

Power Systems

*SAS RAID controllers for IBM i*

**IBM**



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**Note**

Before using this information and the product it supports, read the information in “Safety notices” on page v, “Notices” on page 57, the *IBM Systems Safety Notices* manual, G229-9054, and the *IBM Environmental Notices and User Guide*, Z125-5823.

This edition applies to IBM Power Systems™ servers that contain the POWER8® processor and to all associated models.

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## Safety notices

Safety notices may be printed throughout this guide:

- **DANGER** notices call attention to a situation that is potentially lethal or extremely hazardous to people.
- **CAUTION** notices call attention to a situation that is potentially hazardous to people because of some existing condition.
- **Attention** notices call attention to the possibility of damage to a program, device, system, or data.

### World Trade safety information

Several countries require the safety information contained in product publications to be presented in their national languages. If this requirement applies to your country, safety information documentation is included in the publications package (such as in printed documentation, on DVD, or as part of the product) shipped with the product. The documentation contains the safety information in your national language with references to the U.S. English source. Before using a U.S. English publication to install, operate, or service this product, you must first become familiar with the related safety information documentation. You should also refer to the safety information documentation any time you do not clearly understand any safety information in the U.S. English publications.

Replacement or additional copies of safety information documentation can be obtained by calling the IBM Hotline at 1-800-300-8751.

### German safety information

Das Produkt ist nicht für den Einsatz an Bildschirmarbeitsplätzen im Sinne § 2 der Bildschirmarbeitsverordnung geeignet.

### Laser safety information

IBM® servers can use I/O cards or features that are fiber-optic based and that utilize lasers or LEDs.

#### Laser compliance

IBM servers may be installed inside or outside of an IT equipment rack.

**DANGER:** When working on or around the system, observe the following precautions:

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

- If IBM supplied the power cord(s), 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.
  - For AC power, disconnect all power cords from their AC power source.
  - For racks with a DC power distribution panel (PDP), disconnect the customer's DC power source to the PDP.
- When connecting power to the product ensure all power cables are properly connected.

- For racks with AC power, 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.
- For racks with a DC power distribution panel (PDP), connect the customer's DC power source to the PDP. Ensure that the proper polarity is used when attaching the DC power and DC power return wiring.
- 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.
- Do not attempt to switch on power to the machine until all possible unsafe conditions are corrected.
- Assume that an electrical safety hazard is present. Perform all continuity, grounding, and power checks specified during the subsystem installation procedures to ensure that the machine meets safety requirements.
- Do not continue with the inspection if any unsafe conditions are present.
- Before you open the device covers, unless instructed otherwise in the installation and configuration procedures: Disconnect the attached AC power cords, turn off the applicable circuit breakers located in the rack power distribution panel (PDP), and disconnect any telecommunications systems, networks, and modems.

**DANGER:**

- Connect and disconnect cables as described in the following procedures when installing, moving, or opening covers on this product or attached devices.

To Disconnect:

1. Turn off everything (unless instructed otherwise).
2. For AC power, remove the power cords from the outlets.
3. For racks with a DC power distribution panel (PDP), turn off the circuit breakers located in the PDP and remove the power from the Customer's DC power source.
4. Remove the signal cables from the connectors.
5. 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. For AC power, attach the power cords to the outlets.
5. For racks with a DC power distribution panel (PDP), restore the power from the Customer's DC power source and turn on the circuit breakers located in the PDP.
6. Turn on the devices.

Sharp edges, corners and joints may be present in and around the system. Use care when handling equipment to avoid cuts, scrapes and pinching. (D005)

**(R001 part 1 of 2):**

**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. In addition, do not lean on rack mounted devices and do not use them to stabilize your body position (for example, when working from a ladder).





- Each rack cabinet might have more than one power cord.
  - For AC powered racks, be sure to disconnect all power cords in the rack cabinet when directed to disconnect power during servicing.
  - For racks with a DC power distribution panel (PDP), turn off the circuit breaker that controls the power to the system unit(s), or disconnect the customer's DC power source, 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 2 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.

**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 observe the following precautions:
  - Remove all devices in the 32U position (compliance ID RACK-001 or 22U (compliance ID RR001) and above.
  - Ensure that the heaviest devices are installed in the bottom of the rack cabinet.
  - Ensure that there are little-to-no empty U-levels between devices installed in the rack cabinet below the 32U (compliance ID RACK-001 or 22U (compliance ID RR001) level, unless the received configuration specifically allowed it.
- If the rack cabinet you are relocating is part of a suite of rack cabinets, detach the rack cabinet from the suite.
- If the rack cabinet you are relocating was supplied with removable outriggers they must be reinstalled before the cabinet is relocated.
- Inspect the route that you plan to take 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 comes with your rack cabinet for the weight of a loaded rack cabinet.
- Verify that all door openings are at least 760 x 230 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.
- When the rack cabinet is in the new location, complete the following steps:
  - 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)

(L001)



**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)

(L002)



**DANGER:** Rack-mounted devices are not to be used as shelves or work spaces. (L002)

(L003)



or



or



or



or



**DANGER:** Multiple power cords. The product might be equipped with multiple AC power cords or multiple DC power cables. To remove all hazardous voltages, disconnect all power cords and power cables. (L003)

(L007)



**CAUTION:** A hot surface nearby. (L007)

(L008)



**CAUTION:** Hazardous moving parts nearby. (L008)

All lasers are certified in the U.S. to conform to the requirements of DHHS 21 CFR Subchapter J for class 1 laser products. Outside the U.S., they are certified to be in compliance with IEC 60825 as a class 1 laser product. Consult the label on each part for laser certification numbers and approval information.

**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:**

Data processing environments can contain equipment transmitting on system links with laser modules that operate at greater than Class 1 power levels. For this reason, never look into the end of an optical fiber cable or open receptacle. Although shining light into one end and looking into the other end of a disconnected optical fiber to verify the continuity of optic fibers many not injure the eye, this procedure is potentially dangerous. Therefore, verifying the continuity of optical fibers by shining light into one end and looking at the other end is not recommended. To verify continuity of a fiber optic cable, use an optical light source and power meter. (C027)

**CAUTION:**

**This product contains a Class 1M laser. Do not view directly with optical instruments. (C028)**

**CAUTION:**

**Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following information: laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam. (C030)**

**CAUTION:**

**The battery contains lithium. To avoid possible explosion, do not burn or charge the battery.**

*Do Not:*

- **Throw or immerse into water**
- **Heat to more than 100°C (212°F)**
- **Repair or disassemble**

**Exchange only with the IBM-approved part. Recycle or discard the battery as instructed by local regulations. In the United States, IBM has a process for the collection of this battery. For information, call 1-800-426-4333. Have the IBM part number for the battery unit available when you call. (C003)**

## CAUTION:

Regarding IBM provided VENDOR LIFT TOOL:

- Operation of LIFT TOOL by authorized personnel only.
- LIFT TOOL intended for use to assist, lift, install, remove units (load) up into rack elevations. It is not to be used loaded transporting over major ramps nor as a replacement for such designated tools like pallet jacks, walkies, fork trucks and such related relocation practices. When this is not practicable, specially trained persons or services must be used (for instance, riggers or movers).
- Read and completely understand the contents of LIFT TOOL operator's manual before using. Failure to read, understand, obey safety rules, and follow instructions may result in property damage and/or personal injury. If there are questions, contact the vendor's service and support. Local paper manual must remain with machine in provided storage sleeve area. Latest revision manual available on vendor's web site.
- Test verify stabilizer brake function before each use. Do not over-force moving or rolling the LIFT TOOL with stabilizer brake engaged.
- Do not move LIFT TOOL while platform is raised, except for minor positioning.
- Do not exceed rated load capacity. See LOAD CAPACITY CHART regarding maximum loads at center versus edge of extended platform.
- Only raise load if properly centered on platform. Do not place more than 200 lb (91 kg) on edge of sliding platform shelf also considering the load's center of mass/gravity (CoG).
- Do not corner load the platform tilt riser accessory option. Secure platform riser tilt option to main shelf in all four (4x) locations with provided hardware only, prior to use. Load objects are designed to slide on/off smooth platforms without appreciable force, so take care not to push or lean. Keep riser tilt option flat at all times except for final minor adjustment when needed.
- Do not stand under overhanging load.
- Do not use on uneven surface, incline or decline (major ramps).
- Do not stack loads.
- Do not operate while under the influence of drugs or alcohol.
- Do not support ladder against LIFT TOOL.
- Tipping hazard. Do not push or lean against load with raised platform.
- Do not use as a personnel lifting platform or step. No riders.
- Do not stand on any part of lift. Not a step.
- Do not climb on mast.
- Do not operate a damaged or malfunctioning LIFT TOOL machine.
- Crush and pinch point hazard below platform. Only lower load in areas clear of personnel and obstructions. Keep hands and feet clear during operation.
- No Forks. Never lift or move bare LIFT TOOL MACHINE with pallet truck, jack or fork lift.
- Mast extends higher than platform. Be aware of ceiling height, cable trays, sprinklers, lights, and other overhead objects.
- Do not leave LIFT TOOL machine unattended with an elevated load.
- Watch and keep hands, fingers, and clothing clear when equipment is in motion.
- Turn Winch with hand power only. If winch handle cannot be cranked easily with one hand, it is probably over-loaded. Do not continue to turn winch past top or bottom of platform travel. Excessive unwinding will detach handle and damage cable. Always hold handle when lowering, unwinding. Always assure self that winch is holding load before releasing winch handle.
- A winch accident could cause serious injury. Not for moving humans. Make certain clicking sound is heard as the equipment is being raised. Be sure winch is locked in position before releasing handle. Read instruction page before operating this winch. Never allow winch to unwind freely. Freewheeling will cause uneven cable wrapping around winch drum, damage cable, and may cause serious injury. (C048)

## **Power and cabling information for NEBS (Network Equipment-Building System) GR-1089-CORE**

The following comments apply to the IBM servers that have been designated as conforming to NEBS (Network Equipment-Building System) GR-1089-CORE:

The equipment is suitable for installation in the following:

- Network telecommunications facilities
- Locations where the NEC (National Electrical Code) applies

The intrabuilding ports of this equipment are suitable for connection to intrabuilding or unexposed wiring or cabling only. The intrabuilding ports of this equipment *must not* be metalically connected to the interfaces that connect to the OSP (outside plant) or its wiring. These interfaces are designed for use as intrabuilding interfaces only (Type 2 or Type 4 ports as described in GR-1089-CORE) and require isolation from the exposed OSP cabling. The addition of primary protectors is not sufficient protection to connect these interfaces metalically to OSP wiring.

**Note:** All Ethernet cables must be shielded and grounded at both ends.

The ac-powered system does not require the use of an external surge protection device (SPD).

The dc-powered system employs an isolated DC return (DC-I) design. The DC battery return terminal *shall not* be connected to the chassis or frame ground.

The dc-powered system is intended to be installed in a common bonding network (CBN) as described in GR-1089-CORE.





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## SAS RAID controllers for IBM i

This topic provides usage and maintenance information regarding the SAS RAID controllers for IBM i.

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### SAS RAID controllers for IBM i

Find usage and maintenance information regarding controllers for the serial-attached SCSI (SAS) Redundant Array of Independent Disks (RAID) for IBM i. Use this information with your specific system unit and operating system documentation. General information is intended for all users of this product. Service information is intended for a service representative trained on the system unit and the subsystem being serviced.

The SAS RAID controllers for IBM i have the following features:

- PCI-X 266 system interface or PCI Express (PCIe) system interface.
- Physical link speed of 3 Gbps SAS that supports transfer rates of 300 MB per second on PCI-X and PCIe adapters.
- Physical link speed of 6 Gbps SAS supporting transfer rates of 600 MB per second on PCIe2 and PCIe3 adapters.
- Support for SAS devices and nondisk Serial Advanced Technology Attachment (SATA) devices.
- Optimized for SAS disk configurations that use dual paths through dual expanders for redundancy and reliability.
- Controller managed path redundancy and path switching for SAS devices with multiple ports.
- Embedded PowerPC® Reduced Instruction Set Computer (RISC) processor, hardware XOR Direct Memory Access (DMA) engine, and hardware finite field multiplier (FFM) DMA engine for RAID 6.
- Support nonvolatile write cache for RAID disk arrays on some adapters (PCIe2 and PCIe3 adapters feature Flash-Backed-DRAM which eliminates the need for rechargeable batteries).
- Support for RAID 5, RAID 6, and RAID 10 disk arrays and system mirroring.
- Support for attachment of other devices such as non-RAID disks, tape, and optical devices.
- RAID disk arrays and non-RAID devices supported as a bootable device.
- Advanced RAID features:
  - Hot spares for RAID 5, 6, and 10 disk arrays and system mirroring.
  - Ability to increase the capacity of an existing RAID 5 or 6 disk array by adding disks.

**Note:** This feature is not suggested for PCIe2 and higher adapters due to performance considerations.

- Background parity checking.
- Background data scrubbing.
- Disks formatted to 528 or 4224 bytes per sector, providing cyclical redundancy checking (CRC) and logically bad-block checking on PCI-X and PCIe controllers.
- Disks formatted to 528 or 4224 bytes per sector, providing SCSI T10 standardized data integrity fields along with logically bad block checking on PCIe2 and PCIe3 controllers.
- Optimized hardware for RAID 5 and 6 sequential write workloads.
- Optimized skip read-and-write disk support for transaction workloads.
- Supports a maximum of 64 advanced function disks with a maximum of 255 devices on PCI-X and PCIe controllers.
- Supports a maximum of 240 advanced function disks with a maximum of 1023 devices on PCIe2 and PCIe3 controllers.

## Feature comparison of SAS RAID cards

Compare the main features of PCIe3, PCIe2, PCI Express (PCIe), and PCI-X SAS RAID cards for IBM i.

The tables in this section provide a breakdown of the main features of the SAS RAID PCIe3, PCIe2, PCIe, and PCI-X controller cards.

### PCI-X SAS RAID card comparison

Use the table in this topic to compare the features of the various PCI-X SAS RAID cards for IBM i. There are also images of adapters for you to view.

Table 1. PCI-X SAS RAID controller card comparison.

Features	2BD9	2BE1	572A	572C	572F and 575C	57B8
Description	PCI-X266 Planar 3 Gb SAS RAID adapter (RAID/cache storage controller)	PCI-X266 Planar 3 Gb SAS RAID adapter (RAID/cache enablement)	PCI-X 266 Ext Dual-x4 3 Gb SAS adapter	PCI-X 266 planar 3 Gb SAS adapter	PCI-X 266 Ext Tri-x4 3 Gb SAS RAID adapter	PCI-X 266 planar 3 Gb SAS RAID adapter
Form factor	Planar unique 64-bit PCI-X	Planar RAID enablement	Low profile 64 bit PCI-X	Planar integrated	Long 64 bit PCI-X, double-wide card set	Planar RAID enablement
Physical links	6 (two 2x wide ports to shared SAS drives and one 2x wide port to 2BD9 adapter)	8 (two 2x wide ports to shared SAS Drives, one 2x wide port to 2BD9 adapter, one physical link to DVD drive, and optionally one physical link to tape drive)	8 (two mini SAS 4x connectors)	8 <sup>1</sup>	12 (bottom 3 mini SAS 4x connectors) and 2 (top mini SAS 4x connector for high availability only)	8 <sup>1</sup>
RAID levels supported	RAID 5, 6, system mirroring	RAID 5, 6, system mirroring	RAID 5 <sup>3</sup> , RAID 6 <sup>3</sup> , system mirroring	System mirroring	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring
Write cache size	175 MB	175 MB			Up to 1.5 Gb (compressed)	175 MB
Read cache size					Up to 1.6 Gb (compressed)	
Cache battery pack technology	LiIon	LiIon			Lithium ion	Not applicable <sup>2</sup>
Cache battery concurrent maintenance	No	No	No	No	Yes <sup>4</sup>	Not applicable <sup>2</sup>
Cache data present LED	Yes	Yes	No	No	No	No
Removable cache card	No	No	No	No	No	No
Auxiliary write cache (AWC) support	No	No	No	No	Yes	Yes
Dual storage IOA configuration	Yes	Yes	No	No	Yes	No
Requires dual storage IOA configuration	Yes	Yes	No	No	No	No

1. Some systems provide an external mini SAS 4x connector from the integrated backplane controller.
2. The controller contains battery-backed cache, but the battery power is supplied by the 57B7 controller through the backplane connections.
3. The write performance of RAID 5 and RAID 6 might be poor on adapters that do not provide write cache. Consider using an adapter that provides write cache when using RAID 5 or RAID 6, or use solid-state drives (SSDs) where they are supported to improve write performance.
4. The cache battery pack for both adapters is contained in a single battery field-replaceable unit (FRU), which is physically located on the 575C Auxiliary Cache card.

### Adapter graphics

View the SAS RAID controllers.

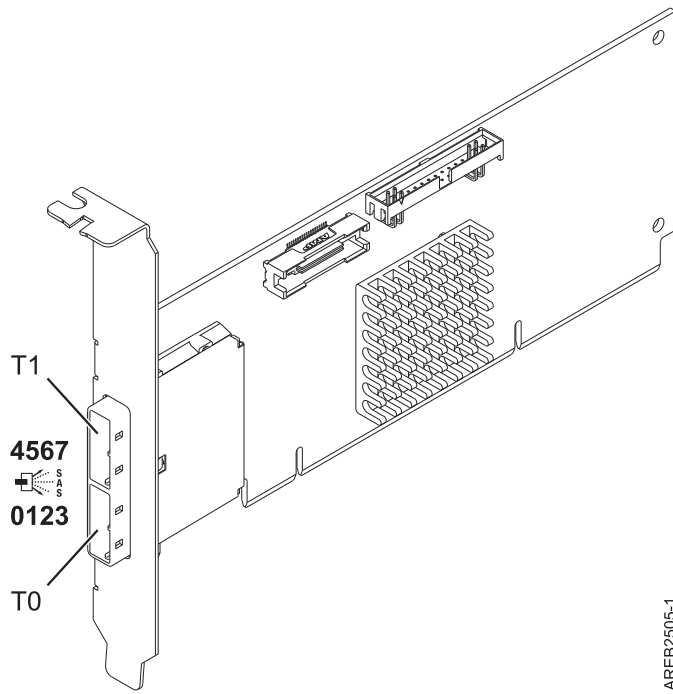


Figure 1. CCIN 572A PCI-X266 External Dual-x4 3 Gb SAS adapter

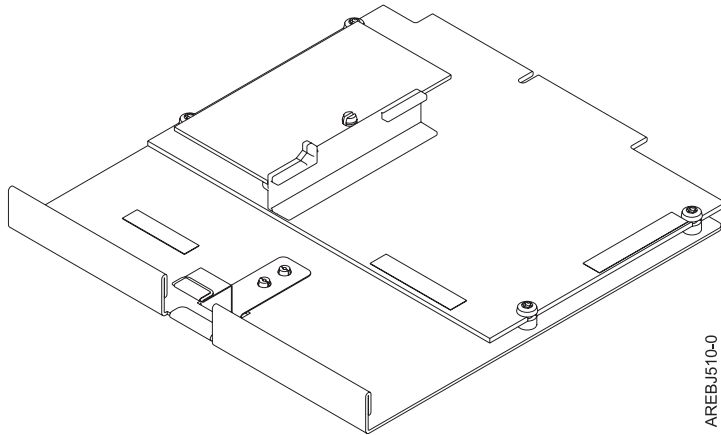


Figure 2. CCIN 57B8 planar RAID enablement card

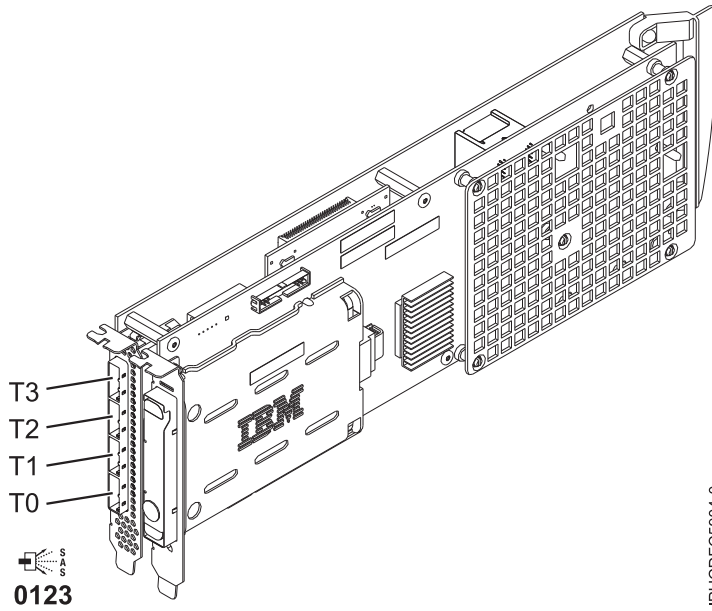


Figure 3. CCIN 572F PCI-X266 Ext Tri-x4 3 Gb SAS RAID adapter and CCIN 575C PCI-X266 auxiliary cache adapter

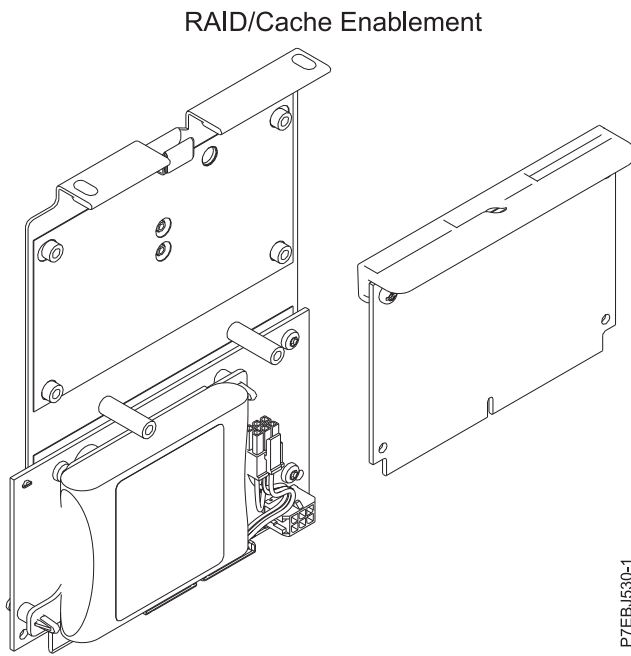


Figure 4. CCIN 2BE1 PCI-X266 Planar 3 Gb SAS adapter

## Planar RAID/Cache Storage Controller

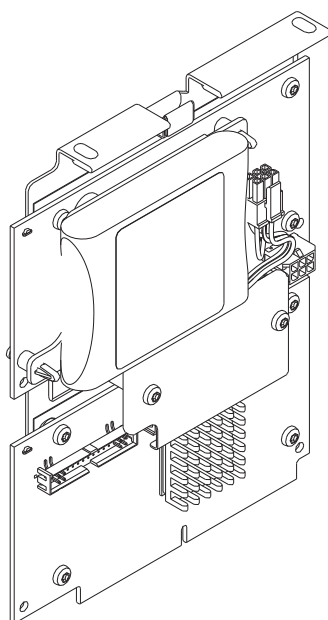


Figure 5. CCIN 2BD9 PCI-X266 Planar 3 Gb SAS RAID adapter

### Related concepts:


“Dual storage IOA configurations” on page 25

You can increase availability using a dual storage I/O adapter (IOA) configuration to connect multiple controllers to a common set of disk expansion drawers and the included disks and disk arrays.

“Dual storage IOA functions” on page 27

Consider these factors when using dual storage I/O adapter (IOA) functions.

### Related information:

 SAS subsystem

## PCIe SAS RAID card comparison

Use the tables in this topic to compare the features of the various PCI Express (PCIe) SAS RAID cards for IBM i. There are also images of adapters for you to view.

Table 2. PCIe SAS RAID controller card comparison.

Features	2B4C	574E	57B3	57B7
Description	PCIe x4 Internal 3 Gb SAS RAID adapter	PCIe x8 Ext Dual-x4 3 Gb SAS RAID adapter	PCIe x8 Ext Dual-x4 3 Gb SAS adapter	PCIe x1 Auxiliary Cache adapter
Form factor	Planar unique PCIe	PCIe x8	PCIe x8	Planar Auxiliary Cache
Physical links	6 (two 2x wide ports to shared SAS drives and one 2x wide port to 57CB)	8 (two mini SAS 4x connectors)	8 (two mini SAS 4x connectors)	2
RAID levels supported	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring	RAID 5 <sup>1</sup> , RAID 6 <sup>1</sup> , system mirroring	
Write cache size	175 MB	380 MB		175 MB
Read cache size				
Cache battery pack technology	Lithium ion	Lithium ion		Lithium ion
Cache battery concurrent maintenance	No	Yes	No	Yes
Cache data present LED	Yes	Yes	No	Yes
Removable cache card	No	Yes	No	No
Auxiliary write cache (AWC) support	No	No	No	Yes

Table 2. PCIe SAS RAID controller card comparison (continued).

Features	2B4C	574E	57B3	57B7
Dual storage IOA configuration	Yes	Yes	No	No
Requires dual storage IOA configuration	Yes	Yes	No	No
<sup>1</sup> The write performance of RAID 5 and RAID 6 might be poor on adapters that do not provide write cache. Consider using an adapter that provides write cache when using RAID 5 or RAID 6, or use solid-state drives (SSDs) where they are supported to improve write performance.				

Table 3. PCIe SAS RAID controller card comparison.

Features	57C7	57CB	57CD	57CF
Description	PCI Express x8 Planar 3 Gb SAS adapter (disk/media backplane)	PCIe x4 Planar 3 Gb SAS RAID adapter	PCIe SAS RAID and SSD adapter 3 Gb x8	PCI Express x8 planar 3 Gb SAS RAID adapter (with 175 MB Cache RAID - Dual IOA Enablement card)
Form factor	Planar	Planar cache enablement	Double-wide PCIe x8 with 1 to 4 integrated SSDs	Planar and Enablement card
Physical links	8	8 (two 2x wide ports to shared SAS drives and one 2x wide port to 2B4F, one physical link to DVD, and optionally one physical link to tape drive)	4 (one direct SAS physical link to each integrated SSD)	8
RAID levels supported	RAID 5 <sup>1</sup> , RAID 6 <sup>1</sup> , system mirroring	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring
Write cache size		175 MB		175 MB
Read cache size				
Cache battery pack technology		Lithium ion		Lithium ion
Cache battery concurrent maintenance	No	No	No	Yes
Cache data present LED	No	Yes	No	Yes
Removable cache card	No	No	No	No
Auxiliary write cache (AWC) support	No	No	No	No
Dual storage IOA configuration	No	Yes	No	Yes
Requires dual storage IOA configuration	No	Yes	No	Yes
520-byte virtual disk support	No	No	No	No
<sup>1</sup> The write performance of RAID 5 and RAID 6 might be poor on adapters that do not provide write cache. Consider using an adapter that provides write cache when using RAID 5 or RAID 6, or use solid-state drives (SSDs) where they are supported to improve write performance.				

## Adapter graphics

View the SAS RAID controllers.

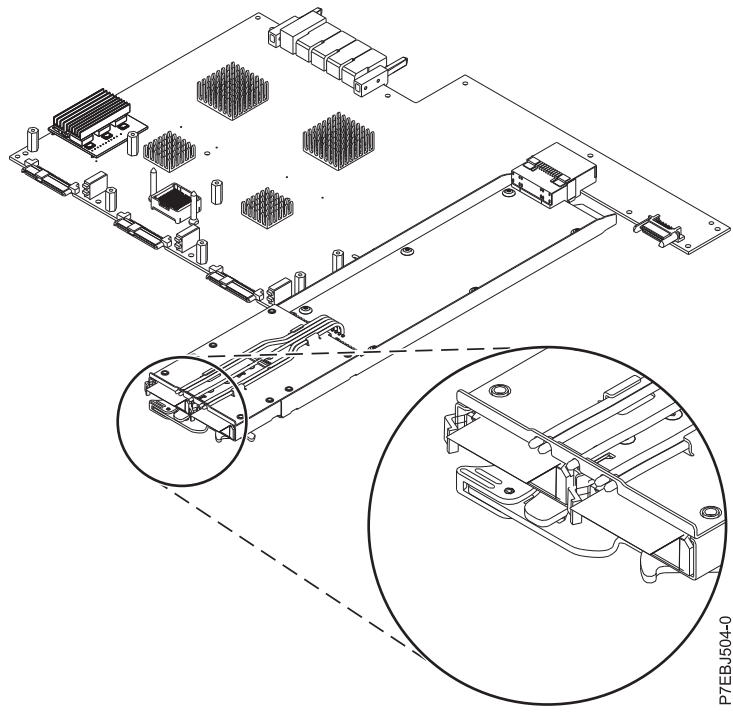


Figure 6. CCIN 57CF PCI Express x8 Planar 3 Gb SAS RAID adapter (with 175 MB Cache RAID - Dual IOA Enablement card)

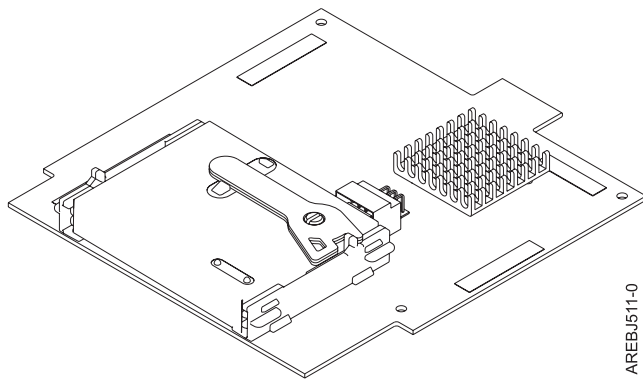


Figure 7. CCIN 57B7 Planar Auxiliary Cache

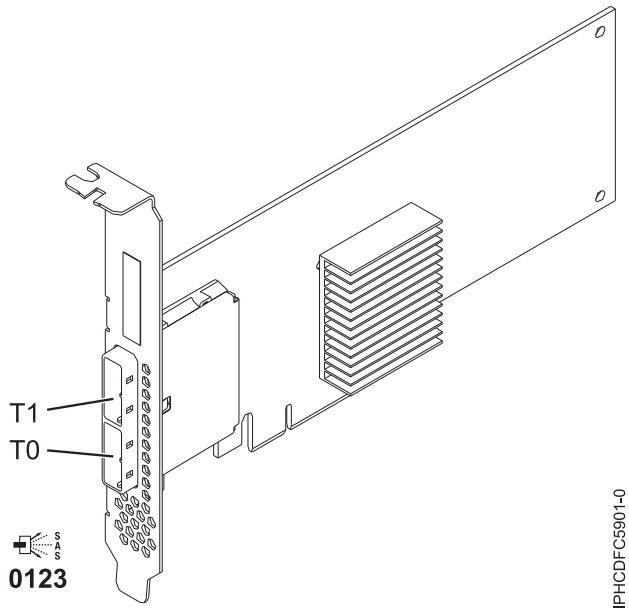


Figure 8. CCIN 57B3 PCIe x8 Ext Dual-x4 3 Gb SAS adapter

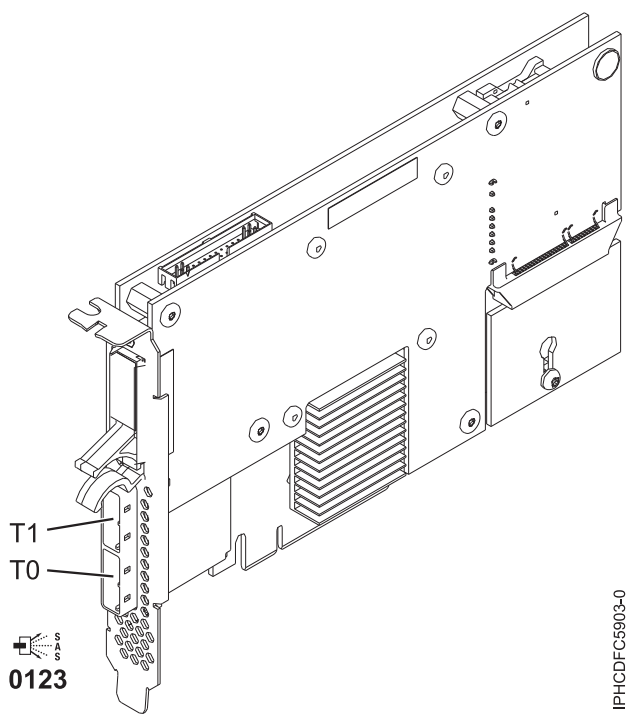


Figure 9. CCIN 574E PCIe x8 Ext Dual-x4 3 Gb SAS RAID adapter



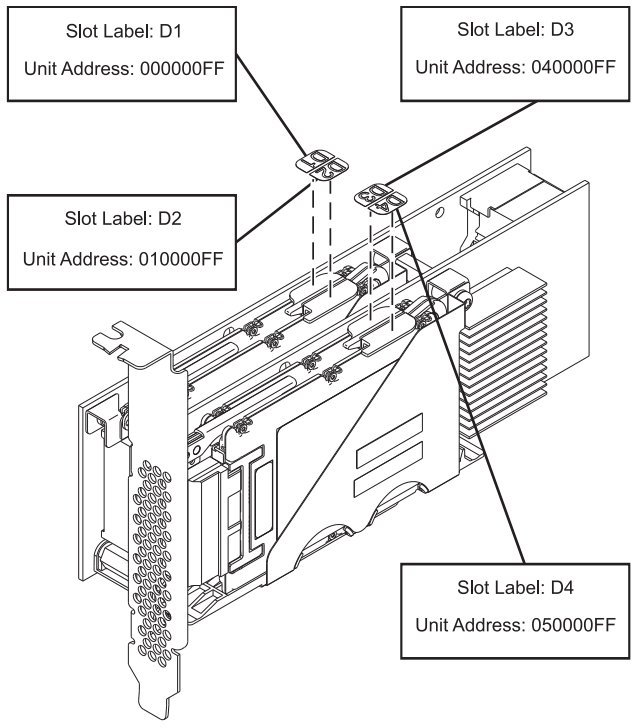


Figure 10. CCIN 57CD PCIe SAS RAID and SSD adapter 3 Gb x8

#### Planar RAID/Cache Storage Controller

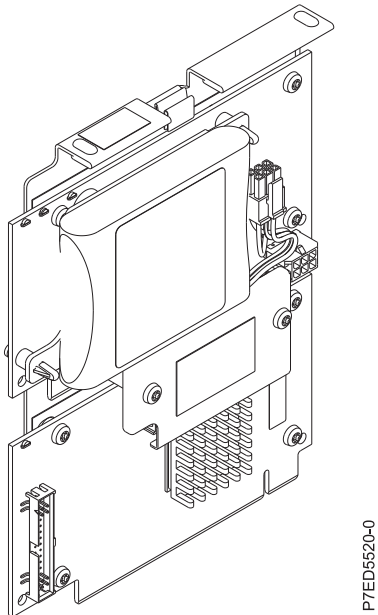


Figure 11. CCIN 2B4C PCIe x4 Planar 3Gb SAS RAID adapter

#### Related concepts:

“Dual storage IOA configurations” on page 25

You can increase availability using a dual storage I/O adapter (IOA) configuration to connect multiple controllers to a common set of disk expansion drawers and the included disks and disk arrays.

“Dual storage IOA functions” on page 27

Consider these factors when using dual storage I/O adapter (IOA) functions.

## PCIe2 SAS RAID card comparison

Use this table to compare the features of the various PCI Express 2.0 (PCIe2) SAS RAID cards for IBM i.

Table 4. PCIe2 SAS RAID controller cards.

CCIN (custom card identification number)	57B5 <sup>1</sup>	57BB	57C3	57C4 <sup>2</sup>
Description	PCIe2 1.8 GB Cache RAID SAS adapter Tri-port 6 Gb	PCIe2 1.8 GB Cache RAID SAS adapter Tri-port 6 Gb	PCIe2 3.1 GB Cache RAID SAS enclosure 6 Gb x8	PCIe2 RAID SAS adapter Dual-port 6 Gb
Form factor	PCIe2 x8	PCIe2 x8	PCIe2 x8 Storage Enclosure	PCIe2 x8
Physical links	11 (three mini SAS HD 4x connectors with top connector containing only three physical links)	11 (three mini SAS HD 4x connectors with top connector containing only three physical links)	11 (internally integrated with two external mini SAS HD 4x connectors, each containing three physical links)	8 (two mini SAS HD 4x connectors)
Supported RAID levels	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring	RAID 5, RAID 6, system mirroring
Write cache size	1.8 GB	1.8 GB	3.1 GB	
Read cache size				
Cache battery pack technology	None (uses supercapacitor technology)	None (uses supercapacitor technology)	None (uses supercapacitor technology)	
Cache battery concurrent maintenance				
Cache data present LED				
Removable cache card				
Auxiliary write cache (AWC) support	No	No	No	No
Dual-storage IOA configuration	Yes	Yes	Yes	Yes
Requires dual storage IOA configuration	Yes	Yes	Yes	No
SAS tape support	No	No	No	No
SATA DVD support	No	No	No	No
Native 4K block device support	No	No	No	No
520-byte virtual disk support	Yes	Yes	Yes	Yes
<b>Notes:</b>				
1. Feature 5913 (CCIN 57B5) adapters installed in POWER6 <sup>®</sup> servers must be placed in I/O expansion units. Feature 5913 (CCIN 57B5) adapters are not supported in POWER6 system units. Feature 5913 (CCIN 57B5) is supported for the full set of SAS adapter functions on POWER6 servers, except for controlling boot drives or load source drives.				
2. Feature ESA1 or ESA2 (CCIN 57C4) only supports connecting to SSD devices.				

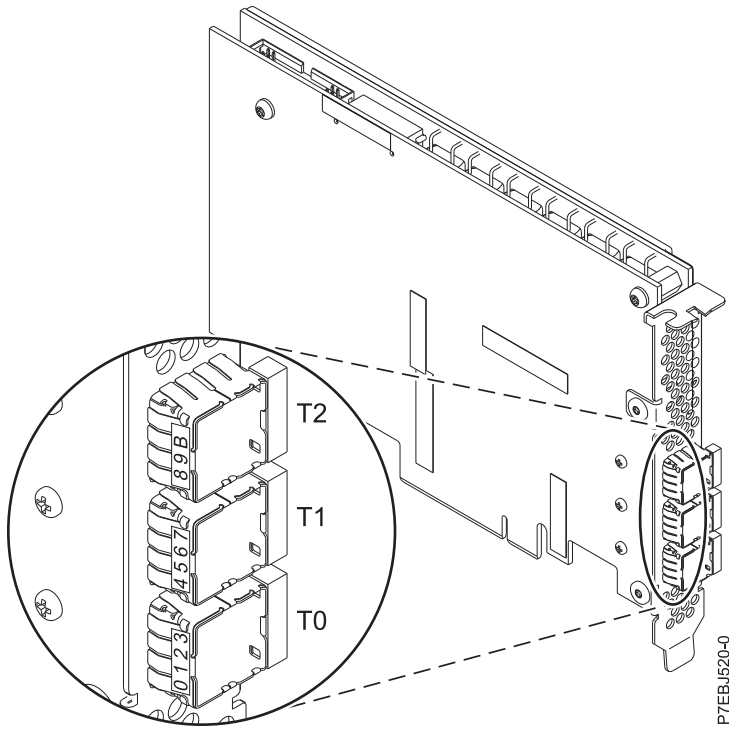


Figure 12. CCIN 57B5 PCIe2 1.8 GB cache RAID SAS adapter Tri-port 6 Gb

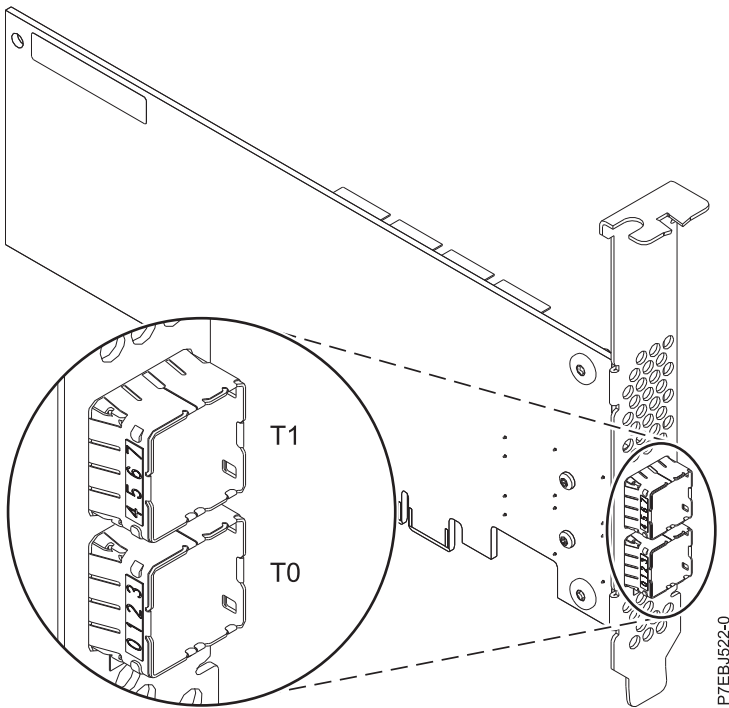


Figure 13. CCIN 57C4 PCIe2 RAID SAS Adapter Dual-port 6 Gb

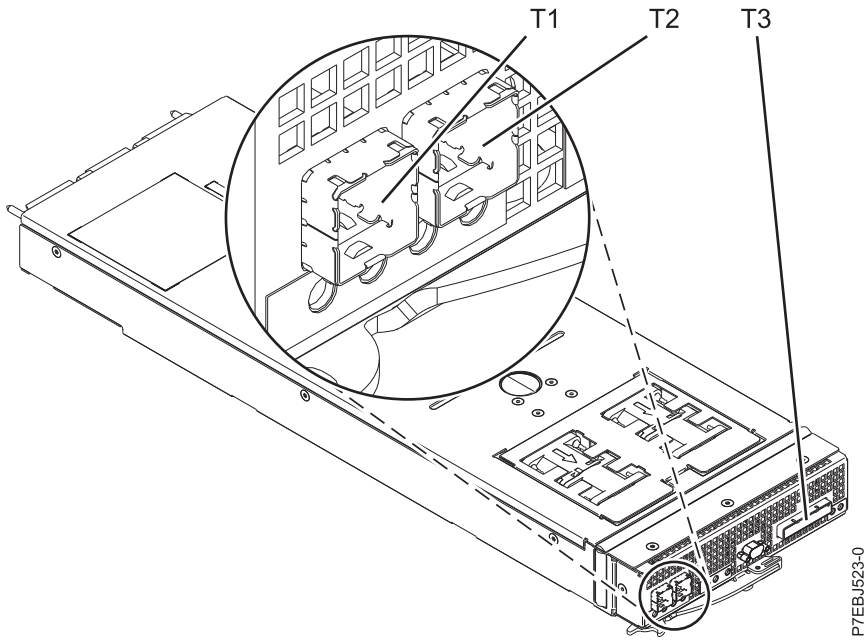


Figure 14. CCIN 57C3 PCIe2 3.1 GB Cache RAID SAS Enclosure 6 Gb x8

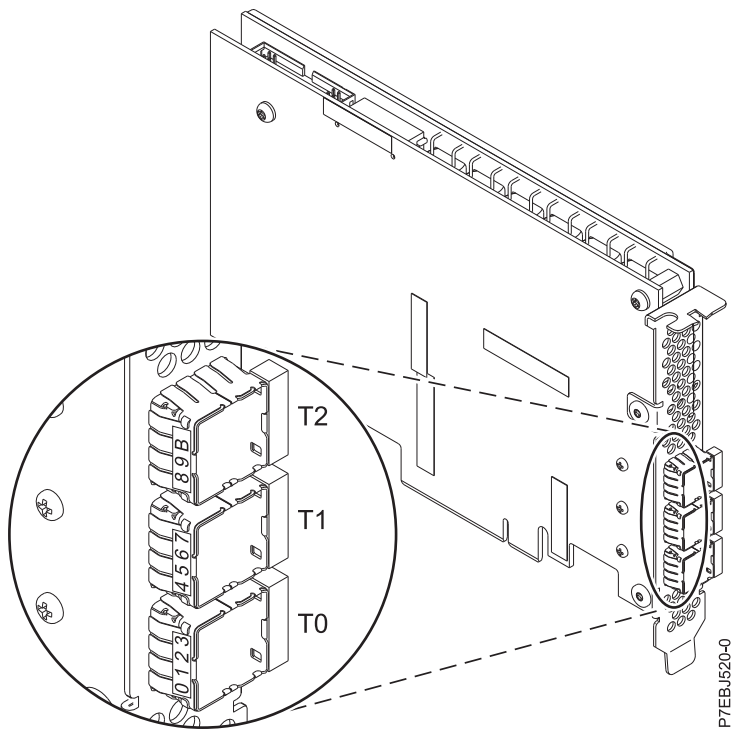


Figure 15. CCIN 57BB PCIe2 1.8 GB cache RAID SAS adapter Tri-port 6 Gb

**Related concepts:**

“Dual storage IOA configurations” on page 25

You can increase availability using a dual storage I/O adapter (IOA) configuration to connect multiple controllers to a common set of disk expansion drawers and the included disks and disk arrays.

“Dual storage IOA functions” on page 27

Consider these factors when using dual storage I/O adapter (IOA) functions.

## PCIe3 SAS RAID card comparison

This table compares the main features of PCI Express 3.0 (PCIe3) SAS RAID cards.

Table 5. PCIe3 SAS RAID controller cards.

CCIN (custom card identification number)	57B1	57B4	57CE	57D7	57D8
Description	PCIe3 12 GB Cache RAID+ SAS adapter Quad-port 6 Gb	PCIe3 RAID SAS adapter Quad-port 6 Gb x8	PCIe3 12 GB Cache RAID SAS adapter Quad-port 6 Gb x8	PCIe3 x8 SAS RAID internal adapter 6 Gb	PCIe3 x8 Cache SAS RAID internal adapter 6 Gb
Form factor	PCIe3 x8	PCIe3 x8	PCIe3 x8	Planar-unique PCIe3 x8	Planar-unique PCIe3 x8
Physical links	16 (four mini SAS HD 4x connectors)	16 (four mini SAS HD 4x connectors)	16 (four mini SAS HD 4x connectors)	16 (internal connection to directly attached SAS drives)	16 (internal connections to directly attached SAS drives and remote adapter link) and 4 (one mini SAS HD 4x connector for external SAS attach)
Supported RAID levels	RAID 5, RAID 6, RAID 10 <sup>3</sup> , and System mirroring	RAID 5, RAID 6, RAID 10 <sup>3</sup> , and System mirroring	RAID 5, RAID 6, RAID 10 <sup>3</sup> , and System mirroring	RAID 5, RAID 6, RAID 10, and System mirroring	RAID 5, RAID 6, RAID 10, and System mirroring
Write cache size	Up to 12 GB (compressed)		Up to 12 GB (compressed)		Up to 7.2 GB (compressed)
Read cache size					
Cache battery pack technology	None (uses supercapacitor technology)		None (uses supercapacitor technology)		None (uses supercapacitor technology)
Auxiliary write cache (AWC) support	No	No	No	No	No
Dual-storage IOA configuration	Yes	Yes	Yes	No	Yes
Requires dual-storage IOA configuration	Yes	No	Yes	No	Yes
SAS tape support	No	Yes <sup>1</sup>	No	No	No
SAS DVD support	No	Yes <sup>1, 2</sup>	No	Yes	Yes
Native 4K block device support	Yes	Yes	Yes	Yes	Yes
520-byte virtual disk support <sup>4</sup>	Yes	Yes	Yes	Yes	Yes

**Note:**

1. SAS tape and SATA DVD is only supported in a single adapter configuration and cannot be mixed with SAS disk on the same adapter.
2. SATA DVD is supported on all CCIN 57B4 adapters, except for those with initial part numbers of either 00FX843, 00MH900, 00FX846, or 00MH903.
3. RAID 10 requires IBM i Version 7.2, or later.
4. For a description of possible performance considerations with VIOS and IBM i clients see **Limitations and restrictions for IBM i client logical partitions** ([http://www.ibm.com/support/knowledgecenter/POWER8/p8hb1/p8hb1\\_i5osrestrictions.htm](http://www.ibm.com/support/knowledgecenter/POWER8/p8hb1/p8hb1_i5osrestrictions.htm))

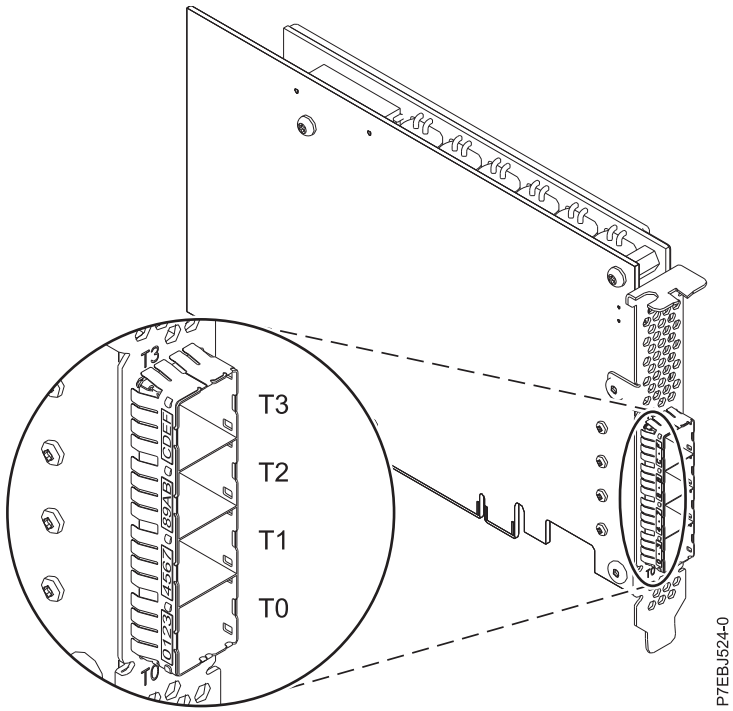


Figure 16. CCIN 57B1 PCIe3 12 GB cache RAID+ SAS adapter Quad-port 6 Gb x8

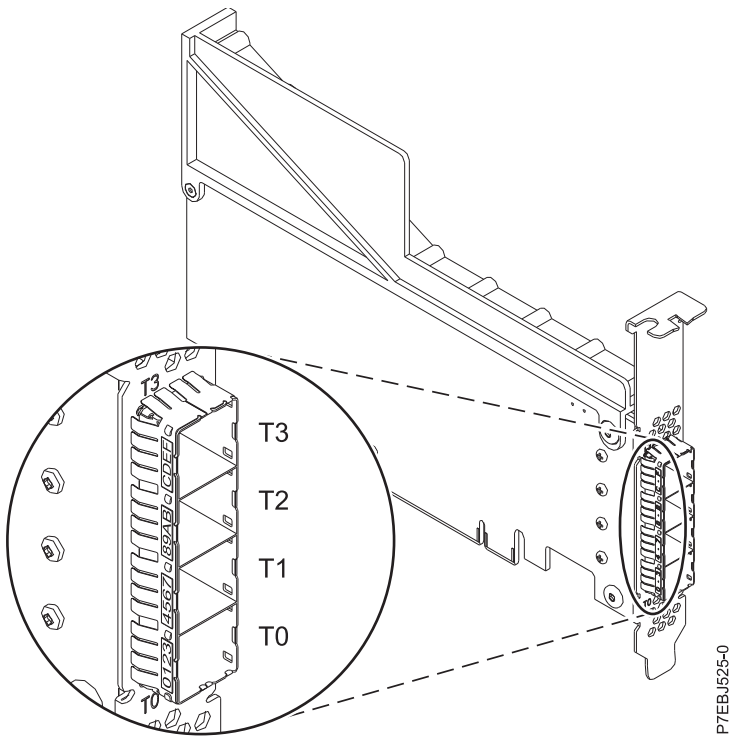


Figure 17. CCIN 57B4 PCIe3 RAID SAS adapter Quad-port 6 Gb x8, four units

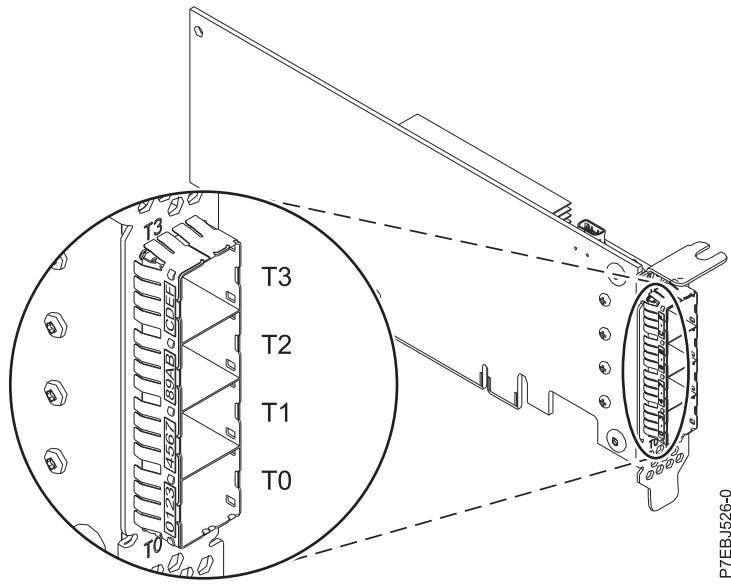


Figure 18. CCIN 57B4 PCIe3 RAID SAS adapter Quad-port 6 Gb x8, two units

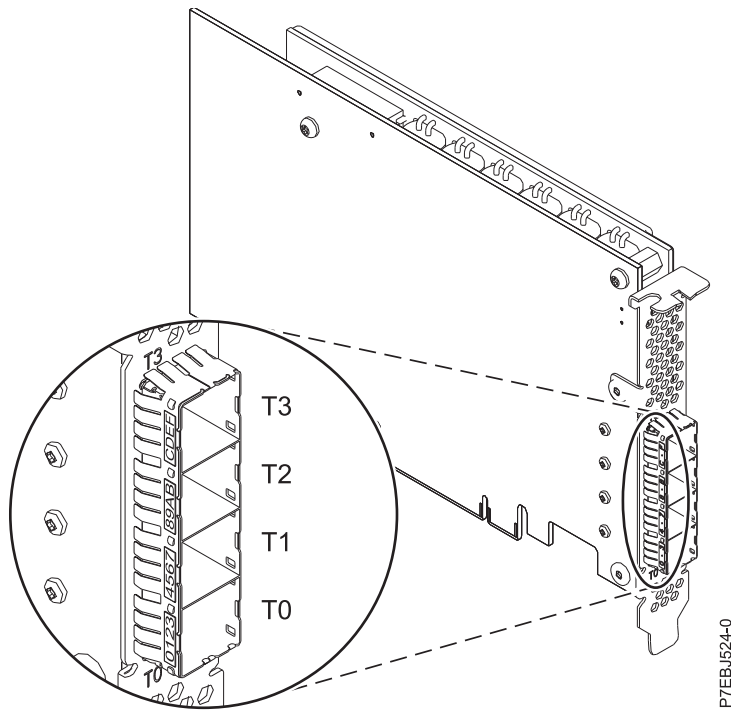


Figure 19. CCIN 57CE PCIe3 12 GB cache RAID SAS adapter Quad-port 6 Gb x8

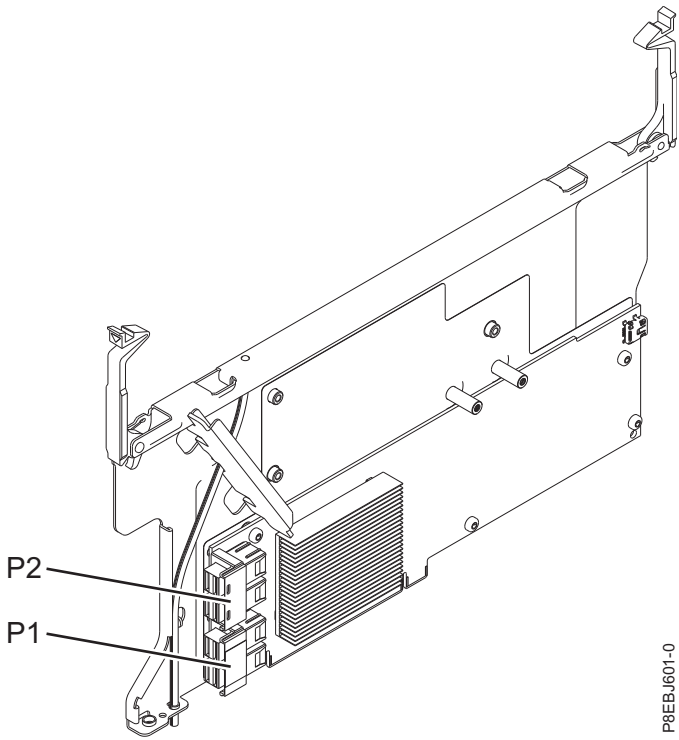


Figure 20. CCIN 57D7 PCIe3 x8 SAS RAID internal adapter 6 Gb

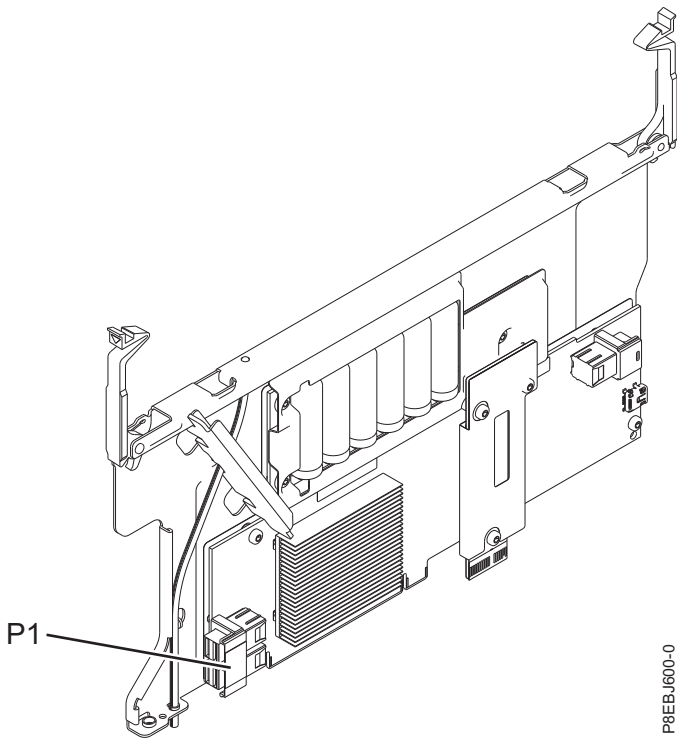


Figure 21. CCIN 57D8 PCIe3 x8 Cache SAS RAID internal adapter 6 Gb for 8286-41A or 8286-42A systems



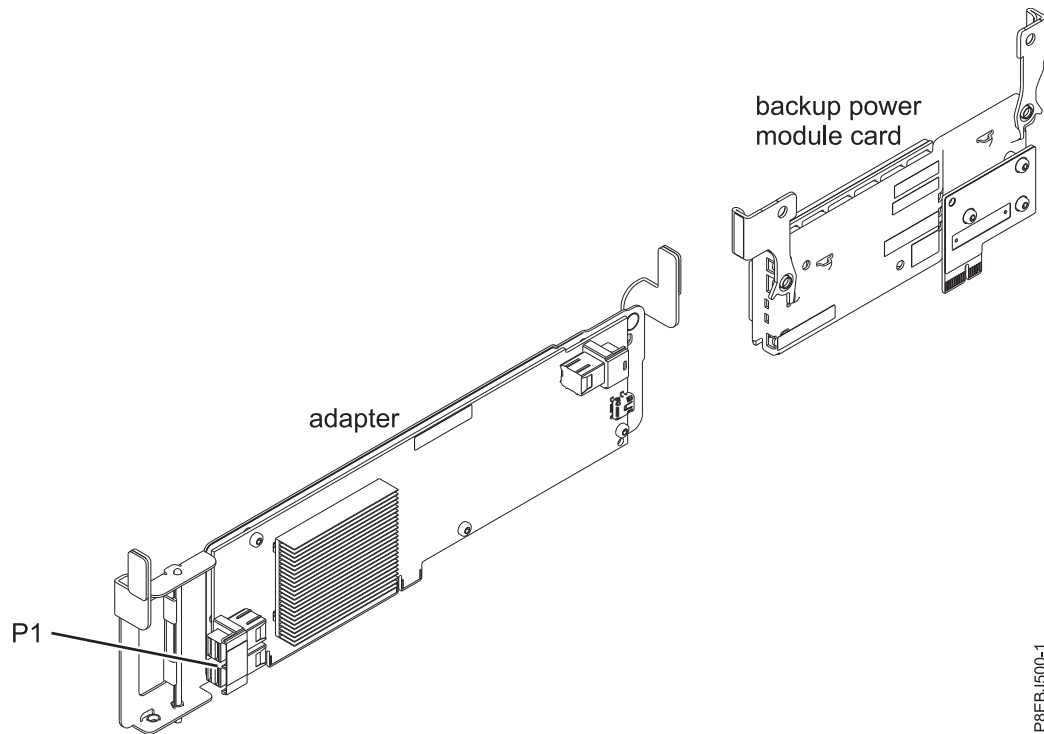


Figure 22. CCIN 57D8 PCIe3 x8 Cache SAS RAID internal adapter 6 Gb for 5148-21L, 5148-22L, 8247-21L, 8247-22L, 8284-21A, or 8284-22A systems

#### Related concepts:

“Dual storage IOA configurations” on page 25

You can increase availability using a dual storage I/O adapter (IOA) configuration to connect multiple controllers to a common set of disk expansion drawers and the included disks and disk arrays.

“Dual storage IOA functions” on page 27

Consider these factors when using dual storage I/O adapter (IOA) functions.

## SAS architecture

Serial-attached SCSI (SAS) architecture describes a serial device interconnection and transportation protocol that defines the rules for information exchange between devices.

SAS is an evolution of the parallel SCSI device interface into a serial point-to-point interface. *SAS physical links* are a set of four wires used as two differential signal pairs. One differential signal transmits in one direction, while the other differential signal transmits in the opposite direction. Data can be transmitted in both directions simultaneously. Physical links are contained in SAS ports, which contain one or more physical links. A port is a wide port if there are more than one physical link in the port. If there is only one physical link in the port, it is a narrow port. A port is identified by a unique SAS worldwide name (also called SAS address).

An SAS controller contains one or more SAS ports. A *path* is a logical point-to-point link between a SAS initiator port in the controller and a SAS target port in the I/O device (for example, a disk). A *connection* is a temporary association between a controller and an I/O device through a path. A connection enables communication to a device. The controller can communicate to the I/O device over this connection by using either the SCSI command set or the Advanced Technology Attachment (ATA) and Advanced technology Attachment Packet Interface (ATAPI) command set depending on the device type.

An SAS expander enables connections between a controller port and multiple I/O device ports by routing connections between the expander ports. Only a single connection through an expander can exist

at any given time. Using expanders creates more nodes in the path from the controller to the I/O device. If an I/O device supports multiple ports, more than one path to the device can exist when there are expander devices included in the path.

An *SAS fabric* refers to the summation of all paths between all SAS controller ports and all I/O device ports in the SAS subsystem including cables, enclosures, and expanders.

The following example SAS subsystem shows some of the concepts described in this SAS overview. A controller is shown with eight SAS physical links. Four of those physical links are connected into two different wide ports. One connector contains four physical links grouped into two ports. The connectors have no significance in SAS other than causing a physical wire connection. The four-physical links connector can contain one to four ports depending on the type of cabling that is used. The uppermost port in the figure shows a controller-wide port number 6 that consists of physical link numbers 6 and 7. Port 6 connects to an expander, which attaches to one of the dual ports of the I/O devices. The dashed red line indicates a path between the controller and an I/O device. Another path runs from the controller's port number 4 to the other port of the I/O device. These two paths provide two different connections for increased reliability by using redundant controller ports, expanders, and I/O device ports. The SCSI Enclosure Services (SES) is a component of each expander.

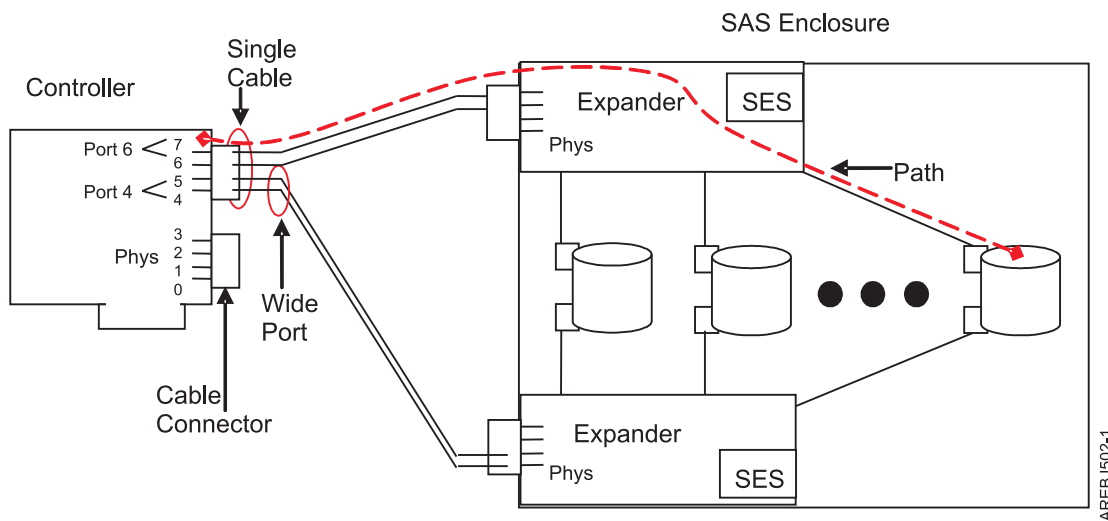


Figure 23. Example SAS subsystem

## Disk arrays

Disk arrays are groups of disks that work together with a specialized array controller to take advantage of potentially higher data transfer rates and data redundancy.

Disk arrays use RAID technology to offer data redundancy and to provide improved data transfer rates over single large disks. If a disk failure occurs, the disk can typically be replaced without interrupting normal system operation.

## Data redundancy

The disk array controller tracks how the data is distributed across the disks. RAID 5 and RAID 6 disk arrays provide data redundancy, ensuring that data is not lost if a disk in the array fails. If a disk failure occurs, the disk can typically be replaced without interrupting normal system operations. System mirroring provides data redundancy by mirroring the same data across pairs of disks.

## Supported RAID levels

The RAID level of a disk array determines how data is stored on the disk array and the level of protection that is provided.

If a part of the RAID system fails, different RAID levels help to recover lost data in different ways. If a single drive fails within an array, the array controller can reconstruct the data for the failed disk by using the data stored on other hard drives within the array. This data reconstruction has little or no impact to current system programs and users. The controller supports RAID levels 5 and 6 as well as system mirroring. Not all controllers support all RAID levels. Each RAID level supported by the controller has its own attributes and uses a different method of writing data. The following information provides details for each supported RAID level.

### Related concepts:

“PCI-X SAS RAID card comparison” on page 2

Use the table in this topic to compare the features of the various PCI-X SAS RAID cards for IBM i. There are also images of adapters for you to view.

“PCIe SAS RAID card comparison” on page 5

Use the tables in this topic to compare the features of the various PCI Express (PCIe) SAS RAID cards for IBM i. There are also images of adapters for you to view.

### Related information:

[↗ Device parity protection concepts](#)

## RAID 5:

Learn how data is written to a RAID 5 array.

RAID 5 stripes data across all disks in the array. RAID level 5 also writes array parity data. The parity data is spread across all the disks. For a RAID 5 array of three disks, array data and parity information is written in the following pattern:

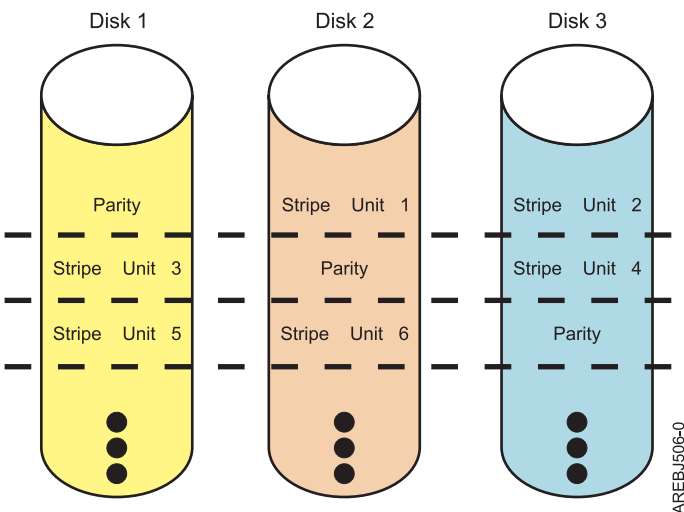


Figure 24. RAID 5

If a disk fails in a RAID 5 array, you can continue to use the array normally. A RAID 5 array that is operating with a single failed disk is said to be operating in degraded mode. Whenever data is read from

a degraded disk array, the array controller recalculates the data on the failed disk by using data and parity blocks on the operational disks. If a second disk fails, the array is placed in the failed state and is not be accessible.

**Related information:**

[RAID 5 concepts](#)

**RAID 6:**

Learn how data is written to a RAID 6 array.

RAID 6 stripes data across all disks in the array. RAID level 6 also writes array P and Q parity data. The P and Q parity data, is spread across all the disks. For a RAID 6 array of four disks, array data and parity information is written in the following pattern:

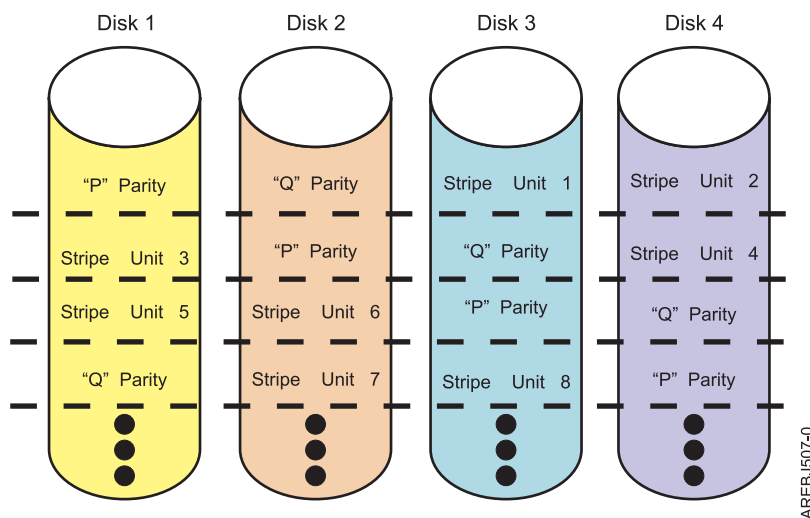


Figure 25. RAID 6

If one or two disks fail in a RAID 6 array, you can continue to use the array normally. A RAID 6 array that is operating with a one or two failed disks is said to be operating in degraded mode. Whenever data is read from a degraded disk array, the array controller recalculates the data on the failed disks by using data and parity blocks on the operational disks. A RAID 6 array with a single failed disk has similar protection to that of a RAID 5 array with no disk failures. If a third disk fails, the array is placed in the failed state and is not be accessible.

**Related information:**

[RAID 6 concepts](#)

**RAID 10:**

Learn how data is written to a RAID 10 array.

RAID 10 uses mirrored pairs to redundantly store data. The array must contain an even number of disks. Two is the minimum number of disks needed to create a RAID 10 array. The data is striped across the mirrored pairs. For example, a RAID 10 array of four disks would have data written to it in the following pattern:

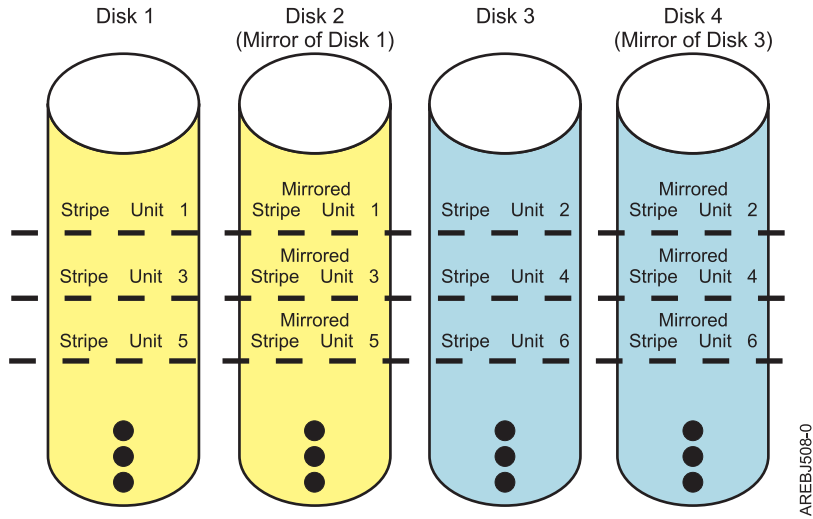


Figure 26. RAID 10

RAID 10 tolerates multiple disk failures. If one disk in each mirrored pair fails, the array will still be functional, operating in Degraded mode. You can continue to use the array normally because for each Failed disk, the data is stored redundantly on its mirrored pair. However, if both members of a mirrored pair fail, the array will be placed in the Failed state and will not be accessible.

When a RAID 10 disk array is created, the controller will automatically attempt to select the disks for each mirrored pair from a different controller connector (a different cable to a different device enclosure). For example, if four disks selected for the disk array are located on one of the controller connectors and another four disks selected are located on another of the controller's connectors, the controller will automatically attempt to create each mirrored pair from one disk on each controller connector. In the event of a controller port, cable, or enclosure failure, each mirrored pair will continue to operate in a Degraded mode. Such redundancy requires careful planning when you are determining where to place devices.

### System mirroring:

Mirrored protection is beneficial if you have a multibus system or a system with a large single bus. A greater number of disk units provides more opportunity for failure and increased recovery time.

See Mirrored protection for more information.

### Disk array capacities

These guidelines help you calculate the capacity of a disk array.

The capacity of a disk array depends on the capacity of the disks that are used and the RAID level of the array. To calculate the capacity of a disk array, use the following methods:

#### RAID 5

Multiply one fewer than the number of disks by the disk capacity.

#### RAID 6

Multiply two fewer than the number of disks by the disk capacity.

#### RAID 10

Multiply the number of disks by the disk capacity and divide by 2.

### System mirroring

Multiply the number of disks by the disk capacity and divide by two.

**Note:** If disks of different capacities are used in the same disk array, all disks are treated as if they have the capacity of the smallest disk.

## RAID level summary

Compare RAID levels according to their capabilities.

The following information provides data redundancy, usable disk capacity, read performance, and write performance for each RAID level.

*Table 6. RAID level summary*

RAID level	Data redundancy	Usable disk capacity	Read performance	Write performance	Devices per array on PCI-X and PCIe adapters	Devices per array on PCIe2 and PCIe3 adapters
RAID 5	Very good	67% - 94%	Very good	Good	Minimum: 3 Maximum: 18	Minimum: 3 Maximum: 32
RAID 6	Excellent	50% - 89%	Very good	Fair to good	Minimum: 4 Maximum: 18	Minimum: 4 Maximum: 32
RAID 10	Excellent	50%	Excellent	Very good	Not applicable	Minimum: 2 Maximum: 32 <b>Note:</b> Supported on PCIe3 and above only
System mirroring	Excellent	50%	Excellent	Very good	Not applicable	Not applicable

### RAID 5

Creates array parity information so that the data can be reconstructed if a disk in the array fails. This level provides better capacity than System Mirroring but possibly lower performance.

### RAID 6

Creates array "P" and "Q" parity information so that the data can be reconstructed if one or two disks in the array fail. This level provides better data redundancy than RAID 5 but with slightly lower capacity and possibly lower performance. It also provides better capacity than System Mirroring but possibly lower performance.

### RAID 10

Stores data redundantly on mirrored pairs to provide maximum protection against disk failures. Provides generally better performance than RAID 5 or 6, but has lower capacity.

**Note:** A two-drive RAID level 10 array is equivalent to RAID level 1.

### System mirroring

Stores data redundantly on mirrored pairs to provide maximum protection against disk failures. This level provides better performance than RAID 5 or RAID 6, but has lower capacity.

---

## Controller software

For the adapter to be identified and configured by the IBM i operating system, the requisite software support must be installed. The requisite software for the adapter is often preinstalled during IBM i installation.

It might be necessary to perform operations related to the installation, verification, and maintenance of the IBM i software support for the adapter.

Software for the adapter is packaged in Program Temporary Fix (PTF) format and distributed as part of the base IBM i installation media, cumulative package media, and through the Fix Central website. This

information is an overview of the IBM i software support that is required for the adapter. For complete information related to the installation and maintenance of IBM i, see the IBM i Knowledge Center website.

The adapter runs onboard microcode. Although a version of adapter microcode might be distributed along with the IBM i, this does not necessarily represent the most recent version of microcode that is available for the adapter. Newer PTFs might be available for the most current level of adapter microcode. Contact your technical support to verify the latest PTFs available for your specific adapters.

For the latest PTFs for your IBM irelease, and for fixes and updates, go to the Fix Central website.

## Verifying the controller software

Verify the minimum software support that is required for your specific controller.

Support for the controller is contained in the Licensed Internal Code of IBM i.

Each controller requires a supported release of IBM i. Verify other possible code prerequisites that are described in the following table and at IBM Prerequisite.

**Attention:** Ensure that the adapters have the latest adapter microcode PTFs as part of the initial installation.

*Table 7. CCIN and version and release data.*

CCIN (Custom card identification number)	Minimum required IBM i version and release
2BD9	IBM i 6.1.1 or later <sup>1</sup>
2BE0	IBM i 6.1.1 or later <sup>1</sup>
2BE1	IBM i 6.1.1 or later <sup>1</sup>
572A	IBM i V5R4M5 or later <sup>1</sup>
572C	IBM i V5R4M5 or later
572F and 575C	IBM i V5R4M5 or later <sup>1</sup>
574E	IBM i 6.1.1 or later <sup>1</sup>
57B3	IBM i 6.1 or later <sup>1</sup>
57B4	IBM i 6.1.1 or later <sup>1</sup>
57B5	IBM i 6.1.1 or later <sup>1</sup>
57B7	IBM i V5R4M5 or later
57B8	IBM i V5R4M5 or later
57BB	IBM i 6.1.1 or later <sup>1</sup>
57C4	IBM i 6.1.1 or later <sup>1</sup>
57C7	IBM i 6.1.1 or later <sup>1</sup>
57CD	IBM i 7.1 or later <sup>1</sup>
57CE	IBM i 6.1.1 or later <sup>1</sup>
57CF	IBM i 6.1.1 or later <sup>1</sup>
57D7	IBM i 7.1 or later <sup>1</sup>
57D8	IBM i 7.1 or later <sup>1</sup>
1. See the <b>PCI adapter information by feature type</b> topic in Managing PCI adapters for the minimum IBM i level requirements.	

It might become necessary to install software updates so that you have the latest available level of adapter software support. Updates to the adapter software support are packaged, distributed, and installed through the same mechanisms that are used for other portions of the IBM i Licensed Internal Code. The standard IBM i technical support procedures can be used to determine the latest available level of adapter software support.

**Related concepts:**

“Dual storage IOA functions” on page 27

Consider these factors when using dual storage I/O adapter (IOA) functions.

**Related information:**

 [PCI adapter information by feature type](#)

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## Common controller and disk array management tasks

You can perform various tasks to manage SAS RAID disk arrays.

Use the information in this section to manage your SAS RAID disk arrays.

- Device parity protection  
The topic describes the use of device parity protection on IBM i.
- Managing disk arrays  
Refer to this topic to see the interface for performing various tasks with disk arrays.
- Creating a disk array  
Use this procedure to start device parity protection.
- Using hot spare disks  
Hot spare disks are used to automatically replace a disk that has failed in a RAID environment.
- Disk unit management  
This procedure allows viewing disk status and disk unit details.

### Viewing IBM SAS disk information

This procedure enables you to view SAS disk information, status, and details.

To view the SAS disk information and status, see the following:

- IBM i Service Functions
- DST options

**Note:** The disk unit information options can also be accessed through System Service Tools. The system does not need to be in dedicated service mode to display disk information. Some disk configuration functions do require dedicated service mode.

- Work with disk units
- Display disk configuration

**Note:** This display shows disk unit details such as type, model, serial number, operating status, capacity, and protection status.

### Considerations for solid-state drives

Use this information to understand the importance of controller functions when you use solid-state drives (SSD).

Hard-disk drives (HDD) use a spinning magnetic platter to store nonvolatile data in magnetic fields. SSDs are a storage device using nonvolatile solid-state memory, typically flash memory, to emulate HDDs. HDDs have an inherent latency and access time caused by mechanical delays in the spinning of the platter and movement of the read/write head. SSDs greatly reduce the latency and time to access the stored data. The nature of solid-state memory is such that read operations can be performed faster than write operations and write cycles are limited. Using techniques, such as wear leveling and overprovisioning, enterprise class SSDs are designed to withstand many years of continuous use.



## SSD and HDD use

Follow these guidelines when using SSDs and HDDs.

- Do not mix SSDs and HDDs within the same disk array. A disk array must only contain SSDs or HDDs.
- Do not mix SSDs and HDDs with system mirroring in the same mirrored pair. A mirrored pair must only contain SSDs or HDDs.
- It is important to plan for hot-spare devices when you use arrays of SSDs. An SSD hot-spare device replaces a failed device in an SSD disk array. An HDD hot-spare device replaces a failed device for an HDD disk array.
- It is preferred that SSDs be protected by RAID 5, RAID 6, RAID 10, or by system mirroring.
- Identify the specific configuration and placement requirements related to the SSD devices. See Disk drives depending on the type of your system.
- Some adapters, known as RAID and SSD adapters, contain SSDs that are integrated on the adapter. See the PCIe SAS RAID card comparison table for features and additional information for your specific adapter type.

---

## Dual storage IOA configurations

You can increase availability using a dual storage I/O adapter (IOA) configuration to connect multiple controllers to a common set of disk expansion drawers and the included disks and disk arrays.

**Note:** Not all controllers support all configurations. See the PCI-X SAS RAID cards or the PCIe SAS RAID card comparison tables to look for controllers that have dual storage IOA configurations.

### Related concepts:

“PCI-X SAS RAID card comparison” on page 2

Use the table in this topic to compare the features of the various PCI-X SAS RAID cards for IBM i. There are also images of adapters for you to view.

“PCIe SAS RAID card comparison” on page 5

Use the tables in this topic to compare the features of the various PCI Express (PCIe) SAS RAID cards for IBM i. There are also images of adapters for you to view.

“PCIe2 SAS RAID card comparison” on page 10

Use this table to compare the features of the various PCI Express 2.0 (PCIe2) SAS RAID cards for IBM i.

“PCIe3 SAS RAID card comparison” on page 13

This table compares the main features of PCI Express 3.0 (PCIe3) SAS RAID cards.

## Possible disk storage IOA configurations

This topic shows a table illustrating what is needed to have dual storage IOA configurations with RAID or operating system mirroring and images of dual storage IOA configurations.

*Table 8. Disk protection with dual storage.* This table describes what is needed to have dual storage with different kinds of disk protection.

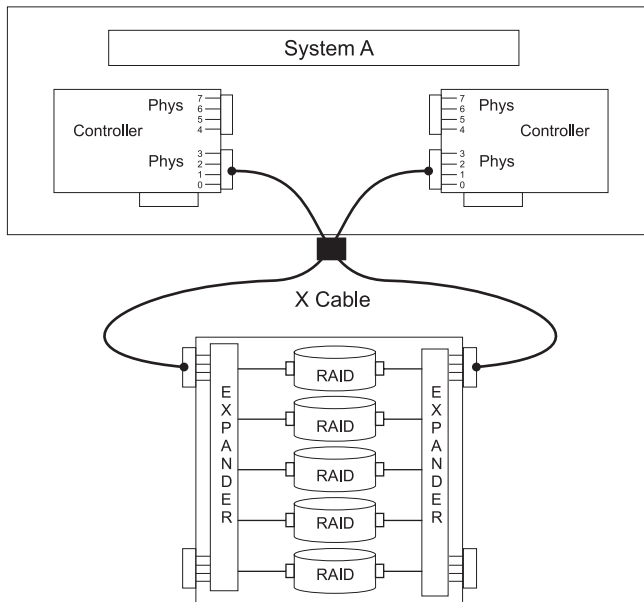
Multi-initiator configuration	Dual storage IOA
RAID	<ul style="list-style-type: none"><li>• Two controllers</li><li>• Both controllers must have the same write cache capability and write cache sizes</li><li>• Both controllers must support dual storage IOA configuration</li><li>• Controllers are in the same system or partition</li></ul>

Table 8. Disk protection with dual storage (continued). This table describes what is needed to have dual storage with different kinds of disk protection.

Multi-initiator configuration	Dual storage IOA
Operating system mirroring	<ul style="list-style-type: none"> <li>• Four controllers (two pairs of controllers)</li> <li>• Each pair of controllers must have the same write cache capability and write cache sizes</li> <li>• Each pair of controllers must support dual storage IOA configuration</li> <li>• Controllers are in the same system or partition</li> </ul>

The following figure illustrates an example of a Dual storage IOA configuration with RAID.

**Dual Storage IOAs with RAID Configuration**



ARED5500-1

Figure 27. Dual storage IOA RAID configuration

## Dual Storage IOAs with System Mirroring Configuration

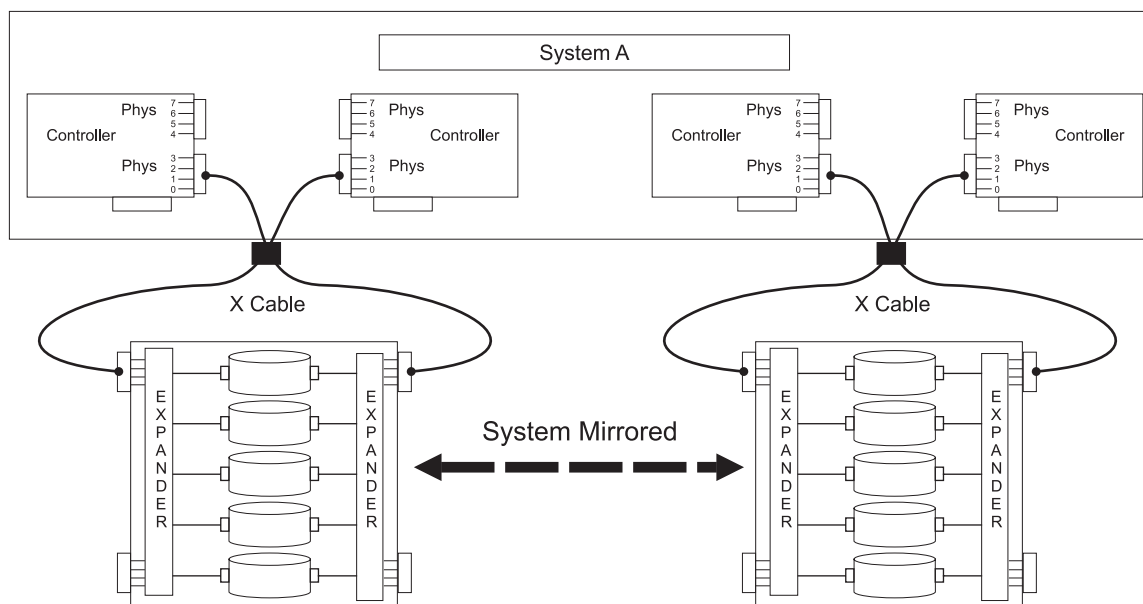


Figure 28. Dual storage IOA system mirroring configuration

## Dual storage IOA functions

Consider these factors when using dual storage I/O adapter (IOA) functions.

Use of the dual storage IOA function requires controller and IBM i software support. Controller support is shown in the feature comparison tables for PCI-X, PCIe, PCIe2, and PCIe3 cards. Look for controllers that have *Dual Storage IOA configuration* marked as Yes. The IBM i software levels that are required for multi-initiator support are identified in the Controller software verification topic.

Controllers connected in a dual storage IOA configuration must have the same write cache size (assuming that they support write cache). A configuration error is logged if the write caches for the controllers are not the same size.

When you configure a controller for a dual storage IOA configuration, no mode jumpers or special configuration settings are needed.

For all dual storage IOA configurations, one controller functions as the primary controller. Primary controllers perform management of the physical devices, such as creating a disk array. The other controller functions as the secondary controller and is not capable of physical device management.

If the secondary controller detects that the primary controller is going offline, it switches roles to become the primary controller. When the original primary controller comes back online, it becomes the secondary controller.

Both controllers are capable of performing direct I/O accesses (read and write operations) to the disk arrays. At any given time, only one controller in the pair is optimized for the disk array. The controller optimized for a disk array is the one that directly accesses the physical devices for I/O operations. The controller that is not optimized for a disk array forwards read and write requests, through the SAS fabric, to the optimized controller.

The primary controller logs most errors that are related to problems with a disk array. Disk array errors might also be logged on the secondary controller if a disk array is optimized on the secondary controller at the time the error occurred.

Typical reasons for the primary and secondary controllers to switch roles from what was expected are as follows:

- Controllers switch roles for asymmetric reasons. For example, one controller detects more disk drives than the other. If the secondary controller is able to find devices that are not found by the primary controller, an automatic transition (failover) occurs. The controllers communicate with each other, compare device information, and switch roles.
- Powering off the primary controller causes an automatic transition (failover) to occur.
- Failure of the primary controller causes an automatic transition (failover) to occur.
- If the primary controller loses contact with the disks that are also accessible by the secondary controller, an automatic transition (failover) occurs.
- Downloading controller microcode might cause an automatic transition (failover) to occur.

Innovative improvements have been made in IBM i 7.2 TR 2 and IBM i 7.1 TR 10 to drastically reduce the recovery time for some of those failover scenarios so their impact on performance is measurable in seconds rather than minutes. The breadth of impact for some of the scenarios has been greatly reduced also, to not affect the operation of active paths. These improvements apply to PCIe3 SAS RAID adapters.

**Related concepts:**

“Verifying the controller software” on page 23

Verify the minimum software support that is required for your specific controller.

“PCI-X SAS RAID card comparison” on page 2

Use the table in this topic to compare the features of the various PCI-X SAS RAID cards for IBM i. There are also images of adapters for you to view.

“PCIe SAS RAID card comparison” on page 5

Use the tables in this topic to compare the features of the various PCI Express (PCIe) SAS RAID cards for IBM i. There are also images of adapters for you to view.

“PCIe2 SAS RAID card comparison” on page 10

Use this table to compare the features of the various PCI Express 2.0 (PCIe2) SAS RAID cards for IBM i.

“PCIe3 SAS RAID card comparison” on page 13

This table compares the main features of PCI Express 3.0 (PCIe3) SAS RAID cards.

“Dual storage IOA access optimization” on page 32

View the active or passive path of your disk units and controller.

**Dual storage IOA function attributes**

Find out which controller functions are supported with dual storage IOA configurations. See the following table for information about the controller functions that are supported with dual storage IOA configurations.

*Table 9. SAS controller functions.*

Controller functions	Dual storage IOA configurations
Disks formatted to 512 bytes per sector	No <sup>1</sup>
Disks formatted to 528 bytes per sector	Yes
Mirrored write cache between controllers that have write cache	Yes
Mirrored RAID parity footprints between controllers	Yes
Dual paths to disks	Yes
System-level mirroring	Yes

Table 9. SAS controller functions (continued).

Controller functions	Dual storage IOA configurations
IBM-qualified disk drives	Yes
IBM-qualified disk expansion drawers	Yes
Tape or optical devices	No
Load source capable	Yes
Operating mode <sup>2</sup>	Primary or secondary adapter
<ol style="list-style-type: none"> <li>1. Disks formatted to 512 bytes per sector are not to be used functionally, but these disks can be formatted to 528 bytes per sector.</li> <li>2. The operating mode can be viewed by using the Auxiliary Storage Hardware Resource Detail display.</li> </ol>	

## Viewing dual storage IOA attributes

This topic collection provides the details for using the Auxiliary Storage Hardware Resource Detail display to obtain dual storage I/O adapter (IOA) configuration information.

Perform the following steps to view details about your adapters.

1. Select **Start a service tool** on the Use System Service Tools (SST) menu.
2. Select **Hardware service manager** on the Start a Service Tool menu.
3. Select **Logical hardware resources (buses, IOPs, controllers)** on the Hardware Service Manager menu.
4. Select **System bus resources on the Logical Hardware Resources** on the System Bus menu.
5. Type 9 (Resources associated with IOP) in front of the adapter that you want.
6. Type 5 (Display detail) in front of **Storage IOA** to get details about the storage IOA. This is an example of the display:

Auxiliary Storage Hardware Resource Detail

Description . . . . . : Storage IOA  
Type-model . . . . . : 574E-001  
Status . . . . . : Operational  
Serial number . . . . . : YL3028269C6B  
Part number . . . . . : 0000044V4198  
Resource name . . . . . : DC10  
Cache size (MB) . . . . . : 380  
PCI bus . . . . . :  
    System bus . . . . . : 517  
    System board . . . . . : 0  
    System card . . . . . : 0  
Storage . . . . . :  
    I/O adapter . . . . . : Not used  
    I/O bus . . . . . : 127  
    Controller . . . . . :  
    Device . . . . . :  
Operating mode . . . . . : Primary Storage IOA

More...

F3=Exit      F5=Refresh      F6=Print

F9=Change detail    F12=Cancel    F14=Dual Storage IOA Configuration

7. Press F14 (Dual Storage IOA Configuration) to view a list of both adapters in the dual storage IOA pair. This is an example of the display:

```

Dual Storage IOA Configuration

Type options, press Enter.
2=Change detail    5=Display detail    6=I/O debug
8=Associated packaging resource(s) 9=Resources associated with controlling IOP

Resource  Type-          Serial
Opt Name  Model   Status      Number      Operating Mode
_ DC10    574E-001 Operational  YL3028269C6B  Primary Storage IOA
_ DC09    574E-001 Operational  YL3028270DA0  Secondary Storage IOA

F3=Exit    F5=Refresh    F6=Print    F12=Cancel

```

- To see details about each individual adapter, type 5 (Display detail) in front of the adapter that you want.

For additional details on how to set up a configuration, see “Installing dual storage IOA configurations” on page 35.

**Related concepts:**

“Installing dual storage IOA configurations” on page 35  
 Use this procedure to install a dual storage I/O adapter (IOA) configuration.

## SAS cabling considerations

Cabling your system correctly is one of the most important aspects of planning for a dual storage I/O adapter (IOA) configuration. For RAID configurations that have disk expansion drawers, correct cabling is required to provide redundancy between each adapter and the disk expansion drawer.

Follow these guidelines when you cable your system.

- For RAID configurations on a 5887 EXP 24S SFF generation-2-bay drawer, X or Y cables are used depending on the type of adapter and mode setting of the disk expansion drawer. This criteria is to provide redundancy for the SAS ports between each controller and disk expansion drawer and redundancy for the SAS ports for each disk drive.
- For RAID configurations on a 5886 EXP 12S disk expansion drawer, X cables provide redundancy for two wide SAS ports between each controller and disk expansion drawer, and it also provides redundancy for two narrow SAS ports for each disk drive.
- For RAID configurations with a 5802 or 5803 PCIe 12X I/O drawer, AT cables are used. SAS topology is incorporated with in the IO drawer wiring. This wiring provides redundancy similar to X cables.
- For RAID configurations with internal SAS disk slots, YR cables provide redundancy for two narrow SAS ports between each controller and internal disk enclosure, and it also provides redundancy for two narrow SAS ports for each disk drive.

To see examples of how to cable dual storage IOA configurations, see Serial attached SCSI cable planning.

**Note:** Some systems have SAS RAID adapters integrated onto the system boards. Separate SAS cables are not required to connect the two integrated SAS RAID adapters to each other.

**Related concepts:**

“Installing dual storage IOA configurations” on page 35

Use this procedure to install a dual storage I/O adapter (IOA) configuration.

**Related information:**

 [Serial attached SCSI cable planning](#)

## Performance considerations

Controller failures can affect performance.

The controller is designed to minimize performance impacts when running in a dual storage IOA configuration. When using RAID 5 and RAID 6, parity footprints are mirrored between the controller's nonvolatile memory, which causes only a slight impact to performance. For controllers with write cache, all cache data is mirrored between the controller's nonvolatile memories, which also causes only a slight impact to performance.

If one controller fails in a dual storage IOA configuration, the remaining controller disables write caching (if auxiliary cache is not also provided by the controllers) and begins to keep an additional copy of parity footprints on disk. This can significantly affect performance, particularly when using RAID 5 and RAID 6.

## Dual storage IOA access optimization

View the active or passive path of your disk units and controller.

Dual storage IOA access characteristics can balance the controller workload. The dual storage IOA access characteristics for a disk array, parity set, specifies which controller is preferred to be optimized for the disk array. It performs direct read and write operations to the physical devices. The controller that is preferred to be optimized for the disk array, contains the active path to the disk units in the disk array. The other controller contains the passive path. The system only sends read and write operations down the active path. The passive path is only used if the active path fails.

Best performance is achieved when the dual storage IOA access characteristics on each disk array have a balanced workload. This happens when the two controllers have an equal number of disk arrays with active paths to the disk units.

The system selects the disk units and dual storage IOA access characteristics for each disk array. When creating disk arrays, set the parity set optimization to Performance. This attribute sets an even number of disk arrays (for example, 2, 4, 6, and so forth) to be created. It also enables the system to optimize disk arrays on each controller. As a result, the two controllers will have an equal number of disk units with an active path.

To change the parity set optimization, see Changing parity set optimization.



## Dual Storage IOA Optimization

The example assumes this setup:  
RAID Array "A" Optimized on Primary  
RAID Array "B" Optimized on Secondary

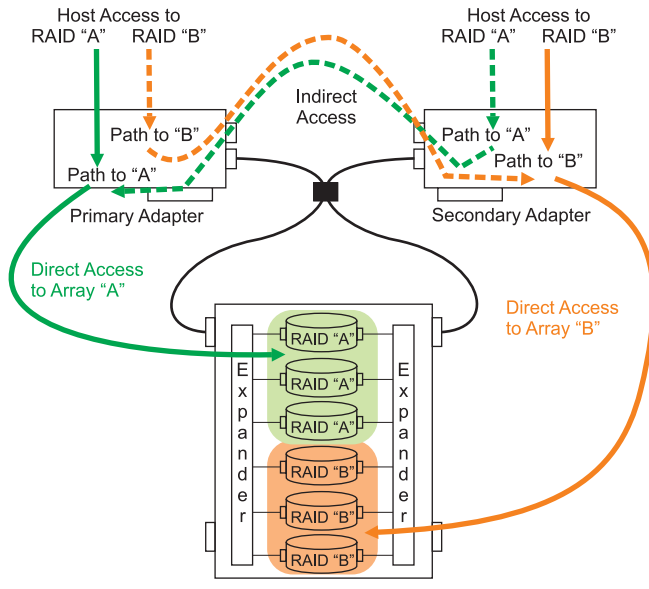


Figure 29. Dual storage IOA optimization. This figure shows RAID arrays with primary and secondary adapters.

## Viewing the active or passive path of disk units

To view the active or passive path of the disk units, complete the following steps.

1. Select **Work with disk units** on the Use System Service Tools (SST) menu.
2. Select **Display disk configuration** from the Work with Disk Configuration display.
3. Select **Display path status** on the Display Disk Configuration display.

## Display Disk Path Status

Serial	Resource	Path
ASP Unit Number	Type Model Name	Status
* * Y6800024F78E	433C 099 DMP001	Active
	DMP002	Passive
* * Y680002AEB3D	433C 099 DMP003	Active
	DMP004	Passive
* * Y6800024F754	433C 099 DMP005	Active
	DMP006	Passive
* * Y6800024F771	433C 099 DMP007	Active
	DMP008	Passive
* * Y68000268517	433C 099 DMP009	Active
	DMP010	Passive
* * Y680002B31DD	433C 099 DMP011	Active
	DMP012	Passive
* * Y6800024F74D	433C 099 DMP013	Active
	DMP014	Passive

More...

Press Enter to continue.

F3=Exit            F5=Refresh            F9=Display disk unit details

F11=Display encryption status            F12=Cancel

## Viewing the active or passive path role for a controller

To view the active or passive path role for a controller, complete the following steps.

1. Select **Start a service tool** on the Use System Service Tools (SST) menu.
2. Select **Hardware service manager** on the Start a Service Tool menu.
3. Select **Logical hardware resources (buses, IOPs, controllers)** on the Hardware Service Manager menu.
4. Select **System bus resources** on the Logical Hardware Resources on the System Bus menu.
5. Select the **Virtual IOP** by typing a 9 (Resources associated with IOP) in front of the desired IBM dual storage IOA.
6. Press F11 (function key) until Path Role is shown.

Logical Hardware Resources Associated with IOP

Type options, press Enter.

2=Change detail    4=Remove    5=Display detail    6=I/O debug  
7=Verify            8=Associated packaging resource(s)

Opt	Description	Type-Model	Path Role	Resource Name
	Virtual IOP	* 572F-001		CMB01
	Storage IOA	572F-001		DC02
	Disk Unit	433B-099	Active	DMP002
	Disk Unit	433B-099	Passive	DMP004
	Disk Unit	433B-099	Active	DMP006
	Disk Unit	433B-099	Passive	DMP008
	Disk Unit	433B-099	Active	DMP010
	Disk Unit	433C-099	Active	DMP012
	Disk Unit	433C-099	Active	DMP014
	Disk Unit	433C-099	Passive	DMP016
	Disk Unit	433B-099	Passive	DMP018

More...

F3=Exit    F5=Refresh    F6=Print    F8=Include non-reporting resources  
F9=Failed resources    F10=Non-reporting resources  
F11=Display status/resource name    F12=Cancel

**Related concepts:**


“Dual storage IOA functions” on page 27

Consider these factors when using dual storage I/O adapter (IOA) functions.

“Installing dual storage IOA configurations”

Use this procedure to install a dual storage I/O adapter (IOA) configuration.

**Related information:**

 Changing parity set optimization

**Installing dual storage IOA configurations**

Use this procedure to install a dual storage I/O adapter (IOA) configuration.

To avoid problems during installation, follow the steps exactly as written.

**Attention:** Disk arrays can be created either before or after the dual storage IOA configuration is set up.

Each storage adapter requires a supported release of IBM i and other possible code prerequisites. Go to the IBM Prerequisites website and click the **Feature Prerequisites** tab.

**Attention:** Ensure that the adapters are updated with the latest adapter microcode, which is available as a program temporary fix (PTF) as part of the initial installation.

To install a dual storage IOA configuration, complete the following steps:

1. Verify that all prerequisites are permanently applied.
2. Install the SAS storage adapters on the system or partition. For instructions, see the PCI adapters topic collections, as applicable to your system type and model.

**Note:** Do not attach any cables to the SAS storage adapters.

3. To prevent errors while connecting the cables, perform a normal shutdown of the system or partition before you attach the cables.
4. Attach the necessary SAS cables from the shared disk enclosure to the same SAS connector on each storage adapter. For examples on how to cable the Dual storage IOA configurations, see “SAS cabling considerations” on page 31.
5. Power on your system or partition.
6. Verify that the cabling and functioning of the storage adapters are correct by using the Dual Storage IOA configuration screen, see “Viewing dual storage IOA attributes” on page 29.
7. Best performance is achieved when dual storage IOA access characteristics for each disk array are such that the workload is balanced between the two storage adapters. See “Dual storage IOA access optimization” on page 32 and create or change the RAID configuration as necessary.

**Related concepts:**

“SAS cabling considerations” on page 31

Cabling your system correctly is one of the most important aspects of planning for a dual storage I/O adapter (IOA) configuration. For RAID configurations that have disk expansion drawers, correct cabling is required to provide redundancy between each adapter and the disk expansion drawer.

“Dual storage IOA access optimization” on page 32


View the active or passive path of your disk units and controller.

**Related tasks:**

“Viewing dual storage IOA attributes” on page 29

This topic collection provides the details for using the Auxiliary Storage Hardware Resource Detail display to obtain dual storage I/O adapter (IOA) configuration information.

**Related information:**

 [Installing PCI adapters](#)

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## SAS RAID controller maintenance

Ensure optimal performance of your controller by using these maintenance procedures.

To help avoid controller and disk array problems, use the following tips:

- Perform a normal system shutdown before physically replacing or moving the RAID controller or members of disk arrays. A normal shutdown of the system flushes the controller's write cache and remove dependencies between the controller and the disks. Powering off the PCI slot using concurrent maintenance options in Hardware Service Manager (HSM) has the same effect as it would on a single controller when the Power Down System (PWRDWNSYS) command is used.

**Note:** Disks that are failed members of an unprotected (exposed) disk array can be replaced and the disk unit data rebuilt while the system continues to run. No system shutdown is required.

- You can physically move disks from one controller to another. However, if the disks are members of a disk array, be sure to move all the disks in the array as a group. Before attempting a disk movement, ensure that the disk array is not in an unprotected state because of a disk failure. The system or partition must be powered off normally before disks are moved.

- When physically removing disks that are members of a disk array, remove the disks from the auxiliary storage pool (ASP) and then stop RAID on the disk array before removing the disks. This action avoids loss of data and disk-array-related problems the next time that these disks are used. The system or partition must be powered off normally before disks are physically removed.
- Always use the Device Concurrent Maintenance option to remove and replace a disk.
- If the load source disk is part of a disk array and the system fails to IPL because of a suspected disk array problem, IPL the system or partition using D-IPL media (CD/DVD or SAVESYS media). Error Log Analysis, and other tools are available on the Dedicated Service Tools menu to help determine and resolve the problem with the disk array.
- Do not attempt to correct problems by swapping controllers and disks unless you are directed to do so by the service procedures. Use Error Log Analysis to determine what actions to perform, and when appropriate, follow the appropriate Isolation Procedures for problem determination. If multiple errors occur at approximately the same time, look at them as a whole to determine if there is a common cause.
- Do not confuse the cache directory card, which is a small rectangular card with round, button-shaped batteries, for a removable cache card. The nonvolatile write cache memory is integrated into the controller. The write cache memory itself is battery-backed by the large, rechargeable cache battery pack. The cache directory card contains only a secondary copy of the write cache directory and no cache data. Do not remove this card except under specific recovery cases as described in the Isolation Procedures.
- Do not unplug or exchange a cache battery pack without following the procedures as outlined in this section or in the Isolation Procedures. Failure to follow these procedures might result in data loss.

## Rechargeable battery maintenance

Rechargeable battery maintenance tasks include displaying rechargeable battery information, forcing a rechargeable battery error, and replacing the rechargeable cache battery pack.

### Displaying rechargeable battery information

Use this procedure to view information about the controller rechargeable battery using the Hardware Service Manager in the IBM® i operating system.

1. Sign on to the system with at least service level authority.
2. On the command line, type `strsst`. Press Enter.
3. On the System Service Tools (SST) Sign On display, type your service tools user ID and service tools password. Press Enter.
4. On the System Service Tools (SST) display, select **Start a Service Tool**. Press Enter.
  - a. On the Start a Service Tool display, select **Hardware Service Manager**. Press Enter.
  - b. On the Hardware Service Manager display, select **Work with resources containing cache battery packs**. Press Enter.
  - c. Select **Display battery information**.

Battery Information

Resource name . . . . . : DC01

Serial number . . . . . : YL3229021013

Actual type-model . . . . . : 572F-001

Unit ID . . . . . : U5094.001.10XS187

Planar ID . . . . . : CB1

Card . . . . . : C01

Battery type . . . . . : Lithium Ion (LiIon)

Battery state . . . . . : No battery warning/error

Power-on time (days) . . . . . : 215

Adjusted power-on time (days) . . . : 236

Estimated time to warning (days) . . : 673

Estimated time to error (days) . . . : 756

Concurrently maintainable :  
battery pack . . . . . : Yes

Battery pack can be safely replaced : No

The following are the fields displayed on the rechargeable battery information screen:

**Resource name**

The resource name of the selected controller.

**Serial number**

Serial number of the selected controller

**Actual type-model**

CCIN of the selected controller

**Unit ID**

Enclosure feature identifier containing the selected controller

**Planar ID**

Planar identifier containing the selected controller

**Card** Physical card slot identifier containing the selected controller

**Battery Type**

The type of rechargeable cache battery pack.

**Battery State**

Indicates if an error condition currently exists related to the rechargeable cache battery pack. The possible values for this field are:

Table 10. Battery state

No battery warning/error	Warning condition	Error condition	Unknown
No warning or error condition currently exists.	A warning condition currently exists and an error has been logged.	An error condition currently exists and an error has been logged.	Information is not available to determine whether a warning or error condition currently exists.

**Power-on time (days)**

Indicates the raw power-on time, in units of days, of the rechargeable cache battery pack.

**Adjusted power-on time (days)**

Indicates the adjusted (prorated) power-on time, in units of days, of the rechargeable cache battery pack.

**Note:** Some rechargeable cache battery packs are negatively affected by higher temperatures and thus are prorated based on the amount of time that they spend at various ambient temperatures.

**Estimated time to warning (days)**

Estimated time, in units of days, until a message is issued indicating that the replacement of the rechargeable cache battery pack must be scheduled.

**Estimated time to error (days)**

Estimated time, in units of days, until an error is reported indicating that the rechargeable cache battery pack must be replaced.

**Concurrently maintainable battery pack**

Indicates if the rechargeable cache battery pack can be replaced while the controller continues to operate.

**Battery pack can be safely replaced**

Indicates if the controller's write cache has been disabled and the rechargeable cache battery pack can be safely replaced.

**Error state**

The cache battery pack must be in an error state before you replace it.

To prevent possible data loss, the cache battery pack must be in an error state before replacing it. This ensures that all cache data is written to disk before battery replacement. Forcing the battery error results in the following:

- The system logs an error.

- Data caching becomes disabled on the selected controller.
- System performance could become significantly degraded until the cache battery pack is replaced and charging of the new battery pack has completed. The new battery pack may take several hours to charge.
- The battery pack can be safely replaced field on the controller rechargeable battery information screen indicates Yes.
- Cache data present LED stops flashing. See the feature descriptions and the figures in the Replacing a battery pack section to determine if your adapter has a cache data present LED and the location of the LED.

This error state requires replacement of the cache battery. Ensure that you have the correct type and quantity of cache battery packs to do the replacement. To resume normal operations, replace the cache battery pack.

The cache battery pack for the 572F storage I/O adapter and the 575C auxiliary cache adapter is contained in a single battery field replacement unit (FRU) that is physically located on the 575C auxiliary cache adapter. The functions of forcing a battery pack error and starting the adapter cache on either adapter in the card set results in the same function automatically being performed on the other adapter in the card set.

### Forcing a rechargeable battery error

Use this procedure to place the controller's rechargeable battery into an error state using the Hardware Service Manager in the IBM i operating system.

To force the cache battery pack into an error state, do the following steps on the system or partition that is using the adapter.

1. Sign on to the system with at least service level authority.
2. On the command line, type `strsst`. Press Enter.
3. On the System Service Tools (SST) Sign On display, type your service tools user ID and service tools password. Press Enter.
4. On the System Service Tools (SST) display, select **Start a Service Tool**. Press Enter.
  - a. On the Start a Service Tool display, select **Hardware Service Manager**. Press Enter.
  - b. On the hardware Service Manager display, select **Work with resources containing cache battery packs**. Press Enter.
  - c. On the Work with Resources containing Cache Battery Packs display, select **Force battery pack into error state for the I/O card**. Press Enter.
  - d. On the **Force Battery Packs Into Error State** display, verify that the correct I/O adapter has been selected, and press the function key that confirms your choice.
  - e. Return to the **Work with Resources containing Cache Battery Packs** display and select **Display battery information** and verify that the **Battery pack can be safely replaced** field indicates yes. If it does not indicate yes, contact your next level of support before continuing this procedure.
5. Verify that the cache data present light emitting diode (LED) is no longer flashing before replacing the cache battery pack. See the feature descriptions and the figures in the PCI adapters section to determine if your adapter has a cache data present LED and the location of the LED.
6. Replace the cache battery pack using the procedure that sent you here. For a list of replacement procedures, see PCI adapters.
7. Restart the adapter's write cache by doing the following:
  - a. Return to the **Work with Resources containing Cache Battery Packs display** and select the **Start IOA cache**. Press Enter.
  - b. Ensure that you get the message Cache was started.



## Replacing a battery pack

Follow these guidelines before you replace the battery pack.

**Note:** When replacing the cache battery pack, the battery must be disconnected for at least 60 seconds before you connect the new battery. This duration is the minimum amount of time that is needed for the card to recognize that the battery has been replaced.

**Note:** The battery is a lithium ion battery. To avoid possible explosion, do not burn. Exchange only with the IBM-approved part. Recycle or discard the battery as instructed by local regulations. In the United States, IBM has a process for the collection of this battery. For information, call 1-800-426-4333. Have the IBM part number for the battery unit available when you call.

**Attention:** To prevent data loss, if the cache battery pack is not already in the error state, follow the steps described in Forcing a rechargeable battery error before proceeding. If the cache data present LED is flashing, do not replace the cache battery pack or data will be lost. See the feature descriptions and the figures in the following sections to determine if your adapter has a cache data present LED and the location of the LED.

**Attention:** Static electricity can damage this device and your system unit. To avoid damage, keep this device in its antistatic protective bag until you are ready to install it. To reduce the possibility of electrostatic discharge, read the following precautions:

- Limit your movement. Movement can cause static electricity to build up around you.
- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.
- While the device is still in its antistatic package, touch it to an unpainted metal part of the system unit for at least 2 seconds. (This duration drains static electricity from the package and from your body.)
- Remove the device from its package and install it directly into your system unit without setting it down. If it is necessary to set the device down, place it on its static-protective package. (If your device is a controller, place it component-side up.) Do not place the device on your system unit cover or on a metal table.
- Take additional care when handling devices during cold weather, as heating reduces indoor humidity and increases static electricity.

## Maintaining the rechargeable battery on the CCIN 574E SAS adapters

Learn about the rechargeable battery maintenance tasks that include displaying rechargeable battery information, forcing a rechargeable battery error, and replacing the rechargeable cache battery pack.

**Attention:** Use these procedures only if directed from an isolation procedure or a maintenance analysis procedure (MAP).

The following list provides references to information about maintaining the rechargeable battery on the SAS adapters for systems or logical partition that run on the AIX®, IBM i, or Linux operating systems:

- For information about maintaining the rechargeable battery for systems that run on the AIX operating system, see [Maintaining the rechargeable battery on the CCIN 574E SAS adapters](#).
- For information about maintaining the rechargeable battery for systems that run on the IBM i operating system, see [Rechargeable battery maintenance](#).
- For information about maintaining the rechargeable battery for systems that run on the Linux operating system, see [Rechargeable battery maintenance](#).

## Replacing a 574E concurrent maintainable battery pack

Use this procedure to replace the concurrent maintainable battery pack on adapter type CCIN 574E.

**Attention:** Before continuing with this procedure, determine that it is safe to replace the cache battery pack. See “Maintaining the rechargeable battery on the CCIN 574E SAS adapters” on page 41. It is safe to replace the cache battery pack when Yes is displayed next to Battery pack can be safely replaced. If the cache data present LED is flashing, do not replace the cache battery pack or data will be lost. See the feature comparison tables for PCIe and PCI-X cards and the following figures to determine whether your adapter has a cache data present LED and its location.

To replace a 574E concurrent maintainable battery pack, complete the following steps:

1. Using the following illustration to locate the battery components, verify that the cache data present LED (C) is not flashing. If it is flashing, do not continue; return to **Forcing a rechargeable battery error**.

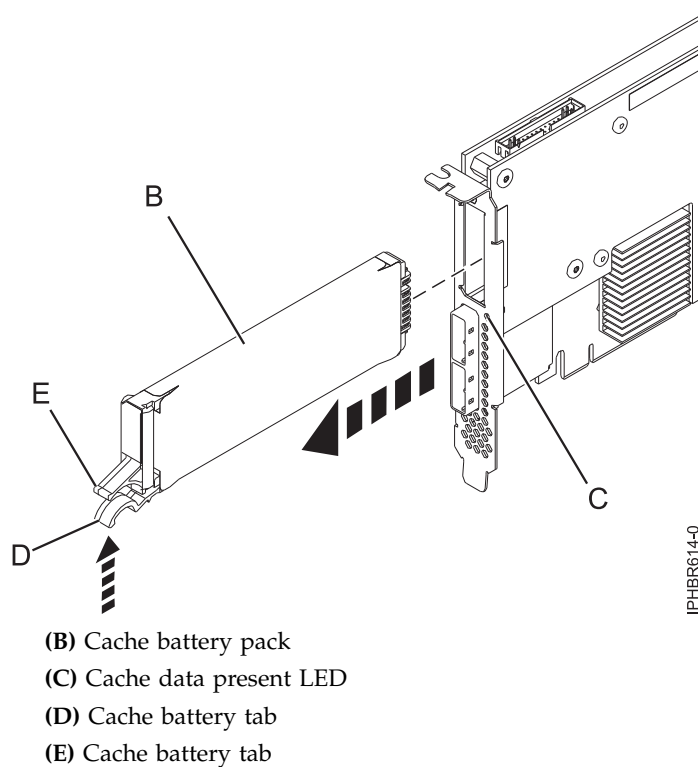


Figure 30. Replacing the 574E cache battery

2. Squeeze tab (D) against tab (E) to disengage the battery retaining tab, pull out the cache battery pack (B), and remove it from the controller.

**Important:** Use caution when squeezing tabs because the plastic parts can be fragile.

**Note:** Ensure that the cache battery pack is disconnected for at least 60 seconds before you connect the new battery. This duration is the minimum amount of time that is needed for the card to recognize that the battery has been replaced.

3. Install the new cache battery pack by reversing this procedure. Ensure that the replacement cache battery pack is fully seated.
4. Restart the write cache of the adapter by completing the following steps:
  - a. Return to the **Work with Resources containing Cache Battery Packs display** and select the **Start IOA cache**. Press Enter.

- b. Ensure that you get the message Cache was started.

## Separating the 572F/575C card set and moving the cache directory card

When the maintenance procedures direct you to separate the 572F/575C card set and move the cache directory card on a 572F controller for recovery purposes, carefully follow this procedure.

**Important:** To avoid loss of cache data, do not remove the cache battery during this procedure.

### Notes:

- This procedure should only be performed if directed from an isolation procedure or a maintenance analysis procedure (MAP).
- If you are removing the adapter from a double-wide cassette, go to the procedures in your system unit's service information for removing a double-wide adapter from a double-wide cassette.

**Attention:** All cards are sensitive to electrostatic discharge. See Handling static-sensitive devices before beginning this procedure.

To separate the 572F/575C card set and move the cache directory card, complete the following steps.

1. Label both sides of the card before separating them.
2. Place the 572F/575C card set adapter on an ESD protective surface and orient it as shown in Figure 31.

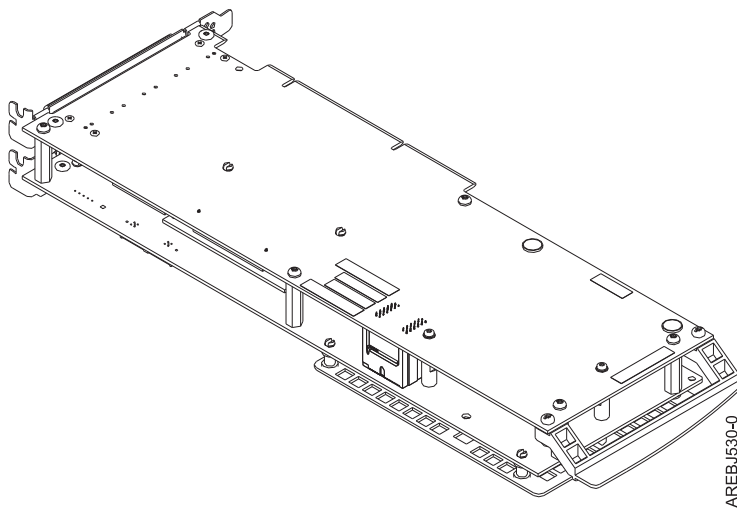


Figure 31. 572F/575C card set adapter

3. To prevent possible card damage, loosen all five retaining screws **C** before removing any of them. After all five retaining screws have been loosened, remove the screws **C** from the 572F storage adapter.

**Important:** Failure to loosen all five retaining screws prior to removing any of the screws can result in damage to the card.

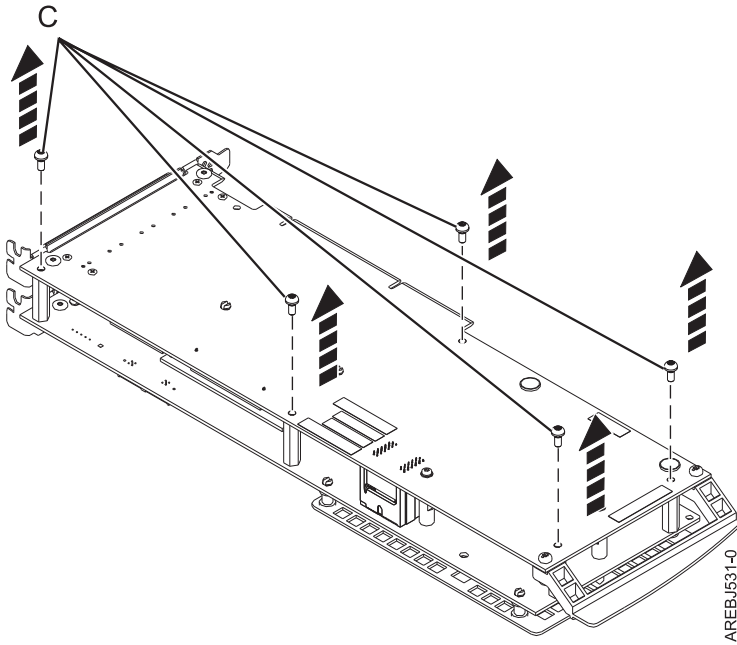


Figure 32. Location of screws on the 572F/575C card set adapter

**C** Screws

4. Grasp the 572F and 575C adapters close to the interconnect connector **A**, as shown in the following figure, and carefully pull the connector apart; then, set the adapters on the ESD protective surface.

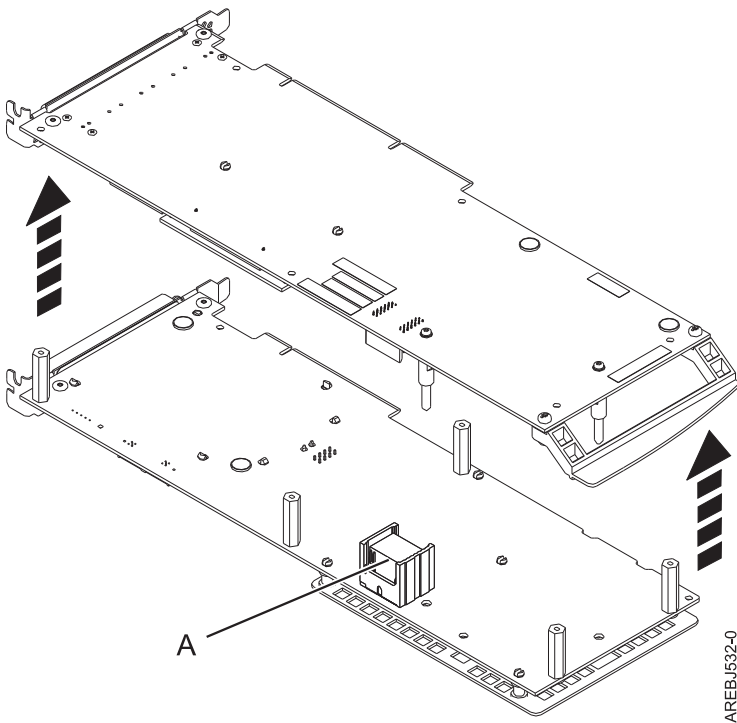


Figure 33. Location of interconnect connector on the 572F/575C card set adapter

**A** Interconnect connector

5. Turn the 572F storage adapter over so the components are facing up. Locate the cache directory card **D** on the 572F storage adapter. The cache directory card is the small rectangular card mounted on

the I/O card.

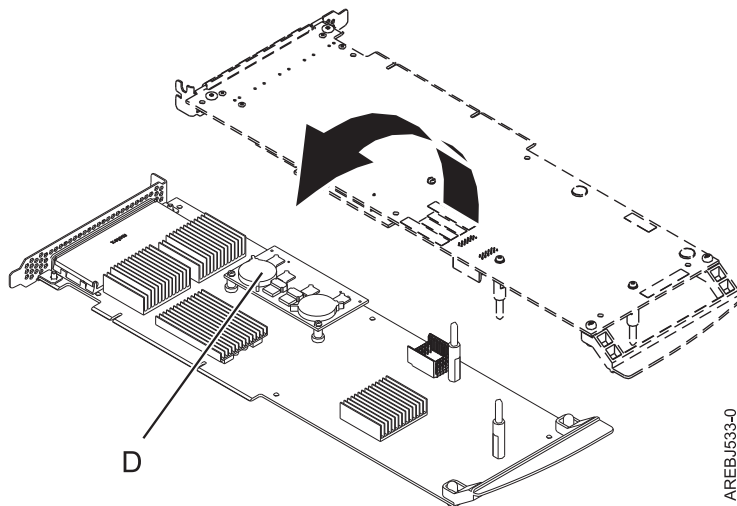


Figure 34. Cache directory card

**D** Cache directory card

6. Unseat the connector on the cache directory card by wiggling the two corners that are farthest from the mounting pegs. To disengage the mounting pegs, pivot the cache directory card back over the mounting pegs.

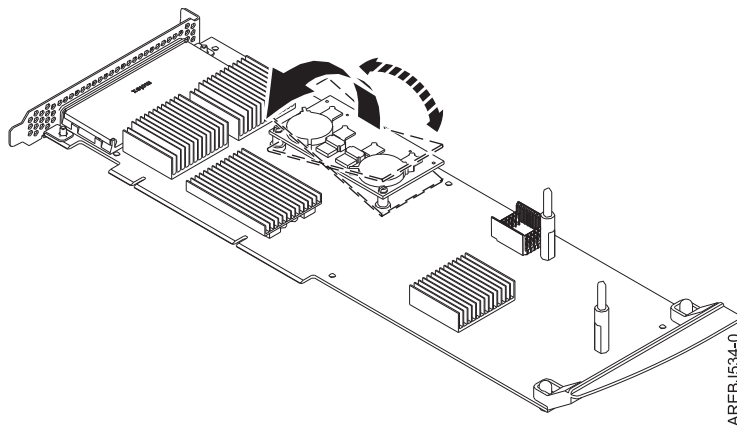


Figure 35. Unseating the connector

7. Move the cache directory card to the replacement 572F storage adapter and seat it on the connector and mounting pegs.
8. To reassemble the cards, perform the preceding procedure in reverse order. When connecting the two adapters together, carefully align guide pins **B** on each side of the interconnect connector **A**. After the connector is seated correctly, apply pressure to completely squeeze the connector together. To prevent possible card damage, insert all five screws **C** before tightening any of them.

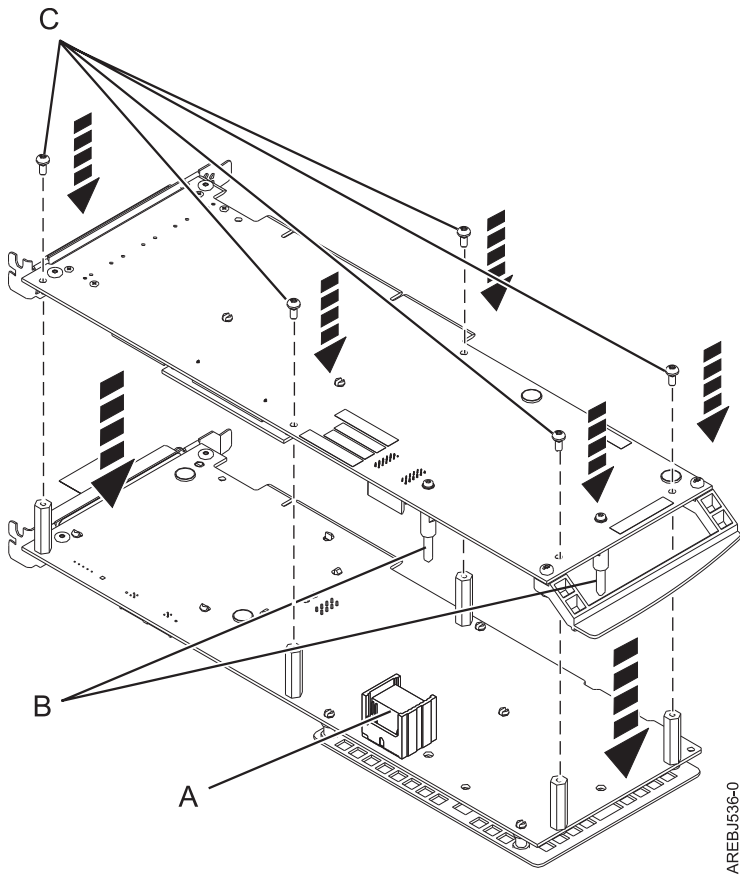
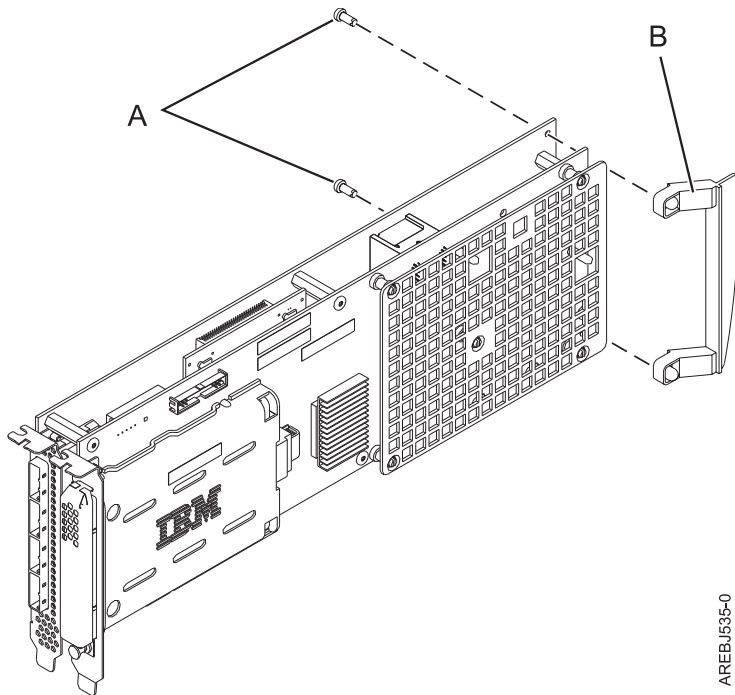


Figure 36. Reassembling the cards

- A** Interconnect connector
- B** Guide pins
- C** Screws

9. Cassette installations only: If you are installing the 572F/575C card set adapter into a cassette, perform the following steps:
  - a. Remove the adapter handle **B** as shown in Figure 37 on page 47.



AREB1635-0

Figure 37. Cassette adapter handle attachment

- A** Push-rivets
- B** Adapter handle

- b. If you removed the double-wide PCI adapter from a cassette in the beginning of this procedure, reinstall the adapter into the double-wide cassette to complete the installation. See the procedures in your system unit's service information for installing a double-wide adapter in a double-wide cassette.

10. Return to the procedure that sent you here. **This ends this procedure.**

### Replacing an SSD module on the PCIe RAID and SSD SAS adapter

Use this procedure to replace an integrated solid-state drive (SSD) on a PCIe serial-attached SCSI (SAS) RAID and SSD Adapter.

Complete the following steps to perform a nonconcurrent SSD replacement on a PCIe SAS RAID and SSD adapter:

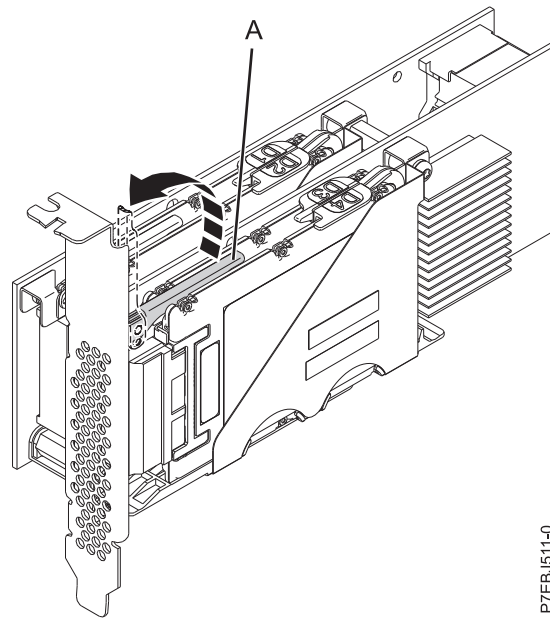
**Note:** When an SSD on the PCIe adapter fails, the entire adapter must be removed from the system prior to replacing the individual SSD. See the documentation for your system for removing a PCI RAID and SSD SAS adapter from the system.

1. Remove the adapter from the system. See PCI adapters.

**Important:** Ensure to follow the concurrent or nonconcurrent replacement procedures depending on the type of data protection enabled:

- If the data protection is RAID, use the nonconcurrent procedure.
  - If the data protection is mirrored (card to card) and the SSD is located in the 5802 or 5803 expansion unit, use the concurrent procedure.
  - If the data protection is mirrored (card to card) but the SSD is not located in the 5802 or 5803 expansion unit, use the nonconcurrent procedure.
2. Place the adapter on a surface that is electrostatic-discharge protected.
  3. Lift the lever (**A**) for the SSD that you are replacing to a fully vertical position.

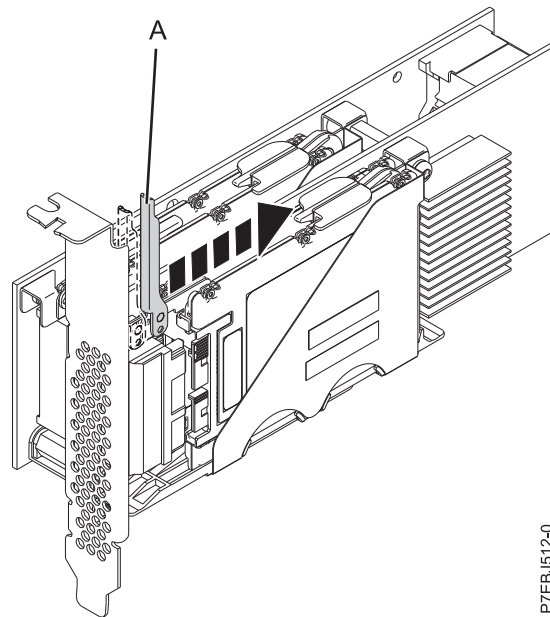
**Note:** Each of the levers (A) undocks two SSDs at a time.



P7EJ511-0

Figure 38. Lifting the levers

4. With the lever (A) in the vertical position, firmly push the lever (A) away from the adapter tailstock to undock the two SSDs from their connectors.

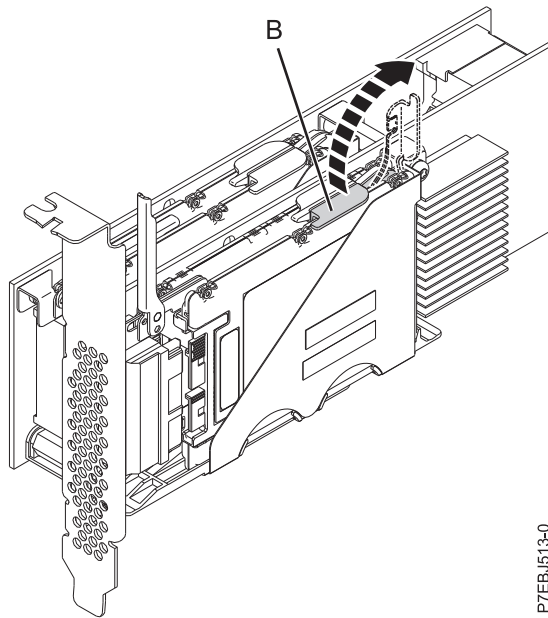


P7EJ512-0

Figure 39. Pushing the lever away from the adapter tailstock

5. Lift the single device retaining latch (B) for only the SSD that you are replacing by first moving it away from the center of the SSD divider and then lifting it to a fully vertical position.

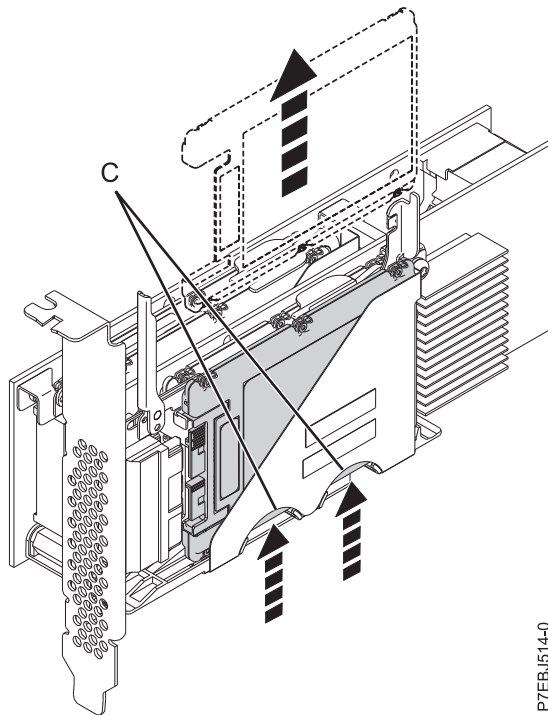




P7EBJ513-0

Figure 40. Lifting the device retaining latch

6. Using the device access finger openings (C), push the single SSD that you are replacing out of the device holder.



P7EBJ514-0

Figure 41. Pushing the SSD that is being replaced

7. Grasp the SSD and continue to remove it from the adapter.
8. Install the replacement SSD by performing steps 2 on page 47 to 7.

**Note:** Ensure that the device retaining latch and undocking lever are in the fully closed position.

9. Reinstall the adapter in the system. See PCI adapters.

10. If you replaced the SSD as a part of another procedure, return to that procedure.

## Viewing SAS fabric path information

Use the Hardware Service Manager to view details of the SAS fabric information.

Perform the following steps to view the SAS fabric information:

1. Start the Hardware Service manager and page forward to the second selection screen.
2. Select **SAS Resource Path Information**.
3. Enter **1** in front of the required adapter resource to display resource path information. The screen displayed looks similar to the following example:

```
SAS Resource Path Information
Type option, press Enter.
  1=Display SAS fabric path graphical view

Opt Resource Name      Path 1 Status   Path 2 Status
DMP001                Operational     Operational
DMP003                Operational     Operational
DMP015                Operational     Operational
DMP005                Operational     Operational
DMP009                Operational     Operational
DMP017                Operational     Operational
DMP019                Operational     Operational
DMP021                Operational     Operational
DMP007                Operational     Operational
DMP011                Operational     Operational
DMP013                Operational     Operational
DMP024                Operational     Operational
DMP026                Operational     Operational
DMP027                Operational     Operational
DMP029                Operational     Operational

More...
  F3=Exit      F5=Refresh    F6=Print      F12=Cancel
P7ED5602-0
```

*Figure 42. SAS resource path information*

Selecting a device displays the details of all the nodes on each path between the controller and the device. Following is an example for Display SAS fabric path graphical view.

SAS Fabric Path Graphical View

```

Adapter
DC03
Path Active      : Yes      Path Active      : Yes
Path State       : Operational Path State       : Operational
-----+-----+
SAS Address      : 5005076C07377C01 || SAS Address      : 5005076C07377C01
Port             : 0         || Port             : 2
Status           : Operational || Status           : Operational
Info            : 3.0 GBPS   || Info            : 3.0 GBPS
-----+-----+
|| ||
-----+-----+
Expander         : 1         || Expander         : 1
-----+-----+
SAS Address      : 500A0B8370F9D000 || SAS Address      : 500A0B82FC269000
Port             : 22        || Port             : 22
Status           : Operational || Status           : Operational
-----+-----+
SAS Address      : 500A0B8370F9D000 || SAS Address      : 500A0B82FC269000
Port             : 5         || Port             : 5
Status           : Operational || Status           : Operational
Info            : 3.0 GBPS   || Info            : 3.0 GBPS
-----+-----+
|| ||
-----+-----+
Device           || Device
-----+-----+
SAS Address      : 5000CCA00357B5CF || SAS Address      : 5000CCA00397B5CF
Port             : 0         || Port             : 1
Status           : Operational || Status           : Operational
Info            : 3.0 GBPS   || Info            : 3.0 GBPS
-----+-----+
SAS Address      : 5000CCA00317B5CF || SAS Address      : 5000CCA00317B5CF
Status           : Operational || Status           : Operational
-----+-----+
Device Lun
DMP003
-----+-----+
Bottom
F3=Exit      F5=Refresh    F6=Print      F12=Cancel
F11=SAS Fabric Path Data View

```

P7ED5501-0

Figure 43. SAS fabric path graphical view

An alternative view can be displayed by selecting F11 (SAS Fabric Path Data View). Following is an example of SAS Fabric Path Data View.

SAS Fabric Path Data View

```

Adapter      Adapter Port  Path Active  Path State  Device
DC03         0             Yes          Operational DMP003
DC03         2             Yes          Operational DMP003

Node  SAS Address      Port Type  Port  Status  Info
1     5005076C07377C01 Adapter   0     Operational 3.0 GBPS
2     500A0B8370F9D000 Expander 22    Operational 3.0 GBPS
3     500A0B8370F9D000 Expander 5     Operational 3.0 GBPS
4     5000CCA00357B5CF Device   0     Operational 3.0 GBPS
5     5000CCA00317B5CF Device Lun 5     Operational Status 0

1     5005076C07377C01 Adapter   2     Operational 3.0 GBPS
2     500A0B82FC269000 Expander 22    Operational 3.0 GBPS
3     500A0B82FC269000 Expander 5     Operational 3.0 GBPS
4     5000CCA00397B5CF Device   1     Operational 3.0 GBPS
5     5000CCA00317B5CF Device Lun 5     Operational Status 0

F3=Exit      F5=Refresh    F6=Print      F12=Cancel

```

P7ED5504-0

Figure 44. SAS fabric path data view

The possible status values for the SAS Fabric Path Data View and the SAS Fabric Path Graphical View are defined in the following table.

Table 11. Possible status values

Status	Description
Operational	No problem detected

Table 11. Possible status values (continued)

Status	Description
Degraded	The SAS node is degraded
Failed	The SAS node is failed
Suspect <sup>1</sup>	The SAS node is suspect of contributing to a failure
Missing <sup>1</sup>	The SAS node is no longer detected by controller
Not valid	The SAS node is incorrectly connected
Unknown	Unknown or unexpected status

<sup>1</sup> This status is an indication of a possible problem; however, the controller is not always able to determine the status of a node. The node can have this status even when the status or node is not displayed.

### Example: Using SAS fabric path information

This data becomes helpful in determining the cause of configuration or SAS fabric problems.

The following example assumes a cascaded disk enclosure with a broken connection on one path between the cascaded enclosures.

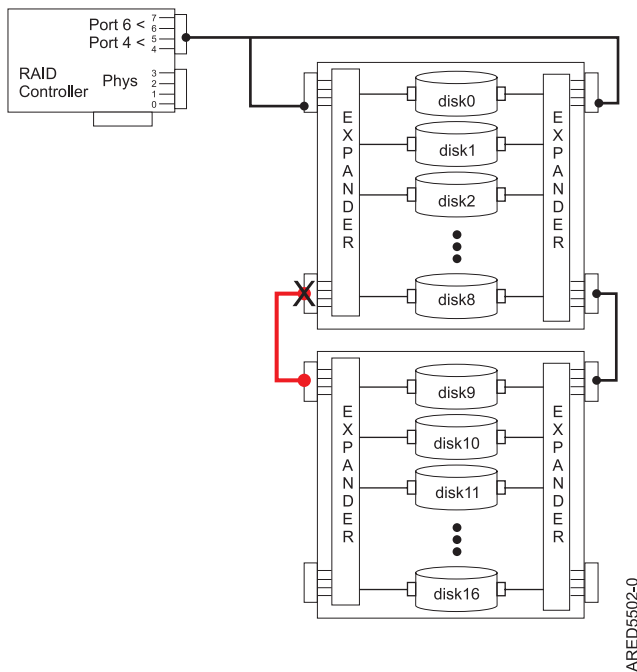


Figure 45. Cascaded disk enclosure

The state of all paths to all devices displays information similar to the following.

SAS Resource Path Information

Type option, press Enter.

1=Display SAS fabric path graphical view

Opt	Resource Name	Path 1 Status	Path 2 Status
	DMP001	Operational	Operational
	DMP002	Operational	Operational
	DMP003	Operational	Operational
	DMP012	Operational	Operational
	DMP013	Failed	Operational
	DMP014	Failed	Operational
	DMP015	Failed	Operational
	DMP024	Failed	Operational
	D01	Operational	
	D02	Operational	
	D03	Failed	
	D04	Operational	

P7ED5505-0

For Display SAS fabric path graphical view, choosing one of the devices with the Failed path displays information similar to the following.

Adapter DC01			
Path Active	: No	Path Active	: Yes
Path State	: Failed	Path State	: Operational
SAS Address	: 5005076C07434609	SAS Address	: 5005076C07434609
Port	: 4	Port	: 6
Status	: Operational	Status	: Operational
Info	: 3.0 GBPS	Info	: 3.0 GBPS
Expander : 1		Expander : 1	
SAS Address	: 500A0B81E1AA9000	SAS Address	: 500A0B81E1B07000
Port	: 20	Port	: 20
Status	: Operational	Status	: Operational
Info	: 3.0 GBPS	Info	: 3.0 GBPS
SAS Address	: 0000000000000000	SAS Address	: 500A0B81E1B07000
Port	: FF	Port	: 16
Status	: Missing	Status	: Operational
Info	: Status 0	Info	: 3.0 GBPS
		Expander : 2	
		SAS Address	: 500A0B8245C4A000
		Port	: 16
		Status	: Operational
		Info	: 3.0 GBPS
		SAS Address	: 500A0B8245C4A000
		Port	: 1
		Status	: Operational
		Info	: 3.0 GBPS
		Device	
		SAS Address	: 5000CCA003A63941
		Port	: 1
		Status	: Operational
		Info	: 3.0 GBPS
SAS Address	: 5000CCA003263941	SAS Address	: 5000CCA003263941
Status	: Missing	Status	: Operational
Device Lun DMP013			

P7ED5505-0

For SAS Fabric Path Data View, pressing the F11 key displays information similar to the following.

SAS Fabric Path Data View

Adapter	Adapter Port	Path Active	Path State	Device
DC01	4	No	Failed	DMP013
DC01	6	Yes	Operational	DMP013

Node	SAS Address	Port Type	Port	Status	Info
1	5005076C07434609	Adapter	4	Operational	3.0 GBPS
2	500A0B81E1AA9000	Expander	20	Operational	3.0 GBPS
3	500A0B81E1AA9000	Expander	FF	Missing	Status 0
4	5000CCA003263941	Device Lun	1	Missing	Status 0
1	5005076C07434609	Adapter	6	Operational	3.0 GBPS
2	500A0B81E1B07000	Expander	20	Operational	3.0 GBPS
3	500A0B81E1B07000	Expander	16	Operational	3.0 GBPS
4	500A0B8245C4A000	Expander	16	Operational	3.0 GBPS
5	500A0B8245C4A000	Expander	1	Operational	3.0 GBPS
6	5000CCA003A63941	Device	1	Operational	3.0 GBPS
7	5000CCA003263941	Device Lun	1	Operational	Status 0

P7ED5506-0

## SAS address and physical location information

Many hardware error logs identify the location of a physical device, such as a SAS disk, using the *unit address*.

### Unit Address Format prior to IBM i 7.1 Technology Refresh PTF Group, Level 8

The unit address format is *cce $ll$ FF*, where:

- *cc* identifies the controller port to which the device, or device enclosure, is attached.
- *ee* is the expander port to which the device is attached. When a device is not connected to a SAS expander, the expander port is set to zero.

**Note:** Generally, the range of the expander port is 00 to 3F hex. A value greater than 3F indicates there are two expanders (for example, cascaded expanders) between the controller and device. For example, a device connected through a single expander might show an expander port of 1A, while a device connected through a cascaded expander might show an expander port of 5A (that is, a value of 40 hex added to the expander port indicates the presence of a cascaded expander), but in both cases, the device is connected off port 1A of the expander.

- *FF* indicates that the expander port is not known.
- *ll* is the logical unit number (LUN) of the device. A value of FF indicates the LUN is not known.

A resource can identify a physical device or it can identify other SAS components. For example:

- FFFFFFFF indicates the identity of the device is not known or indicates a SAS RAID controller.
- ccFFFFFF identifies only a controller SAS port.
- cce $ll$ FF identifies the controller port, expander port, and LUN of an attached device.

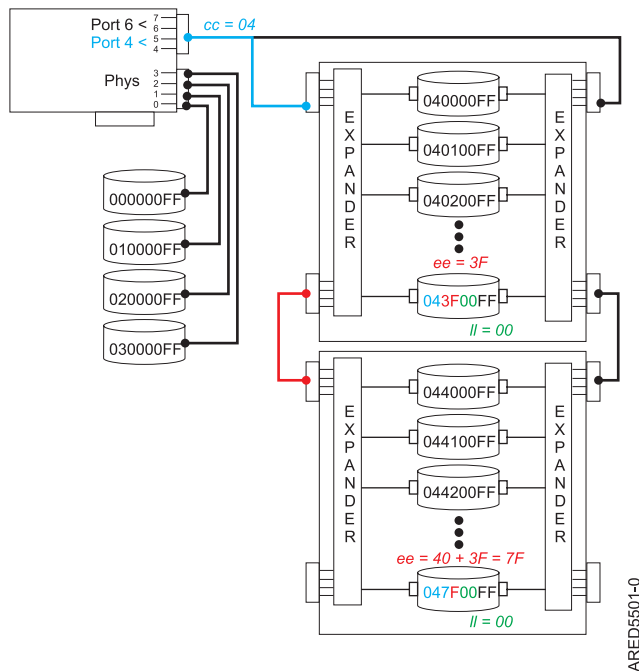


Figure 46. Example of SAS subsystem unit addresses

### Unit Address Format subsequent to IBM i 7.1 Technology Refresh PTF Group, Level 8

The unit address format is *ttccess*, where:

- *tt* identifies the type of device.

**Note:** A value of 00 indicates the device is a physical device (HDD or SSD). A value other than 00 indicates the device is a virtual IOP or a SAS RAID controller.

- *L* is the logical unit number (LUN) of the device
- *cc* identifies the controller's port to which the device, or device enclosure, is attached. Generally, the controller port is 00 to 7F hex. The upper bit of *cc* indicates the LUN of the device. For example, a device with LUN = 1 and attached off controller port = 4 would have a *cc* = 84 hex.
- *ee* is the expander port to which the device, or cascaded expander, is attached. When a device is not connected to a SAS expander, the expander port is set to FF. A value of FF indicates the expander port is not known or no expander exists.
- *ss* is the cascaded expander port to which the device is attached. A value of FF indicates the cascaded expander port is not known or no cascaded expander exists.

A resource can identify a physical device or it can identify other SAS components. For example:

- 00FFFFFF indicates the identity of the device is not known.
- 00ccFFFF identifies only a controller's SAS port or a directly attached device.
- 00cceeFF identifies the controller port and expander port of an attached device.
- 00cceess identifies the controller port, expander port, and cascaded expander port of an attached device.
- FFFFFFFF indicates a SAS RAID controller.
- FFFFFFFF indicates a virtual IOP.

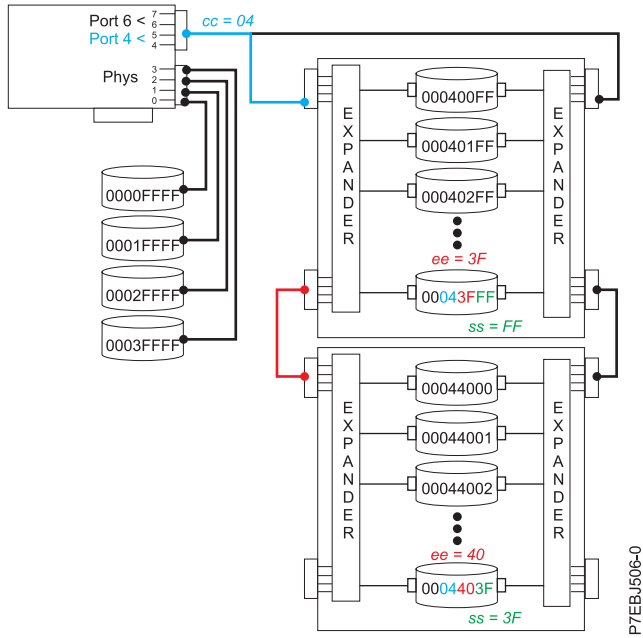


Figure 47. Example of SAS subsystem unit addresses

### Unit Address for PCIe controller 57CD

The following figure depicts the unit addresses for the CCIN 57CD PCIe SAS RAID and SSD Adapter.

**Note:** Each of the integrated SSDs is directly connected and thus the expander port is equal to zero in the unit address. Also, the LUN of each device is zero.

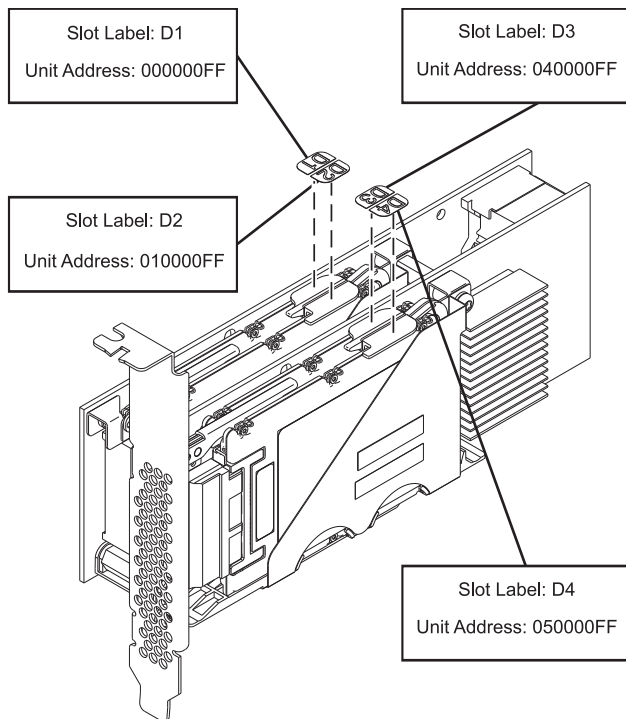


Figure 48. SAS unit addresses for CCIN 57CD PCIe SAS RAID and SSD Adapter 3 Gb x8



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## Electronic emission notices

When attaching a monitor to the equipment, you must use the designated monitor cable and any interference suppression devices supplied with the monitor.

## Class A Notices

The following Class A statements apply to the IBM servers that contain the POWER8 processor and its features unless designated as electromagnetic compatibility (EMC) Class B in the feature information.

## Federal Communications Commission (FCC) Statement

**Note:** 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, may 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 may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

## Industry Canada Compliance Statement

CAN ICES-3 (A)/NMB-3(A)

## European Community Compliance Statement

This product is in conformity with the protection requirements of 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.

European Community contact:  
IBM Deutschland GmbH  
Technical Regulations, Abteilung M456  
IBM-Allee 1, 71139 Ehningen, Germany  
Tel: +49 800 225 5426  
email: [halloibm@de.ibm.com](mailto:halloibm@de.ibm.com)

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

## VCCI Statement - Japan

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

The following is a summary of the VCCI Japanese statement in the box above:

This is a Class A product based on the standard of the VCCI Council. If this equipment is used in a domestic environment, radio interference may occur, in which case, the user may be required to take corrective actions.

## 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

**Electromagnetic Interference (EMI) Statement - People's Republic of China**

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。

Declaration: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may need to perform practical action.

**Electromagnetic Interference (EMI) Statement - Taiwan**

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。

The following is a summary of the EMI Taiwan statement above.

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

**IBM Taiwan Contact Information:**

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

## **Electromagnetic Interference (EMI) Statement - Korea**

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

## **Germany Compliance Statement**

### **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:  
IBM Deutschland GmbH  
Technical Relations Europe, Abteilung M456  
IBM-Allee 1, 71139 Ehningen, Germany  
Tel: +49 (0) 800 225 5426  
email: HalloIBM@de.ibm.com

Generelle Informationen:

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

## Electromagnetic Interference (EMI) Statement - Russia

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

### Class B Notices

The following Class B statements apply to features designated as electromagnetic compatibility (EMC) Class B in the feature installation information.

### Federal Communications Commission (FCC) Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an IBM-authorized dealer or service representative for help.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. Proper cables and connectors are available from IBM-authorized dealers. IBM is not responsible for any radio or television interference caused by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate this equipment.

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

### Industry Canada Compliance Statement

CAN ICES-3 (B)/NMB-3(B)

### European Community Compliance Statement

This product is in conformity with the protection requirements of 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.

European Community contact:  
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取扱説明書に従って正しい取り扱いをして下さい。 VCCI-B

## Japan Electronics and Information Technology Industries Association Statement

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

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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

### IBM Taiwan Contact Information

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

### Germany Compliance Statement

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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.

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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  
Armonk, New York 10504

Tel: 914-499-1900

Der verantwortliche Ansprechpartner des Herstellers in der EU ist:

IBM Deutschland GmbH

Technical Relations Europe, Abteilung M456

IBM-Allee 1, 71139 Ehningen, Germany

Tel: +49 (0) 800 225 5426

email: HalloIBM@de.ibm.com

Generelle Informationen:

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

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