

IBM Storage Networking
MTM 8977-T48

*IBM SAN48C-6 32 Gbps 48-Port Fibre
Channel Switch Installation, Service,
and User Guide*



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Edition notice

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Read this first

Summary of changes

This is the first edition of the IBM® Storage Networking SAN48C-6 Installation, Service, and User Guide.

Getting help

For the latest version of your product documentation, visit the web at <http://www.elink.ibm.link.ibm.com/public/applications/publications/cgibin/pbi.cgi>.

For more information about IBM SAN products, see the following Web site:<http://www.ibm.com/servers/storage/san/>

For support information for this product and other SAN products, see the following Web site:<http://www.ibm.com/servers/storage/support/san>

For detailed information about the Fibre Channel standards, see the Fibre Channel Industry Association (FCIA) Web site at: www.fibrechannel.org/

Visit www.ibm.com/contact for the contact information for your country or region.

You can also contact IBM within the United States at 1-800-IBMSERV (1-800-426-7378). For support outside the United States, you can find the service number at: <http://www.ibm.com/planetwide/>.

Accessibility features

Accessibility features help users who have a disability, such as restricted mobility or limited vision, to use information technology products successfully.

Accessibility features

The following list includes the major accessibility features in this product:

- This product follows WCAG 2.0 Guidelines but has limited accessibility support.

Keyboard navigation

This product does not have an attached or integrated keyboard. Any keyboard navigation is provided through the Data Center Network Manager (DCNM) software and GUI.

Interface information

You can view the publications for this product in Adobe Portable Document Format (PDF) using the Adobe Acrobat Reader. The PDFs are provided on a product documentation CD-ROM that is packaged with the product. The CD-ROM also includes an accessible HTML version of this document.

Vendor software

This product includes certain vendor software that is not covered under the IBM license agreement. IBM makes no representation about the accessibility features of these products. Contact the vendor for the accessibility information about its products.

Related accessibility information

In addition to standard IBM help desk and support websites, IBM has a TTY telephone service for use by deaf or hard of hearing customers to access sales and support services:

TTY service
800-IBM-3383 (800-426-3383)
(within North America)

IBM and accessibility

For more information about the commitment that IBM has to accessibility, see IBM Accessibility(www.ibm.com/able).

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Safety and environmental notices

This section contains information about:

- “Safety notices and labels”
- “Rack safety” on page xix
- “Product recycling and disposal” on page xxi

Safety notices and labels




When using this product, observe the danger, caution, and attention notices contained in this guide. The notices are accompanied by symbols that represent the severity of the safety condition. The danger and caution notices are listed in numerical order based on their IDs, which are displayed in parentheses, for example (D004), at the end of each notice. Use this ID to locate the translation of these danger and caution notices in the Safety Notices publication that is shipped with this product.




The following notices and statements are used in IBM documents. They are listed below in order of increasing severity of potential hazards. Follow the links for more detailed descriptions and examples of the danger, caution, and attention notices in the sections that follow.

- **Note:** These notices provide important tips, guidance, or advice.
- **“Attention notices” on page xviii:** These notices indicate potential damage to programs, devices, or data.
- **“Caution notices”:** These statements indicate situations that can be potentially hazardous to you.
- **“Danger notices” on page xv:** These statements indicate situations that can be potentially lethal or extremely hazardous to you. Safety labels are also attached directly to products to warn of these situations.
- In addition to these notices, “Safety labels” on page xvii may be attached to the product to warn of potential hazards.

Caution notices

A caution notice calls attention to a situation that is potentially hazardous to people because of some existing condition. A caution notice can be accompanied by different symbols, as in the examples below:

Example symbol	Symbol meaning
	A hazardous electrical condition with less severity than electrical danger.
	A generally hazardous condition not represented by other safety symbols.
 svc00169	A specification of product weight that requires safe lifting practices. The weight range of the product is listed below the graphic, and the wording of the caution varies, depending on the weight of the device.

Example symbol	Symbol meaning
	A potential hazard of pinching the hand or other body parts between parts.
	A hazardous condition due to moving parts nearby.
	A hazardous condition due to the use of a laser in the product. Laser symbols are always accompanied by the classification of the laser as defined by the U. S. Department of Health and Human Services (for example, Class I, Class II, and so forth).

Read and comply with the following caution notices before installing or servicing this device.



CAUTION:

Energy hazard present. Shorting may result in system outage and possible physical injury. Remove all metallic jewelry before servicing. (C001)



>55kg (121.2 lb)

CAUTION:

The weight of this part or unit is more than 55 kg (121.2 lb). It takes specially trained persons, a lifting device, or both to safely lift this part or unit. (C011)



CAUTION:

The system contains circuit cards, assemblies, or both that may contain lead solder. To avoid the release of lead (Pb) into the environment, do not burn. Discard the circuit card as instructed by local regulations. (C014)



CAUTION:

This product is equipped with a 3-wire (two conductors and ground) power cable and plug. Use this power cable with a properly grounded electrical outlet to avoid electrical shock. (C018)



CAUTION:

This product might contain one or more of the following devices: CD-ROM drive, DVD-ROM drive, DVD-RAM drive, or laser module, which are Class 1 laser products. Note the following information:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of the controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.

(C026)



CAUTION:

The power-control button on the device does not turn off the electrical current supplied to the device. The device might also have more than one connection to dc power. To remove all electrical current from the device, ensure that all connections to dc power are disconnected at the dc power input terminals. (C031)



CAUTION:

Servicing of this product or unit is to be performed by trained service personnel only. (C032)

CAUTION:

For CA residents only: IBM recommends installing this product in a room size of 62 cubic meters (2190 cubic feet) or larger at 0.4 ACH ventilation rate to reduce the concentrations of any chemicals emitted by the product.

Danger notices

A danger notice calls attention to a situation that is potentially lethal or extremely hazardous to people. A lightning bolt symbol accompanies a danger notice to represent a dangerous electrical condition. Read and comply with these danger notices before installing or servicing this device.



DANGER

To prevent a possible shock from touching two surfaces with different protective ground (earth), use one hand, when possible, to connect or disconnect signal cables. (D001)



DANGER

Overloading a branch circuit is potentially a fire hazard and a shock hazard under certain conditions. To avoid these hazards, ensure that your system electrical requirements do not exceed branch circuit protection requirements. Refer to the information that is provided with your device or the power rating label for electrical specifications. (D002)



DANGER

If the receptacle has a metal shell, do not touch the shell until you have completed the voltage and grounding checks. Improper wiring or grounding could place dangerous voltage on the metal shell. If any of the conditions are not as described, *STOP*. Ensure the improper voltage or impedance conditions are corrected before proceeding. (D003)



DANGER

An electrical outlet that is not correctly wired could place hazardous voltage on metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock. (D004)

A general electrical danger notice provides instructions on how to avoid shock hazards when servicing equipment. Unless instructed otherwise, follow the procedures in this danger notice.



DANGER

When working on or around the system, observe the precautions:

Electrical voltage and current from power, telephone, and communication cables are hazardous. To avoid a shock hazard:

- Connect power to this unit only with the IBM provided power cord. Do not use the IBM provided power cord for any other product.
- Do not open or service any power supply assembly.
- Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.
- The product might be equipped with multiple power cords. To remove all hazardous voltages, disconnect all power cords.
- Connect all power cords to a properly wired and grounded electrical outlet. Ensure that the outlet supplies proper voltage and phase rotation according to the system rating plate.
- Connect any equipment that will be attached to this product to properly wired outlets.
- When possible, use one hand only to connect or disconnect signal cables.
- Never turn on any equipment when there is evidence of fire, water, or structural damage.
- Disconnect the attached power cords, telecommunications systems, networks, and modems before you open the device covers, unless instructed otherwise in the installation and configuration procedures.
- Connect and disconnect cables as described below when installing, moving, or opening covers on this product or attached devices.

To disconnect:

1. Turn off everything (unless instructed otherwise).
2. Remove the power cords from the outlets.
3. Remove the signal cables from the connectors.
4. Remove all cables from the devices.

To connect:

1. Turn off everything (unless instructed otherwise).
2. Attach all cables to the devices.
3. Attach the signal cables to the connectors.
4. Attach the power cords to the outlets.
5. Turn on the devices.

(D005)

Delivery and subsequent transportation of the equipment

The customer should prepare his environment to accept the new product based on the installation planning information provided, with assistance from an IBM Installation Planning Representative (IPR) or

IBM authorized service provider. In anticipation of the equipment delivery, the final installation site should be prepared in advance such that professional movers/riggers can transport the equipment to the final installation site within the computer room. If for some reason, this is not possible at the time of delivery, the customer will need to make arrangements to have professional movers/riggers return to finish the transportation at a later date. Only professional movers/riggers should transport the equipment. The IBM authorized service provider will only perform minimal frame repositioning within the computer room, as needed, to perform required service actions. The customer is also responsible for using professional movers/riggers in the case of equipment relocation or disposal.



DANGER

Heavy equipment—personal injury or equipment damage might result if mishandled. (D006)

Safety labels

As an added precaution, safety labels are often installed directly on products or product components to warn of potential hazards. These can be either danger or caution notices, depending upon the level of the hazard.

The actual product safety labels may differ from these sample safety labels:



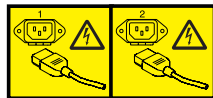
DANGER

Hazardous voltage, current, or energy levels are present inside any component that has this label attached. Do not open any cover or barrier that contains this label. (L001)



DANGER

Rack-mounted devices are not to be used as a shelf or work space. (L002)



DANGER

Multiple power cords. The product might be equipped with multiple power cords. To remove all hazardous voltages, disconnect all power cords. (L003)



DANGER

Hazardous voltage present. Voltages present constitute a shock hazard, which can cause severe injury or death. (L004)



CAUTION:
Hazardous moving parts nearby. (L008)

Attention notices

An attention notice indicates the possibility of damage to a program, device, or system, or to data. An exclamation point symbol may accompany an attention notice, but is not required. A sample attention notice follows:

Attention: Do not bend a fibre cable to a radius less than 5 cm (2 in.); you can damage the cable. Tie wraps are not recommended for optical cables because they can be easily overtightened, causing damage to the cable.

ESD precautions

Attention: Many of the field replaceable units (FRUs) are sensitive to electrostatic discharge (ESD), and can potentially be damaged by improper handling. When working with any FRU, use correct ESD precautions:

- Attach ground to the indicated area on the chassis
- Wear a wrist grounding strap connected to chassis ground (if the switch is plugged in) or a bench ground.

Note: For safety reasons, the ESD wrist strap should contain a series 1 megaohm resistor.

- Store ESD-sensitive components in antistatic packaging

Rack safety

Rack installation

DANGER

Observe the following precautions when working on or around your IT rack system:

- Heavy equipment—personal injury or equipment damage might result if mishandled.
- Always lower the leveling pads on the rack cabinet.
- Always install stabilizer brackets on the rack cabinet.
- To avoid hazardous conditions due to uneven mechanical loading, always install the heaviest devices in the bottom of the rack cabinet. Always install servers and optional devices starting from the bottom of the rack cabinet.
- Rack-mounted devices are not to be used as shelves or work spaces. Do not place objects on top of rack-mounted devices.



- Each rack cabinet might have more than one power cord. Be sure to disconnect all power cords in the rack cabinet when directed to disconnect power during servicing.
- Connect all devices installed in a rack cabinet to power devices installed in the same rack cabinet. Do not plug a power cord from a device installed in one rack cabinet into a power device installed in a different rack cabinet.
- An electrical outlet that is not correctly wired could place hazardous voltage on the metal parts of the system or the devices that attach to the system. It is the responsibility of the customer to ensure that the outlet is correctly wired and grounded to prevent an electrical shock.

(R001 part 1 of 2)

CAUTION:

- Do not install a unit in a rack where the internal rack ambient temperatures will exceed the manufacturer's recommended ambient temperature for all your rack-mounted devices.
- Do not install a unit in a rack where the air flow is compromised. Ensure that air flow is not blocked or reduced on any side, front, or back of a unit used for air flow through the unit.
- Consideration should be given to the connection of the equipment to the supply circuit so that overloading of the circuits does not compromise the supply wiring or overcurrent protection. To provide the correct power connection to a rack, refer to the rating labels located on the equipment in the rack to determine the total power requirement of the supply circuit.
- *(For sliding drawers)* Do not pull out or install any drawer or feature if the rack stabilizer brackets are not attached to the rack. Do not pull out more than one drawer at a time. The rack might become unstable if you pull out more than one drawer at a time.
- *(For fixed drawers)* This drawer is a fixed drawer and must not be moved for servicing unless specified by the manufacturer. Attempting to move the drawer partially or completely out of the rack might cause the rack to become unstable or cause the drawer to fall out of the rack.

(R001 part 2 of 2)

Rack relocation (19" rack)

CAUTION:

Removing components from the upper positions in the rack cabinet improves rack stability during relocation. Follow these general guidelines whenever you relocate a populated rack cabinet within a room or building:

- Reduce the weight of the rack cabinet by removing equipment starting at the top of the rack cabinet. When possible, restore the rack cabinet to the configuration of the rack cabinet as you received it. If this configuration is not known, you must complete these steps:
 - Remove all devices in the 32U position and above.
 - Ensure that the heaviest devices are installed in the bottom of the rack cabinet.
 - Ensure that there are no empty U-levels between devices installed in the rack cabinet below the 32U level.
 - If the rack cabinet you are relocating is part of a suite of rack cabinets, detach the rack cabinet from the suite.
 - Inspect the route that you plan to take when moving the rack to eliminate potential hazards.
 - Verify that the route that you choose can support the weight of the loaded rack cabinet. Refer to the documentation that came with your rack cabinet for the weight of a loaded rack cabinet.
 - Verify that all door openings are at least 760 x 2030 mm (30 x 80 in.).
 - Ensure that all devices, shelves, drawers, doors, and cables are secure.
 - Ensure that the four leveling pads are raised to their highest position.
 - Ensure that there is no stabilizer bracket installed on the rack cabinet during movement.
 - Do not use a ramp inclined at more than 10 degrees.
 - Once the rack cabinet is in the new location, do the following:
 - Lower the four leveling pads.
 - Install stabilizer brackets on the rack cabinet.
 - If you removed any devices from the rack cabinet, repopulate the rack cabinet from the lowest position to the highest position.
 - If a long distance relocation is required, restore the rack cabinet to the configuration of the rack cabinet as you received it. Pack the rack cabinet in the original packaging material, or equivalent. Also, lower the leveling pads to raise the casters off of the pallet and bolt the rack cabinet to the pallet.

(R002)

Product recycling and disposal

Refer to the *IBM Systems Environmental Notices and User Guide (Z125-5823)* for translated environmental statements and information regarding product recycling and disposal. This document may be provided either in printed version or on the product documentation CD. A more current version may be available through this link ftp://public.dhe.ibm.com/systems/support/warranty/envnotices/environmental_notices_and_user_guide.pdf.

About this document

This document is intended for use by systems administrators and technicians experienced with networking, Fibre Channel, and storage area network (SAN) technologies. It describes how to install, service, and use the IBM Storage Networking SANC48-6 Switch. Throughout this document, the product is referred to as the *IBM SAN48C-6*, or simply the *switch*.

This document has been created to include information specific to IBM SAN48C-6 switches running on NX-OS version 8.4(1) or later. This document does not support all Fabric OS versions. It is specific to NX-OS version 8.4(1) or later. Refer to the NX-OS version 8.4(1) Release Notes for more information.

IBM and Cisco product matrix

The product matrix provides a cross-reference between the comparable IBM and Cisco product models.

When you use any of the Cisco documents, such as the Fabric Configuration Guide, you will notice that the model numbers reflect the corresponding Cisco products. Table 1 provides a product matrix to correlate the Cisco products and models to the IBM product names and machine types and model numbers. Products withdrawn from marketing are not listed.

Table 1. Cisco and IBM product and model number matrix

Cisco product name	IBM product name	IBM machine type and model number
9148T Fibre Channel Switch	SAN48C-6	8977 Model T48
9396T Multilayer Fabric Switch	SAN96C-6	8977 Model T96
9132T Fabric Switch	SAN32C-6	8977 Model T32
9250i Multi-service Switch	SAN50C-R	8977 Model R50
9706 Multilayer Director	SAN192C-6	8978 Model E04
9710 Multilayer Director	SAN384C-6	8978 Model E08
9718 Multilayer Director	SAN768C-6	8978 Model E16

Product documentation

The following documents contain information related to this product:

Draft comment

Do we want to include the documents from the last Raven release or just the current docs?

- *IBM SAN48C-6 Installation, Service and User Guide, SC27-9572-00*
- *IBM SAN96C-6 Installation, Service and User Guide, SC27-9571-00*
- *IBM SAN32C-6 Installation, Service and User Guide, SC27-9275-00*
- *IBM SAN50C-R Installation, Service and User Guide, SC27-9274-00*
- *IBM SAN192C6, 384C-6, 768C-6 Installation, Service and User Guide, SC27-9276-00*
- *IBM Systems Environmental Notices and User Guide, Z125-5823*

Overview of the IBM SAN48C-6 Fibre Channel Switch

The IBM SAN48C-6 switch has 48 x 4/8/16/32 Gbps multispeed ports and is a powerful and compact 1-rack unit (1RU) SAN fabric switch. This switch has the following major features:

- Provides consistent 32 Gbps quality performance for every Fibre Channel port on the switch.
- Port-channel link members can be used across the three 16 port port groups providing additional high availability.
- Provides minimum configuration option of twenty four 32 Gbps Fibre Channel ports in the base variant, which can be enabled in increments of 8 ports to up to 48 ports. This allows four possible configurations of 24, 32, 40, and 48 ports.
- Supports enterprise-class features, such as Auto Zone, Smart Zoning, Slow Drain Detection and Isolation, Virtual SAN (VSAN) and Inter-VSAN routing (IVR), and migration from fabric-wide Quality of Service (QoS) from SAN islands to enterprise-wide storage networks.
- Provides intelligent diagnostics tools such as Inter-Switch Link (ISL) diagnostics, HBA diagnostics with leading HBA vendors, read diagnostic parameters, protocol decoding, network analysis tools, and integrated Call Home.
- Supports the Virtual Machine Identifier (VMID) feature that provides visibility into virtual machines that are accessing the storage devices in the fabric.
- Supports Representational State Transfer (REST) and NX-API capabilities.
- Supports onboard hardware that protects the switch from malicious attacks by securing access to critical components such as the bootloader, system image loader, and Joint Test Action Group (JTAG) interface.

Switch Overview

Front View

The following figure shows the front view of a IBM SAN48C-6:

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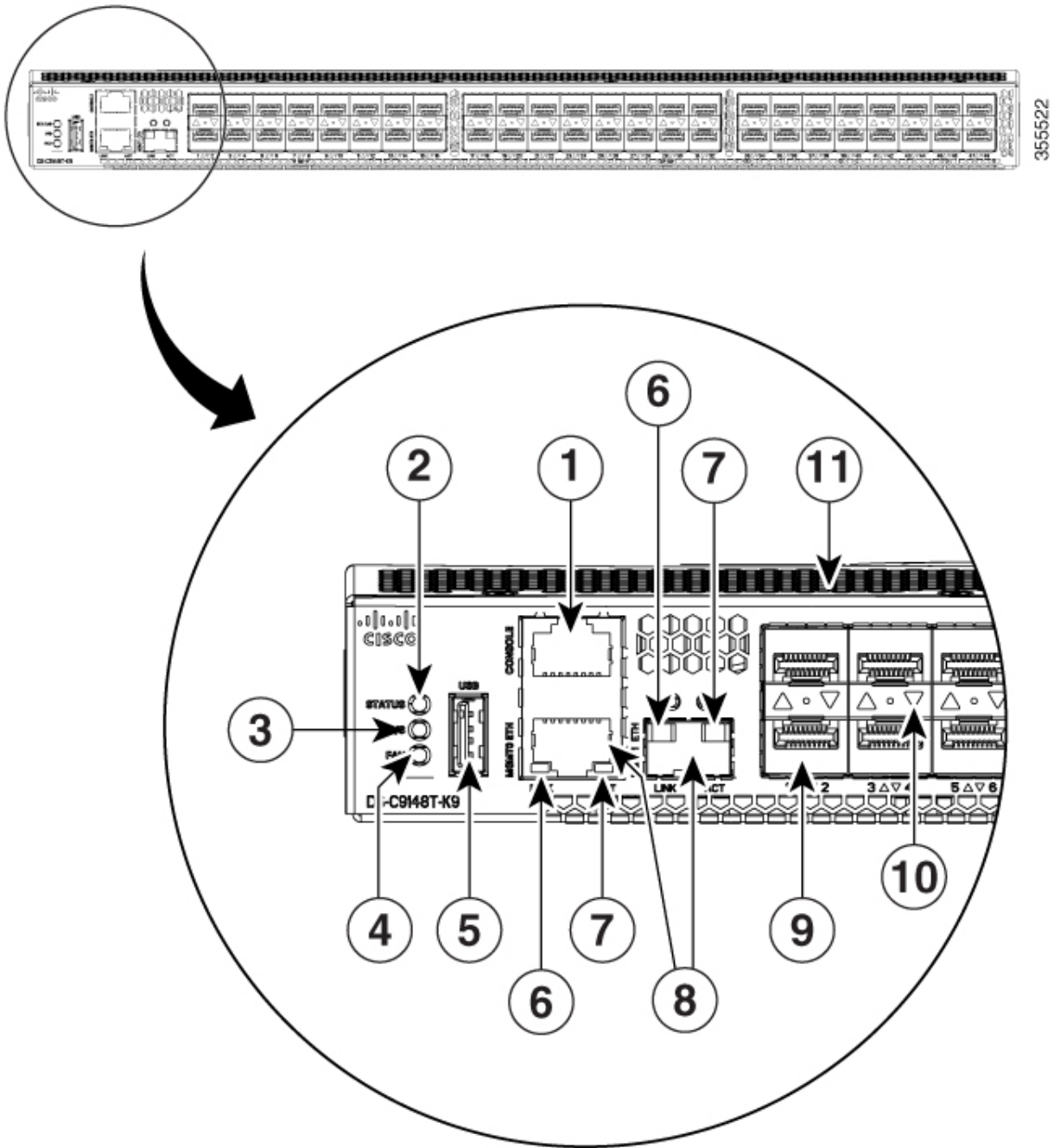


Figure 1. Front View of the IBM SAN48C-6 Switch

1	Serial console port	7	Activity status LED
2	System status LED	8	Ethernet management ports (2)
3	Power status LED	9	Fixed FC ports
4	Fan status LED	10	FC port status LEDs (48)
5	USB port	11	Airflow grill
6	Link status LED		

Rear View

The following figure shows the rear view of a IBM SAN48C-6 Switch:

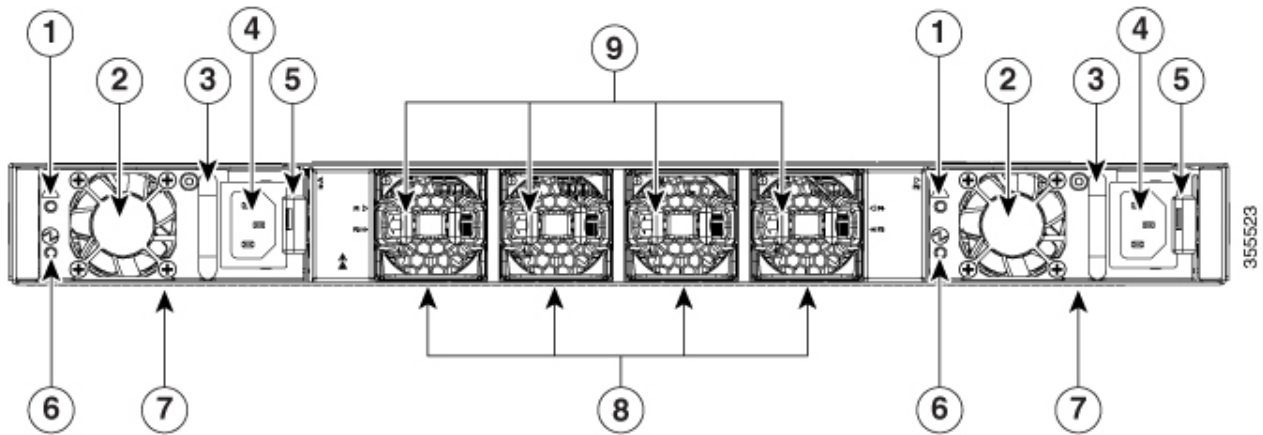


Figure 2. Rear View of the IBM SAN48C-6 Switch

1	Power supply failure status LED	6	Power supply status LED
2	Power supply unit fan	7	Power supply units (2 units)
3	Power supply unit handle	8	Chassis fan modules (4 units)
4	Unswitched power receptacle	9	Chassis fan module release latches (8)
5	Power supply unit latch release		

Side View

The following figure shows the side view of a IBM SAN48C-6 Switch:

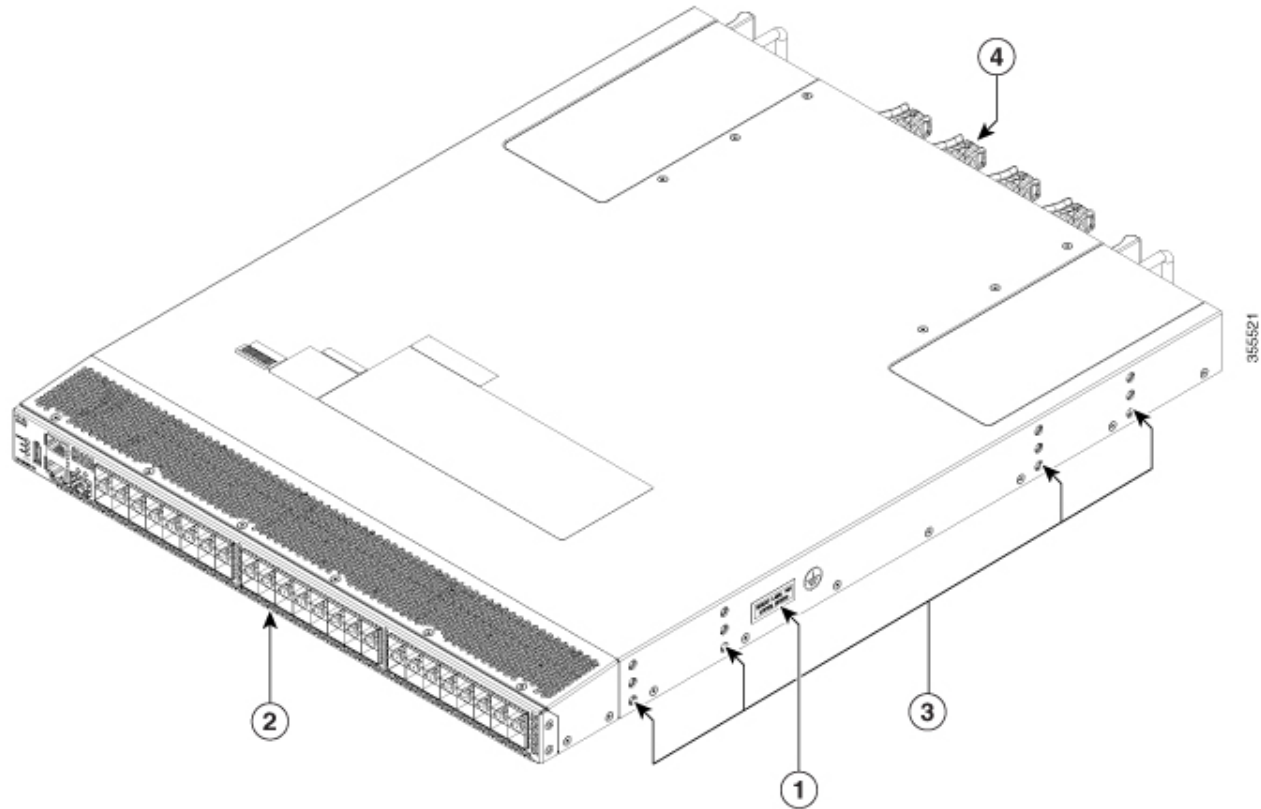


Figure 3. Side View of the IBM SAN48C-6 Switch

1	Grounding point	3	Rack mounting holes
2	Port side of the switch	4	Rear side of the switch

Fan Modules

The IBM SAN48C-6 Switch fan modules have a fixed handle for insertion and removal from the chassis. The IBM SAN48C-6 Switch requires a minimum of two operating fan modules to prevent automatic shutdown. It supports up to four fan modules. This provides redundancy for uninterrupted operation in the event of fan module failure. The IBM SAN48C-6 Switch fan modules are hot-swappable to also allow swapping out of a fan module during operation for uninterrupted operation. During a fan module replacement, the internal airflow through the chassis is changed. If the internal airflow is disrupted for too long, the preset temperature thresholds will be exceeded and the system will automatically shut down to prevent permanent damage.

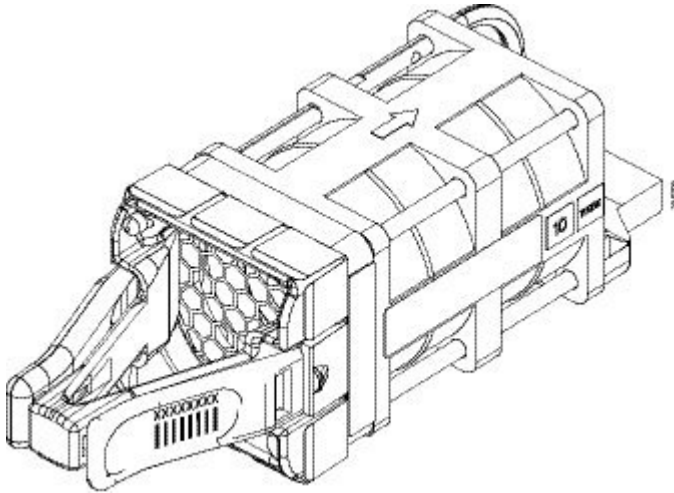


Figure 4. IBM SAN48C-6 Fan Module

To facilitate different data center cooling configurations of hot or cold aisles and racks, there are two models of fan modules. The first type has airflow with port-side intake and exhaust at the rear of the chassis. The second type has airflow in the opposite direction, that is, rear-chassis intake and port-side exhaust. The airflow direction is denoted on each fan module as follows:

- Red—Port-side intake airflow
- Blue—Port-side exhaust airflow

For more information on installing and removing fan modules, see *Installing and Removing Fan Modules*.

Power Supplies

The IBM SAN48C-6 Switch PSUs have an unswitched power receptacle, a PSU status LED and a handle for insertion and removal of the PSU from the chassis. The IBM SAN48C-6 Switch requires a minimum of one operating PSU. It supports up to two PSUs. This provides redundancy for uninterrupted operation in the event of PSU or grid failure. The PSUs are hot-swappable to allow swapping out of a PSU during operation for uninterrupted operation. During a PSU replacement, the internal airflow through the chassis is changed. If the internal airflow is disrupted for too long, the preset temperature thresholds will be exceeded and the system will automatically shut down to prevent permanent damage.

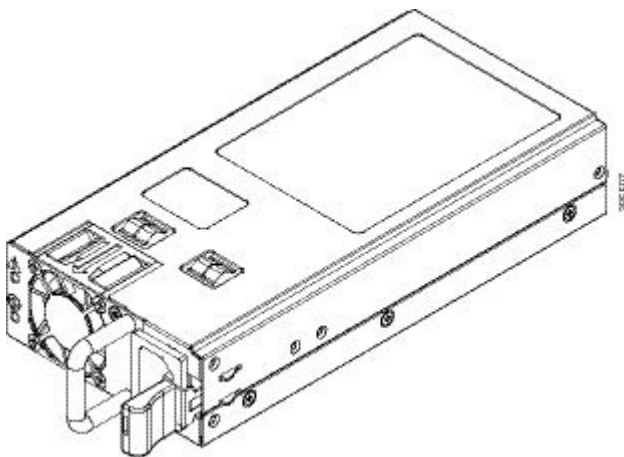


Figure 5. IBM SAN48C-6 PSU

To facilitate different data center cooling configurations of hot or cold aisles and racks, there are two models of PSUs. The first type has airflow with port-side intake and exhaust at the rear of the chassis. The second type has airflow in the opposite direction, that is, rear-chassis intake and port-side exhaust. The airflow direction is denoted on each PSU as follows:

- Red—Port-side intake airflow
- Blue—Port-side exhaust airflow

The switch supports PSUs of only one airflow type at a time. Both PSUs have to be either port-side exhaust, or port-side intake PSUs.

Note: The direction of PSU airflow must match the direction of the fan module airflow.

For more information on installing and removing PSUs, see *Installing and Removing Power Supplies*.

LEDs

The IBM SAN48C-6 switch has LEDs on both the front and back of the switch to indicate the status of different system components during boot-up tests and online operation. The following tables describe the location of each LED and the meaning of its color:

Table 2. Chassis Activity LEDs for a IBM SAN48C-6 Switch

Indicator	Location	Function	Color	Status	State
Power LED	Front panel of the chassis	Chassis Power/Health	Off	Off	Either of the following conditions exists: <ul style="list-style-type: none"> • The system is not receiving sufficient power from the PSUs. • The operating system is not running.
			Green	Solid On	Both PSUs are installed and operational.
			Red	Solid On	Either of the following conditions exists: <ul style="list-style-type: none"> • A PSU has failed. • A PSU has been removed.

Table 2. Chassis Activity LEDs for a IBM SAN48C-6 Switch (continued)

Indicator	Location	Function	Color	Status	State
Status LED	Front panel of the chassis	System Status	Green	Solid On	All diagnostics have passed, NX-OS is running and the system is operational.
			Orange	Solid On	Any of the following conditions exists: <ul style="list-style-type: none"> The system is running boot-up diagnostics. The system is booting. A minor temperature threshold is exceeded.
			Red	Blinking	Mismatched airflow direction observed in one of the following modules: <ul style="list-style-type: none"> Fan modules—The switch will go down in 10-15 seconds. PSUs—The switch will go down after 10 minutes. Fan modules and PSUs—The switch will go down after 10 minutes.
				Solid On	One of the following conditions exists: <ul style="list-style-type: none"> A diagnostic test failed or another fault occurred during bootup. A major temperature threshold is exceeded.
Fan status	Front panel of the chassis	Fan health	Green	Solid on	All fan modules are operational.
			Red	Solid on	Fan failure.
PSU Status Indicators	Faceplate of each PSU	PSU input/output	Green	Off	No input to the PSU.
				Solid on	PSU output is OK.
				Blinking	PSU output is not OK, but input is OK.
		PSU operation	Amber	Off	PSU is operating normally.
				Solid on	One of the following conditions exists in the PSU: <ul style="list-style-type: none"> Over voltage Over current Over temperature Fan failure.
				Blinking	PSU has a fault, but is still operational.
Fan Status	Faceplate of each fan module	Fan module	Green	Solid on	Fan module is operating normally.
			Amber	Solid on	The fan in the fan module has failed.

The following table describes the Ethernet port LEDs for an IBM SAN48C-6 Fan switch.

LED Position	Status	State
Left	Off	There is no link.
	Solid Green	Indicates a physical link.
Right	Off	There is no link traffic.
	Blinking Yellow	Indicates link traffic.

The following table describes the Fibre Channel port LEDs for an IBM SAN48C-6 switch.

Status	State
Solid Green	The link is up.
Regular Blinking Green	The link is up and the port beacon is active.
Intermittent Blinking Green	The link is up (and traffic is flowing through the port).
Solid Orange	The link is disabled by the software.
Blinking Orange	A fault condition exists.
Off	No link.

Transceivers

SFP+ transceivers are field replaceable. You can use any combination of SFP+ transceivers that are supported by the switch. The only restrictions are that SWL transceivers must be paired with SWL transceivers on the peer device, and LWL transceivers with LWL transceivers on the peer device. Port path cabling must not exceed the stipulated total length or dB loss for reliable communications.

For a list of SFP+ transceivers supported on the IBM SAN48C-6 Switch, see SFP Transceiver Specifications. SFP+ transceivers can be ordered either separately or with the IBM SAN48C-6 Switch.

Note: Use only IBM provided transceivers in the IBM SAN48C-6 switches. Each transceiver is encoded with model information that enables the switch to verify that the transceiver meets the requirements for the switch.

Cabinet and Rack Installation

Before installing the switch, be sure the following cabinet and rack requirements are met.

Cabinet and Rack Requirements

This section provides the IBM Storage Networking SAN c-type Family Series switches requirements for the following types of cabinets and racks in an external ambient air temperature range of 0 to 40°C. If you are selecting an enclosed cabinet, we recommend that you choose one of these thermally validated types:

- Standard perforated cabinets
- Solid-walled cabinets with a roof fan tray (bottom-to-top cooling)

General Requirements for Cabinets and Racks

A cabinet or rack must belong to one of the following types:

- Standard 19-in. four-post EIA cabinet or rack, with mounting posts that conform to English universal hole spacing per section 1 of ANSI/EIA-310-D-1992. See Requirements Specific to Perforated Cabinets and Requirements Specific to Solid-Walled Cabinets.
- Standard two-post telco rack, with mounting posts that conform to English universal hole spacing per section 1 of ANSI/EIA-310-D-1992.

The cabinet or rack must also meet the following requirements:

- The minimum vertical rack space per chassis should be 1 RU, equal to 1.75 in. (4.4 cm).
- The width between the inside edges of the mounting posts must be at least 17.75 in. (45.1 cm). This is the distance between the two front posts of the four-post EIA racks.
- The minimum rack-load ratings per RU are listed in the following table:

Rack Type	SAN48C-6
EIA (4 post)	7.5 lb (3.4 kg)
Telco (2 post)	15 lb (6.8 kg)

For four-post EIA cabinets (perforated or solid-walled):

- The distance between the front door and front mounting posts should be a minimum of 3 in. (7.6 cm) to allow for the bend radius of FC port fibre-optic patch cables.
- The distance between the outside face of the front mounting post and the outside face of the back mounting post should be to 32 in. (66 to 81 cm) to allow for installation with the rack mounting kit.
- The distance between the rear of the chassis and the perforated rear door of the cabinet (required for airflow in the cabinet, if used) should be a minimum of 3.0 in. (7.6 cm).
- No clearance is required between the chassis and the sides of the rack or cabinet (no side airflow).
- The amount of clearance required for interface cables is 3 in. [7.6 cm] minimum and module handles is 1 in. [25 mm] minimum.

Notes:

- Optional jumper power cords are available for use in a cabinet. See Jumper Power Cord. IBM SAN48C-6 switches are compatible with Cisco racks (such as Cisco R42612) and PDUs.

Requirements Specific to Perforated Cabinets

In addition to the requirements listed in the “General Requirements for Cabinets and Racks” on page 9 section, perforated cabinets with front-to-back airflow must meet the following requirements:

- The front and rear doors must have at least a 60 percent open area perforation pattern, with at least 15 sq. in. (96.7 sq cm) of open area per rack unit of door height.
- We recommend that the roof be perforated with at least 20 percent open area, unless the cabinet only contains switch, in which case the roof does not have to be perforated.
- We recommend an open or perforated cabinet floor to enhance cooling but it is not required.

Reference Perforated Cabinet

A perforated cabinet that conforms to the above requirements is available from Rittal Corporation:

Rittal Corporation

One Rittal Place

Springfield, OH 45504

Phone: (800) 477-4000

Cabinet P/N: Rittal 9969427

Cabinet description: PS-DK/OEM Cabinet Assembly, 1998 x 600 x 1000 (H x W x D) (42U)

Requirements Specific to Solid-Walled Cabinets

In addition to the requirements listed in the “General Requirements for Cabinets and Racks” on page 9 section, solid-walled cabinets must meet the following requirements:

- A roof-mounted fan tray and an air-cooling scheme in which the fan tray pulls air in at the bottom of the cabinet and sends it out from the top, with a minimum airflow of 849.5 m³/h exiting the cabinet roof through the fan tray, to be available.
- Non-perforated (solid and sealed) front and back doors and side panels to be present so that air travels predictably from bottom to top.
- The overall cabinet depth to be 36 to 42 in. (91.4 to 106.7 cm) to allow the doors to close and to facilitate adequate airflow.
- A minimum of 150 sq. in. (968 sq. cm) of open area to be available at the floor air intake of the cabinet.
- The lowest piece of equipment to be installed at a minimum of 1 RU (1.75 in. or 4.4 cm) above the floor openings to prevent blockage of the floor intake.

Installing the IBM SAN48C-6 Switch

Use the topics in this section to install a IBM SAN48C-6 switch and its components.

Before you install, operate, or service the system, see the *Regulatory Compliance and Safety Information for the Cisco MDS 9000 Family* document for important safety information.

Note: 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

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

Preinstallation

Before installing the SAN48C-6 switch, be sure you understand and follow the guidelines outlined in this section.

IBM Storage Networking SAN48C-6 and Telco and EIA Shelf Bracket

The Telco and EIA Shelf Bracket Kit can temporarily or permanently support the IBM SAN48C-6 switch during installation. After the front rack-mount brackets are securely attached to the rack-mounting rails, the shelf bracket can be removed.

The Telco and EIA Shelf Bracket kit supports the following configurations:

- An IBM SAN48C-6 Switch in a two-post Telco rack
- An IBM SAN48C-6 Switch in a four-post EIA rack

This section describes the procedure for installing an IBM SAN48C-6 switch in a rack or cabinet using the Telco and EIA Shelf Bracket Kit.

Shelf-Installation Guidelines

CAUTION:

- If the rack is on wheels, ensure that the brakes are engaged or the rack is otherwise stabilized.
- If you are installing this kit in an EIA rack, attach the shelf to all four rack-mounting posts; the EIA posts may not be thick enough to prevent flexing of shelf brackets if only two posts are used.

Before Installing the Shelf Brackets

Before installing the shelf brackets, inspect the contents of your kit. The following table lists the contents of the shelf bracket kit:

Quantity	Part Description
2	Slider brackets
2	Shelf brackets
1	Crossbar
2	10-32 x 3/8-in. Phillips pan-head screws
16	12-24 x 3/4-in. Phillips screws
16	10-24 x 3/4-in. Phillips screws

Required Equipment: You need the following equipment for this installation:

- Number 2 Phillips screwdriver
- Tape measure and level (to ensure that shelf brackets are at level with each other)

Installing the Shelf Bracket Kit into a Two-Post Telco Rack:

About this task

The following figure shows the installation of the shelf bracket kit into a two-post Telco rack:

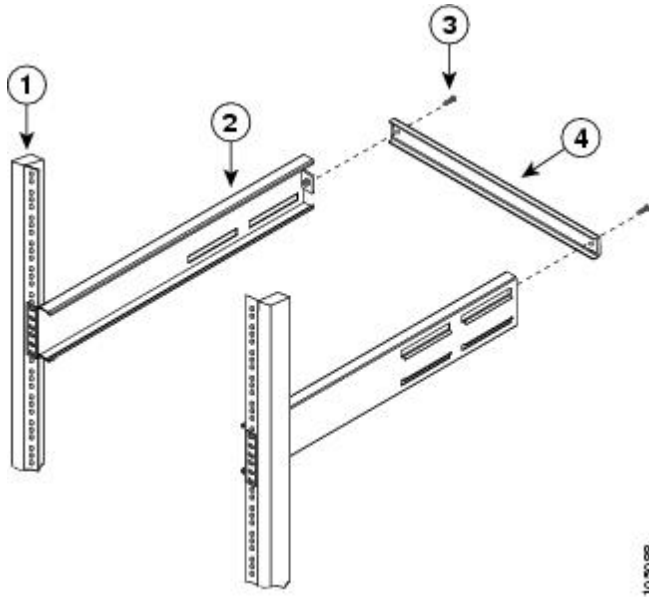


Figure 6. Installing the Shelf Bracket Kit into a Telco Rack

1	Rack-mounting post	3	10-32 screws
2	Shelf bracket	4	Crossbar

To install the shelf brackets in a Telco rack, follow these steps:

Procedure

1. Position a shelf bracket inside a rack-mounting post as shown in Figure 6 and align the screw holes at the front of the shelf bracket with the holes in the rack-mounting post. Then, attach the shelf bracket to the rack-mounting post using a minimum of four 12-24 or 10-24 screws.

Note: The bottom hole of the shelf bracket should align with the bottom hole (the hole immediately above the 1/2 in. spacing) of a rack unit on the rack-mounting post.

2. Repeat Step 1 with the other shelf brackets.
3. Verify that the shelf brackets are at the same height (using the level or tape measure, as desired).
4. Attach the crossbar to the rear of the shelf brackets, as shown in Figure 6, using the 10-32 screws.

Installing the Shelf Bracket Kit into a Four-Post EIA Rack:

About this task

The following figure shows the installation of the shelf bracket kit into a four-post EIA rack:

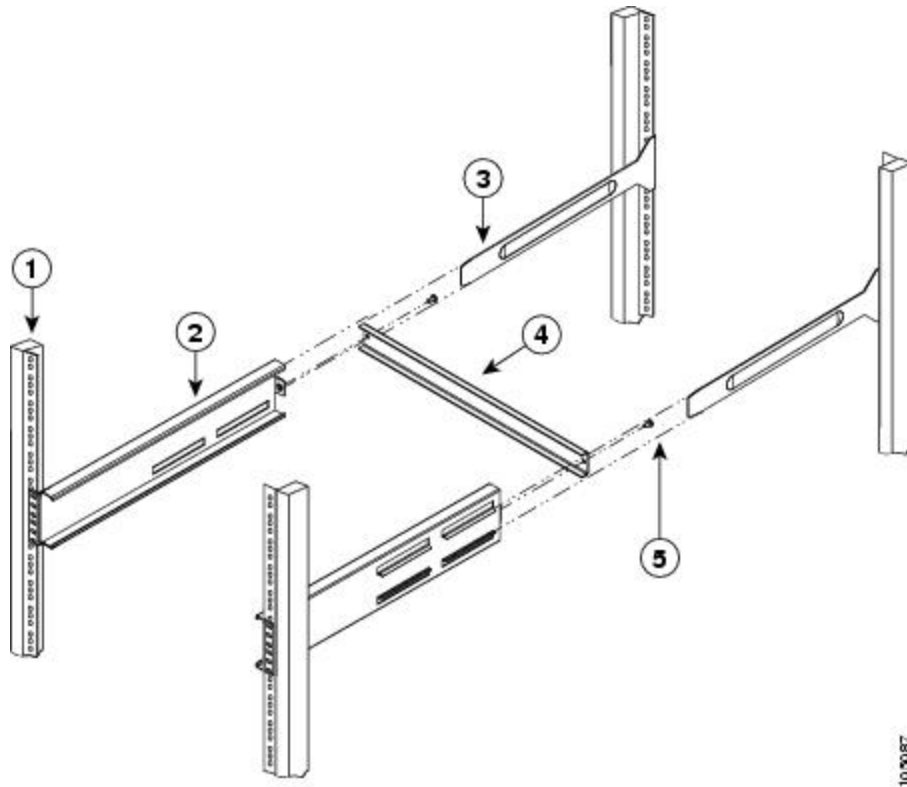


Figure 7. Installing the Shelf Bracket Kit into an EIA Rack

1	Rack-mounting post	4	Crossbar
2	Shelf bracket	5	10-32 screws
3	Slider post		

To install the shelf brackets in an EIA rack, follow these steps:

Procedure

1. Position a shelf bracket inside the rack-mounting posts, as shown in Figure 7. Align the screw holes at the front of the shelf bracket with the holes in the front rack-mounting post. Then, attach the shelf bracket to the front rack-mounting post using a minimum of four 12-24 or 10-24 screws.

Note: The bottom hole of the shelf bracket should align with the bottom hole (the hole immediately above the 1/2 in. spacing) of a rack unit on the rack-mounting post.

2. Repeat Step 1 with the other shelf brackets.
3. Verify that the shelf brackets are at the same height (using the level or tape measure, as desired).
4. Attach the crossbar to the shelf brackets, as shown in Figure 7, using the 10-32 screws.
5. Insert the slider posts into the shelf brackets, as shown in Figure 7. Attach them to the rear rack-mounting posts, using a minimum of four 12-24 or 10-24 screws.

Airflow Considerations

The switch comes with fan modules and power supply units that have either port-side intake or port-side exhaust airflow for cooling the switch. If you are orienting the switch with the FC ports facing a cold aisle, make sure that the switch has a port-side intake fan and power supply modules with red colorings. If you are orienting the switch with the fan and power supply modules facing a cold aisle, make sure

that the switch has port-side exhaust fan and power supply units with blue colorings. All fan modules and power-supply modules must have the same direction of airflow.

Connection Guidelines for AC-Powered Systems

To connect to the IBM SAN48C-6 switch AC power supply units to the site power source, follow these guidelines:

- For power redundancy, each power supply should be connected to a separate power feed (at a minimum, separate branch circuits).
- Circuits should be sized according to local and national codes.
- The AC power receptacles that are used to power the chassis must be the grounding type. The grounding conductors that connect to the receptacles should connect to protective earth ground in the service equipment.

Installation Guidelines

Follow these guidelines when installing the IBM SAN48C-6 switch:

- Each new switch requires a license. See the NX-OS Licensing Guide for instructions on installing a license.
- Plan your site configuration and prepare the site before installing the switch. The recommended site planning tasks are listed in the Site Planning and Maintenance Records section.
- Ensure that there is adequate space around the switch to allow for servicing the switch and for adequate airflow. The airflow requirements are listed the Technical Specifications section.
- Ensure that you are positioning the switch in a rack so that it takes in cold air from the cold aisle and exhausts air to the hot aisle. For more information, see the Airflow Considerations section.
- Ensure that the air-conditioning meets the heat dissipation requirements listed in the Technical Specifications section.
- Ensure that the cabinet or rack meets the requirements listed in the Cabinet and Rack Installation section.
- Ensure that the chassis is adequately grounded. If the switch is not mounted in a grounded rack, we recommend that you connect both the system ground on the chassis and the site power ground to an earth ground.
- Ensure that the site power meets the power requirements listed in the Technical Specifications section. If available, you can use an uninterruptible power supply (UPS) to protect against power failures.

CAUTION:

Avoid UPS types that use ferro-resonant technology. These UPS types can become unstable with systems such as the IBM c-type Series, triggered by substantial current draw fluctuations due to fluctuating data traffic patterns.

- Ensure that the chassis is adequately grounded. If the switch is not mounted in a grounded rack, we recommend that you connect both the system ground on the chassis and the site power ground to an earth ground.
- Ensure that the site power meets the power requirements listed in the Technical Specifications section. If available, you can use an uninterruptible power supply (UPS) to protect against power failures.

CAUTION:

Avoid UPS types that use ferro-resonant technology. These UPS types can become unstable with systems such as the IBM c-type Series, triggered by substantial current draw fluctuations due to fluctuating data traffic patterns.

- Ensure that the chassis is adequately grounded. If the switch is not mounted in a grounded rack, we recommend that you connect both the system ground on the chassis and the site power ground to an earth ground.
- Ensure that the site power meets the power requirements listed in the Technical Specifications section. If available, you can use an uninterruptible power supply (UPS) to protect against power failures.

CAUTION:

Avoid UPS types that use ferro-resonant technology. These UPS types can become unstable with systems such as the IBM c-type Series, triggered by substantial current draw fluctuations due to fluctuating data traffic patterns.

- Ensure that electrical circuits are sized according to local and national codes. For North America, the 650 W power supplies require a 15 A circuit. If you are using a 200 or 240 VAC power source in North America, the circuit must be protected by a two-pole circuit breaker.

CAUTION:

To prevent loss of input power, ensure that the total maximum loads on the circuits supplying power to the switch are within the electrical current ratings for circuit for wiring and breakers.

- As you install and configure the switch, record the information listed in the Site Planning and Maintenance Records section.

Unpacking and Inspecting the Switch

CAUTION:

When handling switch components, wear an ESD strap and handle modules using only the carrier edges.

Tip: Retain the shipping container in case the chassis has to be shipped in the future.

Note: The switch is thoroughly inspected before shipment. If any damage occurs during transportation, or if any item is missing, contact your customer representative immediately. If you purchased Cisco support through a Cisco reseller, contact the reseller directly. If you purchased support directly from Cisco, contact Cisco Technical Support.

To inspect the shipment, follow these steps:

1. Compare the shipment to the equipment list provided by your customer service representative and verify that you have received all items, including the following:
 - Grounding lug kit
 - Rack-mount kit
 - ESD wrist strap
 - Cables and connectors
 - Optional items, if any, ordered
2. Check for damage and report any discrepancies or damage, to your customer service representative. Have the following information ready:
 - Invoice number of shipper (see packing slip)
 - Model and serial number of the damaged unit
 - Description of damage
 - Effect of damage on the installation
3. Check if all the power supplies and the fan trays have the expected direction of airflow. Port-side intake airflow modules have a red coloring, and port-side exhaust airflow modules have blue coloring. For more information, see the Power Supplies and Fan Modules sections.

NEBS Compliance

In case of port-side intake airflow, the chassis is not Network Equipment-Building System (NEBS) compliant by default. To be NEBS compliant, install the NEBS kit by performing these steps:

1. Install the NEBS rack-mount brackets onto the switch.
2. Install the NEBS air baffle by aligning the notches on the baffle with the slots on the brackets and sliding the ends of the baffle so that the baffle locks into place.

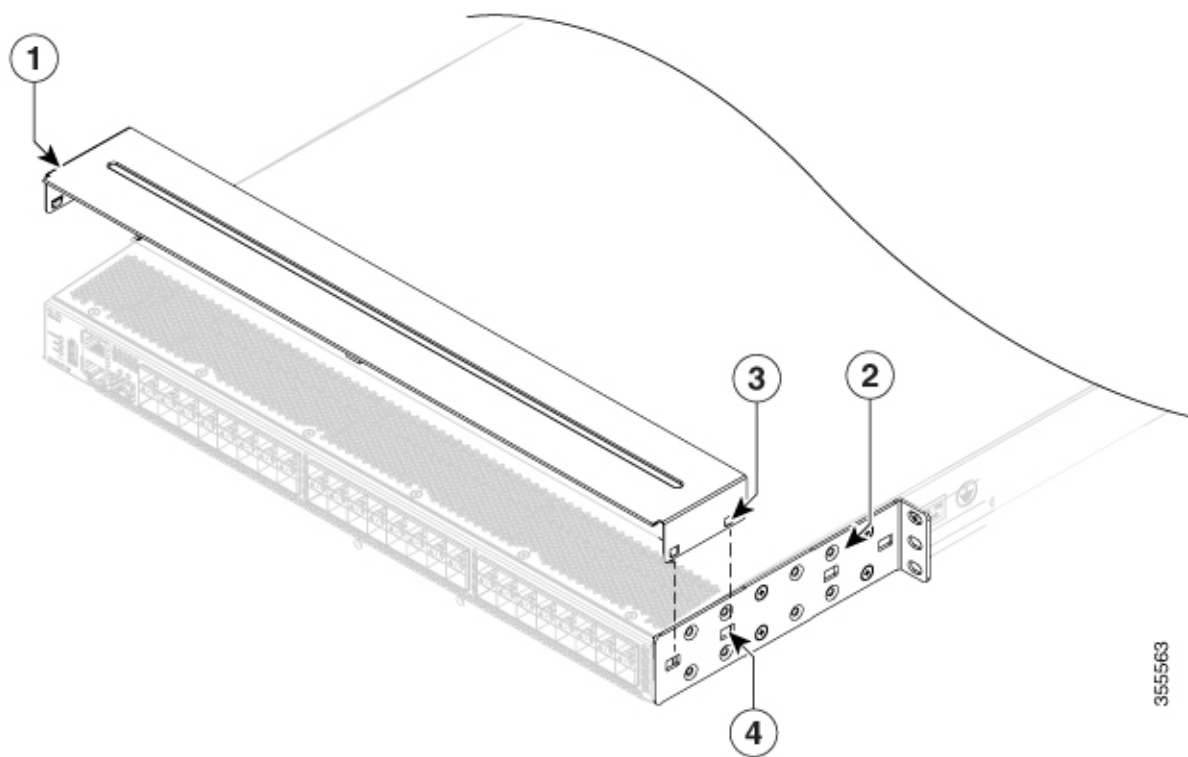


Figure 8. NEBS Kit for 2-Post Installation

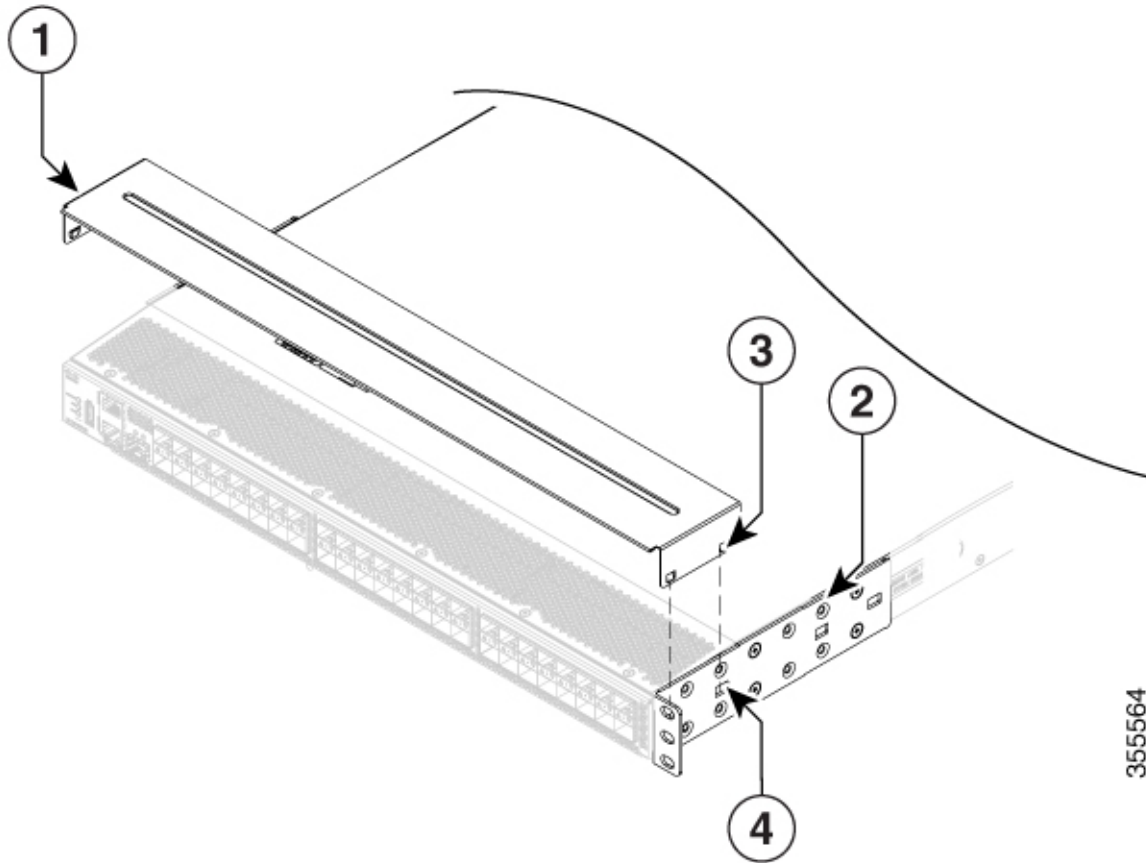


Figure 9. NEBS Kit for 4-Post Installation

1	NEBS air baffle	3	notch
2	NEBS rack-mount brackets	4	slot

For more information on how to install the switch, see the [Installing the Switch in a 4-Post Rack](#) and [Installing the Switch in a 2-Post Rack](#).

Installing the Switch

This section describes how to use the rack mount kit to install the IBM SAN48C-6 switch into a cabinet or rack that meets the requirements described in the [Cabinet and Rack Requirements](#) section.

Installing the Switch in a 4-Post Rack

Before you begin

- Inspect the switch shipment to ensure that you have everything you ordered.
- Make sure that the switch rack-mount kit includes the following parts:
 - Rack-mount brackets (2)
 - Rack-mount guides (2)
 - Slider rails (2)
 - M4 x 0.7 x 8-mm Phillips countersink screws (12)
- Make sure that the rack is installed and secured to its location.

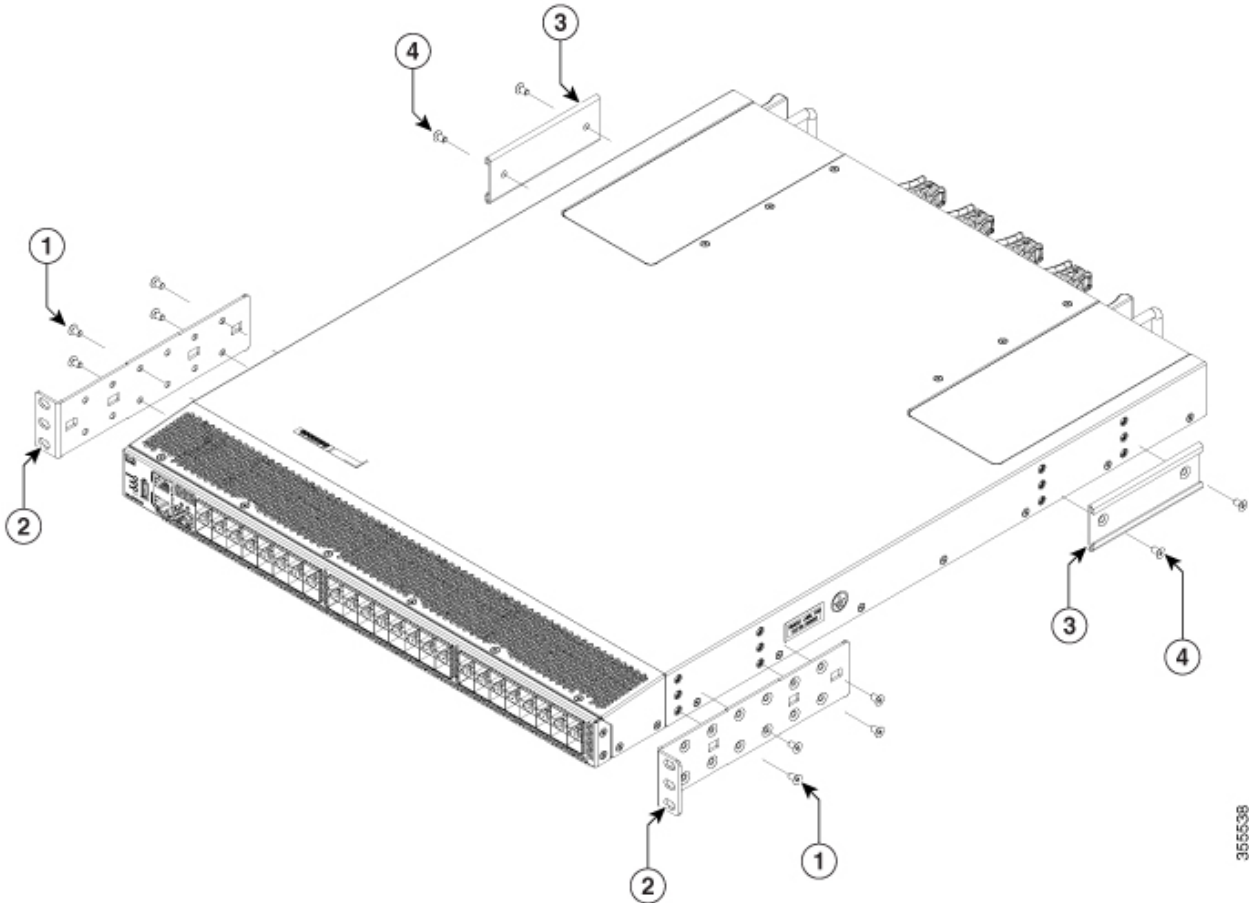
- If your switch must meet NEBS standards, ensure that it is configured to be compliant. For more information, see the NEBS Compliance section.
- - If the switch has port-side intake modules (fan modules and power supply units with red coloring), position the switch so that its ports are in the cold aisle.
 - If the switch has port-side exhaust modules (fan modules and power supply units with blue coloring), position the switch so that its fan modules and power supply units are in the cold aisle.

About this task

To install the switch, you must attach the front and rear mounting guides to the switch, install the slider rails on the rear of the rack, slide the switch into the slider rails, and secure the switch to the front of the rack. Typically, the front of the rack is the side that is easiest to access for maintenance.

Procedure

1. Determine which end of the chassis is to be located in the cold aisle.
 - If the switch has port-side intake modules (fan modules and power supply units with red coloring), position the switch so that its ports are in the cold aisle.
 - If the switch has port-side exhaust modules (fan modules and power supply units with blue coloring), position the switch so that its fan modules and power supply units are in the cold aisle.
2. Determine which way the chassis should slide in and out of the rack—port-side entry first or rear-side entry first. You might consider whether the front or back of the rack provides better clearance for maneuvering the chassis in and out during installation and servicing. The end that needs to enter the rack first requires the guides and the other end the brackets.
3. Install two rack-mount brackets to the switch as follows:
 - a. Position a rack-mount bracket so that four of its screw holes are aligned to the screw holes on the side of the chassis. You can align any four of the holes in the rack-mount bracket to four of the six screw holes on the side of the chassis. The holes that you use depend on the requirements of your rack and the amount of clearance. For more information on clearance, see the “General Requirements for Cabinets and Racks” on page 9.
 - b. You can install the rack-mount bracket either at the front or rear of the chassis. The choice is determined by which end of the chassis will be inserted into the rack first. If the rear end of the chassis is to be inserted first, then mount the brackets on the front of the chassis. If the front end of the chassis is to be inserted first, then mount the brackets on the rear of the chassis.



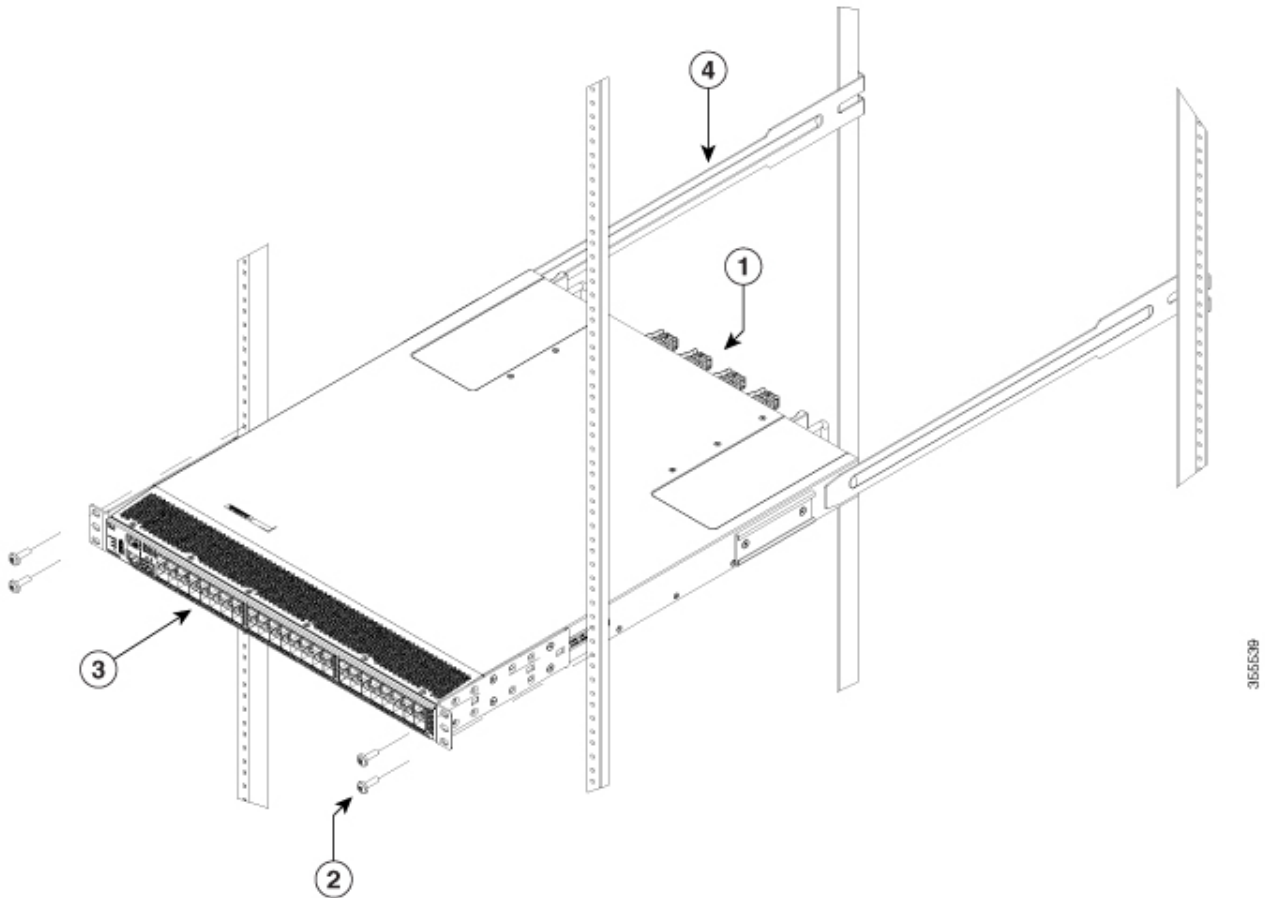
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Figure 10. Installing Rack-Mount Brackets on the Front Side of the Chassis

1.	Four M4 screws	3.	Rack-mount guide
2.	Rack-mount bracket	4.	Two M4 screws

- c. Secure the rack-mount bracket to the chassis using the four M4 screws and tighten each screw to 12 in-lb (1.36 N•m) of torque.
- d. Repeat Step 1 for the other rack-mount bracket on the other side of the switch, and be sure to position it in the same distance from the front of the switch.
4. Install the two rack-mount guides on the chassis, as follows:
 - a. Align the two screw holes on a rack-mount guide to the middle two screw holes in the remaining six screw holes on a side of the chassis.
 - b. Attach the guide to the chassis using two M4 screws. Tighten the screws to 12 in-lb (1.36 N•m) of torque.
 - c. Repeat Step 2 for the other rack-mount guide on the other side of the switch.
5. If you are installing the chassis into an ungrounded rack, you must attach a customer-supplied grounding wire to the chassis, as explained in Grounding the Switch. However, if you are installing the chassis into a grounded rack, you can skip this step.
6. Install the slider rails into the rack or cabinet, as follows:
 - a. Determine which two posts of the rack or cabinet you should use for the slider rails. Of the four vertical posts in the rack or cabinet, two will be used for the rack-mount brackets, and the other two posts will have the slider rails.

- b. Position a slider rail at the desired level side of the rack and use two 12-24 screws or two 10-32 screws, depending on the rack thread type, to attach the slider rail to the rack. Tighten the 12-24 screws to 30 in-lb (3.39 N•m) of torque, or tighten the 10-32 screws to 20 in-lb (2.26 N•m) of torque.
 - c. Repeat Step 3 to attach the other slider rail to the other side of the rack. To make sure that the slider rails are at the same level, you should use a level tool or tape measure, or carefully count the screw holes in the vertical mounting posts.
7. Insert the switch into the rack and attach it as follows:



1.	Fan-tray end of the chassis	3.	Direction of insertion
2.	rack-mount screws	4.	Slider rails

- a. Holding the switch with both hands, position the two rack-mount guides on the switch between the rack or cabinet posts that do not have slider rails attached to them.
- b. Align the two rack-mount guides on either side of the switch with the slider rails installed in the rack. Slide the guides onto the slider rails, and then gently slide the switch all the way into the rack until the brackets come in contact with two rack or cabinet posts.

Note: If you attached a grounding cable to the chassis, you will need to flex one of the rack-mount posts slightly to allow the grounding lug to go behind the post.

- c. Holding the chassis level, insert two screws (12-24 or 10-32, depending on the rack type) into each of the two brackets (using a total of four screws), and into the cage nuts or threaded holes in the rack or cabinet posts.

- d. Tighten the 10-32 screws to 20 in-lb (2.26 N•m), or tighten the 12-24 screws to 30 in-lb (3.39 N•m).
8. Holding the switch with both hands, position the two rack-mount guides on the switch between the rack or cabinet posts that do not have slider rails attached to them.
9. If you have attached a grounding wire to the chassis grounding pad, connect the other end of the wire to the facility ground.

Installing the Switch into a 2-Post Rack

Before you begin

If your switch must meet NEBS standards, ensure that it is configured to be compliant. For more information, see the NEBS Compliance section.

Determine how you want to set up your switch:

Procedure

1. Determine which end of the chassis is to be located in the cold aisle.
 - If the switch has port-side intake modules (fan modules and power supply units with red coloring), position the switch so that its ports are in the cold aisle.
 - If the switch has port-side exhaust modules (fan modules and power supply units with blue coloring), position the switch so that its fan modules and power supply units are in the cold aisle.
2. Determine which way the chassis should slide in and out of the rack—port side entry first or rear-side entry first. You might consider whether the front or back of the rack provides better clearance for maneuvering the chassis in and out during installation and servicing. The end that needs to enter the rack first requires the guides and the other end the brackets.
3. Install two rack-mount brackets onto the switch as follows:
 - a. Position a rack-mount bracket so that four of its screw holes are aligned to the screw holes on the side of the chassis. You can align any four of the holes in the rack-mount bracket to four of the six screw holes on the side of the chassis. The holes that you use depend on the requirements of your rack and the amount of clearance. For more information on clearance, see the “General Requirements for Cabinets and Racks” on page 9.
 - b. You can install the rack-mount bracket either at the front or rear of the chassis. The choice is determined by which end of the chassis will be inserted into the rack first. If the rear end of the chassis is to be inserted first, then mount the brackets on the front of the chassis. If the front end of the chassis is to be inserted first, then mount the brackets on the rear of the chassis.

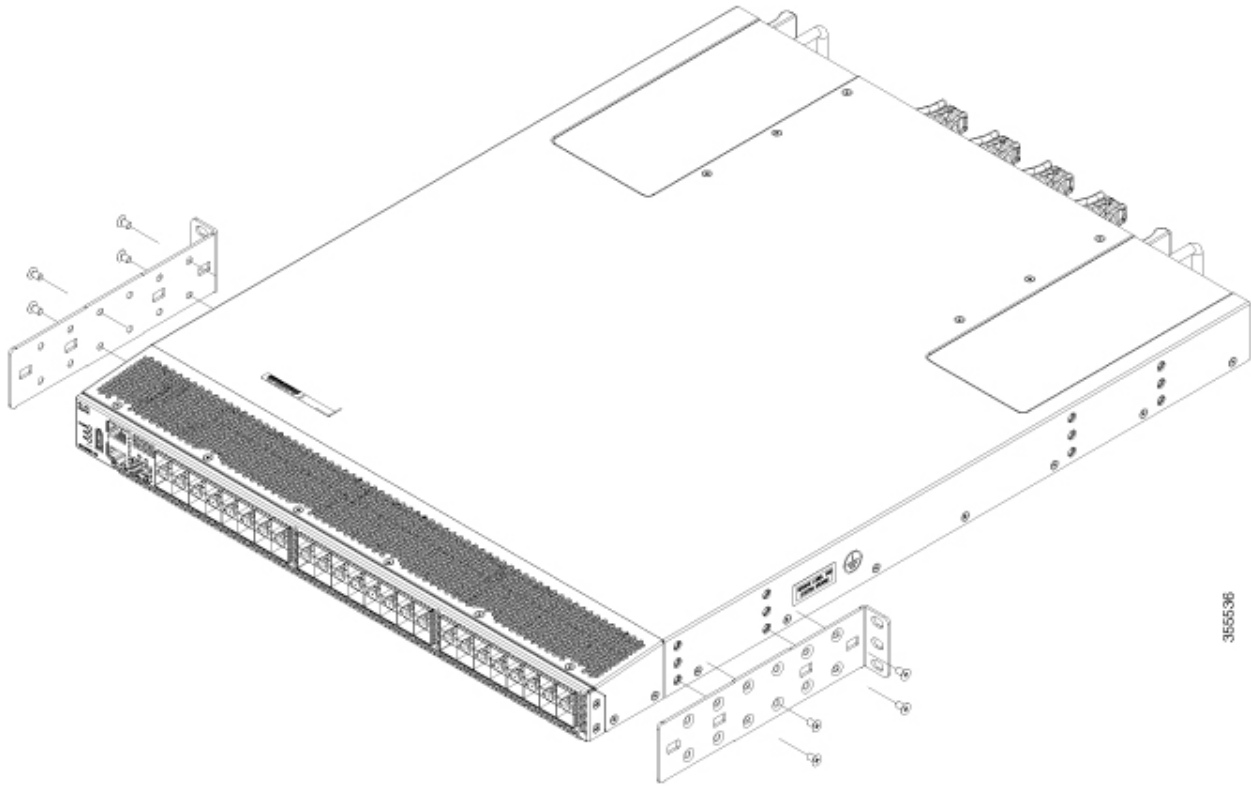
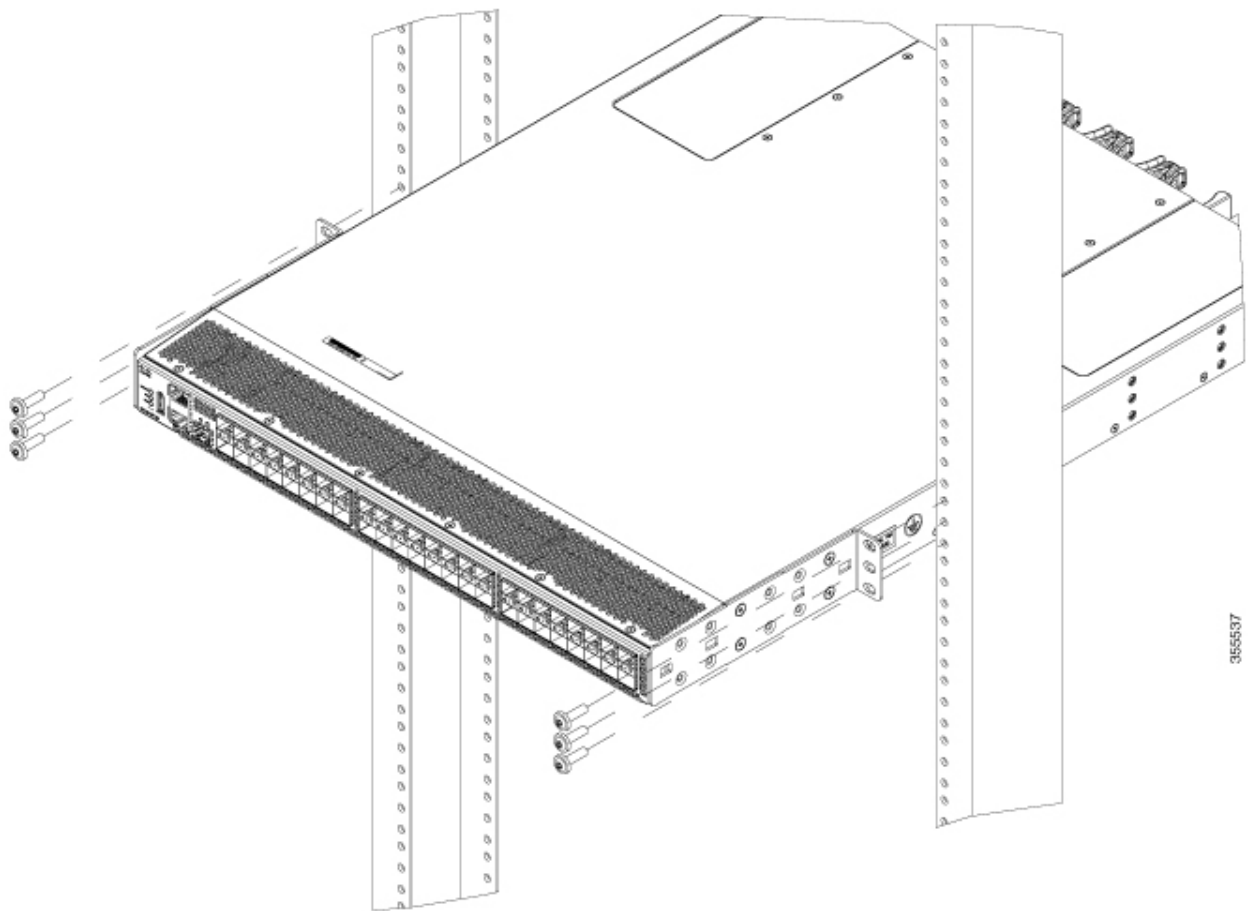


Figure 11. Installing Rack-Mount Brackets on the Front Side of the Chassis

4. If you are installing the chassis into an ungrounded rack, you must attach a customer-supplied grounding wire to the chassis, as explained in Grounding the Switch. However, if you are installing the chassis into a grounded rack, you can skip this step.
5. Install the switch onto the 2-post rack:
 - a. Holding the switch with both hands, position the back of the switch between the two posts of the rack. Then gently move the switch until the rack-mount brackets come in contact with two rack posts.
 - b. Holding the chassis level, insert three screws (12-24 or 10-32, depending on the rack type) into each of the two rack-mount brackets (using a total of six screws) and into the cage nuts or threaded holes in the rack or cabinet posts.



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Figure 12. Installing the Switch onto the 2-Post Rack From the Front Side of the Chassis

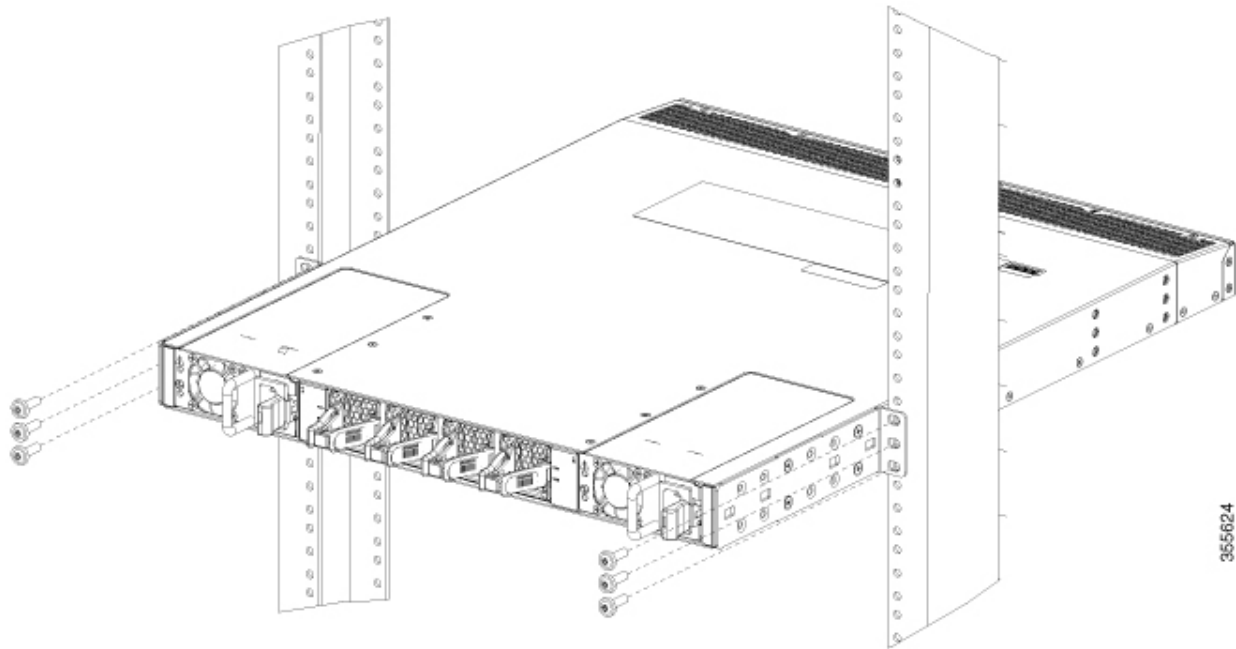


Figure 13. Installing the Switch onto the 2-Post Rack From the Rear Side of the Chassis

- c. Tighten the 10-32 screws to 20 in-lb (2.26 N.m) or tighten the 12-24 screws to 30 in-lb (3.39 N.m).
6. If you have attached a grounding wire to the chassis grounding pad, connect the other end of the wire to the facility ground.

Grounding the Switch

About this task

The switch chassis is automatically grounded when you install the switch properly in a grounded rack with metal-to-metal connections between the switch and rack. Alternatively, you can ground the chassis (this is required if the rack is not grounded) by attaching a customer-supplied grounding cable to the chassis grounding pad and the facility ground.

Note: 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**

Note: When installing or replacing the unit, the ground connection must always be made first and disconnected last. **Statement 1046**

Procedure

1. Use a wire-stripping tool to remove approximately 0.75 in. (1.9 cm) of the covering from the end of the grounding wire.
2. Insert the stripped end of the grounding wire into the open end of the grounding lug, and use a crimping tool to crimp the lug to the wire. Verify that the ground wire is securely attached to the grounding lug by attempting to pull the wire out of the crimped lug.
3. Remove the label covering the grounding pad on the chassis. Secure the grounding lug to the chassis grounding pad with two M4 screws, and tighten each screw to 11.5 to 15 in-lb (1.3 to 1.7 N•m) of

torque.

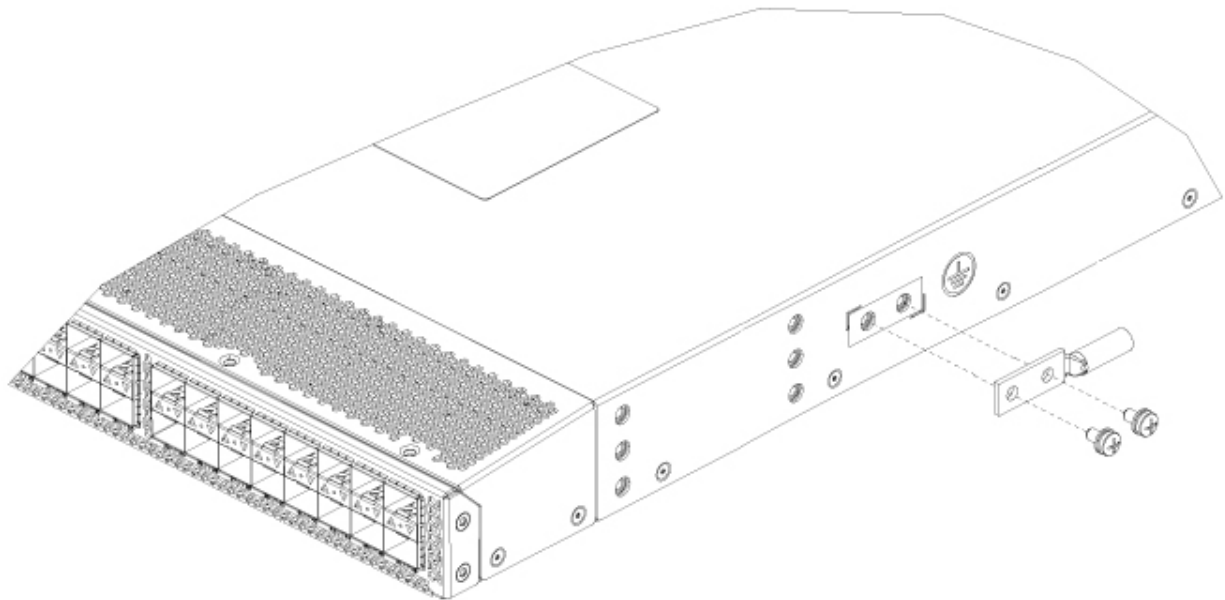


Figure 14. Grounding the Switch

4. Prepare the other end of the grounding wire and connect it to an appropriate grounding point in your site to ensure an adequate earth ground for the switch. If the rack is fully bonded and grounded, connect the grounding wire, as explained in the documentation provided by the vendor from whom you bought the rack.

Installing and Removing Components

Note: Hazardous voltage or energy is present on the backplane when the system is operating. Use caution when servicing. Statement 1034

CAUTION:

During this procedure, wear grounding wrist straps to avoid ESD damage to the switch.

Installing the ESD Grounding Strap

This section illustrates how to prepare yourself before removing the chassis from the sealed antistatic bag.

The figures show how to cuff the ESD strap around the wrist and the ground cord that connects the cuff to the ground. ESD wrist straps are the primary means of controlling static charge on personnel.

Note: These images are for only representation purposes. The chassis' actual appearance and size may vary.

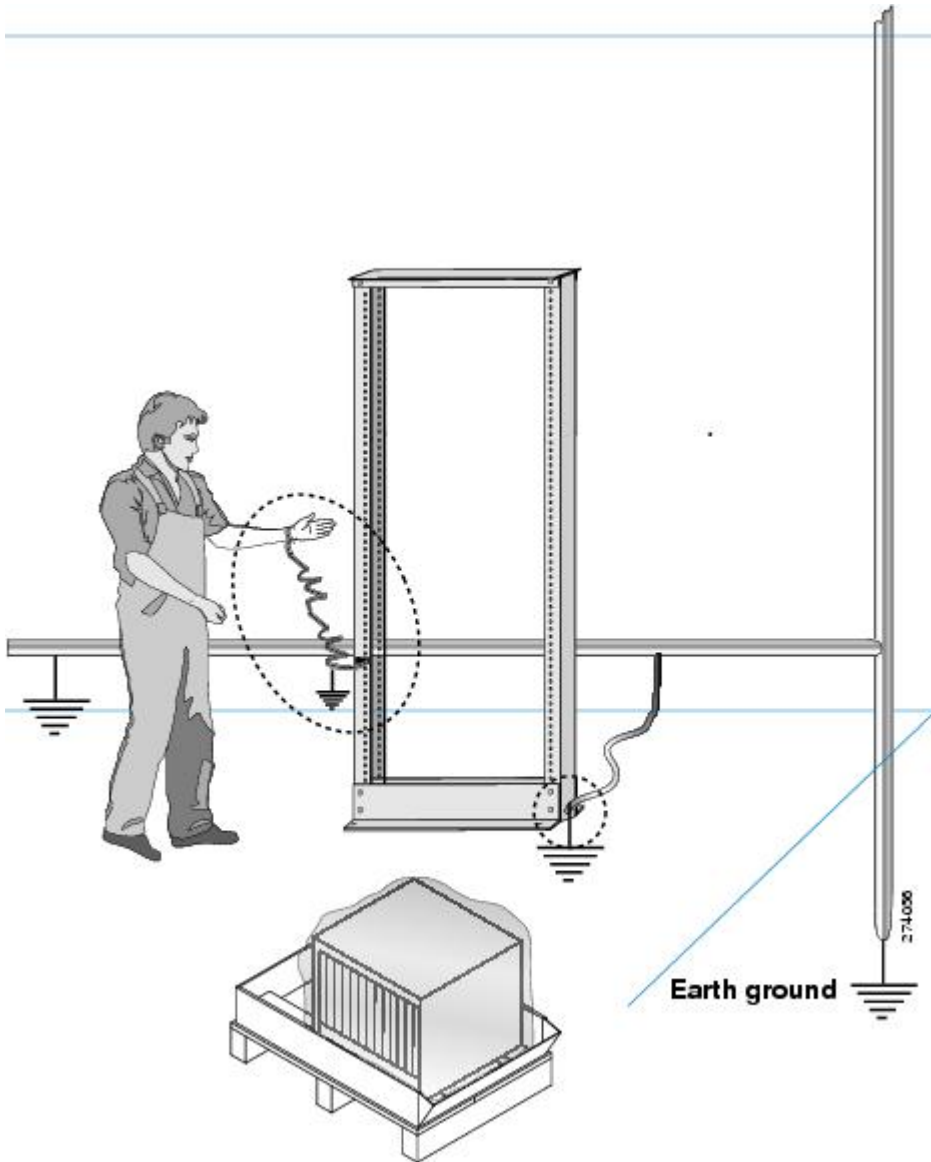


Figure 15. Wearing the ESD Strap

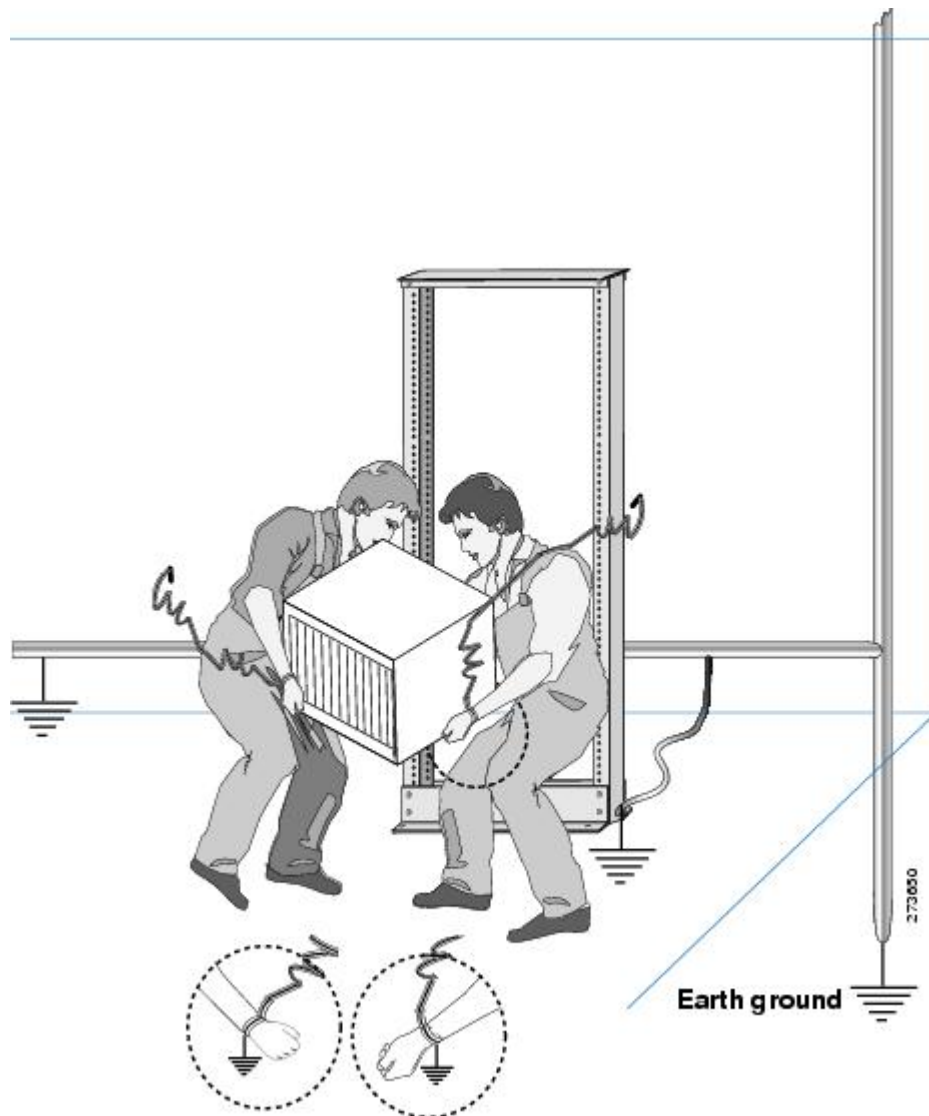


Figure 16. Handling the Chassis

Installing and Removing Power Supply Units

This section provides instructions for installing and removing the power supply units in the IBM SAN48C-6 switch.

Installing Power Supply Units

Before you begin

To implement n+n redundancy, each PSU must be connected to a separate power feed. Otherwise, only one power feed is required. There must be an earth ground connection to the chassis to which you are installing the replacement module. Typically, the chassis is grounded by its metal-to-metal connection with a grounded rack. If you need to ground the chassis, see [Grounding the Switch](#).

About this task

You can replace one power supply unit (PSU) while the other one provides power to the switch.

Procedure

1. Holding the PSU with one hand underneath it and the other hand holding the handle, turn the PSU so that its release latch is on the right side, and align the back end (the end with the electrical connections) to the open power supply slot. Carefully slide the PSU all the way into the slot until it clicks into place.

Note: If the PSU does not fit into the slot opening, turn the unit over and try again.

2. Test the installation by trying to pull the PSU out of the slot without using the release latch. If the PSU does not move out of place, it is secured in the slot. If the PSU moves, carefully press it all the way into the slot until it clicks in place.
3. Attach the power cable to the electrical outlet on the front of the PSU.
4. Make sure that the other end of the power cable is attached to the appropriate power feed for the PSU. If the power feed has a switch, slide it to the On position.

Note: Depending on the outlet receptacle on your power distribution unit, you might need the optional jumper cable to connect the switch to your outlet receptacle.

5. Verify that the PSU is operational by making sure that the PSU LEDs are both green. For information on what the PSU LEDs indicate, see the Switch LEDs section.

Removing Power Supply Units

About this task

You can remove one faulty PSU, while the other one provides enough power to operate the switch.

Procedure

1. Holding the plug for the power cable, pull the plug out from the power receptacle on the PSU, and wait until both the PSU LEDs are off.

Note: If you need to remove an Anderson's Saf-D-Grid power cable connector from a high voltage PSU, press the tab at the top of the connector and pull the connector out of the PSU.

2. Grasp the PSU handle while pressing the release latch towards the handle.
3. Place your other hand under the PSU to support it while you slide it out of the chassis.

CAUTION:

Do not touch the electrical connectors on the back side of the unit and prevent anything else from coming into contact with and damaging the connectors.

Installing and Removing Fan Modules

This section provides instructions for installing and removing the fan modules for the IBM SAN48C-6 switch.

You can replace one of the four fan modules even when the switch is operating so long as you perform the replacement within one minute of removing the old fan module. If you cannot perform the replacement within one minute, leave the original fan module in the chassis to maintain the designed airflow until you have the replacement fan module on hand and can perform the replacement.

CAUTION:

If you are replacing a module during operation, be sure that the replacement fan module has the correct direction of airflow, which means that it has the same airflow direction as the other modules in the chassis. Also, be sure that the airflow direction takes in air from a cold aisle and sends it out to a hot aisle. Otherwise, the switch can overheat and shut down.

If you are changing the airflow direction of all the modules in the chassis, you must shut down the switch before replacing all the fan and power supply modules with modules using the other airflow direction. During operation, all the modules must have the same direction of airflow.

Installing a Fan Module**Before you begin**

- You must have a new fan module on hand and ready to install within one minute of removing the original fan module if the switch is operating.
- The new fan module must have the same airflow direction as the other fan and power supply modules installed in the switch. All of these modules must have either red coloring (port-side intake airflow) or blue coloring (port-side exhaust airflow).
- Remove any blank plate or existing fan module from the fan slot.

About this task

To install a new fan module, follow these steps:

Procedure

1. Holding the fan module by its handle, align the back of the fan module (the side with the electrical connectors) to the open fan slot in the chassis.
2. Slide the fan module into the fan module bay until it clicks into place.
3. Verify that the Status LED turns on and becomes green. For more information on what the LEDs indicate, see the LEDs section.

Removing a Fan Module**About this task**

The fan module is designed to be removed and replaced while the system is operating without presenting an electrical hazard or damaging the system.

CAUTION:

The IBM c-type Series Switches have internal temperature sensors that can shut down the system if the temperature within the chassis exceed certain safety thresholds. To accurately monitor the system temperature, the temperature sensors require sufficient airflow through the chassis. In the event that a fan module is removed from the chassis and the airflow is reduced, the system will bypass the temperature sensor information and shut down after five minutes to prevent undetected overheating. However, the switches will shut down sooner if the major temperature threshold is exceeded.

Note: While removing the fan module, keep your hands and fingers away from the spinning fan blades. Let the fan blades completely stop before you remove the fan module. Statement 258

To remove an existing fan module, follow these steps:

Procedure

1. On the fan module that you are removing, press the two sides of the fan module handle next to where it connects to the fan module and pull on the handles enough to unseat it from its connectors.
2. Holding the handle, pull the module out of the chassis.

CAUTION:

Do not touch the electrical connectors on the back side of the module and prevent anything else from coming into contact with and damaging the connectors.

Connecting the IBM SAN48C-6 Switch

The IBM SAN48C-6 switch provides the following types of ports:

- Console port—An RS-232 port that you can use for a local management connection.
- MGMT 10/100/1000 Ethernet port—Two Ethernet ports that you can use to access and manage the switch by IP address, such as through the CLI or Fabric Manager. One of the Ethernet ports can also be used to export analytic data.
- Fibre Channel ports—Fibre Channel ports that you can use to connect to the SAN, or for in-band management.
- USB port—USB port for USB disk that you can use for configuration file backups, and capturing logs to file.

This chapter describes how to connect the various components of the IBM SAN48C-6 switch.

Preparing for Network Connections

When preparing your site for network connections to the IBM SAN48C-6 switch, consider the following for each type of interface:

- Cabling required for each interface type
- Distance limitations for each signal type
- Additional interface equipment needed

Before installing the component, have all the additional external equipment and cables available.

Connecting the Console Port

This section describes how to connect the RS-232 console port to a PC. The console port allows you to perform the following functions:

- Configure the switch from the CLI.
- Monitor network statistics and errors.
- Configure SNMP agent parameters.
- Download software updates to the switch or distribute software images residing in flash memory to attached devices.
- Perform initial switch configuration
- Perform password recovery

Connecting the Console Port to a PC

About this task

You can connect the console port to a PC serial port for local administrative access to the IBM SAN48C-6 switch.

Note:

The PC must support VT100 terminal emulation. The terminal emulation software—frequently a PC application, such as HyperTerminal Plus—makes the communication between the IBM SAN48C-6 switch and your PC possible during setup and configuration.

To connect the console port to a PC, follow these steps:

Procedure

1. Configure the baud rate and character format of the PC terminal emulation program to match the following management port default characteristics:
 - 9600 baud
 - 8 data bits
 - 1 stop bit
 - No parity
2. Attach the adapter required for your PC to its communication port. It must present an RJ-45 socket towards the switch.
 - For a DB-9 serial port, attach the supplied RJ-45-to-DB-9 female adapter.
 - For a DB-25 serial port, attach the supplied RJ-45-to-DB-25 female adapter.
 - For a USB port, attach a customer-supplied USB-to-serial dongle.
3. Connect one end of the supplied console cable (a rollover RJ-45-to-RJ-45 cable) to the console port. Connect the other end to the female RJ-45 adapter attached to the PC communication port.

Connecting a Modem to a Console Port

You can connect the console port either before or after powering on the switch by using the instructions in this section.

CAUTION:

Do not connect the console port to a modem while the switch is booting. Connect the console port to a modem either before powering the switch on or after the switch has completed the boot process.

Connecting before the switch is powered on About this task

To connect the console port to a modem before the switch is powered on, follow these steps:

Procedure

1. Connect the supplied console cable (a rollover RJ-45-to-RJ-45 cable) to the console port.
2. Connect the other end of the console cable to the supplied RJ-45-to-DB-25 adapter.
3. Connect the RJ-45-to-DB-25 adapter to the DB-25 port on the modem.
4. Power on the switch. The switch boots automatically, and the following default console port characteristics are applied to the modem connection:
 - 9600 baud
 - 8 data bits
 - 1 stop bit
 - No parity
 - Default initialization string (ATE0Q1&D2&C1S0=1\015) if previously configured

Note: For instructions on how to change these settings, see the *Cisco Fabric Manager Fundamentals Configuration Guide*.

Connecting after the switch is powered on About this task

To connect the console port to a modem after the switch is powered on, follow these steps:

Procedure

1. Ensure that the system has completed booting and the system image is running.
2. Connect the supplied console cable (a rollover RJ-45-to-RJ-45 cable) to the console port.
3. Connect the other end of the console cable to the supplied RJ-45-to-DB-25 adapter.
4. Connect the RJ-45-to-DB-25 adapter to the DB-25 port on the modem.
5. Initialize and configure the modem as specified in the *Fabric Manager Fundamentals Configuration Guide* and the *NX-OS Fundamentals Configuration Guide*.

Connecting the Management Ports

The auto-sensing 10/100/1000 Mbps Ethernet management ports are located on the left side of the front panel (labeled MGMT ETH0 and MGMT ETH1), below the console port. MGMT ETH0 is the default Ethernet management port (interface mgmt0). This port is used for out-of-band management and data streaming to remote receivers.

Note: The MGMT ETH1 port is disabled in Cisco MDS NX-OS Release 8.3(1).

Use a modular, RJ-45, straight-through UTP cable to connect the management ports to an external hub or switch. To connect to a router, use a crossover cable.

Connecting to a Fibre Channel Port

The Fibre Channel ports in the IBM SAN48C-6 switch are compatible with FC LC-type fiber-optic SFP+ transceivers and cables (see the Removing and Installing Cables into SFP Transceivers section). You can use these ports to connect to the SAN or for in-band management. For information about configuring the switch for in-band management, see the *Fabric Manager Fundamentals Configuration Guide* or the *NX-OS Fundamentals Configuration Guide*.

Each transceiver must match the transceiver at the other end of the cable, and the cable must not exceed the stipulated cable length for reliable communications. SFP+ transceivers can be ordered either separately or with the IBM SAN48C-6 switch.

Note: **Class 1 laser product.** Statement 1008

Note: **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.** Statement 1051

Note: Wear an ESD wrist strap connected to the chassis when handling transceivers. Keep optical connectors covered when not in use, and do not touch connector ends. The fiber-optic connectors must be free of dust, oil, and other contaminants.

Removing and Installing Cables into SFP Transceivers

CAUTION:

To prevent damage to the fiber-optic cables, do not place more tension on them than the rated limit and do not bend to a radius of less than one inch (2.5 cm) if there is no tension in the cable, or two inches (5 cm) if there is tension in the cable.

Installing a Cable into an SFP Transceiver

About this task

CAUTION:

To prevent possible damage to the cable or transceiver, install the transceiver in the port before installing the cable in the transceiver.

To install a cable into a transceiver, follow these steps:

Procedure

1. Attach an ESD-preventive wrist strap and follow its instructions for use.
2. Remove the dust cover from the connector on the cable.
3. Remove the dust plug from the cable end of the transceiver.
4. Align the cable connector with the transceiver and insert the connector into the transceiver until it clicks into place.

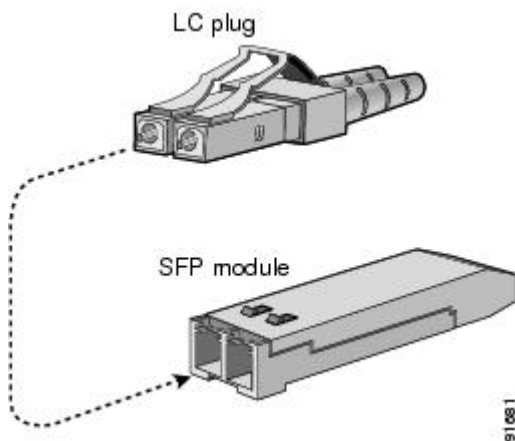


Figure 17. Connecting an LC-Type Cable to a Fibre Channel Port

CAUTION:

The LC connector has keys to allow insertion only one way into the transceiver. If the cable does not install easily, ensure that it is correctly oriented before continuing.

For instructions on verifying connectivity, see the *Fabric Manager Fundamentals Configuration Guide* and the *NX-OS Fundamentals Configuration Guide*.

Removing a Cable from an SFP Transceiver

About this task

CAUTION:

- When pulling a cable from a transceiver, grip the body of the connector. Do not pull on the jacket sleeve because this can compromise the fiber optic termination in the connector.
- If the cable does not remove easily, ensure that any latch present on the cable has been released before continuing.

To remove the cable, follow these steps:

Procedure

1. Attach an ESD-preventive wrist strap and follow its instructions for use.
2. Press the release latch on the cable, grasp the connector near the connection point, and gently pull the connector from the transceiver.
3. Insert a dust plug into the cable-end of the transceiver.
4. Install a dust cover over the end of the cable.

Removing and Installing SFP Transceivers

Note: Removing and installing an SFP transceiver can shorten its useful life. Do not remove and insert SFP transceivers more often than is absolutely necessary. We recommend that you disconnect the cables before installing or removing SFP transceivers to prevent damage to the cable or transceiver.

Note: Use only Cisco transceivers in the IBM SAN48C-6 switch. Each Cisco transceiver is encoded with model information that enables the switch to verify that the transceiver meets the requirements for the switch.

The IBM SAN48C-6 switch supports transceivers with the following types of latching devices:

- Mylar tab latch
- Bale-clasp latch

Installing an SFP Transceiver

About this task

To install an SFP+ transceiver, follow these steps:

Procedure

1. Attach an ESD-preventive wrist strap and follow its instructions for use.
2. Remove the dust plug from the FC port.
3. Insert the transceiver into the port.

CAUTION:

The transceiver can only be inserted one way into the FC port. If the transceiver does not install easily, ensure that it is correctly oriented and the tab or clasp are in the correct position before continuing.

4. Insert or leave the dust plug in the cable-end of the transceiver if a cable is not being installed in the transceiver.

Removing an SFP Transceiver

About this task

To remove an SFP+ transceiver, follow these steps:

Procedure

1. Attach an ESD-preventive wrist strap and follow its instructions for use.
2. Remove attached fibre-optic cables, if any. For more information, see the Removing a Cable from an SFP Transceiver section.
3. Remove the transceiver from the port:
 - If the transceiver has a Mylar tab latch, gently pull the tab straight out (do not twist), and then pull the transceiver out of the port.
 - If the transceiver has a bale-clasp latch, open the clasp by pressing it downwards, and then pull the transceiver out of the port.
4. Insert a dust cover into the cable-end of the transceiver and place the transceiver on an antistatic mat or into a static shielding bag.
5. Protect the FC port by inserting a clean dust plug if another transceiver is not being installed.

Maintaining SFP Transceivers and Fiber-Optic Cables

SFP transceivers and fiber optic cables must be kept clean and dust-free to maintain high signal accuracy and prevent damage to the connectors. Attenuation (loss of light) is increased by contamination. Therefore, attenuation should be kept below 0.35 dB.

Follow these maintenance guidelines:

- SFP transceivers are static-sensitive. To prevent ESD damage, wear an ESD-preventive wrist strap that is connected to the chassis while handling transceivers.
- Do not remove and reinsert a transceiver more often than necessary. Repeated removals and insertions can shorten its useful life.
- Keep all optical connections covered when not in use. If they become dusty, clean them before using in order to prevent dust from scratching the fiber-optic cable ends.
- Do not touch the ends of connectors. This prevents fingerprints and other contamination of the connectors.
- Inspect cables before installation for dust and damage. If damage is suspected, clean the ends and check for excessive light loss with a light meter.

Powering Up the Switch

About this task

This section provides instructions for powering up the switch and verifying component installation.

CAUTION:

During this procedure, wear grounding wrist straps to avoid ESD damage to the switch.

Note: Do not connect the MGMT ETH0 port to the LAN until the initial switch configuration has been performed through the console connection. For instructions on connecting this port, see the Connecting the Management Port section.

To power up the switch and verify hardware operation, follow these steps:

Procedure

1. Verify that sufficient PSUs and fan modules are installed.
2. Plug the power cables into the power supplies and arrange the cables so that they cannot be accidentally pulled out.

Note:

Depending on the outlet receptacle on your power distribution unit, you may need the optional jumper power cord to connect the IBM SAN48C-6 Switch to your outlet receptacle. For more information about the jumper power cord, see the Jumper Power Cord section.

3. Connect the other end of the power cables to the site power outlets that have the required power specification.
4. Ensure that the switch is adequately grounded, as described in the Grounding the Switch section.
5. Connect a terminal device to the serial console port. For more information, see the Connecting the Console Port section.
6. If using Power On Automatic Provisioning (POAP), insert the USB stick with the required files into the USB port.
7. Turn the site power outlet switches to On. The switch boots automatically.
8. Listen for the fans; they should begin operating as soon as the switch is powered on.

Note: Do not operate the switch without a functioning fan module, except briefly during the fan module replacement procedure. IBM c-type SAN Switches can operate for only a few minutes without any functioning fan modules before they begin to overheat.

9. Verify that the LED behavior is as follows when the switch has finished booting:
 - Fan status LED is green.

- Both LEDs on each PSU are green.
- The switch status LED is green. If this LED is orange or red, it indicates that one or more environmental monitors is reporting a problem.
- The Ethernet port link LEDs should not be On unless the cable is connected.

Note: The LEDs for the Fibre Channel ports remain orange until the ports are enabled, and the LED for the management port remains Off until the port is connected.

10. If a component is not operating properly, try removing and reinstalling it. If it still does not operate correctly, contact your customer service representative for a replacement.
11. Verify that the system software has booted and the switch has initialized without error messages. If any problems occur, see the *Cisco MDS 9000 Series System Messages Guide*. If you cannot resolve an issue, contact your customer service representative.
12. If not using POAP, manually complete the initial configuration of the switch via the automatically launched setup script through the console connection.
13. Complete the worksheets provided in Site Planning and Maintenance Records for future reference.

Note: A setup utility is automatically launched the first time you boot the switch and guides you through the basic configuration. For instructions about how to configure the switch and check module connectivity, see the *Cisco Fabric Manager Fundamentals Configuration Guide*.

Technical Specifications

These are the technical specifications for installing and using the SAN48C-6 switch.

Switch Specifications

The following table lists the environmental specifications for the IBM SAN48C-6 switch:

Table 3. Environmental Specifications for the IBM SAN48C-6 Switch

Description	Specification
Temperature, ambient operating	32 to 104°F (0 to 40°C)
Temperature, ambient nonoperating and storage	-40 to 158°F (-40 to 70°C)
Humidity (RH), ambient (noncondensing) operating	10 to 90%
Humidity (RH), ambient (noncondensing) nonoperating and storage	10 to 95%
Altitude, operating	-197 to 6500 ft (-60 to 2000 m)

The following table lists the physical specifications for the IBM SAN48C-6 switch.

Table 4. Physical Specifications for the IBM SAN48C-6 Switch

Description	Specification
Dimensions (HxWxD)	1.72 x 17.3 x 22.3 in. (4.37 x 43.94 x 56.64 cm) excluding PSU and fan module handles
Rack Space	Chassis requires 1 RU (1.75 in. or 4.45 cm)
Weight	18.73 lb (8.5 kg)
Fan Dimensions (WxH)	1.575 x 1.575 in. (4.0 x 4.0 cm)
Fan Slots Opening Dimensions (WxH)	1.614 x 1.602 in. (4.09 x 4.06 cm)
Power Supply	<ul style="list-style-type: none">• 650-W AC, port-side exhaust variant (up to 2 per switch)• 650-W AC, port-side intake variant (up to 2 per switch)• AC input—100 to 240 V AC (10% range)• Frequency—50 to 60 Hz (nominal)
Airflow	<ul style="list-style-type: none">• Back to front (toward ports) using port-side exhaust fans• Front to back (into ports) using port-side intake fans• 50 CFM (0.02 m³/s) through system fan assembly at 25°C• 100 CFM (0.04 m³/s) maximum <p>We recommend that you maintain a minimum air space of 2.5 in. (6.4 cm) between walls and chassis air vents and a minimum horizontal separation of 6 in. (15.2 cm) between two chassis to prevent overheating.</p>

General Power Supply Specifications

The following table lists the specifications for the IBM SAN48C-6 switch AC power supply:

Table 5. Power Supply Specifications

AC Input Power	Specification
AC input voltage	100 to 240 VAC
AC input frequency	Nominal = 50 to 60 Hz
Power supply output capacity	650 W
Output holdup time	20 ms

Power Supply Requirement Specifications

The following table provides a sample calculation of power for the IBM SAN48C-6 switch AC power supply:

Table 6. Power Dissipation for AC Power Supply

Power Mode	PSU	Traffic Rate	Temperature	Voltage	Optics Speed	Optics Number	Fan Trays	Power at 110V/60HZ (Watts)	Power at 220V/50HZ (Watts)
Typical	2	50%	25°C	Nominal	32G-SW	24	4	257	251
						48		305	297
Max	2	100%	25°C	Nomin	32G-SW	24	4	267	260
						48		323	315
			32G-SW	322	315				
			32G-LW	374	348				
			Nominal + 5%	403	385				

Component Power Requirements and Heat Dissipation

Consider heat dissipation when sizing the air-conditioning requirements for an installation. The power and heat associated with a IBM SAN48C-6 32 Gbps 48 Port Fibre Channel Switch varies based on the following considerations:

- The environment (temperature) outside the chassis
- Internal chassis temperature
- Any hardware component failure in the chassis
- Average switching traffic levels

The following table lists the power requirements and heat dissipation for the components of the IBM SAN48C-6 32 Gbps 48 Port Fibre Channel Switch.

Table 7. Power Requirements and Heat Dissipation for the IBM SAN48C-6 32 Gbps 48 Port Fibre Channel Switch

Module Type/Product Number	Power Required (watts)	Heat Dissipation (BTU/hr)	Input Current		
			85VAC(amps)	110VAC(amps)	220VAC(amps)
IBM SAN48C-6 32 Gbps 48 Port Fibre Channel Switch	290 maximum	989	3.41	2.63	1.31

Transceiver Specifications

IBM provided transceivers support 850 to 1610 nm nominal wavelengths, depending upon the transceiver.

For the list of supported transceivers, see the Cisco MDS 9000 Series Compatibility Matrix.

For details about transceivers see the *Cisco MDS 9000 Family Pluggable Transceivers Data Sheet*.

For information about safety, regulatory, and standards compliance, see the *Regulatory Compliance and Safety Information for the Cisco MDS 9000 Family*.

Fibre Channel SFP+ Transceivers

The following table lists the Fibre Channel SFP+ transceivers that are available for the IBM SAN48C-6 switch:

Table 8. Fibre Channel SFP + Transceivers for the IBM SAN48C-6 Switch

Feature Code	Description	Type
AJHE	32 Gbps Fibre Channel SW SFP+	Short wavelength
AJHF	32 Gbps Fibre Channel LW SFP+	Long wavelength
AJHB	16 Gbps Fibre Channel SW, SFP+	Short wavelength
AJHC	16 Gbps Fibre Channel LW, SFP+	Long wavelength
AJHM	8 Gbps Fibre Channel SW, SFP+	Short wavelength
AJHN	8 Gbps Fibre Channel LW, SFP+	Long wavelength

Note: IBM SAN48C-6 does not support 4 Gbps Fibre Channel SW SFP+.

General Specifications for Fibre Channel 32 Gbps SFP+ Transceivers

The following table summarizes cabling specifications for 32 Gbps.

Table 9. General Specifications for 32 Gbps Fibre Channel SFP+ Transceivers

SFP+	Wavelength (nm)	Fibre Type	Core Size (microns)	Baud Rate (GBd)	Cable Distance
AJHE	850	MMF	50.0	28.05	65 ft (20 m) (OM2)
			50.0	28.05	230 ft (70 m) (OM3)
			50.0	28.05	328 ft (100 m) (OM4)
			50.0	28.05	328 ft (100 m) (OM5)
			62.5	14.025	49 ft (15 m) (OM1)
			50.0	14.025	115 ft (35 m) (OM2)
			50.0	14.025	328 ft (100 m) (OM3)
			50.0	14.025	410 ft (125 m) (OM4)
			50.0	14.025	410 ft (125 m) (OM5)
			62.5	8.5	69 ft (21 m) (OM1)
			50.0	8.5	164 ft (50 m) (OM2)
			50.0	8.5	492 ft (150 m) (OM3)
			50.0	8.5	623 ft (190 m) (OM4)
			50.0	8.5	623 ft (190 m) (OM5)
AJHF	1310	SMF	9.0	28.05	10 km (6.2 mi)
			9.0	14.025	10 km (6.2 mi)
			9.0	8.5	10 km (6.2 mi)

Power Requirements and Environmental Conditions for 32 Gbps SFPs

The following table provides the optical parameters for 32 Gbps SFPs:

Table 10. Optical Parameters for 32 Gbps SFPs

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber-Loss Budget (dB)			
	Min	Max	Min	Max	OM2	OM3	OM4	OM5

Table 10. Optical Parameters for 32 Gbps SFPs (continued)

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber-Loss Budget (dB)			
AJHE	-6.2	2.0	-8.2	2.0	1.68 (8 Gbps)	2.04 (8 Gbps)	2.04 (8 Gbps)	2.04 (8 Gbps)
					1.63 (16 Gbps)	1.86 (16 Gbps)	1.95 (16 Gbps)	1.95 (16 Gbps)
					2.02 (32 Gbps)	1.86 (32 Gbps)	1.86 (32 Gbps)	1.86 (32 Gbps)
AJHF	-5.0	2.0	-11.4	2.0	6.4 (8 Gbps)			
					6.4 (16 Gbps)			
					6.4 (32 Gbps)			

The following table provides information on operating and storage temperature ranges for 32 Gbps SFPs:

Table 11. Operating and Storage Temperature Ranges for 32 Gbps SFPs

SFP+	Operating		Storage	
	Min	Max	Min	Max
AJHE	0°C	40°C	-40°C	70°C
AJHF	0°C	40°C	-40°C	70°C

General Specifications for Fibre Channel 16 Gbps SFP+ Transceivers

The following table summarizes cabling specifications for 16 Gbps SFP+ transceivers:

Table 12. General Specifications for 16 Gbps Fibre Channel SFP+ Transceivers

SFP+	Wavelength (nm)	Fibre Type	Core Size (microns)	Baud Rate (GBd)	Cable Distance			
AJHB	850	MMF	62.5	14.025	15 m (49 ft) (OM1)			
			50.0	14.025	35 m (115 ft) (OM2)			
			50.0	14.025	100 m (328 ft) (OM3)			
			62.5	8.5	125 m (410 ft) (OM4)			
			50.0	8.5	21 m (69 ft) (OM1)			
			50.0	8.5	50 m (164 ft) (OM2)			
			62.5	4.25	150 m (492 ft) (OM3)			
			50.0	4.25	190 m (623 ft) (OM4)			
			50.0	4.25	70 m (230 ft) (OM1)			
			50.0	4.25	150 m (492 ft) (OM2)			
			50.0	4.25	380 m (1247 ft) (OM3)			
			50.0	4.25	400 m (1312 ft) (OM4)			
			AJHC	1310	SMF	9.0	14.025	10 km (6.2 mile)
						9.0	8.5	10 km (6.2 mile)
9.0	4.25	10 km (6.2 mile)						

Power Requirements and Environmental Conditions for 16 Gbps SFP+ Transceivers

The following table provides the optical parameters for 16 Gbps SFP+ transceivers:

Table 13. Optical Parameters for 16 Gbps SFP+ Transceivers

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber-Loss Budget (dB)		
	Min	Max	Min	Max	(62.5 microns [OM1])	(50.0 microns [OM2])	(50.0 microns [OM3])

Table 13. Optical Parameters for 16 Gbps SFP+ Transceivers (continued)

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber-Loss Budget (dB)		
AJHB	-7.8	-1.3	-10.3	0	2.08 (4 Gbps)	2.08 (4 Gbps)	2.88 (4 Gbps)
					1.68 (8 Gbps)	1.68 (8 Gbps)	2.04 (8 Gbps)
					1.63 (16 Gbps)	1.63 (16 Gbps)	1.86 (16 Gbps)
AJHC	-5.0	2.0	-12.0	2.0	7.8 (4 Gbps)		
					6.4 (8 Gbps)		
					6.4 (16 Gbps)		

The following table provides information on operating and storage temperature ranges:

Table 14. Operating and Storage Temperature Ranges for 16 Gbps SFP+ Transceivers

SFP+	Operating		Storage	
	Min	Max	Min	Max
AJHB	0°C	40°C	-40°C	85°C
AJHC	0°C	40°C	-40°C	85°C

General Specifications for Fibre Channel 8 Gbps SFP+ Transceivers

The following table summarizes cabling specifications for 8 Gbps transceivers:

Table 15. General Specifications for 8 Gbps Fibre Channel SFP+ Transceivers

SFP+	Wavelength (nm)	Fibre Type	Core Size (microns)	Baud Rate (GBd)	Cable Distance
AJHM	850	MMF	62.5	2.125	150 m (492 ft)
			62.5	4.250	70 m (230 ft)
			62.5	8.500	21 m (69 ft)
			50.0 (OM2)	2.125	300 m (984 ft)
			50.0 (OM2)	4.250	150 m (492 ft)
			50.0 (OM2)	8.500	50 m (164 ft)
			50.0 (OM3)	2.125	500 m (1640 ft)
			50.0 (OM3)	4.250	380 m (1246 ft)
			50.0 (OM3)	8.500	150 m (492 ft)
			50.0 (OM4)	2.125	520 m (1706 ft)
			50.0 (OM4)	4.250	400 m (1312 ft)
			50.0 (OM4)	8.500	190 m (623 ft)
AJHN	1310	SMF	9.0	2.125	10 km (6.2 miles)
			9.0	4.250	10 km (6.2 miles)
			9.0	8.500	10 km (6.2 miles)

Power Requirements and Environmental Conditions for 8 Gbps SFP+ Transceivers

The following table provides the optical parameters for 8 Gbps SFP+ transceivers:

Table 16. Optical Parameters for 8 Gbps SFP+ Transceivers

SFP+	Average Transmit Power (dBm)		Average Receive Power (dBm)		Fiber-Loss Budget (dB)			
	Min	Max	Min	Max	(62.5 microns [OM1])	(50.0 microns [OM2])	(50.0 microns [OM3])	
AJHM	-10 (2 Gbps)	-1.3	—	0	2.10 (2 Gbps)	2.08 (4 Gbps)	3.31 (2 Gbps)	
	-9 (4 Gbps)				1.78 (4 Gbps)	1.68 (8 Gbps)	2.88 (4 Gbps)	
	-8.2 (8 Gbps)				1.58 (8 Gbps)	1.63 (16 Gbps)	2.04 (8 Gbps)	
AJHN	-11.7 (2 Gbps)	-3 (2 Gbps)	—	-3 (2 Gbps)	—	-7.8 (2 Gbps)	—	—
	-8.4 (4 Gbps)	-1 (4 Gbps)		-1 (4 Gbps)	7.8 (4 Gbps)			
	-8.4 (8 Gbps)	0.5 (8 Gbps)		0.5 (8 Gbps)	6.4 (8 Gbps)			

The following table provides information on operating and storage temperature ranges:

Table 17. Operating and Storage Temperature Ranges for 8 Gbps SFP+ Transceivers

SFP+	Operating		Storage	
	Min	Max	Min	Max
AJHM	0°C	40°C	-40°C	85°C
AJHN	0°C	40°C	-40°C	85°C

Appendix A. Cable and Port Specifications

CAUTION:

We strongly recommend that power cable runs and other potential noise sources be located as far away as practical from network cabling that terminates at Cisco equipment. In situations where long parallel cable runs exist, but cannot be separated by at least 3.3 ft. (1 m), we recommend that you shield these potential noise sources. To avoid interference, the source should be shielded by housing it in a grounded metallic conduit.

Cables and Adapters

The IBM SAN48C-6 Switch accessory kit includes the following:

- RJ-45-to-RJ-45 rollover cable
- RJ-45-to-DB-9 female DTE adapter (labeled Terminal)
- RJ-45-to-DB-25 female DTE adapter (labeled Terminal)
- RJ-45-to-DB-25 male DCE adapter (labeled Modem)

Note: Additional cables and adapters can be ordered from your customer service representative.

Console Port

The console port is an asynchronous RS-232 serial port with an RJ-45 connector. You can use the RJ-45-to-RJ-45 rollover cable and the RJ-45-to-DB-9 female adapter or the RJ-45-to-DB-25 female DTE adapter (depending on your computer serial port) to connect the console port to a computer running terminal emulation software.

Console Port Pinouts

The following table lists the pinouts for the console port on the IBM SAN48C-6 switch:

Table 18. Console Port Pinouts

Pin	Signal
1 ¹	RTS
2	DTR
3	TxD
4	GND
5	GND
6	RxD
7	DSR
8	CTS

1. Pin 1 is connected internally to pin 8.

Connecting the Console Port to a Computer Using the DB-25 Adapter

You can use the RJ-45-to-RJ-45 rollover cable and the RJ-45-to-DB-25 female DTE adapter (labeled Terminal) to connect the console port to a computer running terminal emulation software. The following table lists the pinouts for the console port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-25 female DTE adapter:

Table 19. Port-Mode Signaling and Pinouts with DB-25 Adapter

Console Port	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Terminal Adapter	Console Device
	RJ-45 Pin	RJ-45 Pin	DB-25 Pin	Signal
RTS	1	8	5	CTS
DTR	2	7	6	DSR
TxD	3	6	3	RxD
GND	4	5	7	GND
GND	5	4	7	GND
RxD	6	3	2	TxD
DSR	7	2	20	DTR
CTS	8	1	4	RTS

Connecting the Console Port to a Computer Using the DB-9 Adapter

You can use the RJ-45-to-RJ-45 rollover cable and RJ-45-to-DB-9 female DTE adapter (labeled Terminal) to connect the console port to a computer running terminal emulation software. The following table lists the pinouts for the console port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-9 female DTE adapter:

Table 20. Port-Mode Signaling and Pinouts with DB-9 Adapter

Console Port	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-9 Terminal Adapter	Console Device
	RJ-45 Pin	RJ-45 Pin	DB-9 Pin	Signal
RTS	1	8	8	CTS
DTR	2	7	6	DSR
TxD	3	6	2	RxD
GND	4	5	5	GND
GND	5	4	5	GND
RxD	6	3	3	TxD
DSR	7	2	4	DTR
CTS	8	1	7	RTS

Out of Band Ethernet Management Port

Use a modular, RJ-45, straight-through UTP cable to connect the 10/100/1000 management Ethernet port to external hubs and switches.

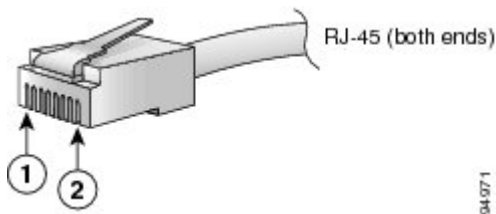


Figure 18. RJ-45 Interface Cable Connector

1. Pin 1	2. Pin 8
----------	----------

The following table lists the connector pinouts and signal names for a 10/100/1000BASE-T management port (MDI) cable.

Table 21. 10/100/1000 BASE-T Management Port Cable Pinout

Pin	Signal
1	BI DA+
2	BI DA-
3	BI DB+
4	BI DC+
5	BI DC-
6	BI DB-
7	BI DD+
8	BI DD-

The following figure shows a schematic representation of the 10/100/1000 BASE-T cable:

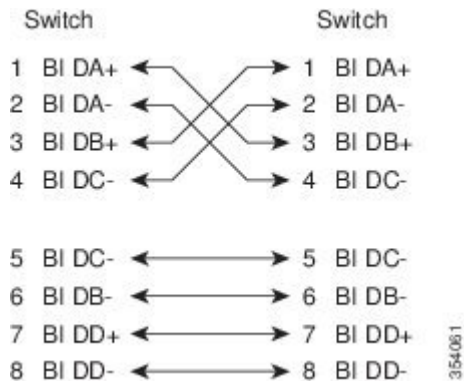


Figure 19. Twisted-Pair 10/100/1000 BASE-T Cable

The following table lists the connector pinouts and signal names for a 10/100 BASE-T management port (MDI) cable:

Table 22. 10/100 BASE-T Management Port Cable Pinout

Pin	Signal
1	TD+
2	TD-
3	RD+
4	RD-
5	Not used
6	Not used
7	Not used
8	Not used

The following figure shows a schematic of the 10/100 BASE-T cable:

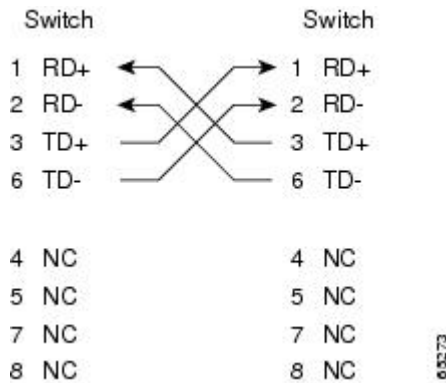


Figure 20. Twisted-Pair 10/100 BASE-T Cable Schematic

Supported Power Cords and Plugs

Each switch power supply unit requires one power cord. Cisco approved cords may be ordered with the product. There are two types: standard power cords with a country specific plug for use with wall outlets and jumper power cords for use with cabinet outlets. The user may also source their own power cords for the product, as long as they meet the power cord specifications for this product.

Note: Only the standard power cords or jumper power cords ordered from Cisco are supported.

CAUTION:

If you do not order a power cord with the system, you are responsible for selecting the appropriate power cord for the product. Using a noncompatible power cord with this product may result in electrical safety hazard. Orders delivered to Argentina, Brazil, and Japan must have the appropriate power cord ordered with the system.

Standard Power Cords

Standard power cords for the IBM SAN48C-6 switch have an IEC C15 connector on the outlet end of the cord and a country specific plug on the inlet end of the cord. To see the list of supported standard power cords, see the IBM SAN48C-6 32 Gbps 48-Port Fibre Channel Switch Data Sheet.

Jumper Power Cord

Jumper power cords have an IEC C15 connector on the outlet end of the cord and an IEC C14 connector on the inlet end of the cord. This cord is compatible with IEC C13 outlet receptacles. This type of outlet receptacle is commonly used for power distribution inside cabinets.

To see the list of supported jumper power cords, see the IBM SAN48C-6 32 Gbps 48-Port Fibre Channel Switch Data Sheet.

Fibre Cable Specifications

For information on the fibre cable specifications, see the Cisco MDS 9000 Family Pluggable Transceivers Data Sheet.

Appendix B. Site Planning and Maintenance Records

This section includes a site planning checklist and maintenance records to use when installing the IBM SAN48C-6 Switch.

For information about how to query the switch for configuration information, see the *NX-OS Fundamentals Configuration Guide*.

Site Preparation Checklist

Planning the location and layout of your equipment rack or wiring closet is essential for successful switch operation, ventilation, and accessibility. The following table lists the site planning tasks we recommend that you complete before installing the IBM SAN48C-6 Switch.

Consider heat dissipation when sizing the air-conditioning requirements for an installation.

Table 23. Site Planning Checklist

Task No.	Planning Activity	Verified By	Time	Date
1	Space evaluation: <ul style="list-style-type: none">• Space and layout• Floor covering• Impact and vibration• Lighting• Maintenance access			
2	Environmental evaluation: <ul style="list-style-type: none">• Ambient temperature• Humidity• Altitude• Atmospheric contamination• Air flow			
3	Power Evaluation: <ul style="list-style-type: none">• Input power type• Power receptacles¹• Receptacle proximity to the equipment• Dedicated circuit for power supply• Dedicated (separate) circuits for redundant power supplies• UPS² for power failures			
4	Grounding evaluation: <ul style="list-style-type: none">• Circuit breaker size• CO ground (AC- powered systems)			

Table 23. Site Planning Checklist (continued)

Task No.	Planning Activity	Verified By	Time	Date
5	Cable and interface equipment evaluation: <ul style="list-style-type: none"> • Cable type • Connector type • Cable distance limitations • Interface equipment (transceivers) 			
6	Electromagnetic interference (EMI) evaluation: <ul style="list-style-type: none"> • Distance limitations for signaling • Site wiring • RFI³ levels 			

1. Verify that the power supply installed in the chassis has a dedicated AC source circuit.

2. UPS = uninterruptible power supply.

3. RFI = radio frequency interference.

Contact and Site Information

Use the following worksheet to record contact and site information:

Table 24. Contact and Site Information

Contact person	
Contact phone	
Contact E-Mail	
Building/site name	
Data center location	
Floor location	
Address (line 1)	
Address (line 2)	
City	
State	
Zip code	
Country	

Chassis and Network Information

Use the following worksheet to record chassis and network information:

Contract Number :

Chassis Serial Number:

Product Number:

Switch IP address	
Switch IP netmask	
Host name	
Domain name	
IP broadcast address	
Gateway/router address	
DNS address	
Modem telephone number	

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Federal Communications Commission Statement

This explains the Federal Communications Commission's (FCC's) statement.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, might cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors, or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device might not cause harmful interference, and (2) this device must accept any interference received, including interference that might cause undesired operation.

Industry Canada Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Australia and New Zealand Class A Statement

Attention: This is a Class A product. In a domestic environment this product might cause radio interference in which case the user might be required to take adequate measures.

European Union Electromagnetic Compatibility Directive

This product is in conformity with the protection requirements of European Union (EU) Council Directive 2014/30/EU on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the fitting of non-IBM option cards.

Attention: This is an EN 55022 Class A product. In a domestic environment this product might cause radio interference in which case the user might be required to take adequate measures.

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Germany Electromagnetic Compatibility Directive

Deutschsprachiger EU Hinweis: Hinweis für Geräte der Klasse A EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2014/30/EU zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022 / EN 55032 Klasse A ein. Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der IBM empfohlene Kabel angeschlossen werden. IBM übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung von IBM verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung von IBM gesteckt/eingebaut werden.

EN 55022 / EN 55032 Klasse A Geräte müssen mit folgendem Warnhinweis versehen werden:
"Warnung: Dieses ist eine Einrichtung der Klasse A. Diese Einrichtung kann im Wohnbereich Funk-Störungen verursachen; in diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen zu ergreifen und dafür aufzukommen."

Deutschland: Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Geräten Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG)." Dies ist die Umsetzung der EU-Richtlinie 2014/30/EU in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC Richtlinie 2014/30/EU) für Geräte der Klasse A Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen.

Verantwortlich für die Einhaltung der EMV-Vorschriften ist der Hersteller:

International Business Machines Corp.
New Orchard Road
Armonk, New York 10504
Tel: 914-499-1900

Der verantwortliche Ansprechpartner des Herstellers in der EU ist:

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Generelle Informationen:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 / EN 55032 Klasse A.

Deutschsprachiger EU Hinweis: Hinweis für Geräte der Klasse B EU-Richtlinie zur Elektromagnetischen Verträglichkeit

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2014/30/EU zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022/ EN 55032 Klasse B ein. Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der IBM empfohlene Kabel angeschlossen werden. IBM übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung von IBM verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung von IBM gesteckt/eingebaut werden.

Deutschland: Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Geräten

Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG)". Dies ist die Umsetzung der EU-Richtlinie 2014/30/EU in der Bundesrepublik Deutschland.

Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC Richtlinie 2014/30/EU) für Geräte der Klasse B

Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen.

Verantwortlich für die Einhaltung der EMV-Vorschriften ist der Hersteller:

International Business Machines Corp.
New Orchard Road
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Der verantwortliche Ansprechpartner des Herstellers in der EU ist:

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e-mail: halloibm@de.ibm.com

Generelle Informationen:

Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022/ EN 55032 Klasse B.

People's Republic of China Class A Statement

中华人民共和国“A类”警告声明

声明

此为A级产品，在生活环境中，该产品可能会造成无线电干扰。在这种情况下，可能需要用户对其干扰采取切实可行的措施。

Taiwan Class A Statement

警告使用者：
這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。^(Taiwan)

Taiwan Contact Information

This topic contains the product service contact information for Taiwan.

IBM Taiwan Product Service Contact Information:
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3F, No 7, Song Ren Rd., Taipei Taiwan
Tel: 0800-016-888

台灣IBM 產品服務聯絡方式：
台灣國際商業機器股份有限公司
台北市松仁路7號3樓
電話：0800-016-888

f2c00790

Japan Voluntary Control Council for Interference Class A Statement

This explains the Japan Voluntary Control Council for Interference (VCCI) statement.

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。

VCCI-A

Japan Electronics and Information Technology Industries Association Statement

This statement explains the Japan JIS C 61000-3-2 product wattage compliance.

(一社) 電子情報技術産業協会 高調波電流抑制対策実施
要領に基づく定格入力電力値： Knowledge Centerの各製品の
仕様ページ参照

This statement explains the Japan Electronics and Information Technology Industries Association (JEITA) statement for products less than or equal to 20 A per phase.

高調波電流規格 JIS C 61000-3-2 適合品

This statement explains the JEITA statement for products greater than 20 A, single phase.

高調波電流規格 JIS C 61000-3-2 準用品

本装置は、「高圧又は特別高圧で受電する需要家の高調波抑制対策ガイドライン」対象機器（高調波発生機器）です。

- 回路分類：6（単相、PFC回路付）
- 換算係数：0

This statement explains the JEITA statement for products greater than 20 A per phase, three-phase.

高調波電流規格 JIS C 61000-3-2 準用品

本装置は、「高圧又は特別高圧で受電する需要家の高調波抑制対策ガイドライン」対象機器（高調波発生機器）です。

- 回路分類：5（3相、PFC回路付）
- 換算係数：0

Korean Communications Commission Class A Statement

This explains the Korean Communications Commission (KCC) statement.

이 기기는 업무용(A급)으로 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

Russia Electromagnetic Interference Class A Statement

This statement explains the Russia Electromagnetic Interference (EMI) statement.

ВНИМАНИЕ! Настоящее изделие относится к классу А.
В жилых помещениях оно может создавать
радиопомехи, для снижения которых необходимы
дополнительные меры

rusemi

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