Environmental Monitoring and Power Management

About Environmental Monitoring

Environmental monitoring of chassis components provides early warning indications of possible component failure. This warning helps you to ensure the safe and reliable operation of your system and avoid network interruptions.

This section describes how to monitor critical system components so that you can identify and rapidly correct hardware-related problems.

Using CLI Commands to Monitor your Environment

Enter the **show environment** [**all** | **counters** | **history** | **location** | **sensor** | **status** | **summary** | **table**] command to display system status information. Keyword descriptions are listed in the following table.

Table 1: Keyword Descriptions

Keyword	Purpose
all	Displays a detailed listing of all the environmental monitor parameters (for example, the power supplies, temperature readings, voltage readings, and so on). This is the default.
counters	Displays operational counters.
history	Displays the sensor state change history.
location	Displays sensors by location.
sensor	Displays the sensor summary.

Keyword	Purpose
status	Displays field-replaceable unit (FRU) operational status and power and power supply fan sensor information.
summary	Displays the summary of all the environment monitoring sensors.
table	Displays a sensor state table.

Displaying Environment Conditions

Supervisor modules and their associated line cards support multiple temperature sensors per card. The environment condition output includes the temperature reading from each sensor and the temperature thresholds for each sensor. These line cards support three thresholds: warning, critical, and shutdown.

The following example illustrates how to display the environment condition on a supervisor module. The thresholds appear within parentheses.

```
Device# show environment

Number of Critical alarms:  0
Number of Major alarms:     0
Number of Minor alarms:     0

Slot    Sensor       Current State       Reading    Threshold(Minor,Major,Critical,Shutdown)
----    ------       -------------       -------    ----------------------------------------

 R0    HotSwap: Volts   Normal           53    V DC    na
 R0    HotSwap: Power   Normal           231   Watts   na
 R0    Temp: Coretemp   Normal           46    Celsius (107,117,123,125)(Celsius)
 R0    Temp: DopplerD   Normal           55    Celsius (107,117,123,125)(Celsius)
 R0    V1: VX1          Normal           845   mV      na
 R0    V1: VX2          Normal           1499  mV      na
 R0    V1: VX3          Normal           1058  mV      na
 R0    V1: VX4          Normal           849   mV      na
 R0    V1: VX5          Normal           1517  mV      na
 R0    V1: VX6          Normal           1306  mV      na
 R0    V1: VX7          Normal           1007  mV      na
 R0    V1: VX8          Normal           1098  mV      na
 R0    V1: VX9          Normal           1205  mV      na
 R0    V1: VX10         Normal           1704  mV      na
 R0    V1: VX11         Normal           1208  mV      na
 R0    V1: VX12         Normal           1804  mV      na
 R0    V1: VX13         Normal           2518  mV      na
 R0    V1: VX14         Normal           3288  mV      na
 R0    Temp:   outlet   Normal           39    Celsius (55 ,65 ,75 ,100)(Celsius)
 R0    Temp:    inlet   Normal           35    Celsius (45 ,55 ,65 ,72 )(Celsius)
```

The following example illustrates how to display the LED status on a supervisor module.

```
Device# show hardware led

Current Mode: STATUS

SWITCH: C9407R
SYSTEM: AMBER

SUPERVISOR: ACTIVE
```

```
STATUS: (10) Te3/0/1:BLACK Te3/0/2:BLACK Te3/0/3:BLACK Te3/0/4:BLACK Te3/0/5:BLACK
Te3/0/6:BLACK Te3/0/7:BLACK Te3/0/8:BLACK Fo3/0/9:BLACK Fo3/0/10:BLACK
BEACON: BLACK

RJ45 CONSOLE: GREEN
FANTRAY STATUS: GREEN
FANTRAY BEACON: BLACK
POWER-SUPPLY 1 BEACON: BLACK
POWER-SUPPLY 3 BEACON: BLACK
```

Displaying On Board Failure Logging (OBFL) information

The OBFL feature records operating temperatures, hardware uptime, interrupts, and other important events and messages that can assist with diagnosing problems with line cards and supervisor modules installed in a switch. Data is logged to files stored in nonvolatile memory. When the onboard hardware is started up, a first record is made for each area monitored and becomes a base value for subsequent records. The OBFL feature provides a circular updating scheme for collecting continuous records and archiving older (historical) records, ensuring accurate data about the system. Data is recorded in one of two formats: continuous information that displays a snapshot of measurements and samples in a continuous file, and summary information that provides details about the data being collected. The data is displayed using the **show logging onboard** command. The message “No historical data to display” is seen when historical data is not available.

```
Switch#show logging onboard RP active voltage detail

--------------------------------------------------------------------------------
VOLTAGE SUMMARY INFORMATION
--------------------------------------------------------------------------------
Number of sensors          : 16
--------------------------------------------------------------------------------
Sensor                     ID         Normal Range          Maximum Sensor Value
--------------------------------------------------------------------------------
SYSTEM Rail-5.0            0          0 - 5                 0
SYSTEM Rail-0.9PEX         1          0 - 5                 1
SYSTEM Rail-0.9            2          0 - 5                 1
SYSTEM Rail-1.8            3          0 - 5                 0
SYSTEM Rail-3.3            4          0 - 5                 1
SYSTEM Rail-2.5            5          0 - 5                 1
SYSTEM Rail-1.5CPU         6          0 - 5                 1
SYSTEM Rail-1.5            7          0 - 5                 1
SYSTEM Rail-1.2            8          0 - 5                 1
SYSTEM Rail-1.1            9          0 - 5                 1
SYSTEM Rail-1.0            10         0 - 5                 1
SYSTEM Rail-0.9CPU         11         0 - 5                 1
SYSTEM Rail-0.85           12         0 - 5                 2
SYSTEM Rail-0.85DOPv
     13         0 - 5                 3
SYSTEM Rail-0.85DOPv^N     14         0 - 5                  5
SYSTEM Rail-0.85DOPv^O     15         0 - 5                  0

--------------------------------------------------------------------------------
Sensor Value
Total Time of each Sensor
--------------------------------------------------------------------------------

--------------------------------------------------------------------------------
No historical data

--------------------------------------------------------------------------------
```

```
--------------------------------------------------------------------------------
VOLTAGE CONTINUOUS INFORMATION
--------------------------------------------------------------------------------
Sensor                    ID
--------------------------------------------------------------------------------

SYSTEM Rail-5.0           0
SYSTEM Rail-0.9PEX        1
SYSTEM Rail-0.9           2
SYSTEM Rail-1.8           3
SYSTEM Rail-3.3           4
SYSTEM Rail-2.5           5
SYSTEM Rail-1.5CPU        6
SYSTEM Rail-1.5           7
SYSTEM Rail-1.2           8
SYSTEM Rail-1.1           9
SYSTEM Rail-1.0           10
SYSTEM Rail-0.9CPU        11
SYSTEM Rail-0.85          12
SYSTEM Rail-0.85DOPv
     13
SYSTEM Rail-0.85DOPv^N     14
SYSTEM Rail-0.85DOPv^O     15
--------------------------------------------------------------------------------
       Time Stamp   | Sensor Voltage 0V
MM/DD/YYYY HH:MM:SS | Sensor Value
--------------------------------------------------------------------------------
05/06/2015 16:42:51  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0
05/06/2015 18:24:24  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0
05/10/2015 17:53:42  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0
08/30/2017 16:14:40  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0
08/30/2017 23:34:24  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0
08/31/2017 22:16:23  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0
09/01/2017 00:57:15  0  1  1  0  1  1  1  1  1  1  1  1  2  3  5  0

--------------------------------------------------------------------------------
```

Emergency Actions

The chassis can power down a single card, providing a detailed response to over-temperature conditions on line cards. However, the chassis cannot safely operate when the temperature of the supervisor module itself exceeds the critical threshold. The supervisor module turns off the chassis' power supplies to protect itself from overheating. When this happens, you can recover the switch only by cycling the power on and off switches on the power supplies or by cycling the AC or DC inputs to the power supplies.

Shutdown temperature emergencies on a supervisor will trigger chassis shutdown. Shutdown temperature emergencies on a linecard will shut down the linecard but not the chassis. Critical temperature emergencies will trigger a warning message and the fan will be at its highest speed, but the chassis will not shut down. This applies to all slots.

The following table lists temperature emergencies but does not distinguish between critical and shutdown emergencies.

Table 2: Emergency and Action

Case 1. Complete fan failure emergency.	SYSLOG message displays and the chassis shuts down.
Case 2. Temperature emergency on a line card.	Power down the line card.

Case 3. Temperature emergency on a power supply. When the shutdown alarm threshold is exceeded, all the power supplies will shut down.	Power cycle the device to recover from power supply shut down.
Case 4. Temperature emergency on the active supervisor module.	Power down the chassis.

System Alarms

Any system has two types of alarms: major and minor. A major alarm indicates a critical problem that could lead to system shutdown. A minor alarm is informational—it alerts you to a problem that could become critical if corrective action is not taken.

The following table lists the possible environment alarms.

Table 3: Possible Environmental Alarms

A temperature sensor over its warning threshold	minor
A temperature sensor over its critical threshold	major
A temperature sensor over its shutdown threshold	major
A partial fan failure	minor
A complete fan failure **Note** A complete fan failure alarm does not result in system shutdown.	major

Fan failure alarms are issued as soon as the fan failure condition is detected and are canceled when the fan failure condition clears. Temperature alarms are issued as soon as the temperature reaches the threshold temperature. An LED on the supervisor module indicates whether an alarm has been issued.

When the system issues a major alarm, it starts a timer whose duration depends on the alarm. If the alarm is not canceled before the timer expires, the system takes emergency action to protect itself from the effects of overheating. The timer values and the emergency actions depend on the type of supervisor module.

Note Refer to the *Hardware Installation Guide* for information on LEDs, including the startup behavior of the supervisor module system LED.

Table 4: Alarms on Supervisor Module

Event	Alarm Type	Supervisor LED Color	Description and Action
Card temperature exceeds the critical threshold.	Major	Red	Syslog message displays when the alarm is issued.
Card temperature exceeds the shutdown threshold.	Major	Red	Syslog message displays when the alarm is issued.

Event	Alarm Type	Supervisor LED Color	Description and Action
Chassis temperature exceeds the warning threshold.	Minor	Orange	Syslog message displays when the alarm is issued.
Chassis fan tray experiences partial failure.	Minor	Orange	Syslog message displays when the alarm is issued.
Chassis fan tray experiences complete failure.	Major	Red	Syslog message displays when the alarm is issued.

Power Management

This section describes the power management feature in the Cisco Catalyst 9400 Series Switchesand the aspects of power management that you can control and configure. For information about the hardware, including installation, removal and power supply specifications, see the *Cisco Catalyst 9400 Series Switches Hardware Installation Guide*.

Power Supply Modes

Cisco Catalyst 9400 Series Switches offer combined and redundant configuration modes for power supplies.

Combined Mode

This is the default power supply mode.

The system operates on one to eight power supplies. All available power supplies are active and sharing power and can operate at up to 100 percent capacity.

Available power in the combined mode is the sum of the individual power supplies.

Redundant Mode

In a redundant configuration, a given power supply module can be either active, or in standby mode, and switch to active when required.

You can configure an n+1 or an n+n redundant mode.

- n+1 redundant Mode—n number of power supply modules are active (n can be one to seven pput ower supply modules). +1 is the power supply module reserved for redundancy.

  The default standby power supply slot is PS8. Specify a standby slot, by entering the **power redundancy-mode redundant n+1** *standby-PSslot* command.

- n+n redundant Mode—n number of power supplies are active and n number of power supply modules are configured as standby.

  The default standby slots for this mode are PS5 through PS8. Specify the standby slots, by entering the **power redundancy-mode redundant n+n** *standby-PSslots* command.

Enter the **show power detail** command in priviledged EXEC mode, to display detailed information about the currently configured power supply mode. See show power detail, on page 9.

Operating States

The operating state refers to the system's capacity to respond to a situation where all active power supply modules fail. The system deems the chassis operating state as full protected, normal protected, or combined depending on these factors:

- Total active output power, which is the total output power that is available from all the active power supply modules in the chassis.
- Required budgeted power, which is the power the system requires only for the supervisor modules, switching modules (line cards), and fan tray to operate in the chassis.

  In the **show** command outputs (**show power**, **show power detail**), this is displayed as `System Power`.
- Total standby output power, which is the total output power that is available from all the power supply modules in the chassis that are configured as standby.

Whether in the n+1 or n+n mode, the system considers the chassis in a full protected state, when ALL of these conditions are met:

- Total active output power is greater than the required budgeted power
- Total standby output power is greater than or equal to total active output power

Whether in the n+1 or n+n mode, the system considers the chassis in a normal protected state, when ALL of these conditions are met:

- Total active output power is greater than the required budgeted power
- Total standby output power is lesser than the total active output power

The system operates in a combined state, when it encounters these conditions (any redundancy configuration is rejected):

- Total active output power is lesser than the required budgeted power
- A standby power supply module is not configured or installed.

Example: Operating State

The following sample output of the **show power** command, shows a power supply configuration that is in a full protected state.

Here, the power supply modules in slots 1 and 2 are active and sharing power; power supply modules in slots 7 and 8 are in standby. The required budgeted power is 2115W and inline power requires 3185W. The switch is in a full protected state because

- Total active output power (`PS1 Capacity + PS2 Capacity`) is greater than the required budgeted power (`System Power - Maximim Used 2115`) and
- Total standby output power (`PS7 Capacity + PS8 Capacity`) is equal to total active output power (`PS1 Capacity + PS2 Capacity`).

```
Device# show power
Power        Model No             Type  Capacity   Status        1    2    3    4
Supply
------       -------------------- ----  --------  ------------  -----------------------
PS1          C9400-PWR-3200AC      AC   3200 W    active        good good good good
PS2          C9400-PWR-3200AC      AC   3200 W    active        good good good good
PS7          C9400-PWR-3200AC      AC   3200 W    standby       n.a. n.a. n.a. n.a.
PS8          C9400-PWR-3200AC      AC   3200 W    standby       n.a. n.a. n.a. n.a.

PS Current Configuration Mode: N+N redundant
PS Current Operating State: Full protected

Power supplies currently active: 2
Power supplies currently available: 3
Power Summary  Maximum
(in Watts)     Used     Available
-------------  ------   --------
System Power   2115     2115
Inline Power   3185     4285
-------------  ------   ---------
Total          5300     6400
Automatic Linecard Shutdown: Enabled
Power Budget Mode          : Dual Sup

<output truncated>
```

Information about the operating state is also displayed in the **show power detail** command output. See show power detail, on page 9.

Power Management Considerations

It is possible to configure a switch that requires more power than the power supplies provide.

- The power requirements for the installed modules exceed the power provided by the power supplies.
  - If the switch has a single power supply module that is unable to meet power requirements, the following error message is displayed:

    ```
    Insufficient power supplies present for specified configuration
    ```

    The **show power** command output will also indicate this state of insufficient input power.
  - If the switch has more than one power supply module, and requirements for the installed modules still exceed the power provided by the power supplies, the following error message is displayed:

    ```
    Insufficient number of power supplies (2) are installed for power redundancy mode
    ```

    The **show power** command output will also indicate this state of insufficient input power.

  If you attempt to insert additional modules into your switch and exceed the power supply, the switch immediately places the newly inserted module into reset mode, and the following error message is displayed:

  ```
  Power doesn't meet minimum system power requirement.
  ```

  Additionally, if you power down a functioning chassis and insert an additional linecard or change the module configuration so that the power requirements exceed the available power, one or more linecards enter reset mode when you power on the switch again.
- The power requirements for the PoE exceed the PoE provided by the power supplies

If you have too many IP phones drawing power from the system, power to IP phones is cut, and some phones may be powered down to reduce the power requirements to match the power supplies.

A module in reset mode continues to draw power as long as it is installed in the chassis; use the **show power module** command to determine how much power is required to bring the module online.

To compute the power requirements for your system and verify that your system has enough power, add the power consumed by the supervisor module(s), the fan trays, and the installed linecards (including PoE). For PoE, total the requirements for all the phones.

The 802.3at-compliant PoE modules can consume up to 60W of PoE. Be sure to add 60W to your PoE requirements for each 802.3at-compliant PoE module to ensure that the system has adequate power for the PDs connected to the switch.

For all POE supported line cards (C9400-LC-48UX, C9400-LC-48U, C9400-LC-48P), PoE consumption is equal to the administrative PoE.

If a powered device (PD) comsumes more power than allocated power, the following Imax error is generated; further the port is shutdown and in a faulty state:

```
*Jun 21 10:06:06.149: %ILPOWER-3-CONTROLLER_PORT_ERR: Controller port error, Interface
 Gi7/0/13: Power Controller reports power Imax error
*Jun 21 10:06:06.208: %ILPOWER-5-IEEE_DISCONNECT: Interface Gi7/0/13: PD removed
Device# show power inline 7/0/13
Gi7/0/13  auto   faulty     0.0        0.0        n/a    n/a
```

show power detail

The **show power detail** command inlcudes the output of **show power** and **show power module** privileged EXEC commmands.

The following is sample output of the **show power detail** command with a different type power supply module in each example. In all the examples, The power supply mode and operating state is `combined`:

```
Switch# show power detail

Power                                                          Fan States
Supply  Model No              Type  Capacity  Status        1     2     3     4
------  --------------------  ----  --------  ------------  ----------------------

PS1     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS2     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS3     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS4     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS5     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS6     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS7     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good
PS8     C9400-PWR-2100AC      AC    2100 W    active        good  good  good  good

PS Current Configuration Mode : Combined
PS Current Operating State    : Combined

Power supplies currently active    : 8
Power supplies currently available : 8

Power Summary          Maximum
(in Watts)    Used    Available
------------  ------  ---------
System Power   2030    2030
```

```
Inline Power   106     14770
-------------  ------  ---------
Total          2136    16800


Automatic Linecard Shutdown : Enabled
Power Budget Mode           : Dual Sup

                           autoLC    Power                                    Out of  In
Mod  Model No              Priority  State     Budget  Instantaneous  Peak    Reset   Reset
---  --------------------  --------  --------  ------  -------------  ----    ------  -----
1    C9400-LC-24XS         0         accepted  200     87             88      200     10
2    C9400-LC-48T          1         accepted  65      35             43      65      5
3    C9400-SUP-1           0         accepted  400     235            253     400     130
4    C9400-SUP-1           0         accepted  400     235            253     400     130
5    C9400-LC-48T          2         accepted  65      35             37      65      5
6    C9400-LC-24XS         3         accepted  200     87             88      200     10
7    C9400-LC-48UX         4         accepted  350     189            203     350     15
--   Fan Tray              0         accepted  350     --             --      350     --
---  --------------------  --------  --------  ------  -------------  ----    ------  -----
Total   2030


Switch# show power detail

Power                                                                 Fan States
Supply  Model No              Type  Capacity  Status        1     2     3     4
------  --------------------  ----  --------  ------------  ------------------------

PS1     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS2     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS3     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS4     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS5     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS6     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS7     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS8     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good

PS Current Configuration Mode : Combined
PS Current Operating State    : Combined

Power supplies currently active    : 8
Power supplies currently available : 8

Power Summary          Maximum
(in Watts)    Used    Available
------------  ------  ---------
System Power   2030    2030
Inline Power   106     23570
-------------  ------  ---------
Total          2136    25600


Automatic Linecard Shutdown : Enabled
Power Budget Mode           : Dual Sup

                           autoLC    Power                                    Out of  In
Mod  Model No              Priority  State     Budget  Instantaneous  Peak    Reset   Reset
---  --------------------  --------  --------  ------  -------------  ----    ------  -----
1    C9400-LC-24XS         0         accepted  200     87             88      200     10
2    C9400-LC-48T          1         accepted  65      35             43      65      5
3    C9400-SUP-1           0         accepted  400     235            253     400     130
4    C9400-SUP-1           0         accepted  400     235            253     400     130
5    C9400-LC-48T          2         accepted  65      35             37      65      5
```

```
6    C9400-LC-24XS          3         accepted  200     87             88    200     10
7    C9400-LC-48UX          4         accepted  350     189            203   350     15
--   Fan Tray               0         accepted  350     --             --    350     --
---  --------------------  --------  --------  ------  -------------  ----  ------  -----
Total   2030
```

Selecting a Power Supply Mode

Your switch hardware configuration dictates which power supply or supplies you should use. For example, if your switch configuration requires more power than a single power supply provides, use the Cisco power calculator on cisco.com to help determine the number of power supplies that is required for either combined or redundant mode.

Configuring the Redundant Mode

By default, the power supplies in the switch are set to operate in combined mode. To effectively use redundant mode, note the following:

- If you have the power supply mode set to redundant mode and only one power supply installed, your switch accepts the configuration but operates without redundancy.
- Choose a power supply module that is powerful enough to support the switch configuration.
- Use the Cisco Power Calculator to help assess the number of power supplies required by the system. Ensure that you install a sufficient number of power supply modules, so that the chassis and PoE requirements are less than the maximum available power. Power supplies automatically adjust the power resources at startup to accommodate the chassis and PoE requirements. Modules are brought up first, followed by IP phones.
- For optimal use of system power, choose power supply modules of the same capacity when configuring a redundant mode on the switch.

To configure redundant mode, perform this task:

SUMMARY STEPS

1. **configure terminal**
2. **power redundancy-mode redundant** [**n+1** *standby-PSslot* | **n+1** *standby-PSslot*]
3. **end**
4. **show power**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 2	**power redundancy-mode redundant** [**n+1** *standby-PSslot*	**n+1** *standby-PSslot*] **Example:**	You can choose from these options: • **power redundancy-mode redundant n+1** *standby-PSslot*—Configures the n+1 redundant mode.

	Command or Action	Purpose
	Device(config)# **power redundancy-mode redundant n+1 5** OR Device(config)# **power redundancy-mode redundant n+n 5 6 7 8**	Enter the standby power supply module slot number. The default standby slot in this redundant mode is 8. In the n+1 example here, the power supply module in slot PS5 (and not the default PS8) is the designated standby module and has been configured accordingly. Operational power supply modules installed in all other slots, are active. • **power redundancy-mode redundant n+n** *standby-PSslot*—Configures the n+n redundant mode. Enter the standby power supply module slot numbers. The default standby slots in this redundant mode are 5 through 8. In the n+n example here, the power supply modules in slots PS5, PS6, PS7, and PS8 are being used as standby modules, and have been configured accordingly. Operational power supply modules installed in all other slots, are active. If you are using power supply modules of different capacities, you must also observe these guidelines: • For the n+1 redundant mode, configure the power supply module with the highest wattage or capacity as the standby. • For the n+n redundant mode – Ensure that the total standby output power is greater than or equal to the total active output power.
Step 3	**end** **Example:** Device(config)# **end**	Exits global configuration mode.
Step 4	**show power** **Example:** Device# **show power**	Displays the power redundancy mode information.

Configuring the Combined Mode

To use the combined mode effectively, follow these guidelines:

- Choose a power supply module that provides enough power so that the chassis and PoE requirements are less than the maximum available power. Power supply modules automatically adjust the power resources at startup, to accommodate the chassis and PoE requirements.
- If you have the power supply mode set to combined mode and only one power supply installed, your switch accepts the configuration, but power is available from only one power supply.

- When your switch is configured to combined mode, available power is the sum of the individual power supplies

To configure combined mode on your switch, perform this task:

Before you begin

Note that this mode utilizes the available power from all the power supplies; however, your switch has no power redundancy.

SUMMARY STEPS

1. **configure terminal**
2. **power redundancy-mode combined**
3. **end**
4. **show power**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 2	**power redundancy-mode combined** **Example:** `Device(config)# power redundancy-mode combined`	Sets the power supply mode to combined mode.
Step 3	**end** **Example:** `Device(config)# end`	Exits global configuration mode.
Step 4	**show power** **Example:** `Device# show power`	Displays the power redundancy mode information.

Power Budgeting for Supervisor Modules

The power budget, or required budgeted power, is the power the system ***requires*** and ***reserves*** for supervisor modules, switching modules (line cards), and the fan tray to operate in the chassis. In the **show power**, and **show power detail** command outputs, this is displayed as `System Power`. The system does not allow any part of this required budgeted power to be automatically redirected for use by other components in the system.

This section describes how power budgeting works with respect to supervisor modules and the configuration options that are available.

By default, the system reserves power for a redundant setup, to ensure high availability. This means that the system reserves the power required by both the supervisor modules in the chassis, as part of the required budgeted power (`System Power`).

You can also configure the system to reserve power for a single supervisor. This configuration option is suited to situations where a single supervisor is installed and the total available power is not sufficent to enable all line cards and PoE ports. In such a scenario, configuring the switch to reserve power for a single supervisor enables you to free-up power and use it for other components, such as PoE ports, or line cards instead.

Note the following restrictions and guidelines:

- If you have installed both supervisor modules, you cannot configure the power budget mode for a single supervisor. The system rejects the configuration and following message is displayed: `cannot enable single sup mode when remote supervisor is present.`
- If you have installed both supervisor modules and the default setting is effective, you must install the necessary number of power supply modules to meet overall system requirements (including line cards, fan tray and POE ports). Do not remove the second supervisor to remedy a situation where there is an insufficient number of power supply modules.
- If you have installed a single supervisor module and configured the power budget mode for a single supervisor, do not install a second supervisor. If you do, one of two things may happen:
  - The system may reject configuration, accompanied by the following error message: `ERROR: Remote supervisor has been detected in slot 6. System is configured to SINGLE-SUP power mode. Remove remote supervisor IMMEDIATELY.`
  - If this action is accompanied by a low power condition where the system does not have sufficient power for the second supervisor, the system may shut down.

  For information about how to safely move from a single to a dual supervisor setup, see task *Moving from a Single to a Dual Supervisor Setup* below.

The following tasks describe the available configuration options:

Configuring the Power Budget Mode for a Single Supervisor

Beginning in the privileged EXEC mode, perform these steps to configure the power budget mode for a single supervisor setup:

Before you begin

Ensure that these prerequisites are met:

- You have installed only one supervisor module in the chassis.
- You have installed a blank in the second supervisor slot.

SUMMARY STEPS

1. **configure terminal**
2. **power budget mode** {**single-sup**}
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 2	**power budget mode** {**single-sup**} **Example:** `Device(config)# power budget mode single-sup`	Reserves power for one supervisor module in the chassis.
Step 3	**end** **Example:** `Device(config)# end`	Exits the global configuration mode.

Moving from a Single to a Dual Supervisor Setup

Beginning in the privileged EXEC mode, perform these steps to move from single to a dual supervisor setup:

Before you begin

Calculate the required power for a dual supervisor setup. Cisco Power Calculator (CPC) enables you to calculate the power supply requirements for a specified configuration:

1. Go to https://cpc.cloudapps.cisco.com/cpc → **Launch Cisco Power Calculator**.
2. Select applicable values for the `Product Family`, `Chassis`, `Supervisor Engine` (both supervisor slots), `Input Voltage`, and `Line Card` fields. Click **Next** to display results.
3. In the results that are displayed, locate the `Configuration Details` section and note the `Output Power` for the supervisor module. This is the amount of spare power that must be available in the system to safely install the second supervisor.
4. Enter the **show power** command in privileged EXEC mode.

   This command displays power supply configuration information.

   In the output, check the difference between the `Total Maximum Available` and `Total Used`, this must be greater that what the CPC says in the `Output Power` column for the supervisor module. If this is the case, proceed with the task, if not, first install the required number of additional power supply modules.

SUMMARY STEPS

1. **configure terminal**
2. **no power budget mode** {**single-sup**}
3. **end**
4. Insert the second supervisor module in the supervisor slot.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 2	**no power budget mode** {**single-sup**} **Example:** `Device(config)# no power budget mode single-sup`	Reverts to the default setting where the system reserves power for both the supervisor modules in the chassis.
Step 3	**end** **Example:** `Device(config)# end`	Exits configuration mode.
Step 4	Insert the second supervisor module in the supervisor slot.	For detailed steps, see the Supervisor Module Installation Note → Removal and Replacement Procedures, on cisco.com.

Enabling Auto Line Card Shutdown

Auto line card shutdown or autoLC, is disabled by default. This feature allows you to configure line card power priority. It enables the hardware to automatically shut down line cards in the event of a power constraint, until the total available power becomes greater than or equal to the total used power displayed in the power summary of the **show power** command. This feature provides deterministic behavior of the switch in case of power supply failure events and prioritized line card shutdown events.

To configure autoLC shutdown and line card power priority, perform the following task:

SUMMARY STEPS

1. **configure terminal**
2. **power supply autoLC shutdown**
3. **power supply autoLCpriority***physical-slot-number*
4. **end**
5. **show power module**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 2	**power supply autoLC shutdown** **Example:** `Device(config)# power supply autoLC shutdown`	(Optional) Enables automatic shutdown of line cards in case of a power supply failure event.

<table>
<tr><th></th><th>Command or Action</th><th>Purpose</th></tr>
<tr><td>Step 3</td><td>power supply autoLCpriorityphysical-slot-number
Example:
<pre>Device(config)# power supply autoLC priority 1 2 5 6 7</pre></td><td>(Optional) Configures line card power priority. Enter the line card slot numbers to indicate their autoLC shutdown priority. The system assigns the highest priority (0) to the slot number you enter first, and this is the last to be shut down in case of a failure.

The system does not accept a partial list of line card slot numbers. For example, for a 7-slot chassis, you must mention all the five line card slots.

In the example configuration provided on the left, the physical slot number order and system-assigned priority for a 7-slot chassis is as follows:

<table><tr><th>Configured Order</th><th>autoLC Priority</th></tr><tr><td>1</td><td>0 (shuts down last)</td></tr><tr><td>2</td><td>1</td></tr><tr><td>5</td><td>2</td></tr><tr><td>6</td><td>3</td></tr><tr><td>7</td><td>4 (shuts down first)</td></tr></table>
If you do not specify an order and autoLC shutdown is enabled, then by default the system shuts down line cards from the highest to the lowest physical slot number. Accordingly, default configuration is as follows:

• 4-slot chassis: power supply autoLC priority 1 4
• 7-slot chassis: power supply autoLC priority 1 2 5 6 7
• 10-slot chassis: power supply autoLC priority 1 2 3 4 7 8 9 10</td></tr>
<tr><td>Step 4</td><td>end
Example:
<pre>Device(config)# end</pre></td><td>Exits global configuration mode.</td></tr>
<tr><td>Step 5</td><td>show power module
Example:
<pre>Device# show power module</pre></td><td>Displays power redundancy mode information, and includes information about whether the autoLC is enabled.</td></tr>
</table>

Powering Down a Line Card

If your system does not have enough power for all modules installed in the switch, you can power down one or more line cards and place them in power-off mode.

To power down a line card, perform this task:

SUMMARY STEPS

1. **configure terminal**
2. **hw-module subslot** *card slot/subslot number* **shutdown unpowered**
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 2	**hw-module subslot** *card slot/subslot number* **shutdown unpowered** **Example:** `Device(config)# hw-module subslot 1/0 shutdown unpowered`	Powers down the specified module by placing it in low power mode.
Step 3	**end** **Example:** `Device(config)# end`	Exits the global configuration mode

Configuration Examples for Power Supply Modes and Operating States

The examples in this section illustrate different power supply setups. They describe how the Power Supply Module Installation Considerations in the *Cisco Catalyst 9400 Series Switches Hardware Installation Guide* and the *Operating States* section in this document affect possible power supply mode configurations. Both combined and redundant power supply modes, and the resulting operating states are covered.

Example: Combined Mode and State

The table below represents the two rows of power supply slots in a Cisco Catalyst 9400 Series chassis. Power supply slots are indicated as PS1, PS2, and so on. For this example, power supply modules of the same capacity and type (C9400-PWR-3200AC) have been installed in slots 1 through 8.

PS1 (Active) C9400-PWR-3200AC	**PS2 (Active)** C9400-PWR-3200AC	**PS3 (Active)** C9400-PWR-3200AC	**PS4 (Active)** C9400-PWR-3200AC
PS5 (Active) C9400-PWR-3200AC	**PS6 (Active)** C9400-PWR-3200AC	**PS7 (Active)** C9400-PWR-3200AC	**PS8 (Active)** C9400-PWR-3200AC

All installed modules are AC-input power supply modules of the same capacity and with the same AC-input voltage voltage level. All available power supply modules are active and sharing power and can operate at up to 100 percent capacity.

The switch is in a combined operating state because a standby power supply module is not configured.

The following is sample output of this setup (the **show power** privileged EXEC command):

```
Device# show power
Power                                                          Fan States
Supply  Model No              Type  Capacity  Status         1     2
------  --------------------  ----  --------  -------------  -----------
PS1     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS2     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS3     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS4     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS5     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS6     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS7     C9400-PWR-3200AC      ac    3200 W    active         good  good
PS8     C9400-PWR-3200AC      ac    3200 W    standby        good  good


PS Current Configuration Mode : Combined
PS Current Operating State    : Combined

Power supplies currently active    : 8
Power supplies currently available : 8

Power Summary          Maximum
(in Watts)    Used    Available
------------  ------  ---------
System Power  2030    2030
Inline Power  106     23570
------------  ------  ---------
Total         2136    25600

<output truncated>
```

In case of failure in the combined mode, each operational power supply increases its output. If the output power does not meet system requirements and the **power supply autolc shutdown** command is disabled, then all the operational power supply modules may be overloaded and go into overcurrent shutdown. All system power is then lost. We recommend enabling the **power supply autolc shutdown** command.

Example: n+1 Redundant Mode (Power Supply Modules of the Same Capacity and Type + Normal Protected State)

The table below represents the two rows of power supply slots in a Cisco Catalyst 9400 Series chassis. Power supply slots are indicated as PS1, PS2, and so on. For this example, power supply modules of the same capacity and type (C9400-PWR-3200AC) have been installed in slots 1 through 8. Slot 8 has the +1 standby power supply module.

PS1 (Active) C9400-PWR-3200AC	**PS2 (Active)** C9400-PWR-3200AC	**PS3 (Active)** C9400-PWR-3200AC	**PS4 (Active)** C9400-PWR-3200AC
PS5 (Active) C9400-PWR-3200AC	**PS6 (Active)** C9400-PWR-3200AC	**PS7 (Active)** C9400-PWR-3200AC	*PS8 (Standby)* C9400-PWR-3200AC

The switch meets all the required conditions for an n+1 redundant mode with a normal protected state.

- It is in an n+1 redundant mode, because one power supply module is configured as standby.

  It also meets all the n+1 redundant mode conditions: All installed modules are AC-input power supply modules of the same capacity and with the same AC-input voltage voltage level.

- It is in a normal protected state, because:

  Total standby output power (3200 W) is lesser than total active output power (22400).

  and

  Total active output power (22400) is greater than the required budgeted power (2030)

The following is sample output of this setup (the **show power** privileged EXEC command):

```
Device# show power

Power                                                          Fan States
Supply  Model No              Type  Capacity  Status        1     2     3     4
------  --------------------  ----  --------  ------------  ------------------------

PS1     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS2     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS3     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS4     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS5     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS6     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS7     C9400-PWR-3200AC      AC    3200 W    active        good  good  good  good
PS8     C9400-PWR-3200AC      AC    3200 W    standby       n.a.  n.a.  n.a.  n.a.

PS Current Configuration Mode : N+1 redundant
PS Current Operating State    : Normal protected
PS Slots Configured standby   : PS8

Power supplies currently active    : 7
Power supplies currently available : 8

Power Summary          Maximum
(in Watts)    Used    Available
------------  ------  ---------
System Power   2030    2030
Inline Power   106     20370
------------  ------  ---------
Total          2136    22400


Automatic Linecard Shutdown : Enabled
Power Budget Mode           : Dual Sup

<output truncated>
```

Other valid configuration options that have the same end result of n+1 with normal protected state:

- Any one of the other power supply slots is configured as standby.
- A power supply module of a different capacity is installed in all the slots. For example C9400-PWR-2100AC power supply modules with the same AC-input voltage voltage level, in all the slots.

Example: n+n Redundant Mode (Power Supply Modules of the Same Capacity + Full Protected State)

The table below represents the two rows of power supply slots in a Cisco Catalyst 9400 Series chassis. Power supply slots are indicated as PS1, PS2, and so on. For this example, power supply modules of the same capacity (C9400-PWR-3200AC) have been installed in slots 1 through 8. Slots 1 through 4 are configured as active; slots 5 through 8 are configured as standby.

PS1 (Active)	**PS2 (Active)**	**PS3 (Active)**	**PS4 (Active)**
C9400-PWR-3200AC	C9400-PWR-3200AC	C9400-PWR-3200AC	C9400-PWR-3200AC
PS5 (Standby)	*PS6 (Standby)*	*PS7 (Standby)*	*PS8 (Standby)*
C9400-PWR-3200AC	C9400-PWR-3200AC	C9400-PWR-3200AC	C9400-PWR-3200AC

The switch meets all the required conditions for an n+n redundant mode with a full protected state.

- It is in an n+n redundant mode, because n number of power supply modules are configured as active, and the same number, as standby

  It also meets all the n+n redundant mode conditions: All installed modules are AC-input power supply modules of the same capacity and with the same AC-input voltage voltage level.

- It is in a full protected state, because:

  Total active output power (12800) is greater than the required budgeted power (3505).

  and

  Total standby output power (12800) is equal to total active output power (12800).

The following is sample output of this setup (the **show power** privileged EXEC command):

```
C9407#show power detail

Power                                                    Fan States
Supply  Model No              Type  Capacity  Status     1     2     3     4
------  --------------------  ----  --------  ---------- ------------------------

PS1     C9400-PWR-3200AC      AC    3200 W    active     good  good  good  good
PS2     C9400-PWR-3200AC      AC    3200 W    active     good  good  good  good
PS3     C9400-PWR-3200AC      AC    3200 W    active     good  good  good  good
PS4     C9400-PWR-3200AC      AC    3200 W    active     good  good  good  good
PS5     C9400-PWR-3200AC      AC    3200 W    standby    n.a.  n.a.  n.a.  n.a.
PS6     C9400-PWR-3200AC      AC    3200 W    standby    n.a.  n.a.  n.a.  n.a.
PS7     C9400-PWR-3200AC      AC    3200 W    standby    n.a.  n.a.  n.a.  n.a.
PS8     C9400-PWR-3200AC      AC    3200 W    standby    n.a.  n.a.  n.a.  n.a.

PS Current Configuration Mode : N+N redundant
PS Current Operating State    : Full protected
PS Slots Configured standby   : PS5, PS6, PS7, PS8

Power supplies currently active    : 4
Power supplies currently available : 8

Power Summary          Maximum
(in Watts)    Used    Available
------------  ------  ---------
System Power   2030    2030
```

```
Inline Power   106     10770
-------------  ------  ---------
Total          2136    12800


Automatic Linecard Shutdown : Enabled
Power Budget Mode           : Dual Sup
```

Other valid configuration options that have the same end result of n+n with full protected state:

- Any of the four slots may be configured as active and any four, as standby.
- A power supply module of a different capacity is installed in all the slots. For example C9400-PWR-2100AC power supply modules with the same AC-input voltage voltage level, in all the slots.

Feature History for Environmental Monitoring and Power Management

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Everest 16.6.1	Environmental Monitoring and Power Management	Environmental monitoring of chassis components provides early warning indications of possible component failure. This warning helps you to ensure the safe and reliable operation of your system and avoid network interruptions.
Cisco IOS XE Fuji 16.8.1a	Power Budget Mode	The power budget mode was introduced Support for the 2100W AC-Input power supply module was introduced (C9400-PWR-2100AC).

Use Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn.