



## **Cisco Wide Area Virtualization Engine 594 and 694 Hardware Installation Guide**

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- Move the equipment farther away from the television or radio.
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# Preface

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This preface describes the purpose of the *Cisco Wide Area Virtualization Engine 594 and 694 Hardware Installation Guide*, who should read it, how it is organized, and its document conventions.

This preface contains the following sections:

- [Purpose](#)
- [Audience](#)
- [Organization](#)
- [Conventions](#)
- [Related Documentation](#)
- [Obtaining Documentation and Submitting a Service Request](#)

## Purpose

This installation guide explains how to prepare your site for installation, how to install a Wide Area Virtualization Engine 594 and 694 (WAVE-594 and WAVE-694) in an equipment rack, and how to maintain and troubleshoot the system hardware. After completing the hardware installation procedures covered in this guide, you will then use the appropriate related publications to configure your system. (See [Related Documentation](#).)

## Audience

To use this installation guide, you should be familiar with internetworking equipment and cabling, and have a basic knowledge of electronic circuitry and wiring practices.

To complete the installation, including the software configuration for your WAVE-594 and WAVE-694 appliance and for the router that works with the WAVE-594 and WAVE-694 appliance, you should be familiar with basic networking principles, router configuration, and web page protocols.



**Warning**

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**Only trained and qualified personnel should be allowed to install, replace, or service this equipment.** Statement 1030

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# Organization

This guide is organized as follows:

Chapter	Title	Description
Chapter 1	<a href="#">Introducing the Cisco Wide Area Virtualization Engine 594 and 694</a>	Describes the physical properties and provides a functional overview of the WAVE-594 and WAVE-694.
Chapter 2	<a href="#">Preparing to Install the WAVE-594 and WAVE-694</a>	Describes safety considerations and gives an overview of the installation and procedures that you should perform <i>before</i> the actual installation.
Chapter 3	<a href="#">Installing the WAVE-594 and WAVE-694</a>	Describes how to install the hardware and connect the external network interface cables.
Chapter 4	<a href="#">Installing Hardware Options for the WAVE-594 and WAVE-694</a>	Describes how to install Cisco Interface Modules, hard disk drives, fans, power supplies, and memory.
Chapter 5	<a href="#">WAVE Interface Modules</a>	Describes the features and cabling requirements of the Cisco WAVE-594 and WAVE-694 Cisco Interface Modules.
Chapter 6	<a href="#">Troubleshooting the System Hardware</a>	Describes troubleshooting procedures for the hardware installation.
Appendix A	<a href="#">WAVE-594 and WAVE-694 Hardware Specifications</a>	Gives a summary of the hardware features and specifications.
Appendix B	<a href="#">Maintaining the WAVE-594 and WAVE-694</a>	Describes how to maintain the WAVE-594 and WAVE-694.

# Conventions

Command descriptions use the following conventions:

Convention	Description
<b>boldface</b> font	Commands and keywords are in <b>boldface</b> .
<i>italic</i> font	Variables for which you supply values are in <i>italics</i> .
[ ]	Elements in square brackets are optional.
{ x   y   z }	Alternative keywords are grouped in braces and separated by vertical bars.
[ x   y   z ]	Optional alternative keywords are grouped in brackets and separated by vertical bars.
string	A nonquoted set of characters. Do not use quotation marks around the string, or the string will include the quotation marks.



Screen examples use the following conventions:

Convention	Description
screen font	Terminal sessions and information the system displays are in screen font.
<b>boldface screen font</b>	Information you must enter is in <b>boldface screen font</b> .
<i>italic screen font</i>	Variables for which you supply values are in <i>italic screen font</i> .
^	The symbol ^ represents the key labeled Control—for example, the key combination ^D in a screen display means hold down the Control key while you press the D key.
< >	Nonprinting characters, such as passwords, are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Notes, cautionary statements, and safety warnings use these conventions:



**Note**

Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.



**Caution**

Means *reader be careful*. You are capable of doing something that might result in equipment damage or loss of data.



Warning

---

## IMPORTANT SAFETY INSTRUCTIONS

---

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

### SAVE THESE INSTRUCTIONS

---

Figyelem

## FONTOS BIZTONSÁGI ELOÍRÁSOK

Ez a figyelmeztető jel veszélyre utal. Sérülésveszélyt rejtő helyzetben van. Mielőtt bármely berendezésen munkát végezte, legyen figyelemmel az elektromos áramkörök okozta kockázatokra, és ismerkedjen meg a szokásos balesetvédelmi eljárásokkal. A kiadványban szereplő figyelmeztetések fordítása a készülékhez mellékelte biztonsági figyelmeztetések között található; a fordítás az egyes figyelmeztetések végén látható szám alapján kereshető meg.

### ORIZZE MEG EZEKET AZ UTASÍTÁSOKAT!

Предупреждение

## ВАЖНЫЕ ИНСТРУКЦИИ ПО СОБЛЮДЕНИЮ ТЕХНИКИ БЕЗОПАСНОСТИ

Этот символ предупреждения обозначает опасность. То есть имеет место ситуация, в которой следует опасаться телесных повреждений. Перед эксплуатацией оборудования выясните, каким опасностям может подвергаться пользователь при использовании электрических цепей, и ознакомьтесь с правилами техники безопасности для предотвращения возможных несчастных случаев. Воспользуйтесь номером заявления, приведенным в конце каждого предупреждения, чтобы найти его переведенный вариант в переводе предупреждений по безопасности, прилагаемом к данному устройству.

### СОХРАНИТЕ ЭТИ ИНСТРУКЦИИ

警告

重要的安全性说明

此警告符号代表危险。您正处于可能受到严重伤害的工作环境中。在您使用设备开始工作之前，必须充分意识到触电的危险，并熟练掌握防止事故发生的标准工作程序。请根据每项警告结尾提供的声明号码来找到此设备的安全性警告说明的翻译文本。

请保存这些安全性说明

**警告** 安全上の重要な注意事項

「危険」の意味です。人身事故を予防するための注意事項が記述されています。装置の取り扱い作業を行うときは、電気回路の危険性に注意し、一般的な事故防止策に留意してください。警告の各国語版は、各注意事項の番号を基に、装置に付属の「Translated Safety Warnings」を参照してください。

これらの注意事項を保管しておいてください。

**주의** 중요 안전 지침

이 경고 기호는 위험을 나타냅니다. 작업자가 신체 부상을 일으킬 수 있는 위험한 환경에 있습니다. 장비에 작업을 수행하기 전에 전기 회로와 관련된 위험을 숙지하고 표준 작업 관례를 숙지하여 사고를 방지하십시오. 각 경고의 마지막 부분에 있는 경고문 번호를 참조하여 이 장치와 함께 제공되는 번역된 안전 경고문에서 해당 번역문을 찾으십시오.

이 지시 사항을 보관하십시오.

**تحذير**

**إرشادات الأمان الهامة**

يوضح رمز التحذير هذا وجود خطر. وهذا يعني أنك متواجد في مكان قد ينتج عنه التعرض لإصابات. قبل بدء العمل، احذر مخاطر التعرض للصدمات الكهربائية وكن على علم بالإجراءات القياسية للحيولة دون وقوع أي حوادث. استخدم رقم البيان الموجود في آخر كل تحذير لتحديد مكان ترجمته داخل تحذيرات الأمان المترجمة التي تأتي مع الجهاز. قم بحفظ هذه الإرشادات

**Upozorenje** VAŽNE SIGURNOSNE NAPOMENE

Ovaj simbol upozorenja predstavlja opasnost. Nalazite se u situaciji koja može prouzročiti tjelesne ozljede. Prije rada s bilo kojim uređajem, morate razumjeti opasnosti vezane uz električne sklopove, te biti upoznat i sa standardnim načinima izbjegavanja nesreća. U prevedenim sigurnosnim upozorenjima, priloženima uz uređaj, možete prema broju koji se nalazi uz pojedino upozorenje pronaći i njegov prijevod.

**SAČUVAJTE OVE UPUTE**

**Upozornění** DŮLEŽITÉ BEZPEČNOSTNÍ POKYNY

Tento upozorňující symbol označuje nebezpečí. Jste v situaci, která by mohla způsobit nebezpečí úrazu. Před prací na jakémkoliv vybavení si uvědomte nebezpečí související s elektrickými obvody a seznamte se se standardními opatřeními pro předcházení úrazům. Podle čísla na konci každého upozornění vyhledejte jeho překlad v přeložených bezpečnostních upozorněních, která jsou přiložena k zařízení.

**USCHOVEJTE TYTO POKYNY**

Προειδοποίηση ΣΗΜΑΝΤΙΚΕΣ ΟΔΗΓΙΕΣ ΑΣΦΑΛΕΙΑΣ

Αυτό το προειδοποιητικό σύμβολο σημαίνει κίνδυνο. Βρίσκεστε σε κατάσταση που μπορεί να προκαλέσει τραυματισμό. Πριν εργαστείτε σε οποιοδήποτε εξοπλισμό, να έχετε υπόψη σας τους κινδύνους που σχετίζονται με τα ηλεκτρικά κυκλώματα και να έχετε εξοικειωθεί με τις συνήθεις πρακτικές για την αποφυγή ατυχημάτων. Χρησιμοποιήστε τον αριθμό δήλωσης που παρέχεται στο τέλος κάθε προειδοποίησης, για να εντοπίσετε τη μετάφρασή της στις μεταφρασμένες προειδοποιήσεις ασφαλείας που συνοδεύουν τη συσκευή.

ΦΥΛΑΞΤΕ ΑΥΤΕΣ ΤΙΣ ΟΔΗΓΙΕΣ

אזהרה

**הוראות בטיחות חשובות**

סימן אזהרה זה מסמל סכנה. אתה נמצא במצב העלול לגרום לפציעה. לפני שתעבוד עם ציוד כלשהו, עליך להיות מודע לסכנות הכרוכות במעגלים חשמליים ולהכיר את הנהלים המקובלים למניעת תאונות. השתמש במספר ההוראה המסופק בסופה של כל אזהרה כד לאתר את התרגום באזהרות הבטיחות המתורגמות שמצורפות להתקן.

**שמור הוראות אלה**

Opomena

**ВАЖНИ БЕЗБЕДНОСНИ НАПАТСТВИЈА**

Симболот за предупредување значи опасност. Се наоѓате во ситуација што може да предизвика телесни повреди. Пред да работите со опремата, бидете свесни за ризикот што постои кај електричните кола и треба да ги познавате стандардните постапки за спречување на несреќни случаи. Искористете го бројот на изјавата што се наоѓа на крајот на секое предупредување за да го најдете неговиот период во преведените безбедносни предупредувања што се испорачани со уредот.  
ЧУВАЈТЕ ГИ ОБИЕ НАПАТСТВИЈА

Ostrzeżenie

**WAŻNE INSTRUKCJE DOTYCZĄCE BEZPIECZEŃSTWA**

**Ten symbol ostrzeżenia oznacza niebezpieczeństwo. Zachodzi sytuacja, która może powodować obrażenia ciała. Przed przystąpieniem do prac przy urządzeniach należy zapoznać się z zagrożeniami związanymi z układami elektrycznymi oraz ze standardowymi środkami zapobiegania wypadkom. Na końcu każdego ostrzeżenia podano numer, na podstawie którego można odszukać tłumaczenie tego ostrzeżenia w dołączonym do urządzenia dokumencie z tłumaczeniami ostrzeżeń.**

**NINIEJSZE INSTRUKCJE NALEŻY ZACHOWAĆ**

**Upozornenie DÔLEŽITÉ BEZPEČNOSTNÉ POKYNY**

Tento varovný symbol označuje nebezpečenstvo. Nachádzate sa v situácii s nebezpečenstvom úrazu. Pred prácou na akomkoľvek vybavení si uvedomte nebezpečenstvo súvisiace s elektrickými obvodmi a oboznámte sa so štandardnými opatreniami na predchádzanie úrazom. Podľa čísla na konci každého upozornenia vyhľadajte jeho preklad v preložených bezpečnostných upozorneniach, ktoré sú priložené k zariadeniu.

**USCHOVAJTE SI TENTO NÁVOD**

**Opozorilo POMEMBNI VARNOSTNI NAPOTKI**

Ta opozorilni simbol pomeni nevarnost. Nahajate se v situaciji, kjer lahko pride do telesnih poškodb. Preden pričnete z delom na napravi, se morate zavedati nevarnosti udara električnega toka, ter tudi poznati preventivne ukrepe za preprečevanje takšnih nevarnosti. Uporabite obrazložitevno številko na koncu posameznega opozorila, da najdete opis nevarnosti v priloženem varnostnem priročniku.

**SHRANITE TE NAPOTKE!**

**警告 重要安全性指示**  
此警告符號代表危險，表示可能造成人身傷害。使用任何設備前，請留心電路相關危險，並熟悉避免意外的標準作法。您可以使用每項警告後的聲明編號，查詢本裝置隨附之安全性警告譯文中的翻譯。  
請妥善保留此指示

## Related Documentation

The WAVE-594 and WAVE-694 appliance supports the Cisco Wide Area Application Services software (WAAS) and can function as either a WAAS Central Manager or as an Application Acceleration Engine.

The Cisco WAAS software document set includes the following documents:

- [Release Note for Cisco Wide Area Application Services](#)
- [Cisco Wide Area Application Services Upgrade Guide](#)
- [Cisco Wide Area Application Services Quick Configuration Guide](#)
- [Cisco Wide Area Application Services Configuration Guide](#)
- [Cisco Wide Area Application Services Command Reference](#)
- [Cisco Wide Area Application Services API Reference](#)
- [Cisco Wide Area Application Services Monitoring Guide](#)
- [Cisco WAAS Installation and Configuration Guide for Windows on a Virtual Blade](#)
- [Cisco WAAS Troubleshooting Guide for Release 4.1.3 and Later](#)

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The documentation for this product also includes the following hardware-related document:

- *Regulatory Compliance and Safety Information for the Cisco Wide Area Virtualization Engines*

## Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

<http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html>

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS version 2.0.



# CHAPTER 1

## Introducing the Cisco Wide Area Virtualization Engine 594 and 694

---

This chapter provides a basic functional overview of the Cisco Wide Area Virtualization Engine 594 and 694 (WAVE-594 and WAVE-694) appliance and describes the hardware, major components, and front and back panel indicators and controls.

This chapter contains the following sections:

- [Supported Products](#)
- [Hardware Features](#)
- [Connecting a Console Terminal](#)

## Supported Products

The WAVE-594 and WAVE-694 appliance supports Cisco Wide Area Application Services (WAAS) software version 4.4.1 and later releases.

## Hardware Features

This section illustrates and describes the front and back panel controls, ports, and LED indicators on the WAVE-594 and WAVE-694.

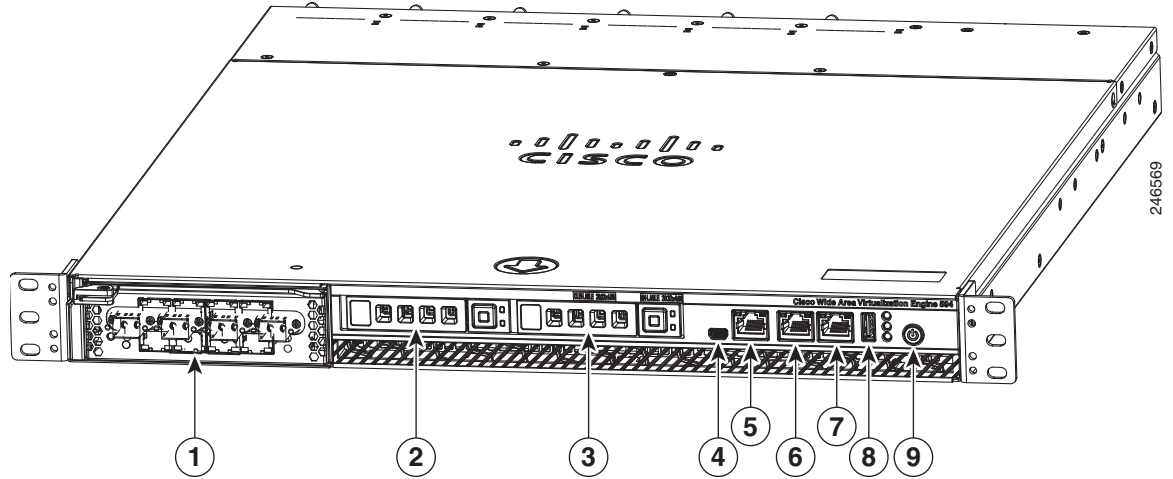
This section contains the following topics:

- [Front Panel Components and LEDs](#)
- [Back Panel Components and LEDs](#)
- [Location of Ports and Connectors](#)

## Front Panel Components and LEDs

Figure 1-1 shows the front panel components.

Figure 1-1 Front Panel



1	Interface Module slot	6	10/100/1000 GE 0/0 connector
2	Hard drive bay 1 (device number 0)	7	10/100/1000 GE 0/1 connector
3	Hard drive bay 2 (device number 1)	8	External USB port
4	Console port (mini-USB)	9	Power On button
5	Console port (RJ-45)		



Figure 1-2 shows the front panel LEDs.

Figure 1-2 Front Panel LEDs

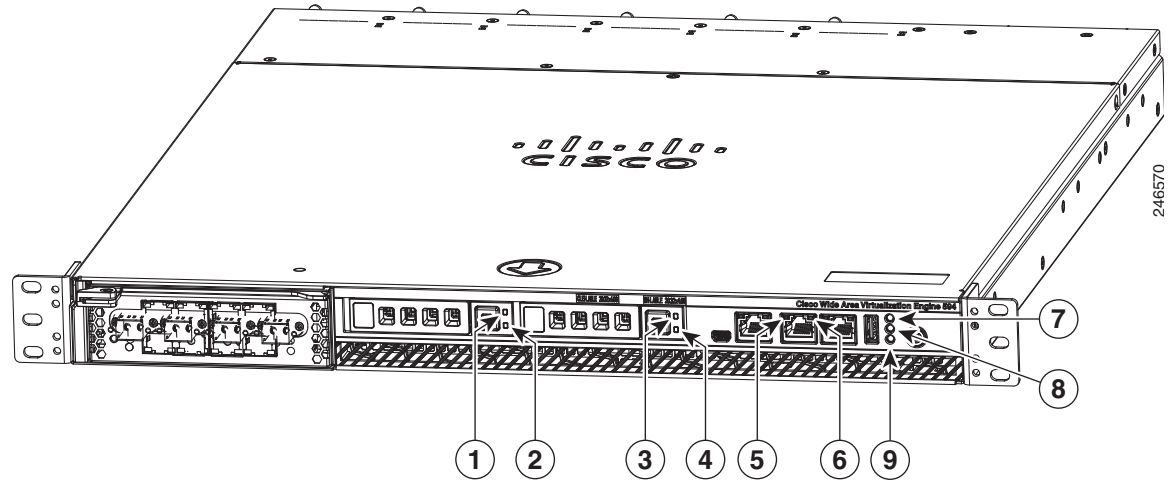


Table 1-1 describes the front panel LEDs and their functions.

Table 1-1 Front Panel LEDs

LED		Color	State	Description
1,3	Drive activity LED	Green	Blinking	Drive activity is normal.
		Green	On	Online.
		Green	Blinking 1Hz	Drive locate.
		—	Off	No reading/writing, no activity.
5	NIC link/activity	Green	On	Link exists.
		Green	Blinking	Activity exists.
		—	Off	No link detected.
6	NIC speed	—	Off	10Mbps connection.
		Green	On	100Mbps connection.
		Yellow	On	1000Mbps connection.
7	System power LED	Green	On	System is on.
		—	Off	Power cord is not attached or power supply failure has occurred.
8	System fault LED	Yellow	On	System has detected a fault. Refer to the <a href="#">“Troubleshooting the System Hardware”</a> chapter for more information.
		—	Off	System operation is normal.
9	Storage activity LED	Green	Blinking	Drive activity is normal.
		Orange	On	Drive failure has occurred.

## Back Panel Components and LEDs

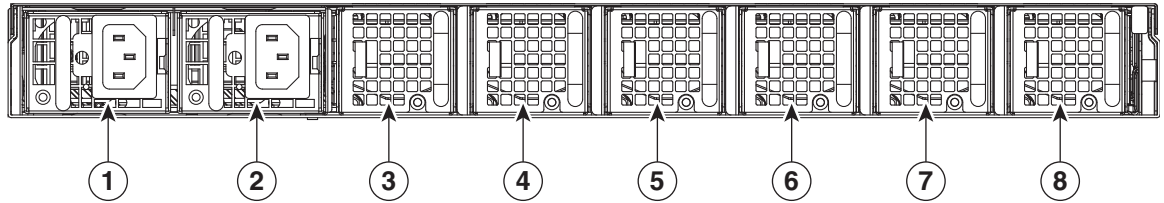
Figure 1-3 shows the back panel components.



Note

To monitor the boot process in normal operation, use a console port.

Figure 1-3 Back Panel Components



1	Power supply 1	5	Fan 4
2	Power supply 0	6	Fan 3
3	Fan 6	7	Fan 2
4	Fan 5	8	Fan 1

Figure 1-4 shows the back panel LEDs.

Figure 1-4 Back Panel LEDs

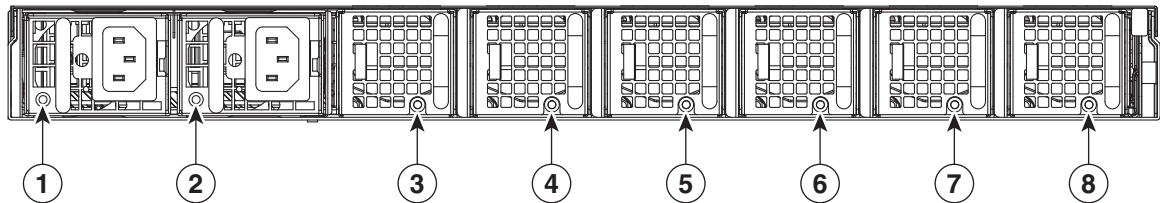


Table 1-2 describes the back panel LEDs and their functions.

Table 1-2 Back Panel LEDs

LED		Color	State	Description
1, 2	Power supply status	—	Off	No AC power to all power supplies.
		Red	Blinking	No AC power to this power supply.
		Green	Blinking	AC power is present, only standby output on.
		Green	On	Power supply DC outputs on and OK.
		Red	On	Power supply failure. Refer to the <a href="#">“Troubleshooting the System Hardware”</a> chapter for more information.

Table 1-2 Back Panel LEDs (continued)

LED		Color	State	Description
3 - 8	Fan status	Orange	On	Alarm.
		Orange	Blinking	Alarm. Fan speed too low.
		—	Off	Normal state.

## Location of Ports and Connectors

The WAVE appliance supports two Ethernet connectors and two Console ports on the front of the appliance.

Figure 1-3 shows the back panel ports and connectors.



**Warning**

**To avoid electric shock, do not connect safety extra-low voltage (SELV) circuits to telephone-network voltage (TNV) circuits. LAN ports contain SELV circuits, and WAN ports contain TNV circuits. Some LAN and WAN ports both use RJ-45 connectors. Use caution when connecting cables.** Statement 1021

This section contains the following topics:

- [Ethernet Port Connectors](#)
- [Console Port Connector](#)

## Ethernet Port Connectors

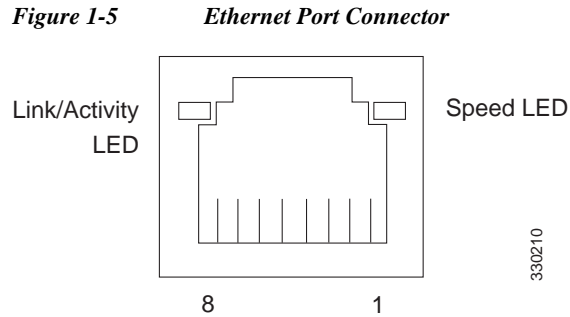
Connect a Category 3, 4, or 5 unshielded twisted-pair cable to an Ethernet connector. 100BASE-TX and 1000BASE-T Fast Ethernet standards require Category 5 or higher cabling.

The WAVE-594 and WAVE-694 appliance has two Ethernet connectors that are attached to the Ethernet controllers (see [Figure 1-5](#)). The Ethernet controllers are integrated on the system board. They provide an interface for connecting to a 10-Mbps, 100-Mbps, or 1-Gbps network and provide full-duplex (FDX) capability, which enables simultaneous transmission and reception of data on the network. If the Ethernet ports in the server support auto negotiation, the controllers detect the data-transfer rate (10BASE-T, 100BASE-TX, or 1000BASE-T) and duplex mode (full duplex or half duplex) of the network and automatically operate at that rate and mode. You do not have to set any jumpers or configure the controllers.



**Note**

There is a third RJ45 connector on the front of the appliance (see [Figure 1-1](#)). This is a console port. Do not connect this port to your network.



## Console Port Connector

The WAVE-594 and WAVE-694 appliance has two console port connectors, serial and mini-USB (see [Figure 1-1](#)). Use a console port connector to access the command-line interface (CLI) for controlling the WAVE appliance.

For information on connecting a console terminal to the mini-USB console port, see [Connecting a Console Terminal](#).

## Connecting a Console Terminal

The WAVE appliance has both serial and mini-USB console ports (see [Figure 1-1](#)). These ports provide administrative access to your appliance with a console terminal or PC.



**Note**

You cannot use both ports at the same time. If both ports are connected, the mini-USB port takes priority.



**Note**

When using the mini-USB port to connect to a Windows-based PC for the first time, you must install the Windows USB driver on the PC first. See [Installing the Cisco USB Driver](#).

## Cabling

The following cables included with the WAVE appliance may be used for connecting the WAVE appliance to a console terminal or PC:

- USB Console cable—5-pin USB to mini-USB Type A-B
- Serial Console cable— EIA RJ-45 to DB-9

## Installing the Cisco USB Driver

When using the mini-USB port to connect a Microsoft Windows based PC as a console terminal to the WAVE appliance, you must first install the Windows USB driver on the PC. Otherwise, the USB interface may not function.

The following Windows operating systems are supported:

- Windows XP—32-bit and 64-bit

- Vista—32-bit, Business edition
- Vista—64-bit
- Windows 7—32-bit and 64-bit

To install the Cisco Microsoft Windows USB driver, perform the following steps:

**Note**

Do not connect the cable from the Windows PC to the WAVE appliance until after the driver is installed.

**Step 1** Load the DVD that came with your WAVE appliance and double-click the CUSBInst.exe file. The Cisco Virtual Com InstallShield Wizard begins.

You can also access the driver from the WAAS software download area of Cisco.com located at:

<https://software.cisco.com/download/release.html?mdfid=280484571&catid=268437639&softwareid=280836712&release=6.2.3&relind=AVAILABLE&relicycle=&reltype=latest>

It's located under release 4.4.1 and the filename is CUSBInst\_Signed\_18May2011.exe

**Step 2** Click **Next**. The Ready to Install the Program window appears.

**Step 3** Click **Install**. The InstallShield Wizard Completed window appears.

**Step 4** Click **Finish**.

**Step 5** Connect the USB cable to the PC USB port and WAVE appliance mini-USB console port. Within a few moments, the Found New Hardware Wizard appears.

Follow the instructions to complete the installation of the driver.

**Step 6** Once the installation is finished, the USB console is ready for use.

**Note**

If the driver has been installed on the PC but does not get bound to the hardware, you can manually browse the driver installation query to the location C:\Windows\tiinst\. The newly attached hardware will appear in the Windows Device Manager as "TUSB3410 EECODE Ser".

This solution also applies when connecting additional WAVE appliances to the same PC. Multiple WAVE appliances can be independently administered by console sessions on the same PC.

**Note**

You do not need to reinstall the driver if you change to a different USB port on your PC.

**Note**

If you happen to install the driver multiple times, each time the driver is installed the virtual COM port number assigned to the USB port gets incremented. This is expected behavior and may not get reset even if you uninstall the driver.





# CHAPTER 2

## Preparing to Install the WAVE-594 and WAVE-694

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This chapter contains important safety information that you should know before you work with the WAVE-594 and WAVE-694. Use the guidelines in this chapter to ensure your own personal safety and to help protect your appliance from potential damage.

This chapter contains the following sections:

- [Safety Warnings and Cautions](#)
- [Safety Guidelines](#)
- [Understanding the Environmental Requirements](#)
- [Understanding the Power Requirements](#)
- [Understanding the Grounding Requirements](#)



Note

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Read the *Regulatory Compliance and Safety Information for Cisco Wide Area Virtualization Engines* document and the *Site Preparation and Safety Guide* that came with your appliance before you begin the installation.

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## Safety Warnings and Cautions

Before you install the WAVE-594 and WAVE-694, observe the following safety warnings and cautions:



Warning

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**Read the installation instructions before connecting the system to the power source.** Statement 1004

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Warning

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**This unit is intended for installation in restricted access areas. A restricted access area can be accessed only through the use of a special tool, lock and key, or other means of security.** Statement 1017

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Warning

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**The plug-socket combination must be accessible at all times, because it serves as the main disconnecting device.** Statement 1019

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**Warning**

**This equipment must be grounded. Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.**  
Statement 1024

**Warning**

**This unit might have more than one power supply connection. All connections must be removed to de-energize the unit.** Statement 1028

**Warning**

**Only trained and qualified personnel should be allowed to install, replace, or service this equipment.** Statement 1030

**Warning**

**This product requires short-circuit (overcurrent) protection, to be provided as part of the building installation. Install only in accordance with national and local wiring regulations.**  
Statement 1045

**Warning**

**Installation of the equipment must comply with local and national electrical codes.** Statement 1074

**Caution**

To properly ventilate the system, you must provide at least 7.6 cm (3.0 in) of clearance at the front and back of the WAVE appliance.

**Caution**

To reduce the risk of electric shock or damage to the equipment:

- Do not disable the power cord grounding plug. The grounding plug is an important safety feature.
- Plug the power cord into a grounded (earthed) electrical outlet that is easily accessible at all times.
- Unplug the power cord from the power supply to disconnect power to the equipment.
- Do not route the power cord where it can be walked on or pinched by items placed against it. Pay particular attention to the plug, electrical outlet, and the point where the cord extends from the WAVE appliance.

**Caution**

To reduce the risk of personal injury or damage to the equipment:

- Observe local occupation health and safety requirements and guidelines for manual handling.
- Obtain adequate assistance to lift and stabilize the chassis during installation or removal. The WAVE appliance is unstable when not fastened to the rails. When mounting the WAVE appliance in a rack, remove the power supplies and any other removable module to reduce the overall weight of the product.

## Safety Guidelines

To reduce the risk of bodily injury, electrical shock, fire, and damage to the equipment, observe the precautions in this section.



This section contains the following topics:

- [General Precautions](#)
- [System Reliability Considerations](#)
- [Protecting Against Electrostatic Discharge](#)

## General Precautions

Observe the following general precautions for using and working with the WAVE-594 and WAVE-694:

- Observe and follow service markings. Do not service any Cisco product except as explained in your system documentation. Opening or removing covers that are marked with the triangular symbol with a lightning bolt may expose you to electrical shock. Components inside these compartments should be serviced only by a trained and qualified service technician.
- If any of the following conditions occur, unplug the product from the electrical outlet and replace the part or contact your customer service representative:
  - The power cable or plug is damaged.
  - An object has fallen into the product.
  - The product has been exposed to water.
  - The product has been dropped or damaged.
  - The product does not operate correctly when you follow the operating instructions.
- Keep your system components away from radiators and heat sources. Also, do not block cooling vents.
- Do not spill food or liquids on your system components, and never operate the product in a wet environment.
- Do not push any objects into the openings of your system components. Doing so can cause fire or electric shock by shorting out interior components.
- Use the product only with other Cisco-approved equipment.
- Allow the product to cool before removing covers or touching internal components.
- Use the correct external power source. Operate the product only from the type of power source indicated on the electrical ratings label. If you are not sure of the type of power source required, consult your service representative or local power company.
- Use only approved power cables. If you have not been provided with a power cable for your WAVE appliance or for any AC-powered option intended for your system, purchase a power cable that is approved for use in your country. The power cable must be rated for the product and for the voltage and current marked on the product's electrical ratings label. The voltage and current rating of the cable should be greater than the ratings marked on the product.
- To help prevent electric shock, plug the system components and peripheral power cables into properly grounded electrical outlets. These cables are equipped with three-prong plugs to help ensure proper grounding. Do not use adapter plugs or remove the grounding prong from a cable.
- Observe power strip ratings. Make sure that the total ampere rating of all products plugged into the power strip does not exceed 80 percent of the power strip ampere ratings limit.
- Do not use appliance or voltage converters or kits sold for appliances with your product.
- To help protect your system components from sudden, transient increases and decreases in electrical power, use a surge suppressor, line conditioner, or uninterruptible power supply (UPS).
- Position cables and power cords carefully; route cables and the power cord and plug so that they cannot be stepped on or tripped over. Be sure that nothing rests on your system components' cables or power cord.
- Do not modify power cables or plugs. Consult a licensed electrician or your power company for site modifications. Always follow your local or national wiring rules.

## System Reliability Considerations

To help ensure proper cooling and system reliability, make sure that the following occurs:

- Each of the hard drive bays has either a drive or a filler panel installed.
- The Interface Module bay has either a Cisco Interface Module or a filler panel installed.
- Each power supply bay has either a power supply or filler panel installed.
- For rack configurations, make sure that space is available around the appliance to enable the cooling system to work properly. See the documentation that comes with the rack for additional information.
- A removed hot-swappable drive is replaced within 1 minute of removal.
- Cables for optional adapters are routed according to the instructions provided with the adapters.
- A failed fan is replaced within 48 hours.

## Protecting Against Electrostatic Discharge

Static electricity can harm delicate components inside the appliance. To prevent static damage, discharge static electricity from your body before you touch any of your system's electronic components. You can do so by touching an unpainted metal surface on the chassis.

You can also take the following steps to prevent damage from electrostatic discharge (ESD):

- When unpacking a static-sensitive component from its shipping carton, do not remove the component from the antistatic packing material until you are ready to install the component in your system. Just before unwrapping the antistatic packaging, be sure to discharge static electricity from your body.
- When transporting a sensitive component, first place it in an antistatic container or packaging.
- Handle all sensitive components in a static-safe area. If possible, use antistatic floor pads and workbench pads.
- Handle the appliance carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the appliance where others can handle and possibly damage the appliance.
- Take additional care when handling appliances during cold weather, because heating reduces indoor humidity and increases static electricity.

## Understanding the Environmental Requirements

To ensure continued safe and reliable equipment operation, install or position the system in a well-ventilated, climate-controlled environment.

For details about the WAVE-594 and WAVE-694 environmental requirements, see [Appendix A, "WAVE-594 and WAVE-694 Hardware Specifications"](#) and the [Appendix B, "Temperature"](#).

## Understanding the Power Requirements

Installation of this equipment must comply with local and regional electrical regulations governing the installation of information technology equipment by licensed electricians. This equipment is designed to operate in installations covered by NFPA 70, 1999 Edition (National Electric Code) and NFPA-75, 1992 (code for Protection of Electronic Computer/Data Processing Equipment).



### Warning

**Take care when connecting units to the supply circuit so that wiring is not overloaded.**  
Statement 1018



### Caution

Protect the WAVE appliance from power fluctuations and temporary interruptions with a regulating uninterruptible power supply (UPS). This device protects the hardware from damage caused by power surges and voltage spikes and keeps the system in operation during a power failure.

When installing more than one WAVE appliance, you may need to use additional power distribution devices to safely provide power to all devices. Observe the following guidelines:

- Balance the WAVE appliance power load between available AC supply branch circuits.
- Do not allow the overall system AC current load to exceed 80 percent of the branch circuit AC current rating.
- Do not use common power outlet strips for this equipment.
- Provide a separate electrical circuit for the WAVE appliance.

For details about the WAVE-594 and WAVE-694 power requirements, see [Appendix A, “WAVE-594 and WAVE-694 Hardware Specifications.”](#)

## Understanding the Grounding Requirements

To ensure proper operation and safety, you must properly ground the WAVE appliance. In the United States, install the equipment in accordance with NFPA 70, 1999 Edition (National Electric Code), Article 250, as well as any local and regional building codes. In Canada, you must install the equipment in accordance with Canadian Standards Association, CSA C22.1, Canadian Electrical Code. In all other countries, you must install the equipment in accordance with any regional or national electrical wiring codes, such as the International Electrotechnical Commission (IEC) Code 364, parts 1 through 7. Furthermore, you must be sure that all power distribution devices used in the installation, such as branch wiring and receptacles, are listed or certified grounding-type devices.

Because of the high ground-leakage currents associated with multiple WAVE appliances connected to the same power source, we recommend the use of a PDU that is either permanently wired to the building's branch circuit or includes a nondetachable cord that is wired to an industrial-style plug. NEMA locking-style plugs or those complying with IEC 60309 are considered suitable for this purpose. Using common power outlet strips for the WAVE appliance is not recommended.



## Installing the WAVE-594 and WAVE-694

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This chapter describes how to install a WAVE-594 and WAVE-694 in an equipment rack.

This chapter contains the following sections:

- [Rack-Mounting Considerations, Parts, and Tools](#)
- [Rack Mounting and Cabling the WAVE-594 and WAVE-694](#)
- [Connecting Power and Booting the System](#)
- [Checking the LEDs](#)
- [Removing or Replacing a WAVE Appliance](#)
- [Upgrading the WAVE-694 to a New Release](#)

Before you begin the installation, read [Chapter 2, “Preparing to Install the WAVE-594 and WAVE-694”](#) and the [Regulatory Compliance and Safety Information for Cisco Wide Area Virtualization Engines](#) document.



**Warning**

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**Read the installation instructions before connecting the system to the power source.** Statement 1004.

---

### Rack-Mounting Considerations, Parts, and Tools

To allow for servicing and adequate airflow, observe the following space and airflow requirements when deciding where to install a rack:

- Leave a minimum clearance of 63.5 cm (25 in) in front of the rack.
- Leave a minimum clearance of 76.2 cm (30 in) behind the rack.
- Leave a minimum clearance of 121.9 cm (48 in) from the back of the rack to the back of another rack or row of racks.

The WAVE-594 and WAVE-694 appliance draws in cool air through the front door and expels warm air through the rear door. Therefore, the front and rear rack doors must be adequately ventilated to allow ambient room air to enter the cabinet, and the rear door must be adequately ventilated to allow the warm air to escape from the cabinet.



**Caution**

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To prevent improper cooling and damage to the equipment, do not block the ventilation openings.

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When vertical space in the rack is not filled by a WAVE appliance or rack component, the gaps between the components cause changes in airflow through the rack and across the WAVE appliances. Cover all gaps with filler panels to maintain proper airflow.

**Caution**

Always use filler panels to fill empty vertical spaces in the rack. This arrangement ensures proper airflow. Using a rack without filler panels results in improper cooling that can lead to thermal damage.

- Observe the following additional requirements to ensure adequate airflow and to prevent damage to the equipment:
  - Front and rear doors—If the 42U rack includes closing front and rear doors, you must allow 5,350 sq cm (830 sq in) of holes evenly distributed from top to bottom to permit adequate airflow (equivalent to the required 64 percent open area for ventilation).
  - Side—The clearance between the installed rack component and the side panels of the rack must be a minimum of 7 cm (2.75 in).

**Note**

Rack-mounting the WAVE-594 and WAVE-694 appliance is supported for rear mount in a 4-post rack or front mount in a 2-post rack.

Table 3-1 lists the rack mounting hardware included in your shipping container. You will need a Phillips screwdriver. Verify that you have received the following items for the installation:

**Table 3-1** Rack Mount Hardware Provided

Item	Name	Description	Qty	Rack Type	
				2-post	4-post
1	Front rack mount bracket	Front rack mount L bracket	2	X	X
2	Rear rack mount bracket holder	Rear rack mount bracket holder	2		X
3	32" rear rack mount bracket	Rear rack mount bracket (32 inch)	2		X
4	Front rack mount bracket screw	Front rack bracket screw, #6-32 x 0.30", Wafer Head, Phillips, Steel w/ Zinc and Black	6	X	X
5	Rear rack mount bracket holder screw	Rear bracket holder screw, M4 x0.7 x 4.85 mm, 120°, Flat Head, Phillips, Steel w/ Zinc and Black	6		X
6	Rack screw	Rack screw, #10-32 x 0.50", Truss Head, Phillips, Steel w/ Ni and Black	8	X	X
7	Rack screw	Rack screw, M5 x 12.7 mm, Truss Head, Phillips, Steel w/ Ni and Black	8		X

## Rack Mounting and Cabling the WAVE-594 and WAVE-694

This section contains the following topics:

- [Mounting in a 4-Post Rack](#)
- [Front-Mounting in a 2-Post Rack](#)
- [Cabling](#)

**Warning**

To prevent bodily injury when mounting or servicing this unit in a rack, you must take special precautions to ensure that the system remains stable. The following guidelines are provided to ensure your safety:

- This unit should be mounted at the bottom of the rack if it is the only unit in the rack.
- When mounting this unit in a partially filled rack, load the rack from the bottom to the top with the heaviest component at the bottom of the rack.
- If the rack is provided with stabilizing devices, install the stabilizers before mounting or servicing the unit in the rack. Statement 1006

## Mounting in a 4-Post Rack

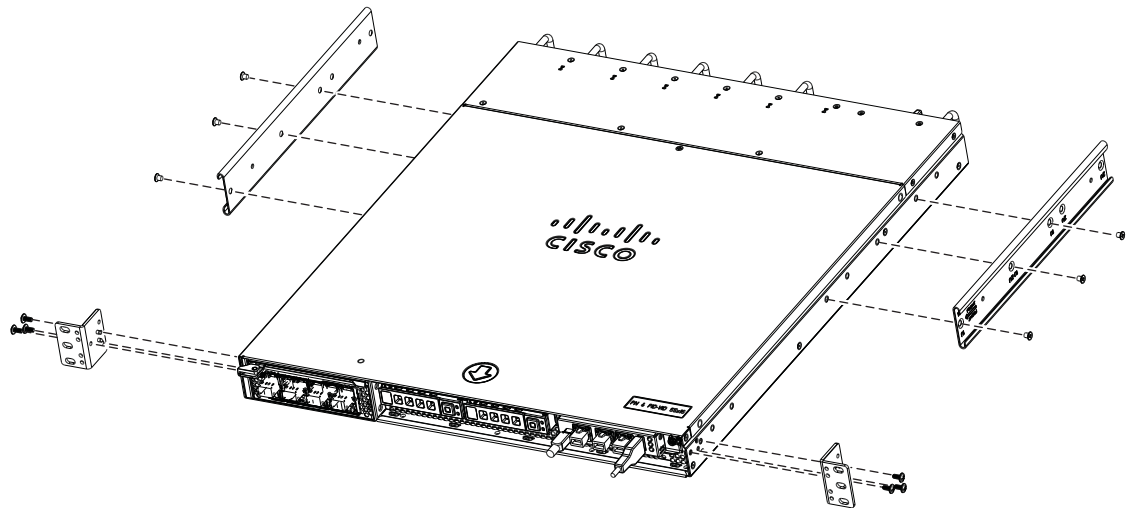
Follow these steps to mount the WAVE appliance in a 4-post rack:

- Step 1** Prepare for installation by reading the “[Rack-Mounting Considerations, Parts, and Tools](#)” section on [page 3-1](#)) and verify that you have the correct tools and rack-mount hardware necessary for the installation.
- Step 2** Attach the front rack mount brackets (item #1 in [Table 3-1](#)) using the six front bracket screws (item #4 in [Table 3-1](#)). (See [Figure 3-4](#).)
- Step 3** Attach the rear rack mount holder brackets (item #2 in [Table 3-1](#)) using the six rear bracket holder screws (item #5 in [Table 3-1](#)).

**Note**

The front arrow must point toward the front of the chassis.

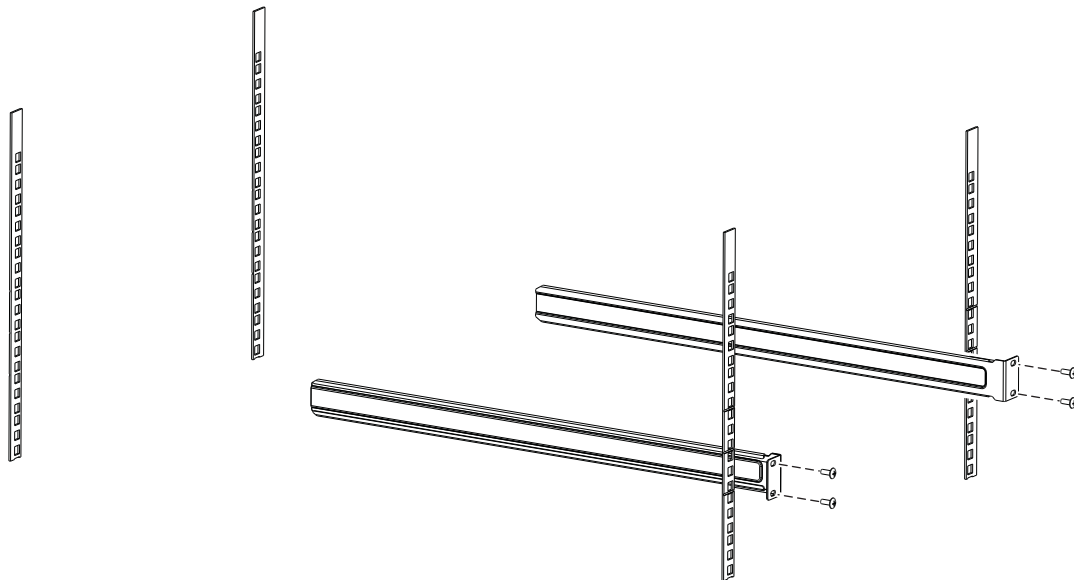
**Figure 3-1** Attaching the Brackets



330144

- Step 4** Attach the rear mount bracket holders (item #3 in [Table 3-1](#)) to the rear rack posts using four appropriate rack screws (item #6 or #7 in [Table 3-1](#)). (see [Figure 3-2](#))

**Figure 3-2** Attaching Rear Rack Mount to the Rack

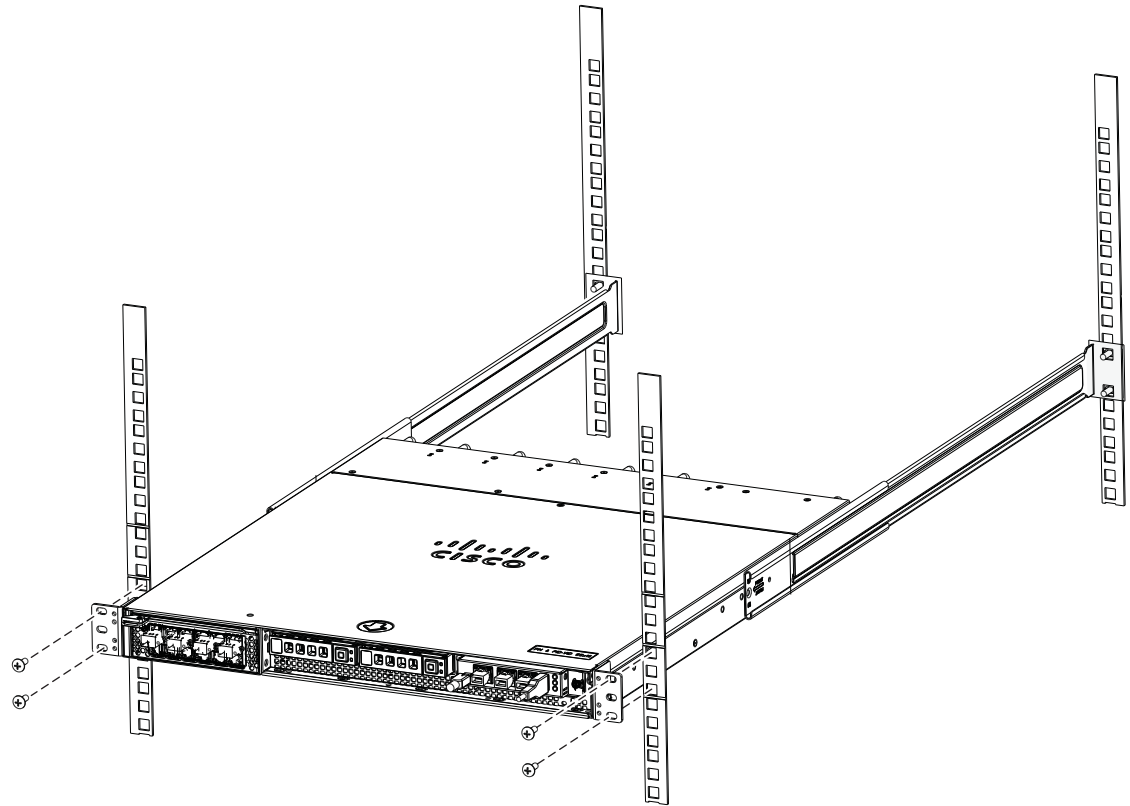


330142

- Step 5** Insert the chassis between the mounting posts and secure (see [Figure 3-3](#)):
- a. Insert the chassis into the rack with the rear rack mount holders sliding into the rear rack mount brackets.
  - b. Align the mounting holes in the front brackets with the mounting holes in the equipment rack.
  - c. Secure the chassis using four (two on each side) rack screws (item #6 or #7 in [Table 3-1](#)) through the holes in the front brackets and into the threaded holes in the mounting post.



Figure 3-3 Rack-Mounting the Chassis



330145

- Step 6** Verify that the chassis is securely installed in the rack.

## Front-Mounting in a 2-Post Rack

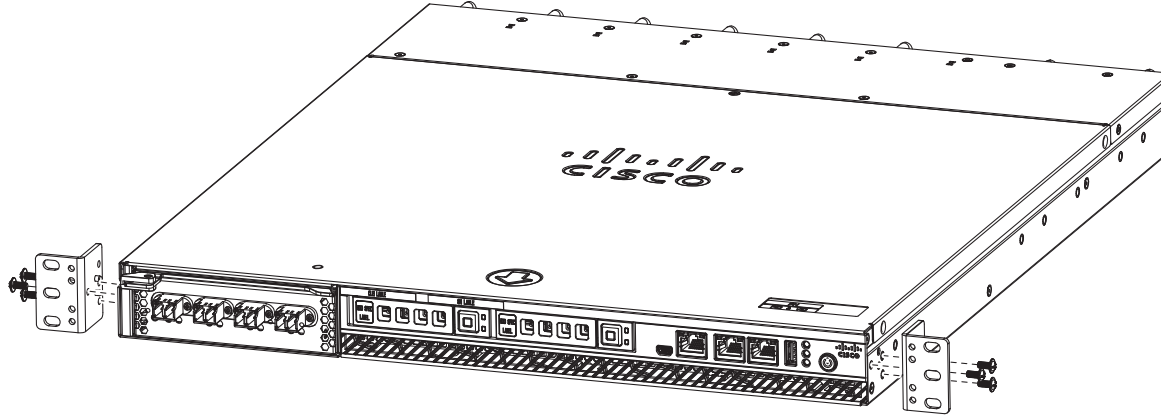
Follow these steps to front-mount the WAVE appliance in a 2-post rack:



- Note** There must be an empty 1RU space in the rack directly below the chassis to allow space for the back edge to sag. A sag of up to 1/2RU (7/8") is acceptable.

- Step 1** Prepare for installation by reading the “[Rack-Mounting Considerations, Parts, and Tools](#)” section on [page 3-1](#)) and verify that you have the correct tools and rack-mount hardware necessary for the installation.
- Step 2** Attach the front rack mount brackets (item #1 in [Table 3-1](#)) using the six front bracket screws (item #4 in [Table 3-1](#)). (See [Figure 3-4](#).)

**Figure 3-4** Attaching the Front Brackets

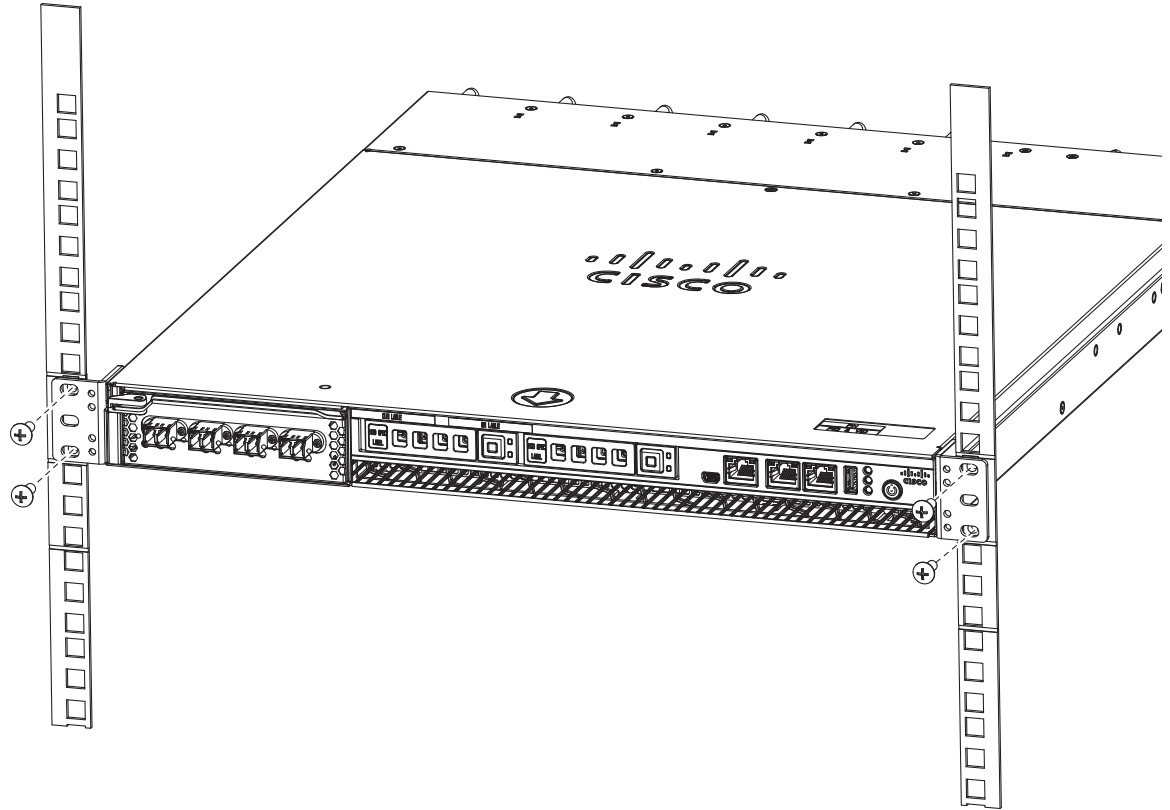


- Step 3** Insert the chassis between the mounting posts and secure (see [Figure 3-5](#)):
- a. Align the mounting holes in the front brackets with the mounting holes in the equipment rack.
  - b. Secure the chassis using four (two on each side) rack screws (item #6 or #7 in [Table 3-1](#)) through the holes in the front brackets and into the threaded holes in the mounting post.
  - c. Use a tape measure and level to ensure that the chassis is installed straight and level.



**Note** Since the chassis is secured in the rack by the front edge only, there must be an empty 1RU space in the rack directly below the chassis to allow space for the back edge to sag. A sag of up to 1/2RU (7/8") is acceptable.

Figure 3-5 Rack-mounting the Chassis



Step 4 Verify that the chassis is securely installed in the rack.

## Cabling

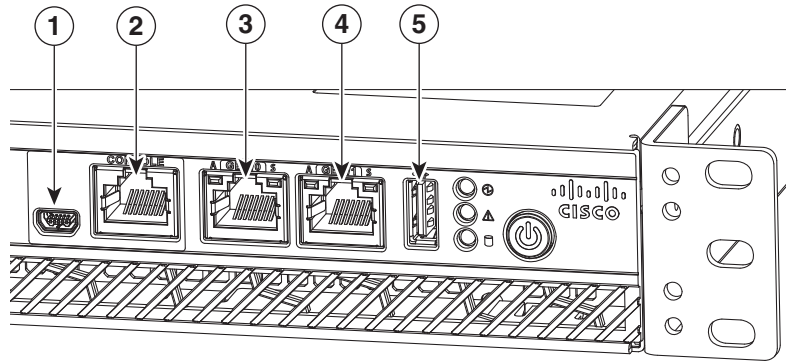
Use the following information (see [Figure 3-6](#)) when connecting peripheral cables to the WAVE appliance.



**Warning**

**To reduce the risk of electric shock, fire, or damage to the equipment, do not plug telephone or telecommunications connectors into RJ-45 connectors.**

Figure 3-6 Cable Connections—Front



1	Console port (mini-USB)	4	10/100/1000 GE 0/1 connector
2	Console port (RJ-45)	5	External USB port
3	10/100/1000 GE 0/0 connector		

## Connecting Power and Booting the System

To connect power to your system, follow these steps:

- Step 1** Review the information in the “[Safety Guidelines](#)” section on [page 2-2](#).
- Step 2** Plug a power cord into the power cord receptacle on the back of the WAVE appliance.
- Step 3** Connect the other end of the power cord to a power source at your installation site.
- Step 4** Power up all externally connected devices.
- Step 5** Press the power control button on the front of the WAVE appliance.

The system should begin booting. Once the operating system boots, you are ready to initialize the basic software configuration. (See the software configuration guide for details.)



**Note** While the WAVE appliance is powering up, the green power-on LED on the front of the appliance is on.

## Checking the LEDs

When the WAVE-594 and WAVE-694 is up and running, observe the front panel LEDs (see [Figure 1-1](#) and [Table 1-1](#)) to verify that your system is operating properly.

To troubleshoot using the LEDs, see [Chapter 6, “Troubleshooting the System Hardware.”](#)

## Removing or Replacing a WAVE Appliance

To remove a WAVE appliance from your network, power it down, disconnect the power cords and network cables, and physically remove the chassis from the rack.

The WAVE appliance is in constant communication with the router on your network. When the router notices that the WAVE appliance is no longer responding to it, the router stops sending requests to the WAVE appliance. This action is transparent to users. If other WAVE appliances are attached to the router, the router continues sending requests to the other WAVE appliances.

When you remove a WAVE appliance, the pages that were cached on that appliance are no longer available to the router or other WAVE appliances. You might see an increase in outgoing web traffic that might have otherwise been fulfilled by the WAVE appliance that you are removing. However, after a time, the router and other WAVE appliances redistribute the load of web traffic.

If you remove the last WAVE appliance from your network, you can also disable WAVE support on the router. However, this action is not necessary because leaving WAVE support enabled when there are no WAVE appliances attached has no effect on the router's performance.

To replace a WAVE appliance, remove it from the network, and then install a new WAVE appliance and configure it using the same configuration parameters (IP address and so forth) that you used for the removed WAVE appliance.

## Upgrading the WAVE-694 to a New Release

Consider the following guidelines when upgrading the WAVE-694 appliance:

- If you upgrade a WAVE-694 from WAAS Version 5.x to Version 6.x, and the WAVE-694 has the following parameters:
  - 24 GB RAM
  - You have used the **disk object-cache extend** command before the upgrade.

After the upgrade from WAAS Version 5.x to 6.x, you may see the **disk\_full** alarm. (For more information on alarms, see of the [WAAS Alarm Book](#).)

To address the above scenario, follow these steps *before* beginning the upgrade process:

- a. Use the **no disk object-cache extend** command to disable the **disk object cache extend** command.
- b. Reload the WAVE-694 in WAAS Version 5.x.
- c. Verify that the device is operational.
- d. Upgrade from WAAS Version 5.x to WAAS Version 6.x.





# Installing Hardware Options for the WAVE-594 and WAVE-694

This chapter provides basic instructions for installing hardware options in your WAVE-594 and WAVE-694. These instructions are intended for technicians who are experienced with setting up Cisco WAVE-594 and WAVE-694 hardware.

This chapter contains the following sections:

- [Installing a Cisco WAVE Interface Module](#)
- [Replacing a Hard Disk Drive/Solid State Drive](#)
- [Replacing a Fan](#)
- [Replacing a Power Supply](#)
- [Installing Memory](#)

## Installing a Cisco WAVE Interface Module

In addition to the two onboard Gigabit Ethernet ports, the WAVE-594 and WAVE-694 can accommodate one optional Interface Module network module:

- 4-port Gigabit Ethernet Copper Bypass Interface Module
- 8-port Gigabit Ethernet Copper Bypass Interface Module
- 4-port Gigabit Ethernet Fiber Optic Bypass Interface Module
- 2-port 10 Gigabit Ethernet Fiber Optic SPF+ Interface Module

For information on the features of the Cisco WAVE Interface Modules and cabling requirements, see [Chapter 5, “WAVE Interface Modules.”](#)



### Note

Interface Modules are not hot-swappable therefore it is necessary to power the system down before installing or replacing.



### Caution

To maintain proper system cooling, do not operate the appliance for more than 1 minute without either an Interface Module or a filler panel installed in the bay.

To install a Cisco Interface Module in the Interface Module slot, follow these steps:

**Step 1** Review the information in the [Safety Warnings and Cautions](#) and [Safety Guidelines](#) sections in Chapter 2, “Preparing to Install the WAVE-594 and WAVE-694.”

**Step 2** Power down the appliance.

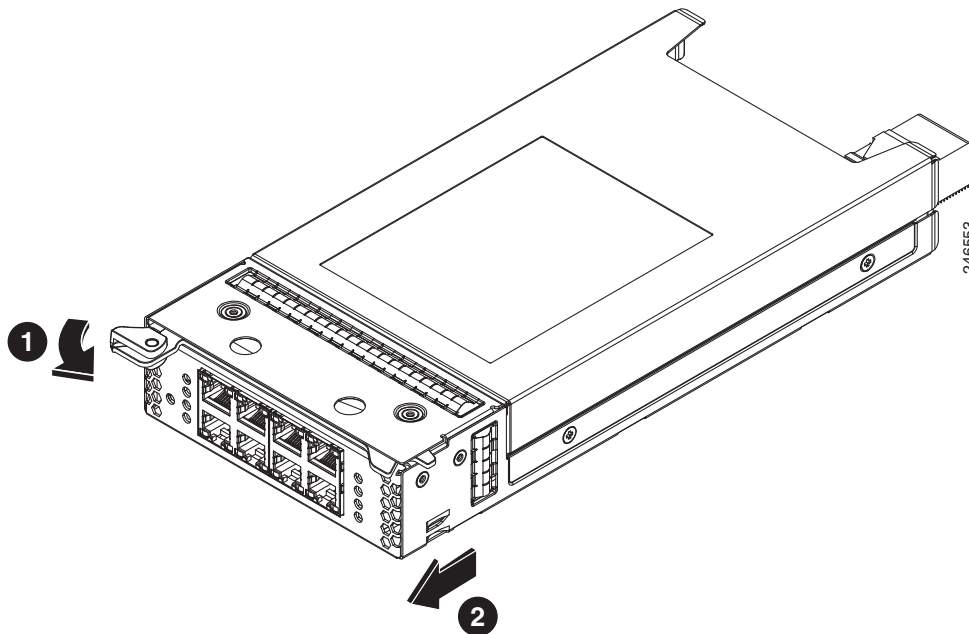


**Note** You must power down the appliance before installing or removing an Interface Module. Interface Modules are not hot-swappable.

**Step 3** Locate the Interface Module slot in the appliance chassis and slide the Cisco Interface Module into the slot until the ejector lever is seated.

To remove an Interface Module, first use the ejector lever to unlatch and then pull out the Interface Module. (See [Figure 4-1](#).)

*Figure 4-1 Interface Module—Removal*



**Step 4** Power on the appliance.

**Step 5** For information about connecting cables to the Cisco WAVE Interface Module ports, see [Chapter 5](#), “WAVE Interface Modules.”

## Replacing a Hard Disk Drive/Solid State Drive

The WAVE appliance supports as many as two 2.5-inch (Small Form Factor) hard drives. The WAVE-594 and WAVE-694 support both Hard Disk Drives and Solid State Drives.



**Note**

The WAVE-594 and WAVE-694 support both Hard Disk Drives and Solid State Drives, but you cannot mix HDD and SSD in the same chassis. For details about the WAVE-594 and WAVE-694 appliance specifications, see [Appendix A, “Appliance Specifications”](#).

## Replacing a Hard Disk Drive

Hard drives are hot-swappable therefore it is not necessary to power the system down before installing or replacing.

When removing hard drives from the WAVE appliance, observe the following general guidelines:

- The system automatically sets all drive numbers.
- Drives must be the same capacity to provide the greatest storage space efficiency when drives are grouped together into the same drive array.

**Note**

All hard disk drives being used in the appliance must be identical.

**Note**

The HDD should not be replaced with SSD when WAVE is in CM device mode, as it is not supported.

**Caution**

To maintain proper system cooling, do not operate the appliance for more than 1 minute without either a hard disk drive or a filler panel installed in each bay.

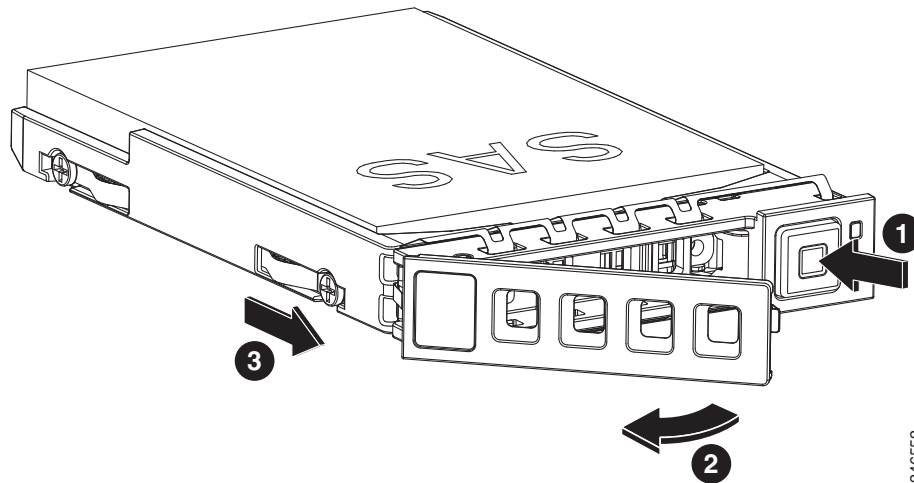
To replace a hard disk drive in a bay, follow these steps:

- Step 1** Review the information in the [Safety Warnings and Cautions](#) and [Safety Guidelines](#) sections in Chapter 2, “Preparing to Install the WAVE-594 and WAVE-694.”
- Step 2** Press the button and swing the handle out. (See [Figure 4-2](#)).

**Note**

Wait 5 seconds before removing to let the disk spin down.

Figure 4-2 Removing a Hard Disk Drive



246552

- Step 3** After waiting 5 seconds, pull the handle to remove the drive assembly from the bay.
- Step 4** Within one minute, insert the new drive into the same slot by aligning the replacement drive assembly with guide rails in the bay and sliding the drive assembly into the bay until it stops. Make sure that the drive is properly seated in the bay.
- Step 5** Close the drive handle.
- Step 6** Check the hard disk drive status LED after the system has booted to verify that the hard disk drive is operating correctly. If the amber hard disk drive status LED for a drive is lit continuously, that drive is faulty and must be replaced. If the green hard disk drive activity LED is flashing, the drive is being accessed.
- Step 7** Wait 1 minute and then verify that the replaced disk drive is in the Rebuilding state by using the **show disks details** command in EXEC mode.



**Note** The system automatically starts the rebuild operation when it detects the removal and reinsertion of a drive that is part of the logical RAID drive.

- Step 8** Wait until the rebuild operation is complete. A disk rebuild operation may take several hours. You can check if the rebuild operation is complete by using the **show disk details** command in EXEC mode. The physical drive state will be Online and the RAID logical drive state will be Okay after the rebuild operation is completed.
- Step 9** Use the **show disk tech** command in EXEC mode to verify that the firmware and BIOS information is correct for both hard drives.

If you have multiple disk failures and your RAID-1 logical status is Offline, you must recreate the RAID-1 array. For more information on disk removal and replacement procedures, see the [Cisco Wide Area Application Services Configuration Guide](#) chapter named “Maintaining Your WAAS System.”

## Replacing a Fan

The WAVE appliance supports six fan assemblies that are hot-swappable.

Fan assemblies can only be inserted in one orientation.



**Note**

Fan assemblies must be inserted and can only function with the surface marked “TOP” facing up.



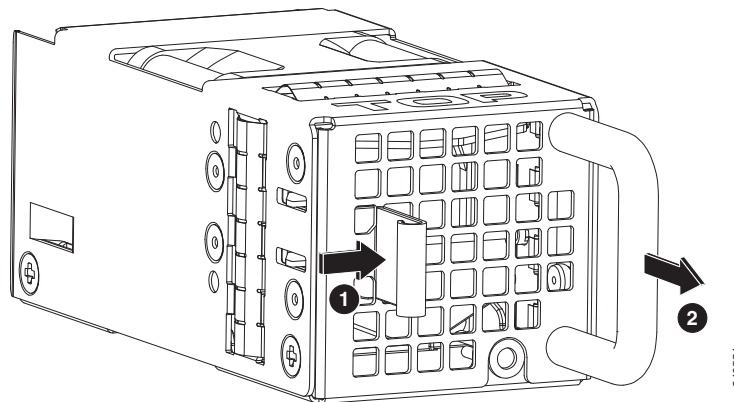
**Caution**

To maintain proper system cooling, do not operate the appliance for more than 1 minute without a fan installed in each bay.

To replace a fan assembly, follow these steps:

- Step 1** Review the information in the [Safety Warnings and Cautions](#) and [Safety Guidelines](#) sections in Chapter 2, “Preparing to Install the WAVE-594 and WAVE-694.”
- Step 2** Disengage the fan latch and pull the fan out by the handle (see [Figure 4-3](#)).

*Figure 4-3 Fan Assembly*



- Step 3** Within one minute, insert the new fan with the surface marked “TOP” facing up and verify that the latch is engaged.
- Step 4** Check the power LED to verify that the new fan is receiving power.



**Note**

If a fan alarm occurs and you power down the WAVE appliance to replace the fan, you must use the **clear bmc event-log** global configuration command and then reboot to clear the alarm.

## Replacing a Power Supply

The WAVE appliance supports two power supply assemblies that are hot-swap capable.

Power supply assemblies can only be inserted in one orientation.



**Note**

Power supply assemblies must be inserted and can only function with the surface marked “TOP” facing up.



**Caution** To maintain proper system cooling, do not operate the appliance for more than 1 minute without either a power supply or a filler panel installed in each bay.

To replace a power supply assembly, follow these steps:

**Step 1** Review the information in the [Safety Warnings and Cautions](#) and [Safety Guidelines](#) sections in Chapter 2, “Preparing to Install the WAVE-594 and WAVE-694.”

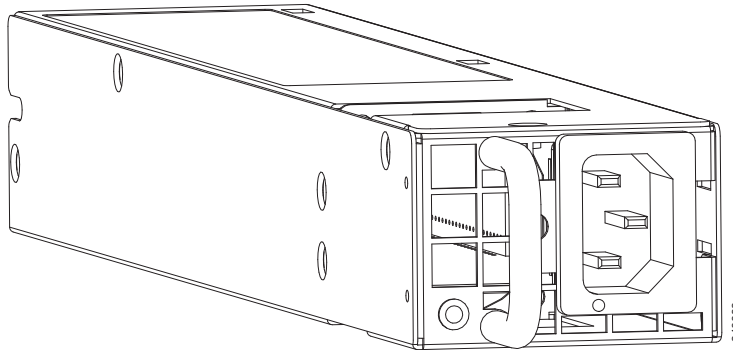
**Step 2** Remove the power cord from the power supply.



**Note** When more than one power supply assembly is present, load-sharing is supported. If one loses power, the second power supply takes over.

**Step 3** Disengage the latch and pull the power supply out by the handle. (See [Figure 4-4](#).)

*Figure 4-4 Power Supply Assembly*



**Step 4** Within one minute, insert the new power supply with the surface marked “TOP” facing up and verify that the latch is engaged.

**Step 5** Insert the power cord into the replacement power supply.

**Step 6** Check the power LED to verify that the new power supply is receiving power.



**Note** If a power supply alarm occurs and you power down the WAVE appliance to replace the power supply, you must use the **clear bmc event-log** global configuration command and then reboot to clear the alarm.

## Installing Memory

This section provides basic instructions for installing memory in your WAVE-594 and WAVE-694.

This section contains the following topics:

- [Removing the Cover](#)
- [Installing Memory Modules](#)

## Removing the Cover

**Warning**

Before working on a system that has an on/off switch, turn OFF the power and unplug the power cord. Statement 1

**Caution**

To reduce the risk of personal injury from hot surfaces, allow the drives and the internal system components to cool before touching them.

**Caution**

Do not operate the WAVE appliance with the access panel open or removed. Operating the WAVE appliance in this manner results in improper airflow and improper cooling that can lead to thermal damage.

To remove the appliance cover, follow these steps:

- Step 1** Review the information in the [Safety Warnings and Cautions](#) and [Safety Guidelines](#) sections in Chapter 2, “Preparing to Install the WAVE-594 and WAVE-694.”
- Step 2** Power off the appliance and all attached devices and disconnect all external cables and power cords.
- Step 3** Remove the WAVE appliance from the rack.
- Step 4** Loosen the screw on the top that secures the access panel to the WAVE appliance.
- Step 5** Slide the access panel toward the front of the WAVE appliance, then lift it from the WAVE appliance.

## Installing Memory Modules

The WAVE-594 appliance supports either 8 GB or 12 GB of memory using 2-GB RDIMM memory modules. The WAVE-694 appliance supports either 16 GB or 24 GB of memory using 4-GB RDIMM memory modules.

Observe the following guidelines when installing additional memory:

- Use only Cisco memory upgrades in your appliance.
- BIOS detects the DIMM population and sets the system to dual-bank interleaved mode (DIMMs installed in both banks with equal bank capacities).

[Figure 4-5](#) shows the memory slot mapping on the system board.

Figure 4-5 Memory Slot Mapping

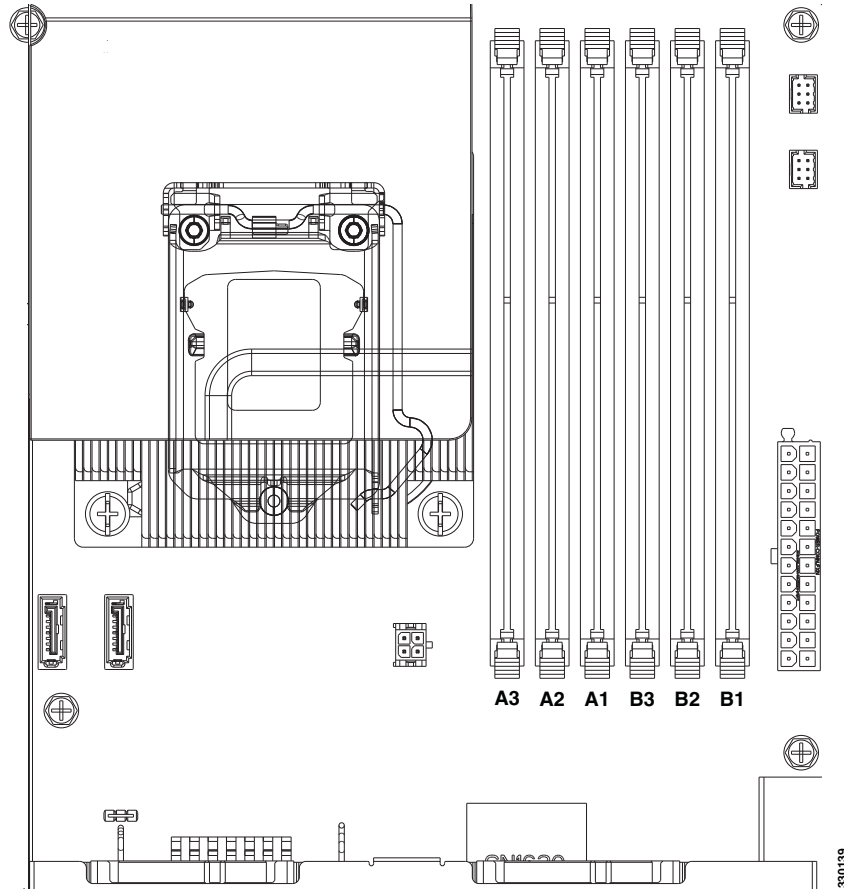


Table 4-1 and Table 4-2 list the RDIMM configurations available for the WAVE-594 and WAVE-694 appliance.

Table 4-1 WAVE-594 RDIMM Configurations

	Slot A3	Slot A2	Slot A1	Slot B3	Slot B2	Slot B1
8 GB Memory	—	2-GB	2-GB	—	2-GB	2-GB
12 GB Memory	2-GB	2-GB	2-GB	2-GB	2-GB	2-GB

Table 4-2 WAVE-694 RDIMM Configurations

	Slot A3	Slot A2	Slot A1	Slot B3	Slot B2	Slot B1
16 GB Memory	—	4-GB	4-GB	—	4-GB	4-GB
24 GB Memory	4-GB	4-GB	4-GB	4-GB	4-GB	4-GB

To install a Cisco memory upgrade on the WAVE-594 from 8 GB to 12 GB or on the WAVE-694 from 16 GB to 24 GB, follow these steps:

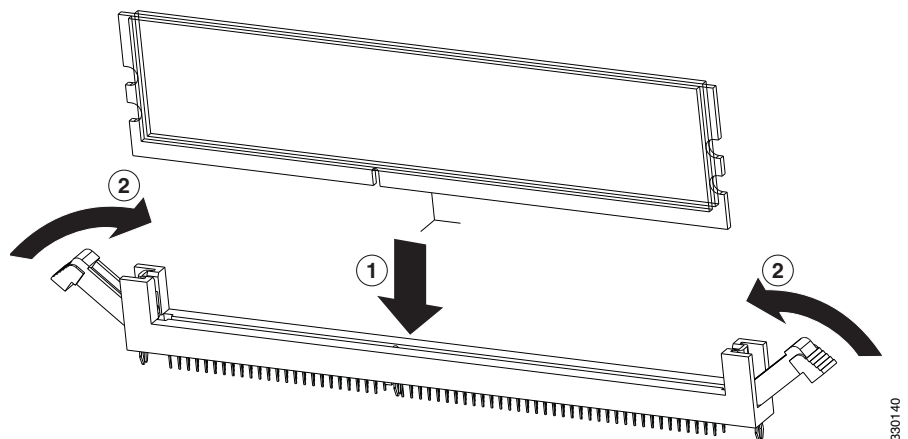
- Step 1** Power down the WAVE appliance.
- Step 2** Remove the WAVE appliance from the rack.
- Step 3** Remove the primary access panel (See [Removing the Cover](#)).
- Step 4** Open the DIMM slot latches for slots A1, A2, B1, and B2 and remove the existing memory modules.



**Note** All existing memory must be removed and replaced by the RDIMMS contained in the Cisco upgrade kit.

- Step 5** Open the DIMM slot latches for slots A3 and B3.
- Step 6** To upgrade from 8 GB to 12 GB on a WAVE-594, install a 2-GB RDIMM memory module into all six slots. (See [Figure 4-6](#).)
- To upgrade from 16 GB to 24 GB on a WAVE-694, install a 4-GB RDIMM memory module into all six slots. (See [Figure 4-6](#).)

**Figure 4-6** Installing an RDIMM



- Step 7** Check to make sure that the DIMM latches are fully engaged in the notches.
- Step 8** Install the access panel.
- Lower the access panel onto the WAVE appliance and then slide the access panel toward the back of the WAVE appliance.
  - Tighten the screw on the top that secures the access panel to the WAVE appliance.
- Step 9** Install the WAVE appliance into the rack.
- For complete rack installation and removal instructions, see [Chapter 3, “Installing the WAVE-594 and WAVE-694.”](#)



**Caution** Install the appliance only in a rack cabinet with perforated doors.



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**Caution** Do not leave open spaces above or below an installed appliance in the rack cabinet. To help prevent damage to appliance components, always install a filler panel to cover the open space and to help ensure proper air circulation. See the documentation that comes with your rack cabinet for more information.

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**Step 10** Connect the cables and power cords. For information on connecting cables and power cords, see [Rack Mounting and Cabling the WAVE-594 and WAVE-694](#) in Chapter 3, “Installing the Wave-594 and WAVE-694.”

**Step 11** Reboot the WAVE appliance.

**Step 12** Use the **show memory EXEC** mode command to verify that the memory you installed is recognized by the WAVE appliance.

**Step 13** Repartition the disks, using the **disk delete-data-partitions** command, and reload.



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**Note** Repartitioning the disks deletes all data, including all virtual blades on the hardware.

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**Note** Repartitioning the disks is required after adding memory to reset the DRE space allocation.

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# WAVE Interface Modules

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This chapter describes Cisco WAVE Interface Modules.

This chapter contains the following sections:

- [Interface Module Descriptions](#)
- [Ports and LED Indicators](#)
- [Network Adapter Cabling Requirements](#)
- [Installation Scenarios and Cabling Examples for Fast Ethernet Connections](#)

For information on installing an inline adapter in your WAVE-594 and WAVE-694, see [Installing a Cisco WAVE Interface Module](#) in Chapter 4, “Installing Hardware Options for the WAVE-594 and WAVE-694.”

For adapter specifications, see [Table A-2](#) in Appendix A.

## Interface Module Descriptions

The WAVE appliance supports one optional 4-port Copper Gigabit Ethernet Interface Module, 8-port Copper Gigabit Ethernet Interface Module, 4-port Fiber Optic Gigabit Ethernet Interface Module, or 2-port SFP+ Fiber Optic 10 Gigabit Ethernet Interface Module.

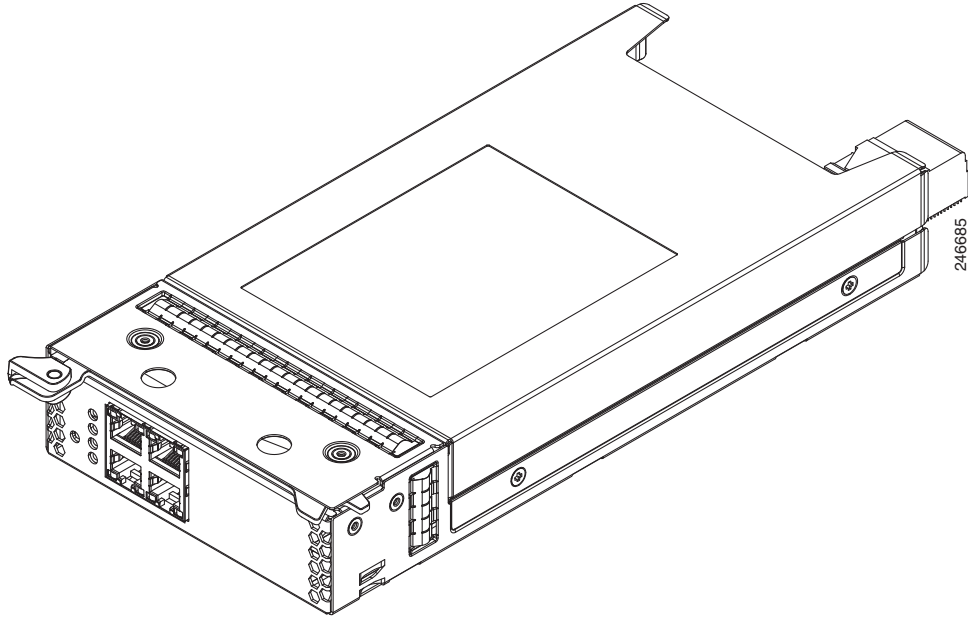
This section contains the following topics:

- [Gigabit Ethernet Interface Module—Copper](#)
- [Gigabit Ethernet Interface Module—Fiber Optic](#)
- [10 Gigabit Ethernet Interface Module—Fiber Optic SFP+](#)
- [Inline Interface](#)

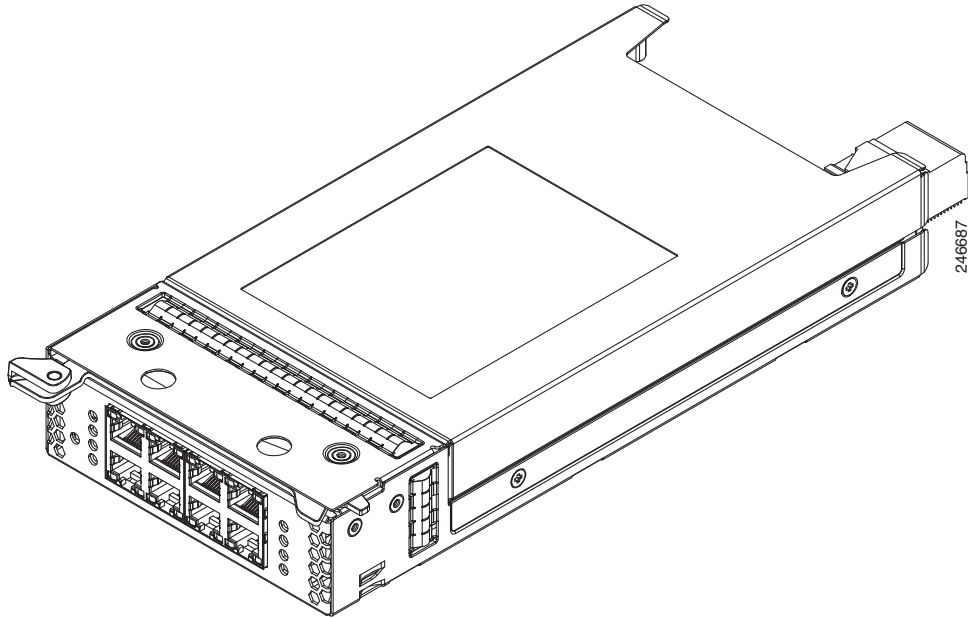
## Gigabit Ethernet Interface Module—Copper

The copper Gigabit Ethernet Interface Module is available in 4 or 8 ports. Both models support bypass. (See [Figure 5-1](#) and [Figure 5-2](#).)

*Figure 5-1 Gigabit Ethernet Interface Module—4-Port Copper*



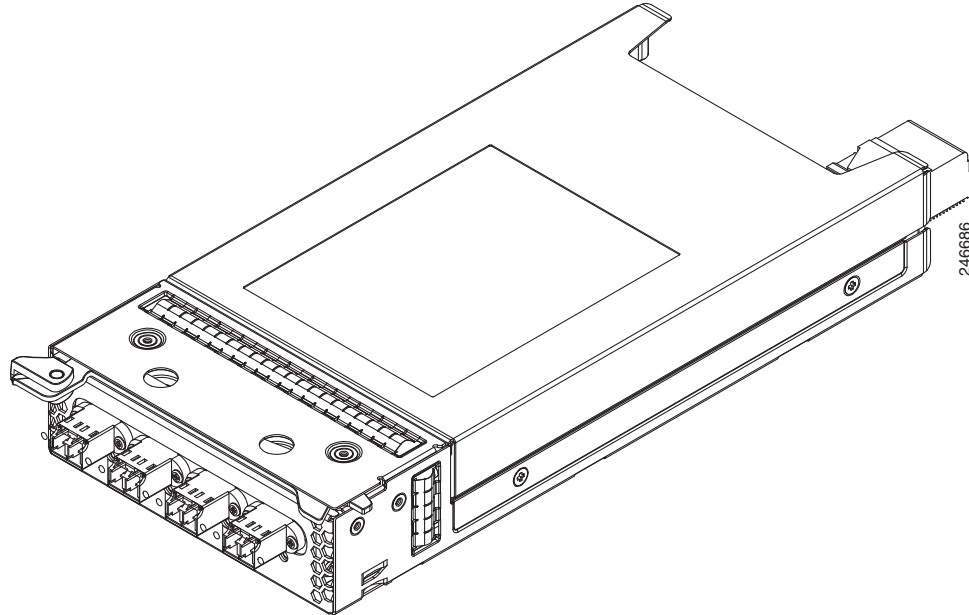
*Figure 5-2 Gigabit Ethernet Interface Module—8-Port Copper*



## Gigabit Ethernet Interface Module—Fiber Optic

The fiber optic Gigabit Ethernet Interface Module is available in 4 ports. This model supports bypass. (See [Figure 5-3](#).)

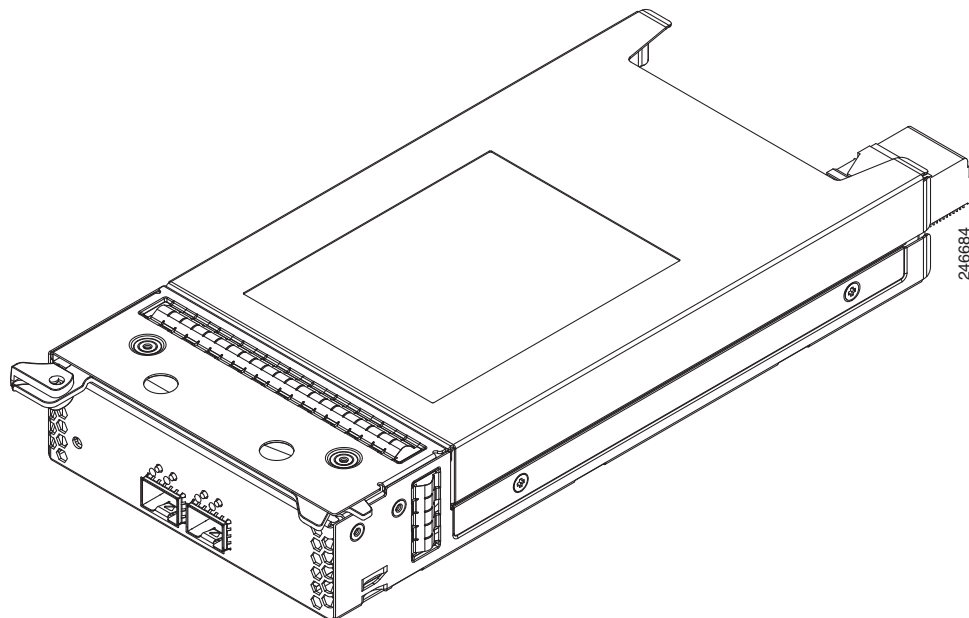
*Figure 5-3 Gigabit Ethernet Interface Module—4-Port Fiber Optic*



## 10 Gigabit Ethernet Interface Module—Fiber Optic SFP+

The fiber optic Gigabit Ethernet Interface Module is available in 2 ports. This model does not support bypass. (See [Figure 5-4](#).)

*Figure 5-4 Gigabit Ethernet Interface Module—2-Port Fiber Optic*



## Inline Interface

When you configure the WAVE appliance for inline interception mode, you can set attributes to control which interfaces are to be used over which VLANs. By default, the module operates on all inline-capable interfaces and VLANs. You can configure the inline redirection feature using the WAAS CLI or the WAAS Central Manager GUI.



### Note

Throughout this section, we refer to a WAVE appliance configured for inline interception mode as a *WAVE inline appliance*.

The WAAS software defines two interface types: A group interface that represents an inline pair grouping and a port interface that represents the individual port. These interfaces are referred to as `inlineGroup` and `inlinePort`.

`InlineGroup` interfaces are numbered using the format `slot/group`. The slot number is the slot in which the adapter is inserted. Since there is only one slot, the slot number is always 1.

The group number starts from 0 and can go up to 4 on 8-port Interface Modules. For 4-port Interface Modules, the groups are numbered 0 and 1. Groups are numbered from left to right.

`InlinePort` interfaces are numbered `slot/group/lan` or `slot/group/wan`. The last attribute is the LAN or WAN designator.

For copper Interface Modules, the top row consists of WAN ports and the bottom row consists of LAN ports. For fiber Interface Modules, the ports are designated as WAN and LAN from left to right. For example, the four ports on the 4-port fiber Interface Module are designated as “W0 L0 W1 L1” in inline mode:

- W0—`InlineGroup 1/0/WAN`
- L0—`InlineGroup 1/0/LAN`
- W1—`InlineGroup 1/1/WAN`
- L1—`InlineGroup 1/1/LAN`

The inline network adapter also includes an onboard programmable watch dog timer (WDT) controller that allows you to set the time to wait after a failure event, such as a power outage or a kernel crash, before the unit begins to operate in mechanical bypass mode. This can be configured using the **inline failover timeout** global configuration command:

```
(config)# inline failover timeout ?
  <1-1> 1 second
  <25-25> 25 seconds
  <5-5> 5 seconds
```

In mechanical bypass mode, the traffic is bridged between the LAN and WAN ports of each group. Mechanical bypass mode prevents the WAVE appliance from becoming a single point of failure and allows traffic to continue to flow between the router and the client while it passes through an unresponsive WAVE appliance without being processed.

For more information about configuring the inline network adapter, see the *Cisco Wide Area Application Services Configuration Guide*.

# Ports and LED Indicators

Figure 5-5 shows the 4-port Copper Gigabit Ethernet Interface Module port numbers, interface designations, and LEDs. Figure 5-6 shows the same information for the 8-port adapter.

Figure 5-5 4-Port Copper Gigabit Ethernet Interface Module—Port Numbering and LEDs

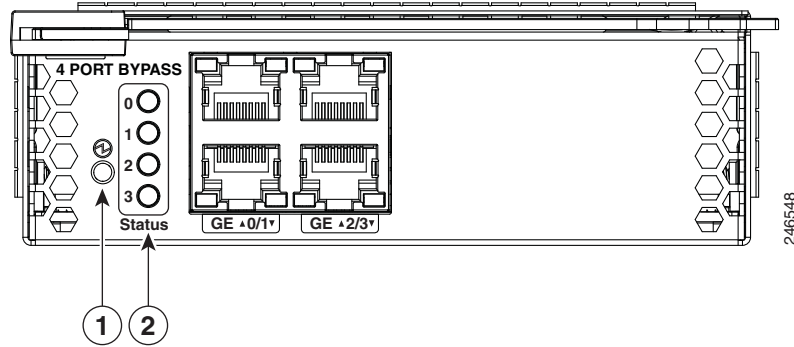
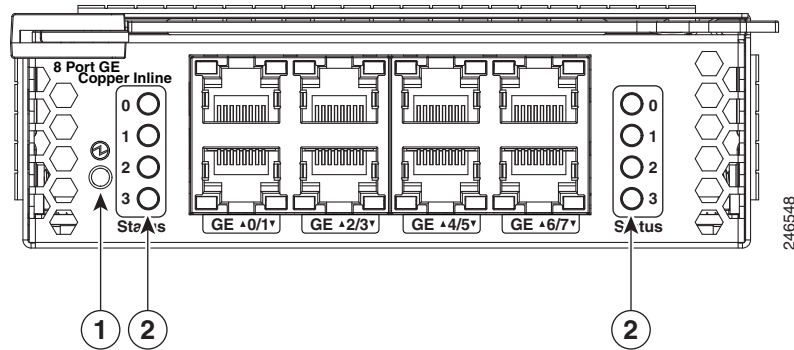


Figure 5-6 8-Port Copper Gigabit Ethernet Interface Module—Port Numbering and LEDs



The Interface Module has an LED that corresponds to each port. Table 5-1 describes the LEDs.

Table 5-1 Copper Interface Module—Power and Status LEDs

LED	Name	Color	State	Description
1	Interface Module power LED	Green	On	Interface Module is receiving power.
		—	Off	Interface Module is not installed or a power supply failure has occurred.
2	Bypass status	Green	Normal	Indicates the inline port pair is in interception mode.
		Amber	Bypass	Indicates the inline port pair is in bypass mode.
		—	Off	No activity exists.

Figure 5-7 shows the Gigabit Ethernet ports and LEDs for the 4-port and 8-port Copper Interface Module.

Figure 5-7 Copper Interface Module—Gigabit Ethernet LEDs

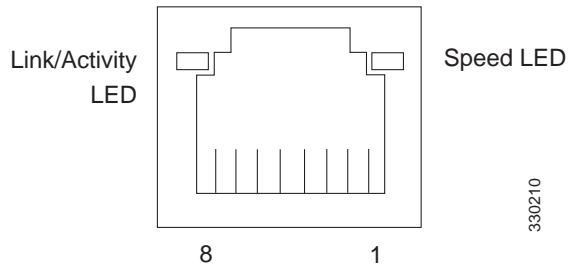


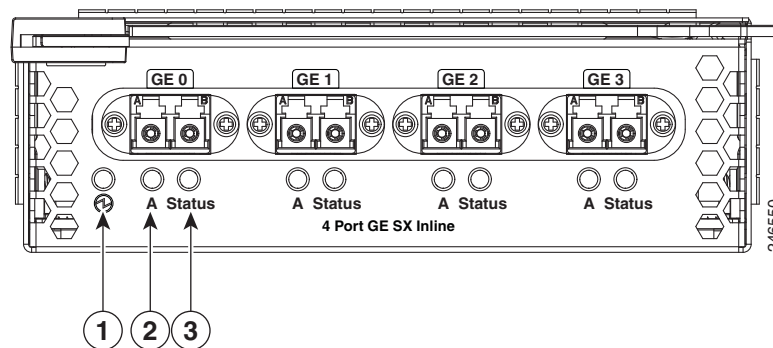
Table 5-2 describes the Gigabit Ethernet port LEDs.

Table 5-2 Copper Interface Module—Gigabit Ethernet LEDs

Name	Color	State	Description
NIC link/activity	Green	On	Link exists.
	Green	Blinking	Activity exists.
	—	Off	No link detected.
NIC speed	—	Off	10Mbps connection.
	Green	On	100Mbps connection.
	Yellow	On	1000Mbps connection.

Figure 5-8 shows the 4-port Fiber Optic Gigabit Ethernet Interface Module port numbers, interface designations, and LEDs.

Figure 5-8 4-Port Fiber Optic Gigabit Ethernet Interface Module—Port Numbering and LEDs



The Interface Module has an LED that corresponds to each port. Table 5-3 describes the LEDs.

Table 5-3 Fiber Optic Interface Module—Power and Status LEDs

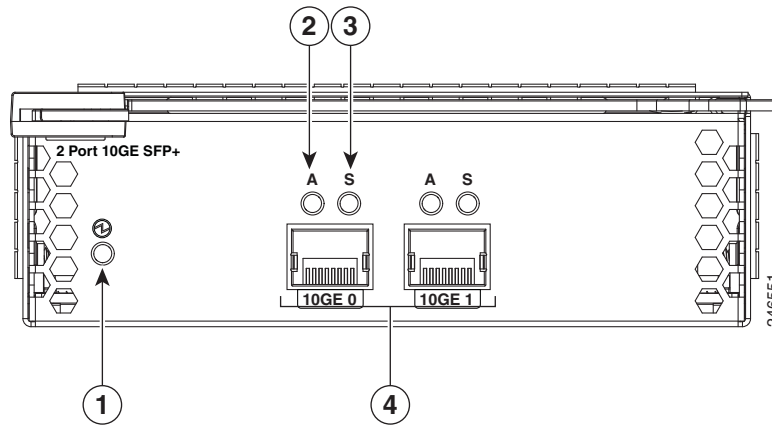
LED	Name	Color	State	Description
1	Interface Module power LED	Green	On	Interface Module is receiving power.
		—	Off	Interface Module is not installed or a power supply failure has occurred.

Table 5-3 Fiber Optic Interface Module—Power and Status LEDs

2	Activity	Green	On	Link exists.
		Green	Blinking	Transmitting.
		—	Off	No link detected.
3	Bypass status	Green	Normal	Indicates the inline port pair is in interception mode.
		Amber	Bypass	Indicates the inline port pair is in bypass mode.

Figure 5-9 shows the 2-port Fiber Optic 10 Gigabit Ethernet SFP+ Interface Module port numbers, interface designations, and LEDs.

Figure 5-9 2-Port Fiber Optic 10 Gigabit Ethernet SFP+ Interface Module—Port Numbering and LEDs



Note

The 2-Port Fiber Optic 10 Gigabit Ethernet SFP+ Interface Module does not support mechanical bypass.

The Interface Module has an LED that corresponds to each port. Table 5-4 describes the LEDs.

Table 5-4 Inline Network Adapter LEDs

LED	Name	Color	State	Description
1	Interface Module Power LED	Green	On	Interface Module is receiving power.
		—	Off	Interface Module is not installed or a power supply failure has occurred.
2	Activity	—	Off	No link is detected.
		Green	On	Link is detected.
		Green	Blinking	Transmitting.
		Yellow	On	Interface Module is administratively shut down.

Table 5-4 Inline Network Adapter LEDs (continued)

LED	Name	Color	State	Description
3	Speed	—	Off	No link is detected.
		Green	On	10 Gigabit Ethernet connection.
		Yellow	On	1 Gigabit Ethernet connection.

## Network Adapter Cabling Requirements

### Gigabit Ethernet—Copper

The Interface Module ships with two types of cables: crossover and straight-through. When you connect the WAVE inline network adapter, the cable that you use depends on the link speed (Gigabit Ethernet or Fast Ethernet) and the types of devices (DCE or DTE) being connected.



#### Note

You must retain the same link speed from one end of the connection to the other end. Inline adapter interfaces are able to autonegotiate link speeds. If you configure any of your connecting interfaces for Fast Ethernet (whether on a switch or a router), your WAVE inline adapter uses Fast Ethernet. If you configure any of your connecting interfaces for Gigabit Ethernet, your WAVE inline adapter uses Gigabit Ethernet. Speed and duplex settings are port specific so that two inline ports can negotiate different speeds independently.

If you are connecting a WAVE inline appliance between two devices using Gigabit Ethernet, you can use either straight-through cables, crossover cables, or any combination of the two cable types, regardless of the type of device. However, for consistency, we recommend that you use straight-through cables for all Gigabit Ethernet connections.

Table 5-5 shows the cable requirements for WAVE appliance and non-WAVE appliance connections when you are using Gigabit Ethernet end to end.

Table 5-5 Cable Requirements for WAVE Connections Using Gigabit Ethernet

Connection	Required Cable
Switch to switch (no WAVE)	Crossover or straight-through
Switch to router (no WAVE)	Crossover or straight-through
Router to router (no WAVE)	Crossover or straight-through
Switch to WAVE and	Crossover or straight-through
WAVE to Router	Crossover or straight-through
Switch to WAVE and	Crossover or straight-through
WAVE to Switch	Crossover or straight-through
Router to WAVE and	Crossover or straight-through
WAVE to Router	Crossover or straight-through
WAVE to WAVE	Crossover or straight-through



Some switches support automatic medium-dependent interface crossover (MDIX). You can configure MDIX by using the **mdix auto** global configuration switch command. If your switch supports MDIX, you do not need to follow these cabling rules because MDIX automatically adjusts transmit and receive pairs when an incorrect cable type (crossover or straight-through) is installed on a 10/100 Fast Ethernet port. However, when you configure MDIX, you must also configure the port to use autosense (not manual selection of speed/duplex).

**Caution**

If you are connecting to Fast Ethernet ports on both the LAN and the WAN sides of the WAVE inline appliance, you must consider the types of devices that are being connected, and you must use the correct cables. You must follow these cabling instructions for the inline network adapter to work properly. (See [Table 5-6](#). For illustrations and examples, see [Installation Scenarios and Cabling Examples for Fast Ethernet Connections](#).)

To connect the inline network adapter using the correct cables for Fast Ethernet connections, follow these steps:

**Step 1**

Determine the type of cable that you would use for a direct connection between your two end devices (without a WAVE inline network appliance connected between them) by using the following standard cabling rules:

- When you are directly connecting two network devices that are similar, such as two switches, use a crossover cable.
- When you are directly connecting two network devices that are different, such as a switch and router, use a straight-through cable.

**Note**

Because the inline network adapter has an internal crossover connection that becomes active when the InlineGroup interface is placed in mechanical bypass mode, you must decide which cable you would use to connect the two network devices directly, and then you must install the other cable type (on one side, usually the WAN side of the inline appliance) instead.

[Table 5-6](#) shows the cable requirements for WAVE and non-WAVE connections when you are using Fast Ethernet end to end.

**Table 5-6** Cable Requirements for WAVE Connections Using Fast Ethernet

Connection	Required Cable
Switch to switch (no WAVE)	Crossover
Switch to router (no WAVE)	Straight-through
Router to router (no WAVE)	Crossover
Switch to WAVE and WAVE to Router	Straight-through Crossover
Switch to WAVE and WAVE to Switch	Straight-through Straight-through
Router to WAVE and WAVE to Router	Straight-through Straight-through
WAVE to WAVE	Crossover

**Step 2** Connect Fast Ethernet ports on both the LAN and the WAN sides of the WAVE inline appliance by using the following cable types:

- On the LAN side of the connection, use a straight-through cable between the WAVE inline appliance and the network device.
- On the WAN side of the connection, use the cable that is different from the cable that you would use to connect the two network devices directly (as determined in [Step 1](#)).

For example, if you are connecting a router and a switch (two different devices) through the WAVE inline appliance, use a straight-through cable on the LAN side of the connection and use a crossover cable on the WAN side of the connection. (If you were connecting the two different devices directly, you would use a straight-through cable, so use the crossover cable instead.)

If you are connecting two switches (or two similar devices), use straight-through cables on both the LAN and the WAN sides of the WAVE inline appliance.

[Figure 5-10](#) through [Figure 5-12](#) show which cables to use for the WAVE LAN and WAN connections between Fast Ethernet ports.

## Gigabit Ethernet—Fiber Optic

The following three SFP+ pluggable transceiver modules are supported for use with the 2-port Fiber Optic 10 Gigabit Ethernet Interface Module:

- SFP-10G-SR—Short range fiber xcvr
- SFP-H10G-CU3M— Three meter captive copper cable with xcvs
- SFP-H10G-CU5M— Five meter captive copper cable with xcvs

Transceivers not supported will be rejected by the software.

For fiber cable length reach and IEEE standards for the supported transceivers, refer to the pluggable 10G optics data sheet on Cisco.com:

[http://www.cisco.com/en/US/prod/collateral/modules/ps5455/data\\_sheet\\_c78-455693.html](http://www.cisco.com/en/US/prod/collateral/modules/ps5455/data_sheet_c78-455693.html)

Optical reach is 137 m (449 ft) to any individual port. This allows for a total of 274 m (899 ft) when operating in bypass mode.

## Installation Scenarios and Cabling Examples for Fast Ethernet Connections

WAVE appliances can be installed physically between two network devices (such as the branch office router and branch office LAN switch) by connecting the WAVE inline network adapter ports to the network devices using the proper cables.

If you are connecting a WAVE inline appliance between two devices using Gigabit Ethernet, you can use either straight-through cables, crossover cables, or any combination of the two cable types, regardless of the type of device. This section shows cabling examples for Fast Ethernet connections only, because Fast Ethernet has specific cabling requirements.

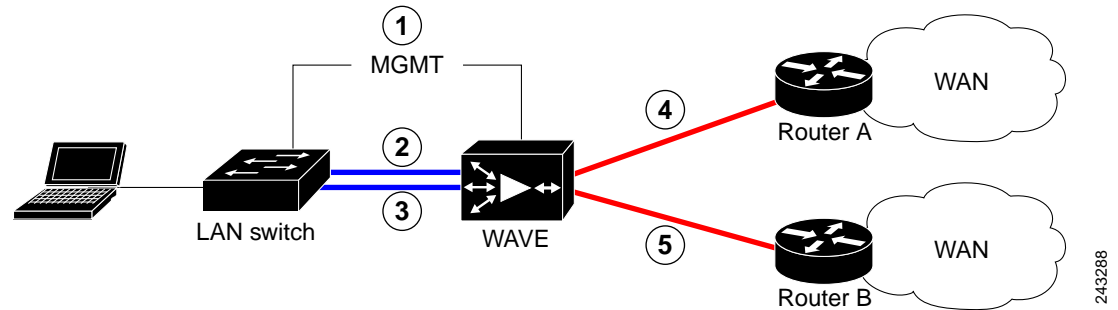
The inline network adapter has four ports that are divided into two inline groups (see [Ports and LED Indicators](#)). The WAVE appliance can be physically placed inline between two distinct network paths, creating redundant WAN links. (See [Figure 5-10](#).)

Two WAVE appliances with inline network adapters can also be installed back-to-back in a serial fashion between two network devices for failover purposes. In this serial cluster configuration, if one WAVE appliance fails, the other WAVE appliance can provide optimization. (See [Figure 5-11.](#))

**Note**

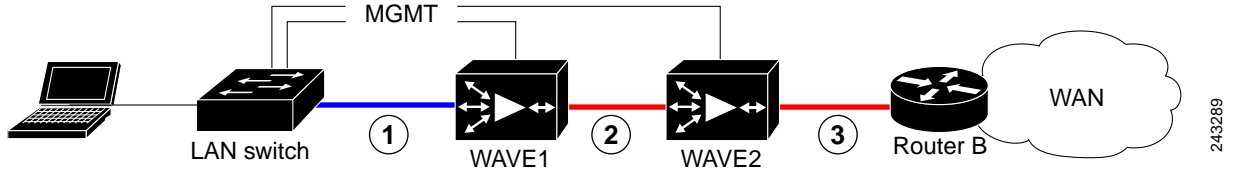
When you connect two WAVE inline appliances to each other serially, always use a crossover cable between the two WAVE appliances. (See [Figure 5-12.](#))

**Figure 5-10** Cabling for a Single Inline WAVE Appliance with Redundant WAN Connections



<b>1</b>	Connection: Management Gigabit Ethernet: 1/0 Cable type: Straight-through (recommended)	<b>2</b>	Connection: WAVE to LAN switch (using InlineGroup 1/0) Fast Ethernet: LAN0 (InlinePort 1/0/lan) Cable type: Straight-through
<b>3</b>	Connection: WAVE to LAN switch (using InlineGroup 1/1) Fast Ethernet: LAN1 (InlinePort 1/1/lan) Cable type: Straight-through	<b>4</b>	Connection: WAVE to WAN router A (using InlineGroup 1/0) Fast Ethernet: WAN0 (InlinePort 1/0/wan) Cable type: Crossover
<b>5</b>	Connection: WAVE to WAN router B (using InlineGroup 1/1) Fast Ethernet: WAN1 (InlinePort 1/1/wan) Cable type: Crossover		

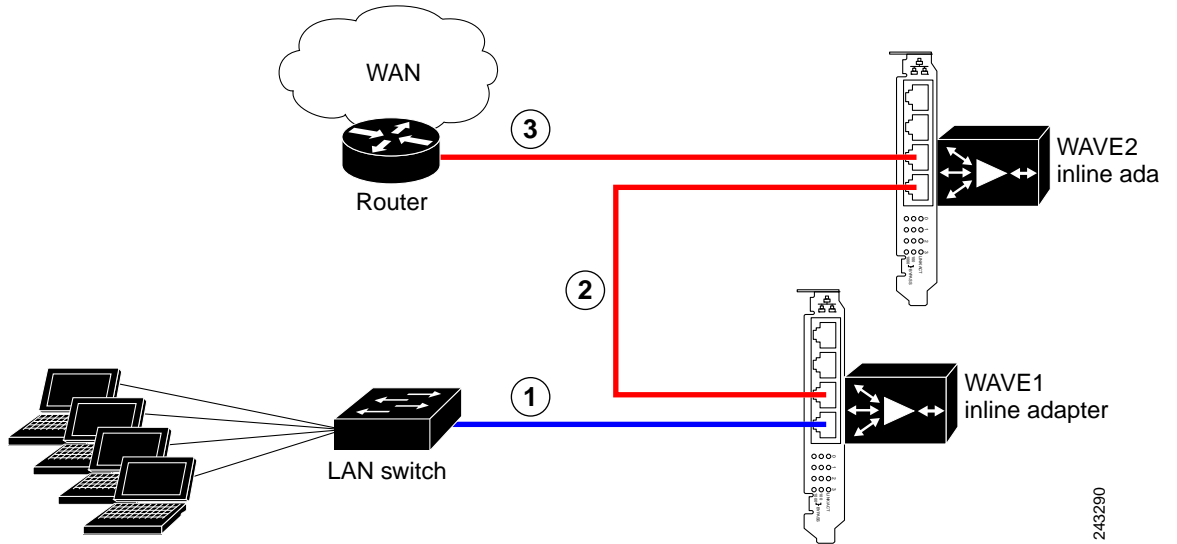
Figure 5-11 Cabling for Serial Cluster Inline WAVEs with a Single WAN Connection



243289

1	Connection: WAVE 1 to LAN switch Fast Ethernet: LAN0 (InlinePort 1/0/lan) Cable type: Straight-through	2	Connection: WAVE 1 to WAVE 2 Fast Ethernet: WAVE1 WAN0 (InlinePort 1/0/wan) to WAVE 2 LAN0 (InlinePort 1/0/lan) Cable type: Crossover
3	Connection: WAVE 2 to WAN router Fast Ethernet: WAVE 2 WAN0 (InlinePort 1/0/wan) Cable type: Crossover		

Figure 5-12 Cabling Between Two Inline WAVEs



243290

<b>1</b>	Connection: WAVE 1 to LAN switch Fast Ethernet: WAVE 1 LAN0 (InlinePort 1/0/lan) Cable type: Straight-through	<b>2</b>	Connection: WAVE 1 to WAVE 2 Fast Ethernet: WAVE 1 WAN0 (InlinePort 1/0/wan) to WAVE 2 LAN0 (InlinePort 1/0/lan) Cable type: Crossover
<b>3</b>	Connection: WAVE 2 to WAN router Fast Ethernet: WAVE 2 WAN0 (InlinePort 1/0/wan) Cable type: Crossover		





# Troubleshooting the System Hardware

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This chapter provides basic troubleshooting information to help you identify some common problems that might occur with your WAVE-594 and WAVE-694.

This chapter contains the following sections:

- [Identifying System Problems](#)
- [Checking Connections and Switches](#)
- [Troubleshooting the Ethernet Controller](#)
- [Undetermined Problems](#)
- [Problem-Solving Tips](#)
- [Error Symptoms](#)

Use the information in this chapter to determine whether a problem originates with the hardware or the software. For further assistance, contact your Cisco customer service representative.



**Note**

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When console redirection is enabled (it is disabled by default), all the tests available from a keyboard are accessible through the console connection as well. (Mouse support, however, is not available through the console connection.)

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**Caution**

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Customer-replaceable components include the WAVE Interface Modules, hard disk drives, power supply assemblies, fans, and memory. All other components that are not orderable as spare hardware options can only be replaced by a qualified service technician. Once you have identified a faulty component, contact the Cisco Technical Assistance Center (TAC).

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## Identifying System Problems

To identify system problems, follow these steps:

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- Step 1** Check the power LED.
- Step 2** Check the system fault LED (see [System fault LED](#) in Chapter 1, “Introducing the Cisco Wide Area Virtualization Engine 594 and 694”). If the status is yellow, check for alarms using the **show alarms** command.
- Step 3** Power down the appliance and all external devices.

- Step 4** Check all cables and power cords. (See [Checking Connections and Switches](#).)
  - Step 5** Power up the appliance.
  - Step 6** If the self-diagnostic programs were completed successfully and you still suspect a problem, see [Undetermined Problems](#).
  - Step 7** Check the system error log to see if an error was recorded by the system.
- 

## Checking Connections and Switches

Improperly set switches and controls and loose or improperly connected cables are the most likely source of problems for the chassis or other external equipment. A quick check of all the switches, controls, and cable connections can easily solve these problems. (See [Figure 1-1](#) for the location of front panel controls and indicators. See [Figure 1-3](#) for the location of back panel connectors on the system.)

To check all the connections and switches, follow these steps:

- 
- Step 1** Power down the system. Disconnect all the power cables from their electrical outlets.
  - Step 2** If the system is connected to a power strip (or power distribution unit), turn the power strip off and then on again.
    - If the power strip is receiving power go to [Step 5](#).
    - If the power strip is not receiving power go to [Step 3](#).
  - Step 3** Plug the power strip into another electrical outlet.
    - If the power strip is receiving power, the original electrical outlet probably does not function. Use a different electrical outlet.
    - If the power strip is not receiving power go to [Step 4](#).
  - Step 4** Plug a system that you know works into the electrical outlet.
    - If the system receives power, the power strip is probably not functioning properly. Use another power strip.
    - If the system does not receive power, go to [Step 5](#).
  - Step 5** Reconnect the system to the electrical outlet or power strip.
    - Make sure that all connections fit tightly together.
  - Step 6** Power up the system.
    - If the problem is resolved, the connections were loose. You have fixed the problem.
    - If the problem is not resolved, call your customer service representative. (See [Obtaining Documentation and Submitting a Service Request](#) in the Preface.)
- 

## Troubleshooting the Ethernet Controller

This section provides troubleshooting information for problems that might occur with the 10/100/1000-Mbps Ethernet controller.



This section contains the following topics:

- [Network Connection Problems](#)
- [Ethernet Controller Troubleshooting Chart](#)

## Network Connection Problems

If the Ethernet controller cannot connect to the network, check the following conditions:

- Make sure that the cable is installed correctly.

The network cable must be securely attached at all connections. If the cable is attached but the problem remains, try a different cable.

If you set the Ethernet controller to operate at either 100 Mbps or 1000 Mbps, you must use Category 5 or higher cabling.

- Determine whether the switch or device to which the WAVE appliance is connected supports autonegotiation. If it does not, try configuring the integrated Ethernet controller manually to match the speed and duplex mode of the switch.
- Check the Ethernet controller LEDs on the appliance back panel. (See [Figure 1-2](#).)

These LEDs indicate whether a problem exists with the connector, cable, or switch:

- The Ethernet link status LED is on when the Ethernet controller receives a link pulse from the switch. If the LED is off, there might be a defective connector or cable or a problem with the switch.
- The Ethernet activity LED is on when the Ethernet controller sends or receives data over the Ethernet network. If the Ethernet activity LED is off, make sure that the switch and network are operating and that the correct device drivers are installed.

## Ethernet Controller Troubleshooting Chart

[Table 6-1](#) lists solutions to 10/100/1000-Mbps Ethernet controller problems.

Table 6-1 Ethernet Troubleshooting Chart

Ethernet Controller Problem	Actions
Ethernet link status LED does not work.	Check the following: <ul style="list-style-type: none"> <li>• Make sure that the switch to which the WAVE appliance is connected is powered on.</li> <li>• Check all connections at the Ethernet controller and the switch.</li> <li>• Use another port on the switch.</li> <li>• If the switch does not support autonegotiation, manually configure the Ethernet controller to match the switch. (Both sides of the connection must be set the same. Mixing autonegotiation and hard-coded configurations will result in half duplex, which causes a CRC error on the interface.)</li> <li>• If you manually configured duplex mode, make sure that you also manually configure the speed.</li> </ul>
The Ethernet activity LED does not work.	Check the following: <ul style="list-style-type: none"> <li>• The network might be idle. Try sending data from this appliance.</li> <li>• Check all connections at the Ethernet controller and the switch.</li> <li>• Use another port on the switch.</li> </ul>
Data is incorrect or sporadic.	Check the following: <ul style="list-style-type: none"> <li>• Make sure that you are using Category 5 or higher cabling when operating the appliance at 100 Mbps or 1000 Mbps.</li> <li>• Make sure that the cables do not run close to noise-inducing sources such as fluorescent lights.</li> <li>• Make sure the RJ-45 jack is securely latched (avoid cables with broken latches).</li> </ul>
The Ethernet controller stopped working without apparent cause.	Check the following: <ul style="list-style-type: none"> <li>• Try a different connector on the switch.</li> <li>• If you suspect the adapter is faulty, contact the Cisco Technical Assistance Center (TAC).</li> </ul>

## Undetermined Problems

Use the information in this section if the diagnostic tests did not identify the failure, the devices list is incorrect, or the system is inoperative.



**Note**

Damaged data in CMOS can cause undetermined problems.



**Note**

Damaged data in BIOS code can cause undetermined problems.

Check the system LEDs for the power supplies (see [Back Panel Components and LEDs](#) in Chapter 1, “Introducing the Cisco Wide Area Virtualization Engine 594 and 694”). If the LEDs indicate the power supplies are working correctly, follow these steps:

- 
- Step 1** Power down the appliance.
- Step 2** Be sure the appliance is cabled correctly.
- Step 3** Remove or disconnect the following devices (one at a time) until you find the failure (power up the appliance and reconfigure it each time):
- Any non-Cisco devices
  - Surge suppressor device (on the appliance)
  - Each Cisco Interface Module
  - Disk drives



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**Note** Any component that is internal to the appliance must be serviced by trained and qualified personnel. Contact your customer service representative.

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- Step 4** Power up the appliance. If the problem remains, contact Cisco TAC.



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**Note** If the problem goes away when you remove a device from the system, and replacing that device does not correct the problem, contact Cisco TAC.

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**Note** If you suspect a networking problem and all the system tests pass, check if there is a network cabling problem external to the system.

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## Problem-Solving Tips

Because of the variety of hardware and software combinations that can be encountered, use the following information to assist you in identifying the problems. If possible, have this information available when requesting technical assistance.

- Machine type and model
- Hardware upgrades
- Failure symptom
  - What, when, where; single or multiple systems?
  - Is the failure repeatable?
  - Has this configuration ever worked?
  - If it has been working, what changes were made before it failed?
  - Is this the original reported failure?
- Hardware configuration

- Print (print screen) configuration currently in use
- BIOS level
- WAAS system software type and version level

To eliminate confusion, identical systems are considered identical only if they meet all these conditions:

- Are the exact machine type and models
- Have the same BIOS level
- Have the same devices or attachments in the same locations
- Have the same cabling
- Have the same WAAS software versions and levels
- Have the same configuration options set in the system
- Have the same setup for the operating system control files

Comparing the configuration and software setup in working and nonworking systems might help to resolve the problem.

## Error Symptoms

You can use the error symptom tables to find solutions to problems that have definite symptoms.

In the following tables (Table 6-2 to Table 6-8), the first entry in the “Cause and Action” column is the most likely cause of the symptom.

**Table 6-2**      *Hard Disk Drive Problems*

Symptom	Cause and Action
Hard disk drive stops responding during system startup.	<ol style="list-style-type: none"> <li>1. Remove the hard disk drive that stopped responding and try starting the appliance again.</li> <li>2. If the system starts successfully, the drive that you removed needs to be replaced.</li> </ol>
A hard disk drive was not detected while the operating system was being started.	Reseat all hard disk drives and cables.

**Table 6-3**      *General Problems*

Symptom	Cause and Action
Problems such as broken cover latch or indicator LEDs not working.	Broken component. Call your customer service representative.

Table 6-4 Intermittent Problems

Symptom	Cause and Action
A problem occurs only occasionally and is difficult to detect.	<ol style="list-style-type: none"> <li>1. Verify the following items:               <ol style="list-style-type: none"> <li>a. All cables and cords are connected securely to the rear of the appliance and attached hardware options.</li> <li>b. When the appliance is powered on, air is flowing from the rear of the appliance at the fan grille. If there is no airflow, the fans are not working. This causes the appliance to overheat and shut down.</li> </ol> </li> <li>2. Check the system error log.</li> <li>3. See <a href="#">Undetermined Problems</a>.</li> </ol>

Table 6-5 Memory Problems

Symptom	Cause and Action
The amount of system memory displayed is less than the amount of physical memory installed.	<ol style="list-style-type: none"> <li>1. Verify the system fault LED is not lit on the front panel.</li> <li>2. Verify the correct number of DIMMS are present (including serial numbers) using the <b>show hardware</b> command.</li> <li>3. Check for memory alarms using the <b>show alarms</b> command.</li> </ol>

Table 6-6 Hardware Option Problems

Symptom	Cause and Action
A hardware option that was just installed does not work.	<ol style="list-style-type: none"> <li>1. Verify the following items:               <ol style="list-style-type: none"> <li>a. The hardware option is designed for the appliance.</li> <li>b. You followed the installation instructions that came with the hardware option.</li> <li>c. The hardware option is installed correctly.</li> <li>d. You have not loosened any other installed hardware options or cables.</li> </ol> </li> <li>2. Check the hardware option that you just installed.</li> </ol>
A hardware option that used to work does not work now.	<ol style="list-style-type: none"> <li>1. Verify that all of the hardware options and cable connections are secure.</li> <li>2. Check for a failing hardware option and replace it if necessary.</li> </ol>

Table 6-7 Power Problems

Symptom	FRU or Action
<p>The power-control button does not work (the appliance does not start).</p> <p><b>Note</b> The power-control button will not function until 20 seconds after the appliance has been connected to power.</p>	<ol style="list-style-type: none"> <li>1. Verify the following items: <ol style="list-style-type: none"> <li>a. The power cables are properly connected to the appliance.</li> <li>b. The electrical outlet functions properly.</li> </ol> </li> <li>2. If you just installed a hardware option, remove it, and restart the appliance.</li> <li>3. See <a href="#">Undetermined Problems</a>.</li> </ol>
<p>The appliance does not power down.</p>	<ol style="list-style-type: none"> <li>1. Turn off the appliance by pressing the power-control button for 5 seconds.</li> <li>2. Restart the appliance.</li> <li>3. If the power-control button does not work, disconnect the power cord for 20 seconds. Reconnect the power cord and restart the appliance.</li> </ol>
<p>The appliance unexpectedly shuts down, and the LEDs on the operator information panel are not lit.</p>	<p>See <a href="#">Undetermined Problems</a>.</p>

Table 6-8 Console Port Problems

Symptom	FRU or Action
<p>A console connection does not work. For more information about the console port, see <a href="#">Console Port Connector</a> in Chapter 1, “Introducing the Cisco Wide Area Virtualization Engine 594 and 694.”</p>	<ol style="list-style-type: none"> <li>1. Verify that the console device is connected to the correct port (see <a href="#">Console Port Connector</a>).</li> <li>2. If using the mini-USB console port, verify that the driver has been installed (see <a href="#">Console Port Connector</a> in Chapter 1, “Introducing the Cisco Wide Area Virtualization Engine 594 and 694”).</li> </ol>



# WAVE-594 and WAVE-694 Hardware Specifications

This appendix provides hardware specifications for the WAVE-594 and WAVE-694 appliance. It contains the following sections:

- [Appliance Specifications](#)
- [Interface Module Specifications](#)

## Appliance Specifications

[Table A-1](#) provides a summary of the features and specifications of the WAVE-594 and WAVE-694.

*Table A-1 WAVE-594 and WAVE-694 Features and Specifications*

Specification	Description
Microprocessor	<ul style="list-style-type: none"> <li>• 1 Intel Xeon Quad-Core Processor X3430, or 1 Intel Xeon Quad-Core Processor X3450</li> <li>• 2.4 GHz and 2.67 GHz respectively</li> <li>• 8 MB cache</li> </ul>
Memory	<ul style="list-style-type: none"> <li>• 8 GB to 24 GB ECC DDR3 SDRAM (RDIMM) 1333MT/s</li> </ul>
Mass storage	<p>WAVE-594</p> <ul style="list-style-type: none"> <li>• 1 500-GB SATA hard disk drive or RAID-1 array with two 500-GB SAS hard disk drives</li> <li>OR</li> <li>• 1 400-GB SATA Solid State Drive (SSD) or RAID-1 array with two 400-GB SATA SSD</li> </ul> <p>WAVE-694</p> <ul style="list-style-type: none"> <li>• RAID-1 array with two 800-GB SATA solid state drives</li> </ul>
Fans	<ul style="list-style-type: none"> <li>• 6 externally accessible, hot-plug fans</li> </ul>
Expansion slots	<ul style="list-style-type: none"> <li>• 1 Interface Module Slot for Cisco Interface Modules</li> </ul>

Table A-1 WAVE-594 and WAVE-694 Features and Specifications (continued)

Specification	Description
Dimensions	<ul style="list-style-type: none"> <li>Height: 42 mm (1.69 in)</li> <li>Depth: 516 mm (20.33 in); includes power supply handles</li> <li>Width: 429 mm (16.89 in)</li> </ul>
Weight	<p>Maximum Weight (no carton): 10.21 kg (22.51 lb)</p> <p>(Includes the weight of one Cisco Interface Module, one power supply, and two hard disk drives.)</p>
Electrical Input Requirements <sup>1</sup>	<ul style="list-style-type: none"> <li>Range Line Voltage: 90 to 132 VAC, 180 to 264 VAC</li> <li>Maximum Rated Input Current: 5 A - 2.5 A (100 - 240VAC)</li> <li>Rated Input Frequency: 47 to 63 Hz</li> <li>Maximum Real Input Power: 530W total (shared load when redundant)</li> </ul>
BTU Rating	1808 BTU/hr Maximum
Power supply output	<ul style="list-style-type: none"> <li>Rated steady-state power: 450 W (across input of 100 - 240 VAC)</li> <li>Efficiency: Minimum of 85% at 100% electrical load</li> </ul>
Acoustic noise <sup>2</sup>	<ul style="list-style-type: none"> <li>Idle: 43.9 dBA</li> <li>Operating (70% load): 46.9 dBA</li> </ul>
Environment	<ul style="list-style-type: none"> <li>Air temperature: <ul style="list-style-type: none"> <li>Operating<sup>3</sup>: 0 to 40 °C (32 to 104 °F)</li> <li>Non-operating: -30 to 60 °C (-22 to 140 °F)</li> </ul> </li> <li>Humidity: <ul style="list-style-type: none"> <li>Operating: 10% to 90% RH (non-condensing)</li> <li>Nonoperating: 5% to 95% RH (non-condensing)</li> </ul> </li> <li>Altitude: <ul style="list-style-type: none"> <li>Operating: 3,050 m (10,000 ft)</li> <li>Nonoperating: 4572 m (15,000 ft)</li> </ul> </li> </ul>

1. Electrical input specifications apply at 23 °C (73.4 °F).

2. Levels are A-weighted sound pressures measured in a 23 °C (73.4 °F) ambient environment. Measurements were made per ISO 7779 (ECMA 74; ANSI S12.10) methods and are declared per ISO 9296 (ECMA 109).

3. All temperature ratings shown are for sea level to 1,000 meters (3,281 ft) with de-rating of maximum temperature for increase in altitude. If operating location is above 1,000 meters (3,281 feet), deduct 3 °C (5.4 °F) from the maximum operating temperature for each additional 1,000 meters (3,281 ft).



# Interface Module Specifications

Table A-2 describes the Interface Module technical and general specifications.

**Table A-2** *Inline Network Adapter Specifications*

Specification	Description
<b>Copper Gigabit Ethernet Bypass (4-port and 8-port)</b>	
IEEE standard	Gigabit Ethernet, 1000BASE-T, IEEE 802.3-2000 Fast Ethernet, 100BASE-T, IEEE 802.3-2000 Ethernet, 10BASE-T, IEEE 802.3-2000
Duplex	Supports both half-duplex and full-duplex operation in all operating speeds
Autonegotiation	Autonegotiates between full-duplex and half-duplex operations and between 1000 Mbps, 100 Mbps, and 10 Mbps speeds
Data transfer rate	1000 Mbps, 100 Mbps, and 10 Mbps speeds per port in half-duplex mode 2000 Mbps, 200 Mbps, and 20 Mbps speeds per port in full-duplex mode
Ports	4-Port Interface Module: 4 × RJ-45 socket connectors 8-Port Interface Module: 8 × RJ-45 socket connectors
<b>Fiber Optic Gigabit Ethernet Bypass (4-port)</b>	
IEEE standard	Gigabit Ethernet, 1000BASE-SX, IEEE 802.3-2000
Duplex	Supports full-duplex only
Optical reach	137 m (449 ft) to any individual port to account for 274 m (899 ft) total when operating in bypass mode
Data transfer rate	2000 Mbps
Ports	4 Fixed LC Duplex Connectors
<b>SFP+ 10 Gigabit Ethernet (2-port)</b>	
IEEE standard	The Cisco 10 Gigabit Ethernet Interface Module for WAAS only supports Cisco pluggable optical transceiver modules. Consult the following data sheet URL for supported modules: <a href="#">Cisco 10GBASE SFP+ Modules</a>
Duplex	Supports full-duplex only
Autonegotiation	Autonegotiates pluggable transceiver type 1 Gbps or 10 Gbps
Data transfer rate	2000 Mbps and 20,000 Mbps
Ports	2-Port Interface Module: 2 Pluggable SFP/SFP+ sockets
Optical reach	Varies per module type. Consult the following data sheet URL for supported modules: <a href="#">Cisco 10GBASE SFP+ Modules</a>
<b>General Technical Specifications</b>	
Dimensions	38 mm (1.5 in) H x 121 mm (4.75 in) W x 264 mm (10.38 in) D
Weight	0.73 kg to 0.91 kg (1.61 lb to 2.01 lb)

*Table A-2 Inline Network Adapter Specifications (continued)*

<b>Specification</b>	<b>Description</b>
Operating humidity	10 to 90% RH (non-condensing)
Operating temperature	0 to 40 °C (32 to 104 °F)
Operating altitude	3,050 m (10,000 ft)
Non-operating temperature	-30 to 60 °C (-22 to 140 °C)
Non-operating humidity	5 to 95% RH (non-condensing)
Non-operating altitude	4,572 m (15,000 ft)



## Maintaining the WAVE-594 and WAVE-694

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Proper use of preventive maintenance procedures can keep the WAVE-594 and WAVE-694 in good operating condition and minimize the need for costly, time-consuming service procedures. This chapter contains maintenance procedures that you should perform regularly.

This chapter covers the tasks required for maintaining a WAVE-594 and WAVE-694 or a WAVE-594 and WAVE-694 farm:

- [Maintaining Your Site Environment](#)
- [Using Power Protection Devices](#)

### Maintaining Your Site Environment

An exhaust fan in the power supply cools the power supply and system by drawing air in through various openings in the system and blowing it out the back. However, the fan also draws dust and other particles into the system, causing contaminant buildup, which results in an increase in the system's internal temperature and interferes with the operation of various system components.

To avoid these conditions, we recommend keeping your work environment clean to reduce the amount of dust and dirt around the system, thereby reducing the amount of contaminants drawn into the system by the power supply fan.

This section discusses various environmental factors that can adversely affect system performance and longevity.

- [Temperature](#)
- [Humidity](#)
- [Altitude](#)
- [Dust and Particles](#)
- [Corrosion](#)
- [Electrostatic Discharge](#)
- [Electromagnetic and Radio Frequency Interference](#)
- [Magnetism](#)
- [Shock and Vibration](#)
- [Power Source Interruptions](#)

## Temperature

Temperature extremes can cause a variety of problems, including premature aging and failure of chips or mechanical failure of appliances. Extreme temperature fluctuations can cause chips to become loose in their sockets and can cause expansion and contraction of disk drive platters, resulting in read or write data errors.

To minimize the negative effects of the temperature on system performance, follow these guidelines:

- Ensure that the system is operated in an environment that does not exceed 0 to 40°C (32 to 104°F) in either direction. The upper end of operating temperature above applies up to an altitude of 1,000 meters (3,281 feet) and then subtract 3°C for each additional 1,000 meters up to a maximum operational altitude of 3,000 meters (9,843 feet).
- Ensure that the system has adequate ventilation. Do not place it within a closed-in wall unit or on top of cloth, which can act as insulation. Do not place it where it will receive direct sunlight, particularly in the afternoon. Do not place it next to a heat source of any kind, including heating vents during winter.

Adequate ventilation is particularly important at high altitudes. System performance may not be optimum when the system is operating at high temperatures as well as high altitudes.

- Make sure that all slots and openings on the system remain unobstructed, especially the fan vent on the back of the system.
- Clean the system at regular intervals to avoid any buildup of dust and debris, which can cause a system to overheat.
- If the system has been exposed to abnormally cold temperatures, allow a 2-hour warm-up period to bring it up to a normal operating temperature before turning it on. Failure to do so may cause damage to internal components, particularly the hard disk drives.
- If intermittent system failures are noticed, try reseating any socketed chips, which might have become loose because of temperature fluctuations.

## Humidity

High-humidity conditions can cause moisture migration and penetration into the system. This moisture can cause corrosion of internal components and degradation of properties such as electrical resistance and thermal conductivity. Extreme moisture buildup inside the system can result in electrical shorts, which can cause serious damage to the system.

Each system is rated to operate at 10 to 90 percent non-condensing relative humidity. Buildings in which climate is controlled by air conditioning in the warmer months and by heat during the colder months usually maintain an acceptable level of humidity for system equipment. However, if a system is located in an unusually humid location, a dehumidifier can be used to maintain the humidity within an acceptable range.

## Altitude

Operating a system at high altitude (low pressure) reduces the efficiency of forced and convection cooling and can result in electrical problems related to arcing and corona effects. This condition can also cause sealed components with internal pressure, such as electrolytic capacitors, to fail or perform at reduced efficiency.

Each system is designed to operate at a maximum altitude of 3000 meters (9,843 feet) with some de-rating of maximum operating temperature (see [Appendix A, “WAVE-594 and WAVE-694 Hardware Specifications”](#)) and can be stored at a maximum altitude of 4572 meters (15,000 feet).

## Dust and Particles

A clean operating environment can greatly reduce the negative effects of dust and other particles, which act as insulators and interfere with the operation of a system’s mechanical components. In addition to regular cleaning, you should follow these guidelines to deter contamination of the system equipment:

- Do not permit smoking anywhere near the system.
- Do not permit food or drink near the system.
- Use dust covers when the system is not in use.
- Close windows and outside doors to keep out airborne particles.

## Corrosion

The oil from a person’s fingers or prolonged exposure to high temperature or humidity can corrode the gold-plated edge connectors and pin connectors on various devices in the system. This corrosion on system connectors is a gradual process that can eventually lead to intermittent failures of electrical circuits.

To prevent corrosion, you should avoid touching contacts on boards and cards. Protecting the system from corrosive elements is especially important in moist and salty environments, which tend to promote corrosion. Also, as a further deterrent to corrosion, the system should not be used in extreme temperatures, as explained in [Temperature](#).

## Electrostatic Discharge

Electrostatic discharge (ESD) results from the buildup of static electricity on the human body and certain other objects. This static electricity is often produced by simple movements such as walking across a carpet. ESD is a discharge of a static electrical charge that occurs when a person whose body contains such a charge touches a component in the system. This static discharge can cause components, especially chips, to fail. ESD is a problem particularly in dry environments where the relative humidity is below 50 percent.

To reduce the effects of ESD, you should observe the following guidelines:

- Wear a grounding wrist strap. If a grounding wrist strap is unavailable, touch an unpainted metal surface on the chassis periodically to neutralize any static charge.
- Keep components in their antistatic packaging until they are installed.
- Avoid wearing clothing made of wool or synthetic materials.

## Electromagnetic and Radio Frequency Interference

Electromagnetic interference (EMI) and radio frequency interference (RFI) from a system can adversely affect devices such as radio and television (TV) receivers operating near the system. Radio frequencies emanating from a system can also interfere with cordless and low-power telephones. Conversely, RFI from high-power telephones can cause spurious characters to appear on the system's monitor screen.

RFI is defined as any EMI with a frequency above 10 kilohertz (kHz). This type of interference can travel from the system to other devices through the power cable and power source or through the air like transmitted radio waves. The Federal Communications Commission (FCC) publishes specific regulations to limit the amount of EMI and RFI emitted by computing equipment. Each system meets these FCC regulations.

To reduce the possibility of EMI and RFI, follow these guidelines:

- Operate the system only with the system cover installed.
- Ensure that the screws on all peripheral cable connectors are securely fastened to their corresponding connectors on the back of the system.
- Always use shielded cables with metal connector shells for attaching peripherals to the system.

## Magnetism

Because they store data magnetically, hard disk drives are extremely susceptible to the effects of magnetism. Hard disk drives should never be stored near magnetic sources such as the following:

- Monitors
- TV sets
- Printers
- Telephones with real bells
- Fluorescent lights

## Shock and Vibration

Excessive shock can damage the function, external appearance, and physical structure of a system. Each system has been designed to operate properly even after withstanding a minimum of six consecutively executed shock pulses in the positive and negative x, y, and z axes (one pulse on each side of the system). Each shock pulse can measure up to 5 gravities (G) for up to 11 milliseconds (ms). In storage, the system can withstand shock pulses of 20 G for 11 ms.

Excessive vibration can cause the same problems as mentioned earlier for shock, as well as causing components to become loose in their sockets or connectors. Systems can be subject to significant vibration when being transported by a vehicle or when operated in an environment with machinery that causes vibration.

## Power Source Interruptions

Systems are especially sensitive to variations in voltage supplied by the AC power source. Overvoltage, undervoltage, and transients (or spikes) can erase data from memory or even cause components to fail. To protect against these types of problems, power cables should always be properly grounded and one or both of the following methods should be used:

- Use one of the power protection devices described in [Using Power Protection Devices](#).
- Place the system on a dedicated power circuit (rather than sharing a circuit with other heavy electrical equipment). In general, do not allow the system to share a circuit with any of the following:
  - Copier machines
  - Air conditioners
  - Vacuum cleaners
  - Space heaters
  - Power tools
  - Teletype machines
  - Adding machines
  - Laser printers
  - Facsimile machines
  - Any other motorized equipment

Besides these appliances, the greatest threats to a system's supply of power are surges or blackouts caused by electrical storms. Whenever possible, turn off the system and any peripherals and unplug them from their power sources during thunderstorms.

If a blackout occurs—even a temporary one—while the system is turned on, turn off the system immediately and disconnect it from the electrical outlet. Leaving the system on may cause problems when the power is restored; all other appliances left on in the area can create large voltage spikes that can damage the system.

## Using Power Protection Devices

A number of devices are available that protect against power problems such as power surges, transients, and power failures. The following subsections describe some of these devices:

- [Surge Protectors](#)
- [Line Conditioners](#)
- [Uninterruptible Power Supplies](#)

## Surge Protectors

Surge protectors are available in a variety of types and usually provide a level of protection commensurate with the cost of the device. Surge protectors prevent voltage spikes, such as those caused during an electrical storm, from entering a system through the electrical outlet. Surge protectors, however, do not offer protection against brownouts, which occur when the voltage drops more than 20 percent below the normal AC line voltage level.

## Line Conditioners

Line conditioners go beyond the overvoltage protection of surge protectors. Line conditioners keep a system's AC power source voltage at a fairly constant level and therefore can handle brownouts. Because of this added protection, line conditioners cost more than surge protectors—up to several hundred dollars. However, these devices cannot protect against a complete loss of power.

## Uninterruptible Power Supplies

Uninterruptible power supply (UPS) systems offer the most complete protection against variations in power because they use battery power to keep the system running when AC power is lost. The battery is charged by the AC power while it is available, so once AC power is lost, the battery can provide power to the system for a limited amount of time—from 15 minutes to an hour or so—depending on the UPS system.

UPS systems range in price from a few hundred dollars to several thousand dollars, with the more expensive units allowing you to run larger systems for a longer period of time when AC power is lost. UPS systems that provide only 5 minutes of battery power let you conduct an orderly shutdown of the system but are not intended to provide continued operation. Surge protectors should be used with all UPS systems, and the UPS system should be Underwriters Laboratories (UL) safety-approved.





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