp tlv-select four-wire-power-management`	This step disables LLDP-UPoE negotiation for all ports on the switch. Any new LLDP negotiations for UPoE power will not happen.
Step 3	**no feature poe** **Example:** `switch# no feature poe`	Disables PoE for all ports on the switch.

Configuring Port Power Priority

Use this procedure to configure the priority on a port.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enter global configuration mode.
Step 2	**feature poe** **Example:** `switch(config)# feature poe`	Enables the PoE feature on the switch.
Step 3	**feature lldp** **Example:** `switch(config)# feature lldp`	Enables the LLDP feature for LLDP and UPoE negotiation.
Step 4	**interface** *type slot/port* **Example:** `switch(config)# interface ethernet 1/1`	Use this command to identify the port on which you want to set a priority.

	Command or Action	Purpose
Step 5	**power inline port priority** *level* **Example:** `switch(config-if)# power inline port priority high`	Configure the priority for the port. The values for *level* are high and low. The default priority is low.

Guaranteeing Power to Specific Ports

Use this procedure to set the maximum wattage to be provided.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enter global configuration mode.
Step 2	**feature poe** **Example:** `switch(config)# feature poe`	Enables the PoE feature on the switch.
Step 3	**feature lldp** **Example:** `switch(config)# feature lldp`	Enables the LLDP feature for LLDP and UPoE negotiation.
Step 4	**interface** *type slot/port* **Example:** `switch(config)# interface ethernet 1/1`	Use this command to identify the port on which you want to disable device detection.
Step 5	**power inline static max** *max-wattage* **Example:** `switch(config-if)# power inline static max 60000`	Configures the UPoE mode on the port. The **max** *max-wattage* keyword and parameter limits the power that is allowed on the port. The range for Cisco UPoE ports is 4000-60000 mW. If no value is specified, the maximum is the default value.

Configuring Port Policing

Use this procedure to configure an action to take when the power allocation is exceeded.

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enter global configuration mode.
Step 2	**feature poe** **Example:** `switch(config)# feature poe`	Enables the PoE feature on the switch.
Step 3	**feature lldp** **Example:** `switch(config)# feature lldp`	Enables the LLDP feature for LLDP and UPoE negotiation.
Step 4	**interface** *type slot/port* **Example:** `switch(config)# interface ethernet 1/1`	Use this command to identify the port on which you want to disable device detection.
Step 5	**power inline police action {errdisable | log}** **Example:** `switch(config-if)# power inline police action errdisable`	Configures the action to be taken when the device attempts to draw more power than was allocated. • **errdisable** - Turns off the power to the port if the real-time power consumption exceeds the maximum power allocation on the port. • **log** - Generates a syslog message and power will be denied to the port.

Verifying Universal Power over Ethernet

To display the Universal Power over Ethernet configuration, enter one of the following commands:

Command	Purpose
show power inline	Displays PoE status for a device or a device stack, for the specified interface, or for a specified stack member.
show power inline ethernet *slot/port*	Displays PoE status for a specific port including supplied and delivered watts. .
show power inline ethernet interface-id detail	Displays PoE status for a device or for the specified interface.
show power inline police	Displays the power policing data.
show power inline priority	Displays the priority setting for the port.