COVER Book Cover

IBM SSA RAID Cluster Adapter
for PC Servers

Installation and User's Guide

Document Number S96H-9839-01

Part Number 02L7634

ABSTRACT Abstract

This book is intended for a network administrator-that is, the individual responsible for configuring, maintaining, managing, and troubleshooting a PC server. It includes information about installing and using the SSA RAID Cluster Adapter, discusses disk-array technology, and describes tasks associated with disk arrays.

NOTICES Notices

+--- **Note!** ----------+
¦ ¦
¦ Before using this information and the product it supports, be sure ¦
¦ to read the general information under "Notices" in topic D.2. ¦
¦ ¦
+---------+

EDITION Edition Notice

Second Edition (October 1997)

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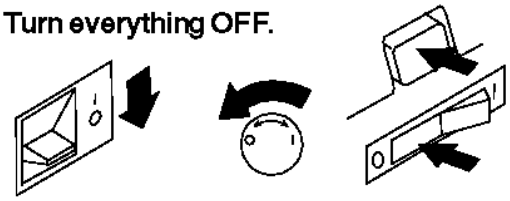
FRONT_1 Safety Information

DANGER:

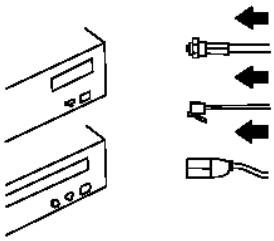
Electrical current from power, telephone, and communication cables is hazardous. To avoid shock hazard, connect and disconnect cables as shown below when installing, moving or opening the covers of this product or attached devices. The power cord must be used with a properly-grounded outlet.

To Connect

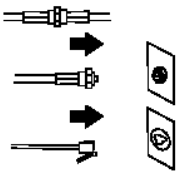
Turn everything OFF.



First, attach all cables to devices. **1**

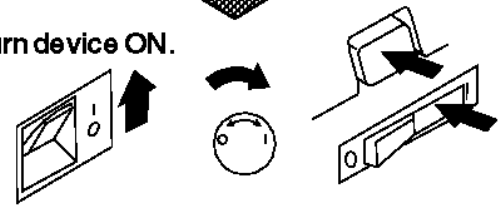


Attach signal cables to receptacles.



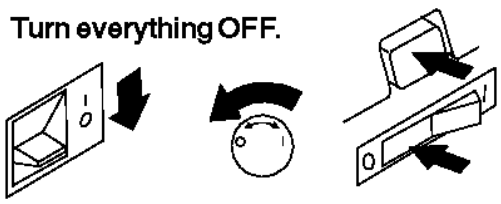
Attach power cord to outlet.

Turn device ON.



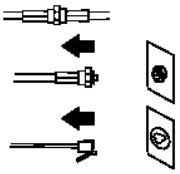
To Disconnect

Turn everything OFF.

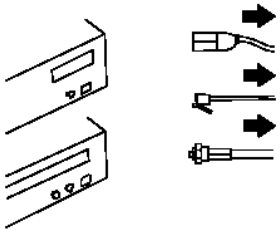


First, remove power cord from outlet. **2**

Remove signal cables from receptacles.



Remove all cables from devices.



1 In the U.K., by law, the telephone cable must be connected after the power cord.

2 In the U.K., by law, the power cord must be disconnected after the telephone line cable.

CAUTION:

A lithium battery can cause fire, explosion, or a severe burn. Do not recharge, disassemble, heat above 100°C (212°F), solder directly to the cell, incinerate, or expose cell to water. Keep away from children. Replace only with the part number specified for your system. Use of another battery might present a risk of fire or explosion.

The battery connector is polarized; do not try to reverse the polarity.

Dispose of the battery according to local regulations.

A module on the SSA RAID Cluster Adapter card contains a lithium battery.

PREFACE About This Book

This book is intended for a network administrator-that is, the individual responsible for configuring, maintaining, managing, and troubleshooting a PC server. It includes information about installing and using the SSA RAID Cluster Adapter, discusses disk-array technology, and describes tasks associated with disk arrays.

Subtopics
PREFACE.1 How This Book Is Organized.
PREFACE.2 Related Publications

PREFACE.1 How This Book Is Organized.

Chapter 1, "Introducing the SSA RAID Cluster Adapter" in topic 1.0 describes the adapter, what is provided with it, and the environments in which it works.

Chapter 2, "Installing an SSA RAID Cluster Adapter" in topic 2.0 describes how to install the adapter and its associated software.

Chapter 3, "Configuring SSA Subsystems" in topic 3.0 describes how to use the configuration utility function provided with the adapter to configure new disk arrays and add them to your system.

Chapter 4, "Dealing with Problems" in topic 4.0 describes what to do if you have trouble with your SSA subsystem.

Chapter 5, "Performing Other Configuration Tasks" in topic 5.0 describes other functions of the array utility programs supplied with the adapter.

Chapter 6, "Getting the Latest Information" in topic 6.0 describes where you can get more information about the adapter and SSA subsystems.

Appendix A, "SSA RAID Cluster Adapter Service Request Numbers" in topic A.0 provides more detail about the messages that the subsystem might give you.

Appendix C, "Introducing SSA and RAID" in topic C.0 gives background information on SSA and RAID in general.

PREFACE.2 Related Publications

Other manuals that you might find useful are:

- *SSA RAID Cluster Adapter: Maintenance Information*, S96H-9840
- *SSA RAID Cluster Adapter: Technical Reference*, SA33-3275.

1.0 Chapter 1. Introducing the SSA RAID Cluster Adapter

The IBM SSA RAID Cluster Adapter for PC Servers is a PCI bus-master adapter that serves as the interface between systems using the Peripheral Component Interconnect (PCI) architecture and devices using the Serial Storage Architecture (SSA). The SSA RAID Cluster Adapter provides for RAID-1 arrays and non-RAID disk drives.

Subtopics

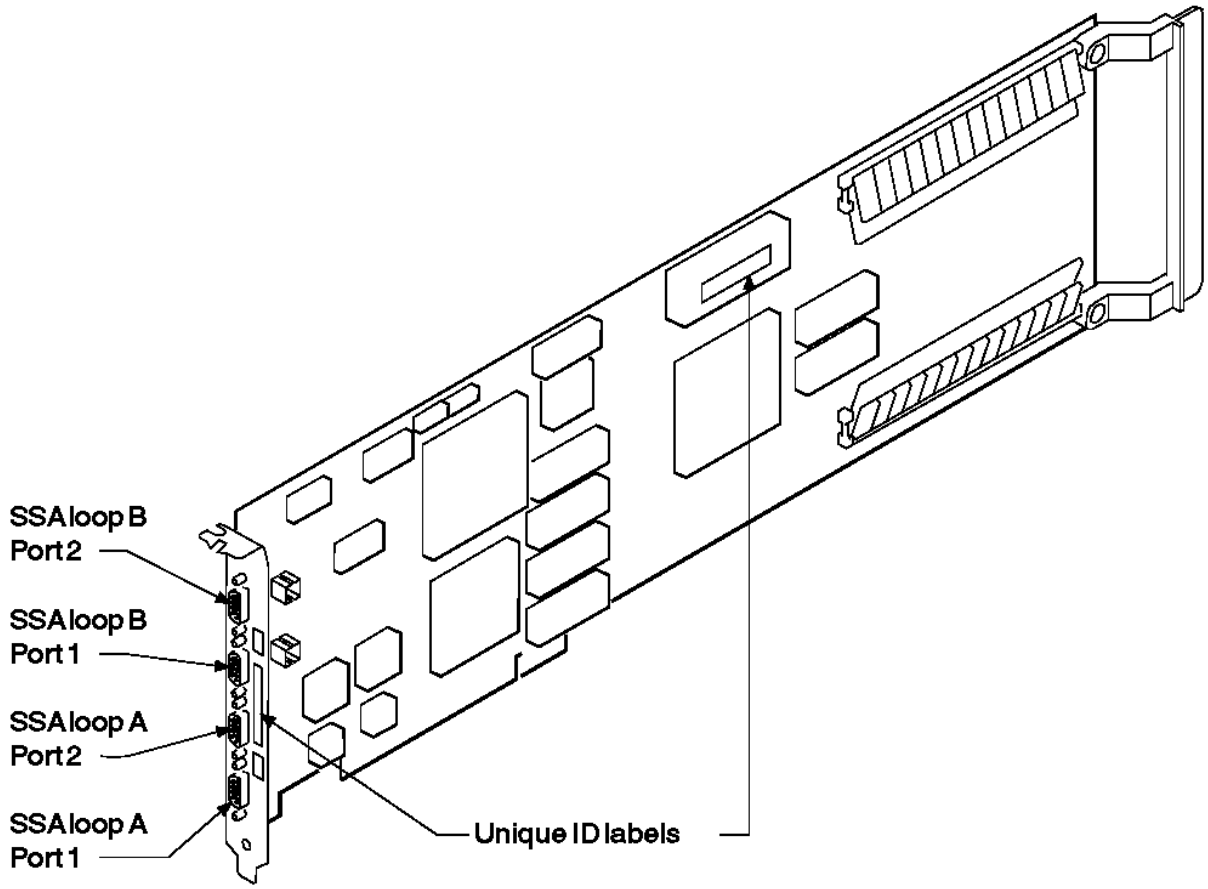
1.1 SSA

SSA is a high-performance serial-interconnect technology used to connect I/O devices and host adapters. SSA is an open standard, and SSA specifications have been approved by the SSA Industry Association and are in the process of being approved as an ANSI standard through the ANSI X3T10.1 subcommittee. SSA retains the SCSI-2 commands, queuing model, status, and sense bytes.

In SSA subsystems, transmissions to several destinations are multiplexed; the effective bandwidth is further increased by spatial reuse of the individual links. Commands are forwarded automatically from device to device along a loop until the target device is reached. Multiple commands can be travelling around the loop simultaneously.

1.2 The Adapter Card

The adapter provides 4 SSA ports for the attachment of storage devices such as hard disk drives. Each port operates at 20 MB/s full-duplex using point-to-point copper cables up to 25 meters long.



On the adapter card, there is a light next to the pair of SSA connectors (port 1 and port 2) for each SSA loop.

- The light is on continuously when power is turned on to the adapter and both ports for that loop are operational; that is, the devices connected next to the adapter in the loop have power turned on to them, are connected correctly to the adapter, and are operational.
- The light flashes continuously if one of the ports is not operational. That occurs when the cable to that port is not connected correctly or the device connected next to the adapter in the loop is not operational.
- The light is off if both ports are not operational.

On the front panel of the adapter and on one of its modules are labels on which is printed the 15-character SSA unique ID of the adapter.

1.3 RAID

RAID (redundant array of independent disks) is the technology of grouping several hard disk drives into an *array* that is defined as a single logical disk drive. This grouping technique increases data availability; if one disk fails, the system continues to run, with no operator intervention required. The failed disk can be replaced without turning off the server (*hot swapping*).

The SSA RAID Cluster Adapter provides RAID functions within the interface between your server and its disk drives. Disk drives connected to the adapter can be configured as individual drives, as members of a RAID-1 array, or as hot spares for future use in an array. The members of an array should be disk drives only; that is, having an array as a member of another array is not supported.

If you need some basic information about RAID technology, refer to Appendix C, "Introducing SSA and RAID" in topic C.0.

1.4 Clustering

Two SSA RAID Cluster Adapters can be connected in one or two SSA loops with SSA disk drives. This arrangement is known as a *cluster*. (Neither of the two servers in an SSA cluster can share disk drives with a third server.) One of the adapters is considered the *primary adapter*. By default, this is the adapter with the higher SSA Unique ID. There is an option within the configuration utility to select the other adapter as the primary adapter; "Changing the Primary Adapter" in topic 5.5 describes how to use this option. The performance of I/O operations to RAID-1 arrays is:

- Highest when the server that contains the primary adapter originates all the I/O operations
- Lowest when the server that contains the non-primary adapter originates all the I/O operations.

The primary adapter controls all the arrays that are configured on the adapters. Commands for an array from the adapter that is not the primary adapter are routed to the primary adapter to be implemented. Commands for disk drives that are not members of an array are implemented by the adapter in the server that issues the command.

If the non-primary adapter detects that the primary adapter has failed, the non-primary adapter becomes the primary adapter and takes control of all the arrays. This is called *failover*.

Appendix C, "Introducing SSA and RAID" in topic C.0 includes more detailed information about the physical configuration needed and the operation of clustered adapters.

1.5 Disk Drives Not in Arrays

Access to disk drives that are not members of arrays can be restricted to one of the adapters of a pair. "Viewing and Changing Disk Drive Access Modes" in topic 5.6 describes how to do this. Access must be restricted in this way if you want to boot from an SSA disk drive that is attached to clustered adapters.

1.6 Operating Systems

The SSA RAID Cluster Adapter, its firmware, and the software supplied with it provide attachments of SSA devices to servers running Microsoft Windows NT 4.0 Server or Microsoft Windows NT 4.0 Server/Enterprise Edition which includes Microsoft Cluster Server.

Microsoft Cluster Server handles failover between clustered adapters. The maximum number of arrays you can define is lower if you are using Microsoft Cluster Server; "Clustering Implementation" in topic C.2 gives details of this.

1.7 Before Installing the Adapter

This book is intended for a network administrator-that is, the person responsible for configuring, maintaining, managing, and troubleshooting a PC server. The administrator should be familiar with RAID and hot-swapping technology.

Attention: Do not open the static-protective bag containing the adapter until instructed to do so.

This option package contains:

- SSA RAID Cluster Adapter
- Installation and User's Guide (this book)
- Hardware Maintenance Manual Supplement
- Diskette package containing:
  - Windows NT Device Driver and Utilities diskette
  - PC-DOS Configurator and Utilities diskette.

Contact the place of purchase if any parts are missing or damaged.

1.8 Installation Requirements

To install this option, you will need the following:

- The documentation that came with your server
- A small flat-blade screwdriver.

2.0 Chapter 2. Installing an SSA RAID Cluster Adapter

To complete the installation, you must:

1. Install the adapter card

2. Connect the necessary SSA cables

3. Revise the system configuration information

4. Load an operating system, unless one is already loaded in the server

5. Load the device drivers and utility programs.

This chapter describes how to perform these tasks. How to configure disk arrays and attach them to your operating system is described in Chapter 3, "Configuring SSA Subsystems" in topic 3.0.

Subtopics

2.1 Installing the Adapter Card

Attention: Remove all power from your PC server and any attached devices before removing the cover.

To install the adapter card, refer to the documentation that came with your PC server. The *User's Handbook* for your server describes how to install an adapter. Perform the steps described in that book, ensuring that you perform the actions relating to the static-protective package correctly. When choosing a slot for the SSA RAID Cluster Adapter, take note of the following restrictions and recommendations:

- The SSA RAID Cluster Adapter card is a long PCI adapter card. On some models of PC Server, there is only one slot in which a long PCI adapter card can be installed without interference with the heat sink on the processor. In these models, it might be necessary to move previously installed adapter cards before installing the SSA RAID Cluster Adapter card.

- The SSA RAID Cluster Adapter cards in the two systems of a cluster must be installed on corresponding buses in the two system units. The *User's Handbook* for your system describes which slots are on which buses.

- If you are connecting the two servers using more than one SSA RAID Cluster Adapter in each system, the SSA adapters must be in the same priority order in the two servers. In some systems, slots with lower numbers have higher priority, in other systems, higher numbers mean higher priority; the *User's Handbook* for your system describes which rule applies.

- If you want to boot from an SSA disk drive: install the SSA adapter in a PCI slot with a higher priority than the slots used by any SCSI adapters. ("Configuring the Adapter" in topic 2.3 describes other actions you must perform to boot from an SSA disk drive.)

- In some server units, the SSA RAID Cluster Adapter card might be too large or the wrong shape to fit into some slot positions. If it helps, remove the blue handle on the SSA RAID Cluster Adapter card by removing the screws that attach it to the adapter card.

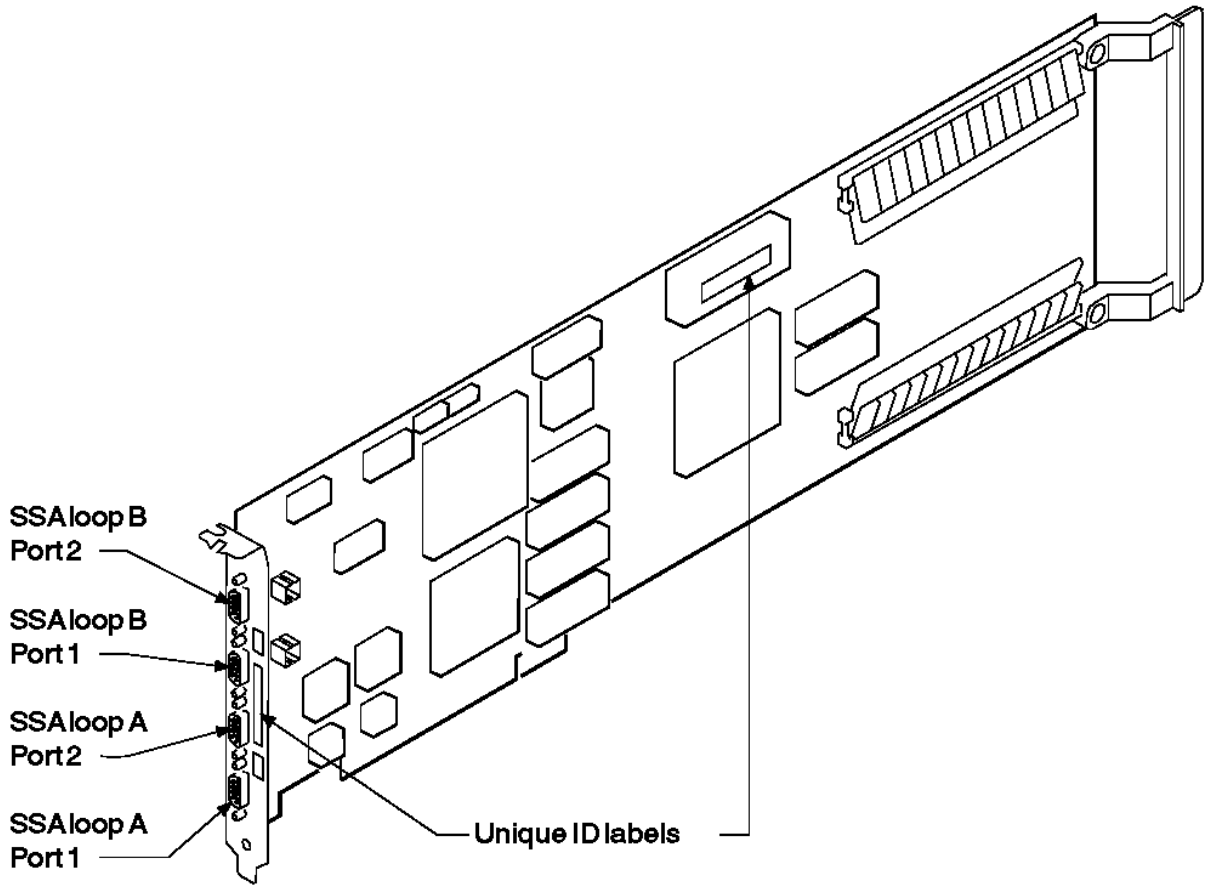
- The manufacturers or suppliers of some server units might have recommendations on which slots to use for disk-drive adapters. For details of this refer to the documentation that is supplied with the server unit. You can find more information about SSA adapters and particular servers at the addresses given in Chapter 6, "Getting the Latest Information" in topic 6.0.

2.2 Connecting the Disk Drives

Each of the 2 pairs of SSA ports can attach up to 48 dual-port devices in a closed loop. Up to two SSA RAID Cluster Adapters can be included in a loop. If two SSA adapters are in a loop and there is a second loop attached to one adapter, it must be attached to the other adapter also.

If multiple SSA RAID Cluster Adapters are installed in two systems sharing disk drives, the priority in each system of the adapters in each loop must be the same. For example, the first adapter (in slot-number order) in one system must be in an SSA loop with the first SSA adapter in the other system.

"SSA Loops and Links" in topic C.1.1 provides a general description of SSA loops and some rules for cabling valid configurations.



To connect the cables:

1. Connect the cables from the devices to the appropriate pair of connectors on the adapter card.

2. Turn the retaining screws on the SSA cable connectors fully clockwise to ensure that a good ground connection is made.

2.3 Configuring the Adapter

The SSA subsystem must be configured before you can the system can use it. To do this:

1. Turn power on to the system unit and to the devices. Your system automatically performs the PCI configuration tasks, which recognize the new adapter, during the boot process.

2. **If you are NOT going to boot from an SSA disk drive**:

   a. Ensure that the CBIOS for the SSA adapter is disabled. To do this, if the message **CBIOS is currently enabled** appears during the boot process, press the tab key.
   b. Enable the BIOS for the other storage adapters in the system (for instructions on how to do this, refer to the information for those adapters).

   If you are going to boot from an SSA disk drive:

   a. Ensure that the CBIOS for the SSA adapter is enabled. To do this, if the message **CBIOS is currently disabled** appears during the boot process, press the tab key.
   b. Before running the Windows NT Install program, run the SSA configuration utility (supplied on the PC-DOS Configurator and Utilities diskette that is supplied with the adapter) to:
      1) Attach SSA disk drives in the order required. (Chapter 3, "Configuring SSA Subsystems" in topic 3.0 describes how to do this.) The Windows NT Install program recognizes disk drives in order starting with the SSA disk drive at the top of the List of System Resources for the highest priority adapter.
      2) Set the disk drive access mode of any disk drives you select for a Boot or System partition to Private to the adapter in the server in which you will run the Windows NT Install program. "Viewing and Changing Disk Drive Access Modes" in topic 5.6 describes how to do this.
   c. If you have a problem when attempting to boot from an SSA disk drive, refer to "Basic Problems" in topic 4.1.

Continue at "Installing the Device Drivers and Utility Programs" in topic 2.4 to complete the subsystem configuration.

2.4 Installing the Device Drivers and Utility Programs

A README.TXT file on the Windows NT Device Driver and Utilities diskette provides detailed instructions on installing the device drivers and the associated utility programs.

When you have installed these programs, reboot your system.

After installing the device drivers, you must configure your disk arrays before you can use them with your system. Chapter 3, "Configuring SSA Subsystems" in topic 3.0 describes how to do this. Then, your SSA subsystem will be ready for use with your system.

The format in which the Event/Error Logger reports errors is controlled by the file EVNCTRLF.TXT in the install directory (which, by default, is system root\issa). Details of the settings and how to change them are contained in the header of the control file.

2.5 Moving Arrays from Another Type of Adapter

If you move a RAID-1 array from an SSA RAID Adapter to an SSA RAID Cluster Adapter, you must change the array's SplitConfirm attribute to enabled. "Changing Array Attributes" in topic 5.4 describes how to do this.

If you are going to move a RAID-1 array from an SSA RAID Cluster Adapter to an SSA RAID Adapter, before you move it, change its SplitConfirm attribute to disabled.

3.0 Chapter 3. Configuring SSA Subsystems

Before new SSA disk drives can be used by the operating system, you must configure them into the SSA subsystem. You use the configuration utility (which is provided on each of the diskettes supplied with the adapter) to do this. The actions that you must perform are:

1. Accept the new disk drives into the subsystem

2. Configure disk arrays, if required

3. Attach the disk arrays or individual disk drives to your system.

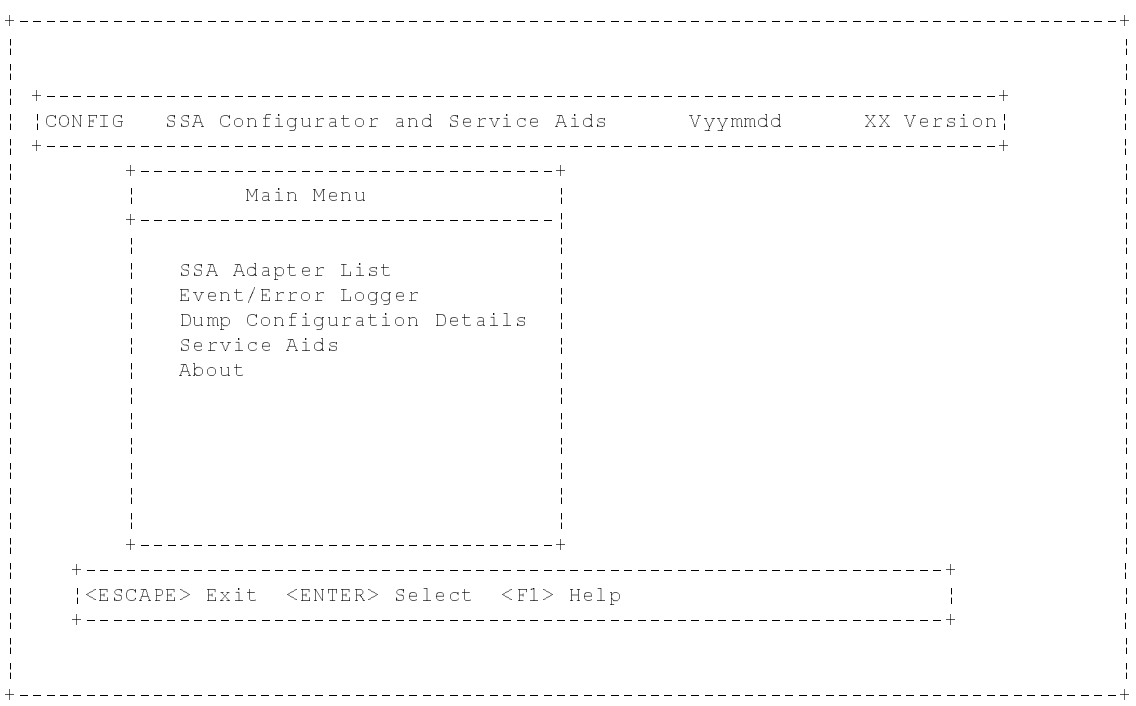
The following sections describe the details of these actions.

Subtopics

3.1 Running the Configuration Utility

To run the configuration utility, execute the program **ISSACFG** or, if it is available, double click on the SSA Configurator icon.

The SSA Main Menu screen is displayed:



To choose an item from a configurator-utility menu, use the arrow keys to move the highlighting to that item and press the appropriate key, for example, press Enter to select that item,

To move to the previous menu, press Esc.

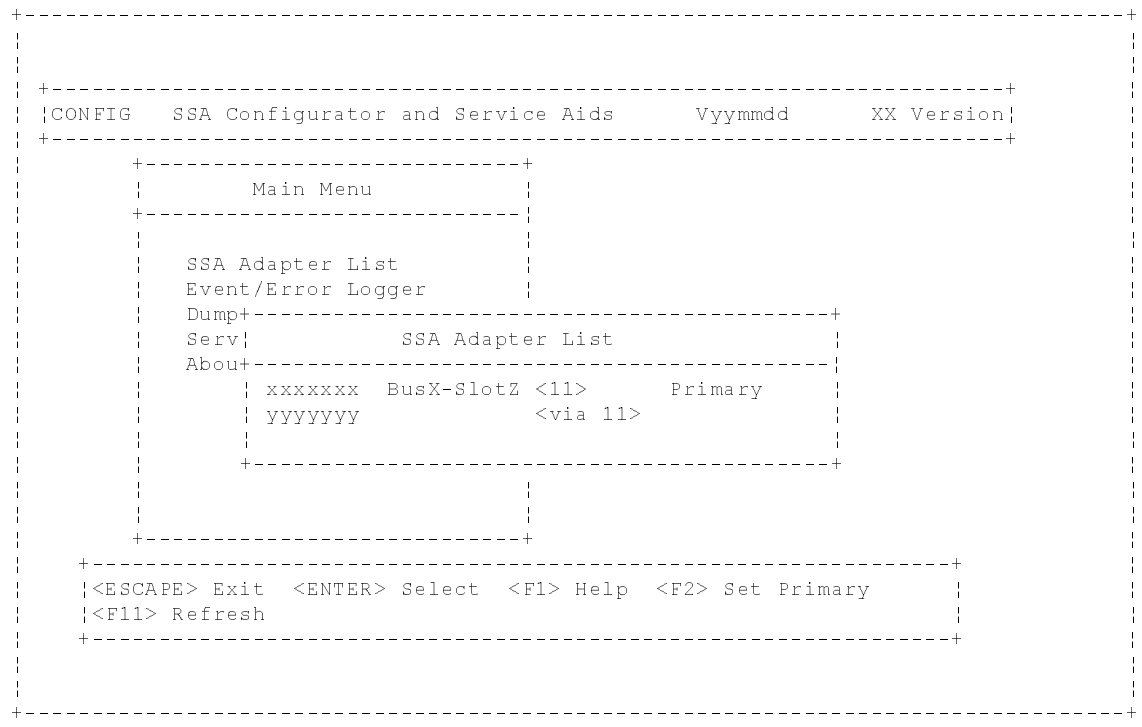
Help is available for every menu; press F1 to reach it.

3.2 Accepting New Disk Drives

To accept new disk drives into the SSA subsystem:

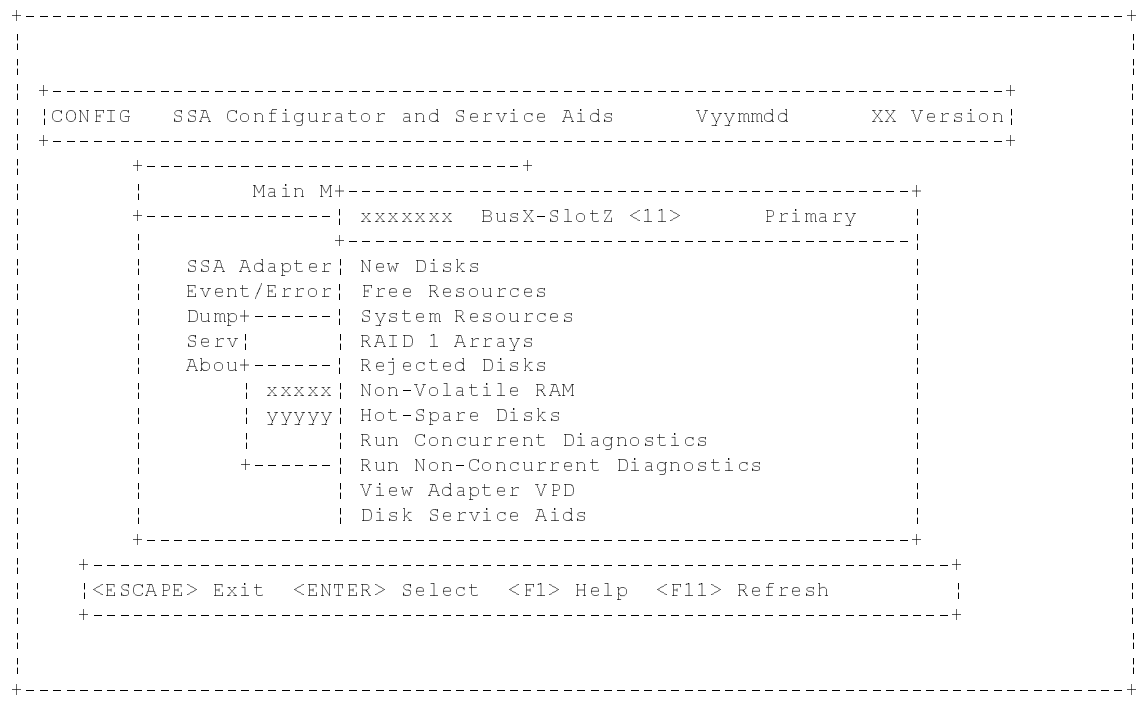
1. From the SSA Main Menu, select **SSA Adapter List**.

2. A window opens containing a list of the SSA adapters in the systems on which you are working:



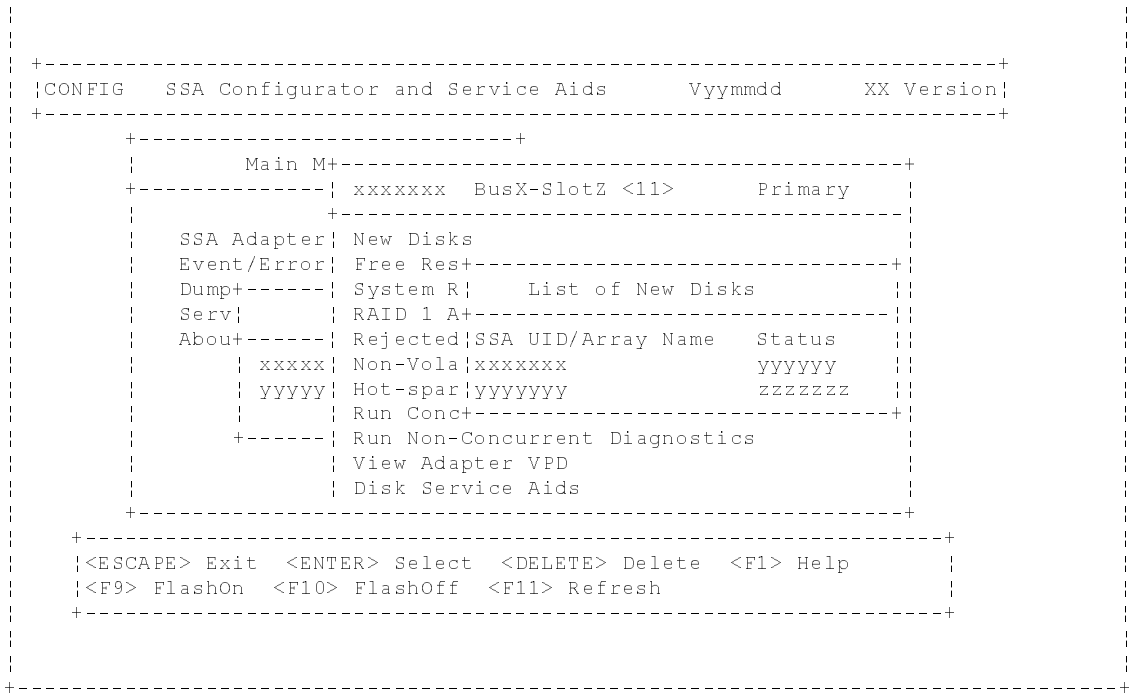
In this list, select one of the adapters to which the new disk drives are attached.

3. The following window opens:



Select **New Disks**.

4. A window opens containing a list of all the disk drives not previously used on this type of adapter:



In this list, for each disk drive that you want to configure into your SSA subsystem, highlight its name and press Delete. At the prompt, confirm the deletion. Its name disappears from the list; it is now in the *free* state.

You can return to the menu for this adapter by pressing Esc.

You can display a list of all the disk drives that are in the free state by selecting **Free Resources** in the adapter menu.

You can define disk drives that are in the free state as members of an array; "Creating an Array" in topic 3.3 describes how to do this. Alternatively, disk drives can be accessed individually; for such disk drives, go directly to "Attaching Resources" in topic 3.4 for instructions on attaching them to the system.

Also, disk drives can be defined as hot spares. "Defining a Hot Spare" in topic 5.1 describes how to do this.

3.3 Creating an Array

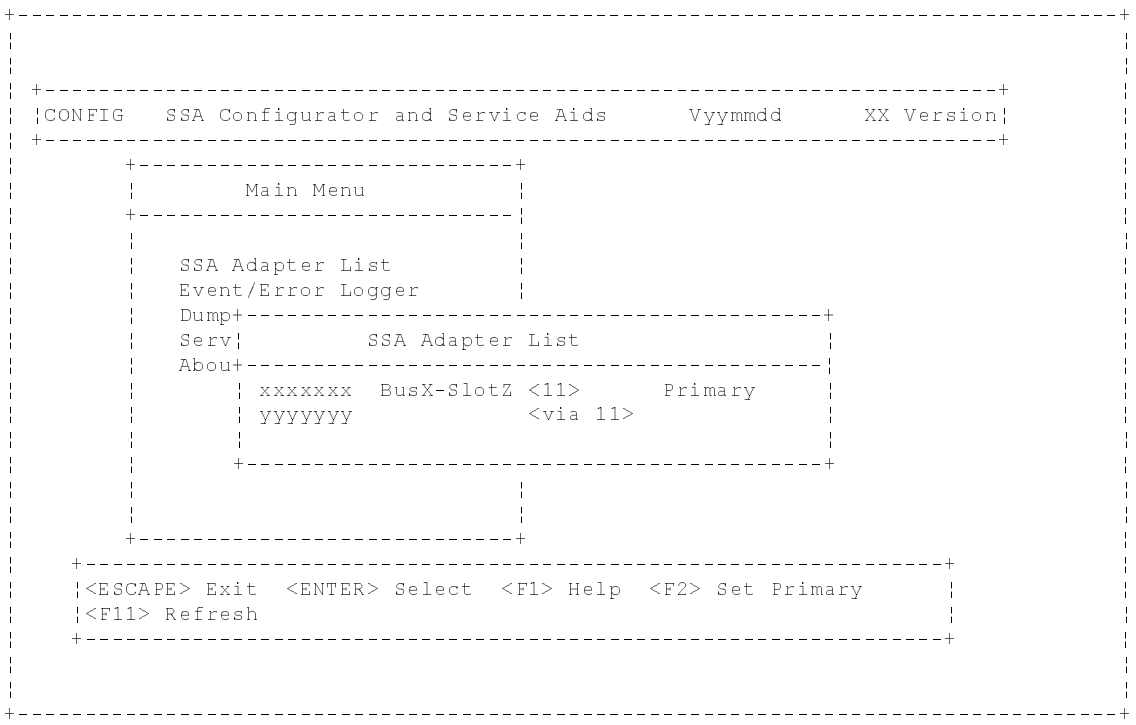
This section describes how to create an array from the free disk drives in the SSA subsystem.

It is recommended that you define one or more hot spares (refer to "Defining a Hot Spare" in topic 5.1 for how to do this) before creating the first array on an adapter.

To create an array:

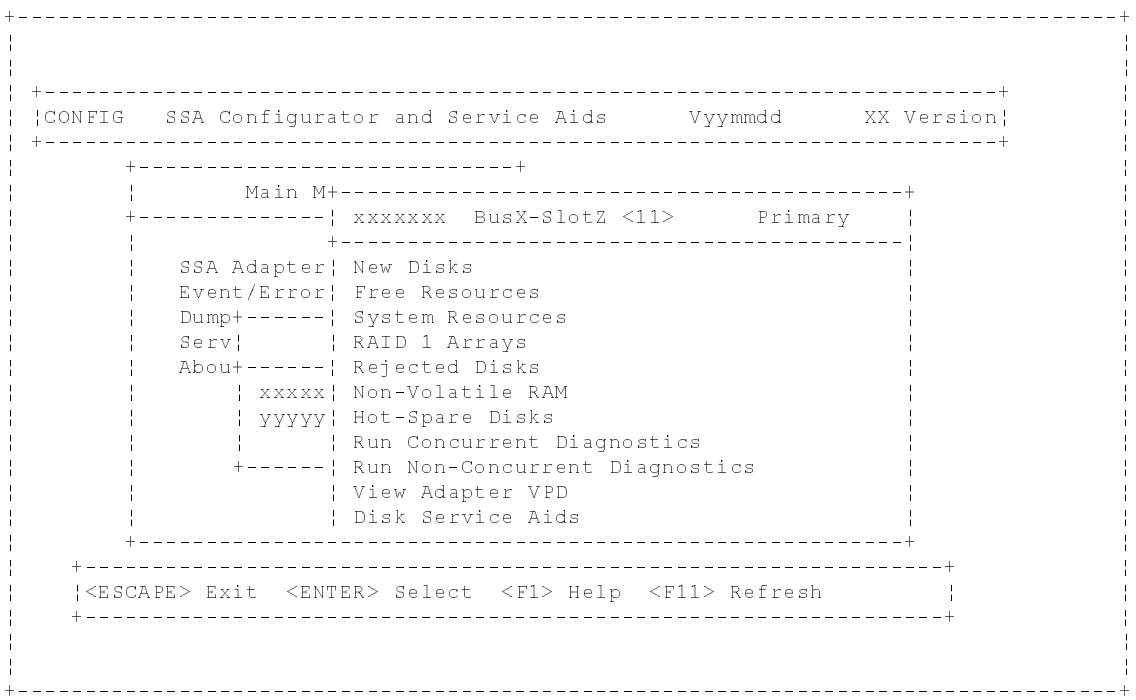
1. From the SSA Main Menu screen, select **SSA Adapter List**.

2. The SSA Adapter List window opens:



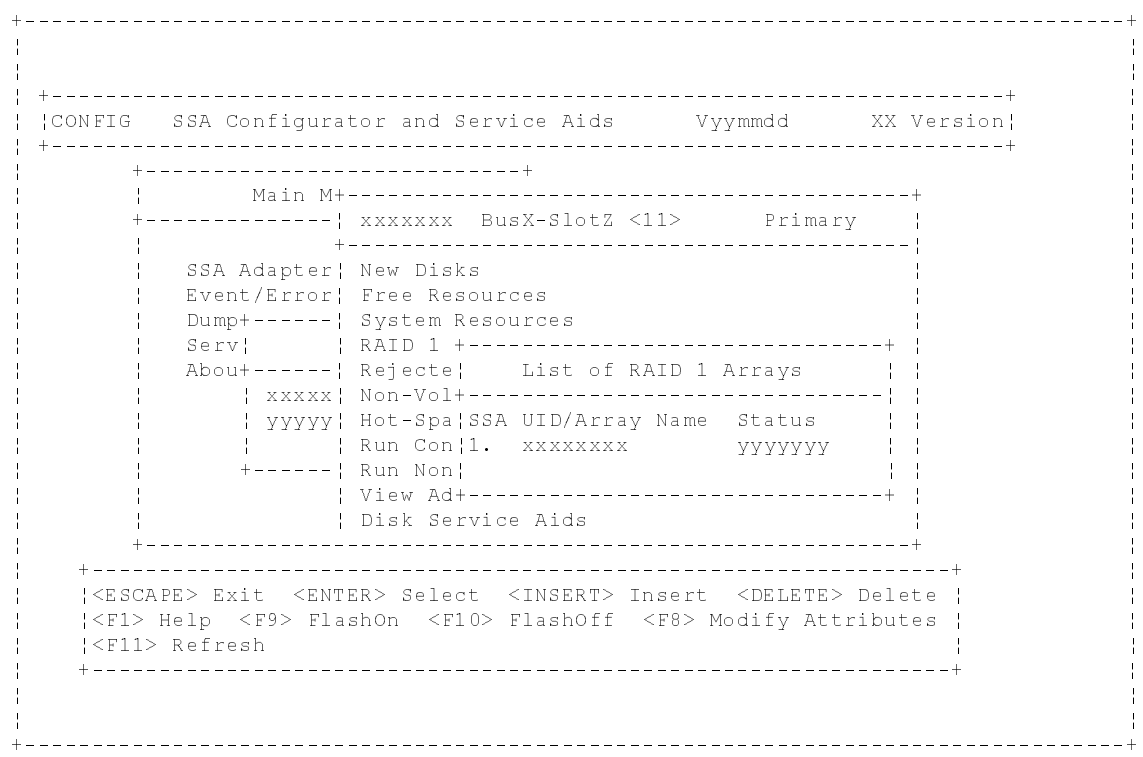
Select or set the primary adapter that is to control the array. The disk drives that you define as members of the array must be connected to this adapter.

3. The Adapter Menu window opens:



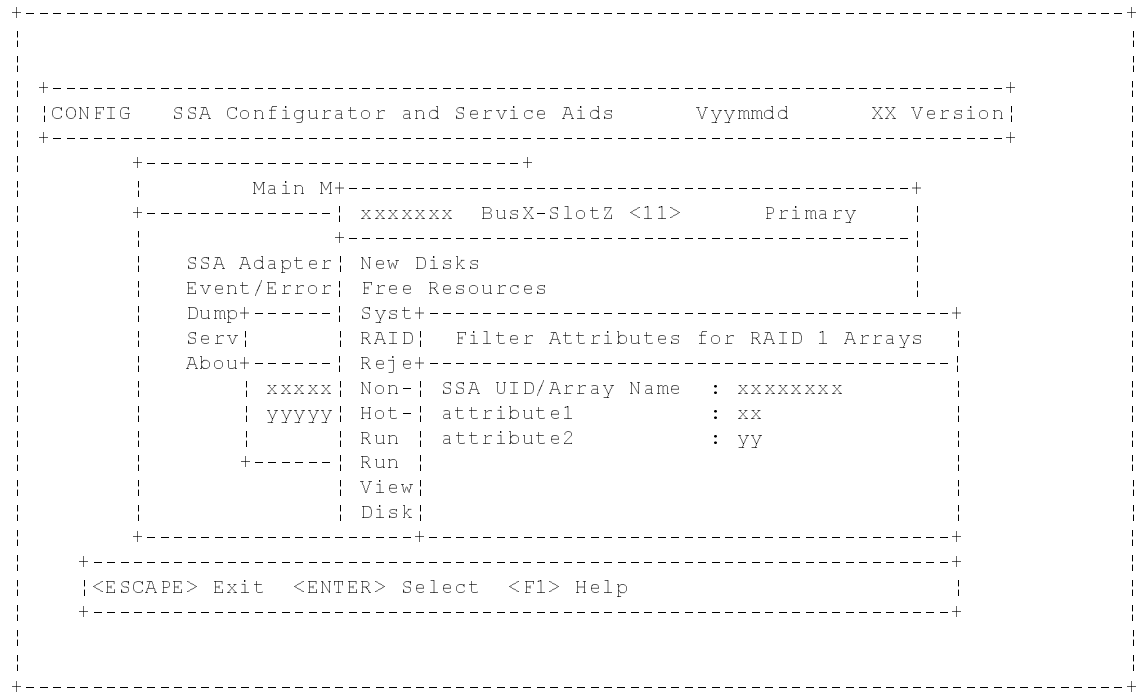
Select the **RAID 1 Arrays**. You can scroll the contents of the window by using the arrow keys.

4. A list of the arrays of this type already controlled by this adapter appears in a new window (this list may be blank):



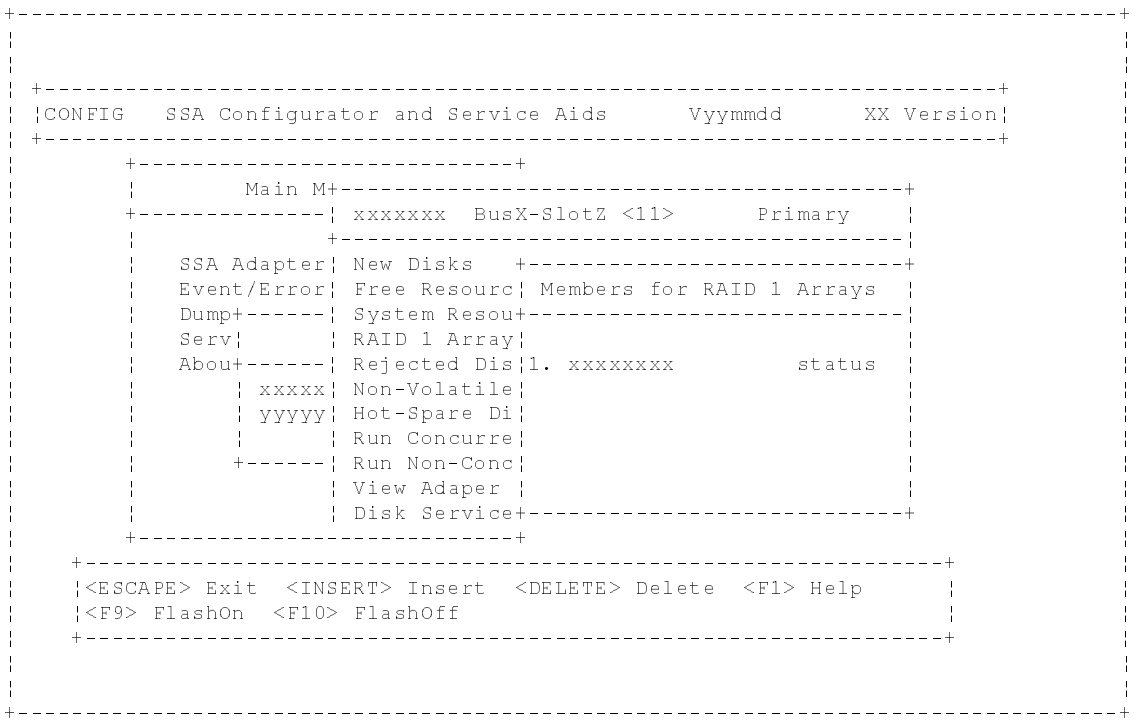
Press Insert.

5. A window opens showing the attributes for a RAID 1 array:



You must type in a unique array name (of up to 14 characters) for the new array. The default values for the attributes are shown. You can change these values by overtyping them. (The Help screen provides details of the values that are allowed.) Use the arrow keys to scroll the contents of the window, if necessary, to ensure that you check all the attributes. Press Enter to set each attribute in turn.

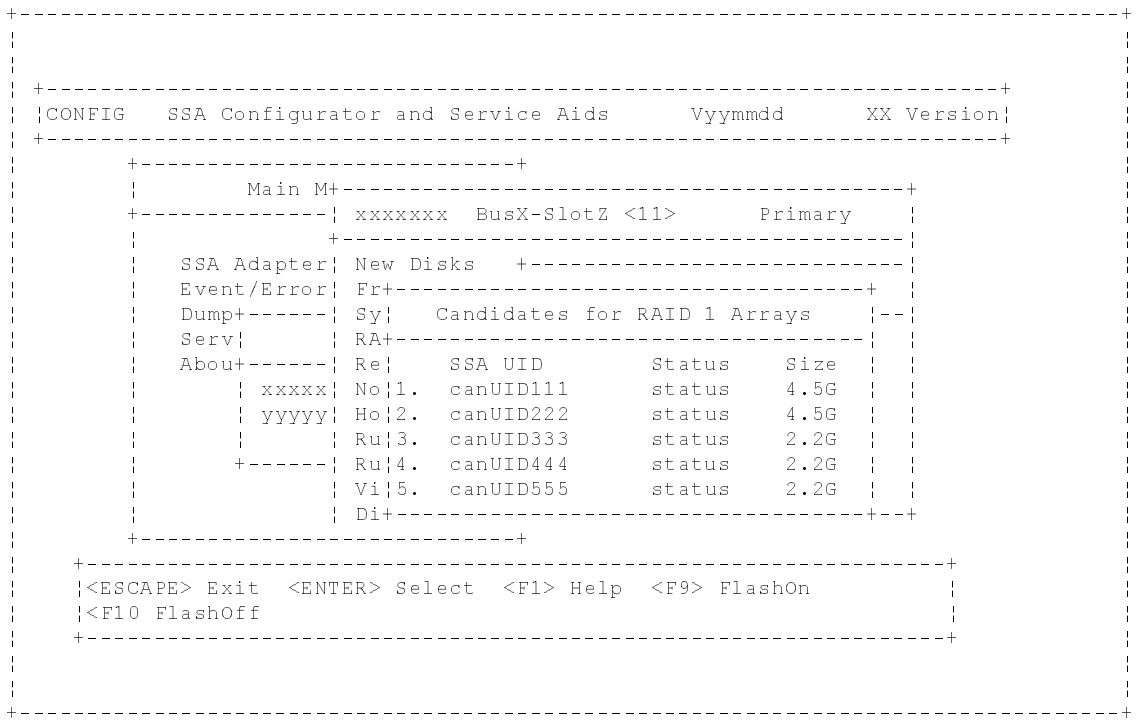
6. When you set the last attribute, the list (initially blank) of members of the array appears in a new window:



Select disk drives for the array from the list of candidates; to do this, **for each disk drive**:

a. Press Insert

b. A list of candidate disk drives is displayed:



c. Select the disk drive that is to be included in the array. (You can identify the disk drive by highlighting its Unique ID in this list and pressing F9. This causes the Check light on the disk drive to flash. Pressing F10 stops the light flashing.)

The previous window reappears now showing the selected disk drive as a member of the array.

7. When you have selected the disk drives required, create the array by pressing Esc and following the prompt to confirm the creation of the array.

The screen shown in step 4 reappears now showing the new array in the list.

You can return to the Main Menu by repeatedly pressing Esc.

The array created is in the *free* state. The next section describes how to attach the array to your system.

3.4 Attaching Resources

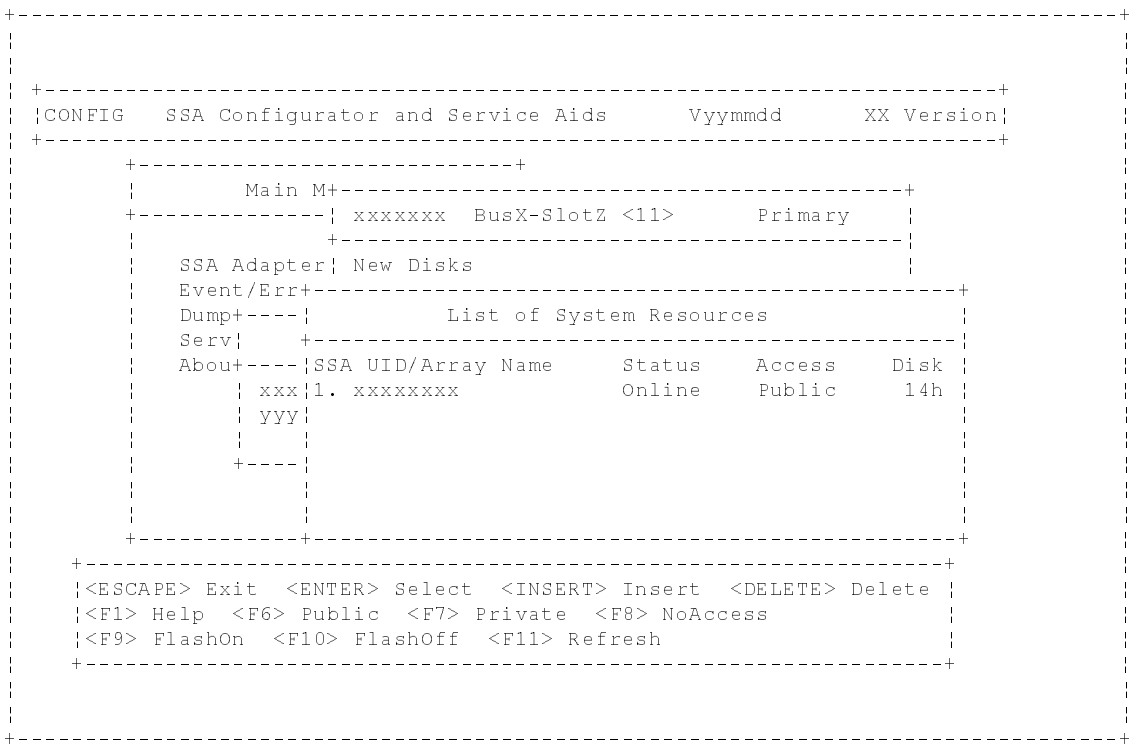
A resource is a disk drive that is to be accessed individually or an array of disk drives.

When a resource has been attached to one system in a cluster, the resource is automatically attached to the other system.

To attach a resource to your system:

1. From the menu screen for this adapter, select **System Resources**.

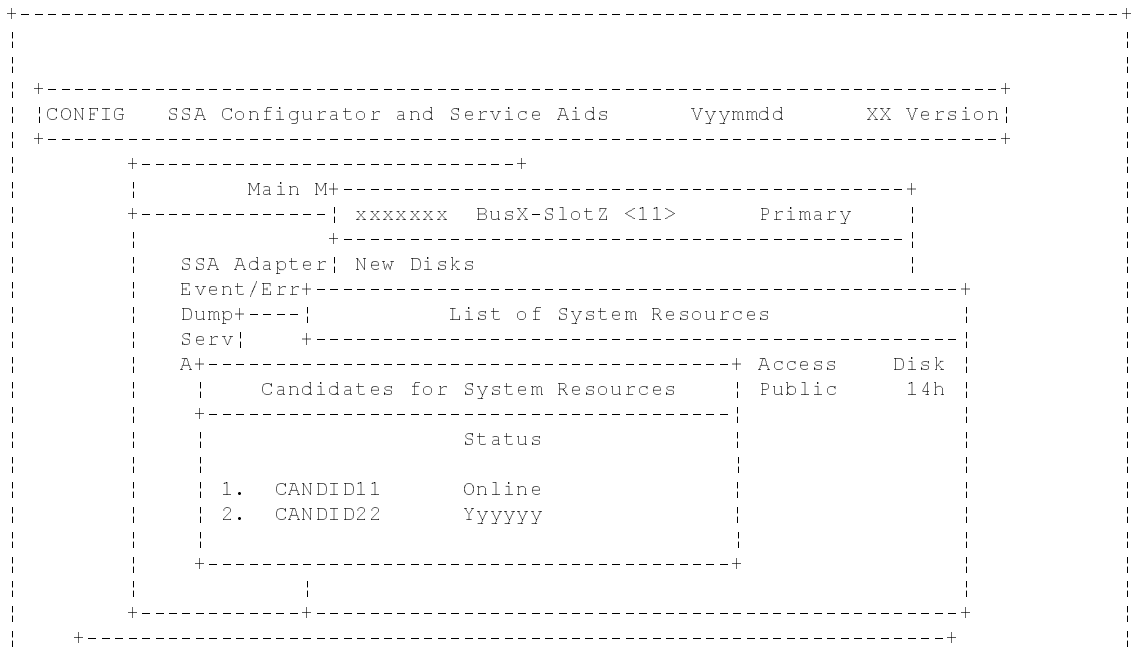
   A list, initially blank, of the resources attached to the system is displayed; the resources are listed in disk-address order. Only resources that are *attached* can be accessed by the operating system.

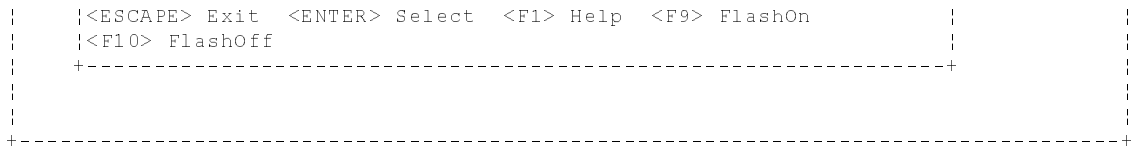


   To attach a resource:

   a. Press Insert.

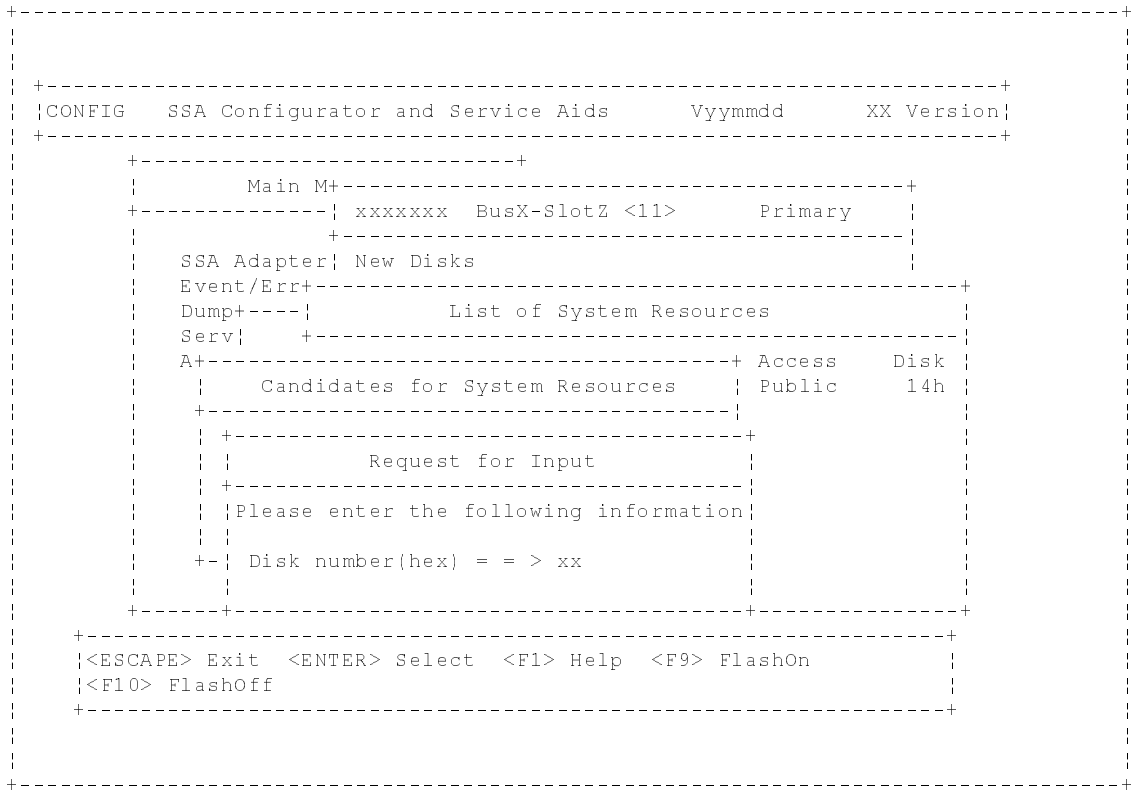
   b. A list of candidate resources is displayed:





These are the resources that are in the free state.

Select the resource that you want to attach. Its name disappears from this list and the Request for Input window opens:



c. The disk number automatically assigned for the new resource is shown; this will be one greater than the highest disk number already assigned. You can change this by overtyping it.

Notes:

1) If you are going to boot from an SSA disk drive, that disk drive must be at the top of the list of the first SSA adapter found by the system (that is, the SSA adapter with the highest priority within the system). The access mode of the disk drive must be local to the system that you are booting ("Viewing and Changing Disk Drive Access Modes" in topic 5.6 describes disk drive access modes and how to set them). For details of the requirements for booting from an SSA disk drive, refer to the README.TXT file on the Windows NT Device Driver and Utilities diskette.

2) At the position in the list that you choose for the new resource, there need not be a gap in the sequence of disk numbers. If there is no gap, the resource that already had the disk number you have chosen is allocated a number one greater than this. This reallocation of disk numbers continues down the list of resources until either a gap in the numbers, or the end of the list is reached.

{Appendix B, "Disk Numbers" in topic B.0 describes disk drive numbers and how they are mapped to logical buses.}

When you have chosen the disk number for the new resource, press Enter.

d. The System resources window reappears with the new resource added to the list. The disk numbers shown include that of the new resource and reflect any reallocation of disk numbers that has been necessary.

2. If either:

- Adding the resource has changed the number of a resource that was already attached, or
- The new resource replaces one with the same number (which you have previously deleted),

reboot your system to configure the new resource into the system.

Otherwise, you do not need to reboot.

3. Use your operating system to assign logical partitions and drive identifiers to the new resources (for example, Disk Administrator).

4.0 Chapter 4. Dealing with Problems

This chapter:

- Provides general guidance on solving basic problems with your SSA subsystem
- Describes how to get detailed information about errors and other events on the adapter and the disk drives attached to it
- Describes the actions you must perform with the adapter utility programs while changing a disk drive.

Subtopics

4.1 Basic Problems

If the system cannot work with the adapter, check the following:

- Is CMOS setup required to enable PCI bus parameters?
- Is the adapter installed in a bus-master PCI slot?
- Are all the cables connected correctly?
- Does the configuration follow the SSA rules for this adapter?

If the system cannot access the SSA disk drives, check the following:

- Is power turned on to the disk drives?
- Has the configuration utility been run for all the required disk drives, and do they appear in the list of system resources?
- Are the disk drives connected in a valid loop? "Rules for SSA Loops" in topic C.1.2 describes the rules for SSA loops.
- Is the light next to the adapter-loop ports on, showing that both ports are operational?

If the system fails to boot from an SSA disk drive, check the following:

- That there is **not** an IDE disk drive installed
- That there is **not** another storage adapter with BIOS enabled installed in a higher-priority PCI slot than the SSA adapter
- That the CBIOS is enabled
- That the SSA device drivers are loaded before the SCSI device drivers
- That the address (drive letter) of the partition from which you are trying to boot has not changed. (Adding extra drives can cause the addresses of existing drives to be changed.)
- That the disk drive is not a member of an array.

4.2 Array Problems

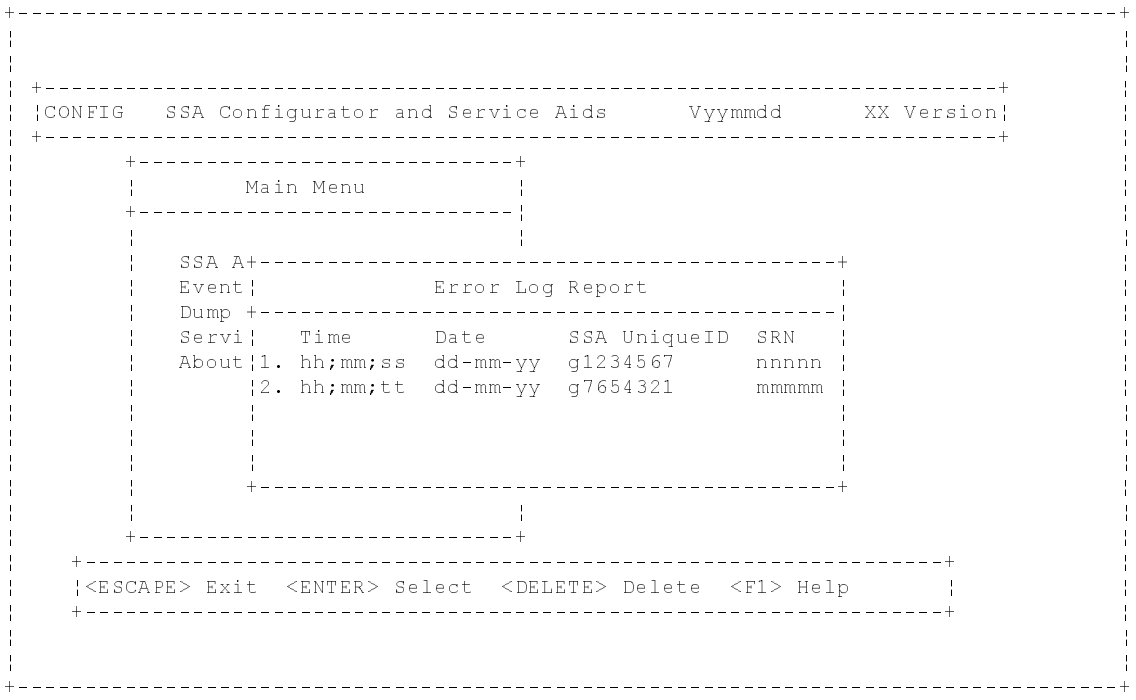
Many problems within an array are not seen by the users of the server. The RAID-1 functions provide a continuing service to the users even when a member of an array has failed. However, unless the failure is corrected, a second failure within that array could cause the whole array to become unavailable. Therefore, it is very important that you check the error log for the adapter regularly. You could do this by making such a check part of the start-up procedure for your operating system. If an array is attached to a cluster of servers, all errors in the array are logged to both servers. Errors that occur during configuration might not be logged to both servers.

To check the error log:

1. Start the configuration utility by executing the program **ISSACFG** or, if it is available, double click on the SSA Configurator icon.

2. From the Main Menu, select **Event/Error Logger** and then **Analyze SSA Event Log**.

   The current list of errors appears in a new window:



The SRNs (service request numbers) describe the errors.

- Some SRNs describe errors with the adapter card or with the SSA configuration. These SRNs are listed in Appendix A, "SSA RAID Cluster Adapter Service Request Numbers" in topic A.0 with a description of what you should do to solve the problem.

- Some SRNs describe errors with the SSA disk drives or the units in which they are installed. For a complete description of these, see the *Installation and User's Guide* or the *Maintenance Information* for that unit.

  If one of the following SRNs appears, you can correct the problem by exchanging a disk drive for a new one:

  ```
  Any SRN whose first character is '1'
  60210
  D0100
  D0300
  ```

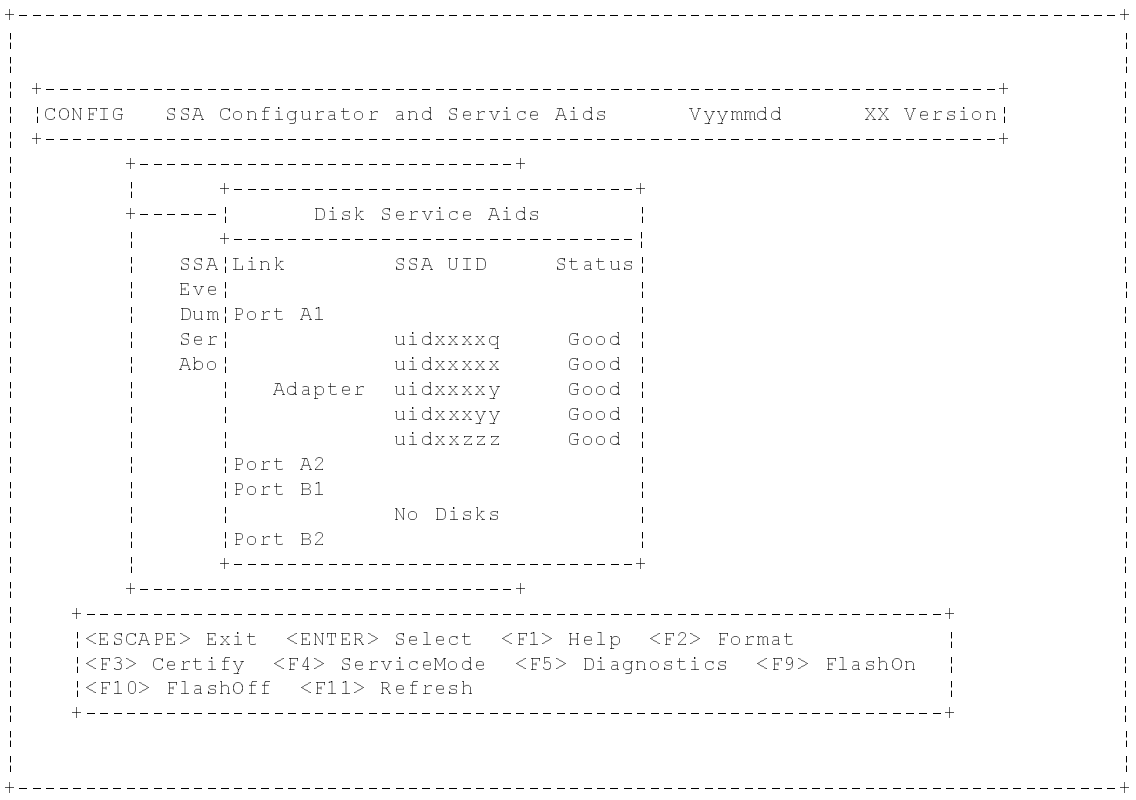
  The following section describes what you need to do with the array configuration utility while changing a disk drive.

4.3 Changing Failed Disk Drives

If you have one of the SRNs in the list above, you can change the disk drive using the following procedure:

1. From the Main Menu, select **SSA Adapter List**, select the adapter, and then select **Disk Service Aids**.

   A list of physical disk drives is displayed:



   In this example, four disk drives are connected between ports A1 and A2 of this adapter, in a loop, in the order shown, with the SSA adapter in the other system. There are no disks connected to ports B1 and B2.

   If a dotted line appears in the list of disk drives, it indicates that the SSA loop is broken at that place.

2. You can identify a disk drive by highlighting its entry in this list and pressing F9. This causes the Check light on the disk drive to flash (if it is not on already) and a + symbol appears beside the entry in the list. Pressing F10 stops the light flashing.

3. Highlight the entry for the disk drive that you are going to replace and press F4.

   This puts that disk drive into service mode; the Check light on the disk drive comes on (it might be on already) and a > symbol appears beside the entry in the list. Only one disk can be in service mode at a time.

4. Replace the physical disk drive. The *User's Handbook* for the unit containing the disk drive describes how to do this.

5. Highlight the entry for the disk drive that you are have just replaced and press F4.

   This removes that disk drive from service mode.

6. Press Esc to return to the Main Menu. (Leaving the Service Aids window automatically removes any disk drive from service mode.)

7. If the disk drive that failed was a member of an array for which no hot spare was available, the entry for the failed disk drive in the list of members of the array is replaced with

```
¦      uidxxxx      Not Present
```

   You must add the new disk drive to the array by exchanging this entry with that for the new disk drive, using the procedure described in "Exchanging a Member of an Array" in topic 5.7.

   If the disk drive that failed was a member of an array for which a hot spare was available, the hot spare will have been exchanged automatically with the faulty disk drive. You can either:

   - Define the new disk drive as a new hot spare, using the procedure described in "Defining a Hot Spare" in topic 5.1, or

- Exchange the new disk drive with the previous hot spare, using the procedure described in "Exchanging a Member of an Array" in topic 5.7. (Define the previous hot spare as a hot spare again.)

5.0 Chapter 5. Performing Other Configuration Tasks

This section describes some of the other uses of the SSA Configuration Utility. Other service-related tasks are described in the *SSA RAID Cluster Adapter: Hardware Maintenance Manual Supplement*.

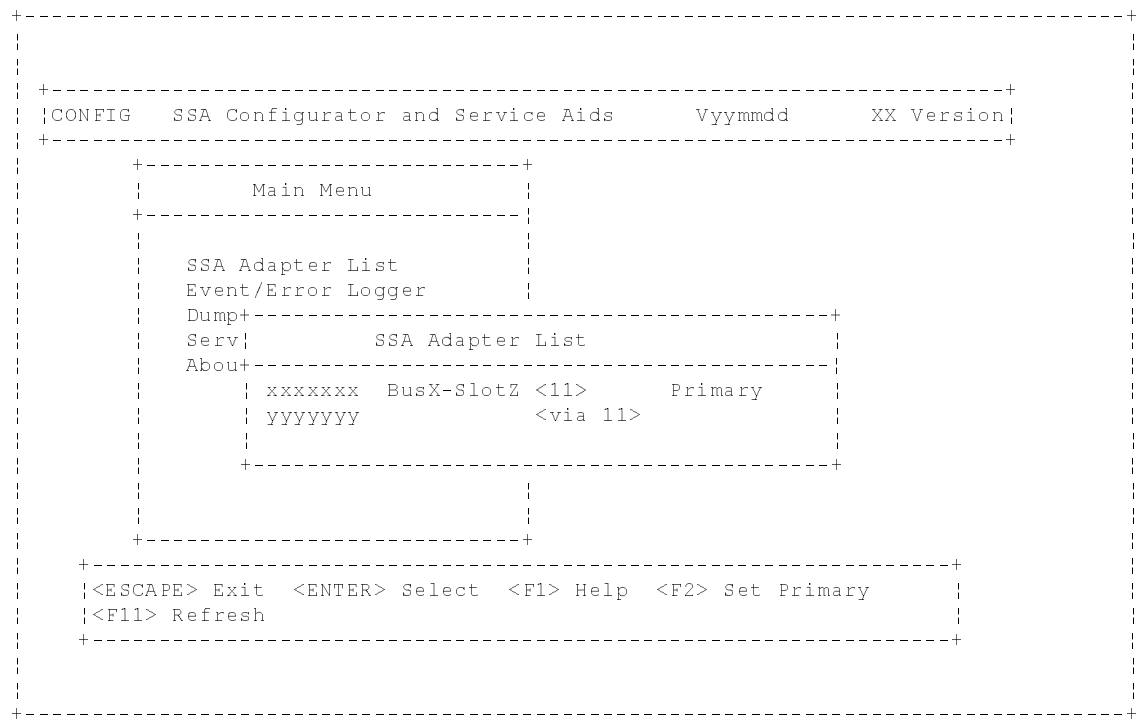
All these tasks use the SSA Configurator Utility provided on the SSA RAID Cluster Adapter diskette for your operating system. To start this utility, execute the program **ISSACFG** or, if it is available, double click on the SSA Configurator icon.

Subtopics

5.1 Defining a Hot Spare

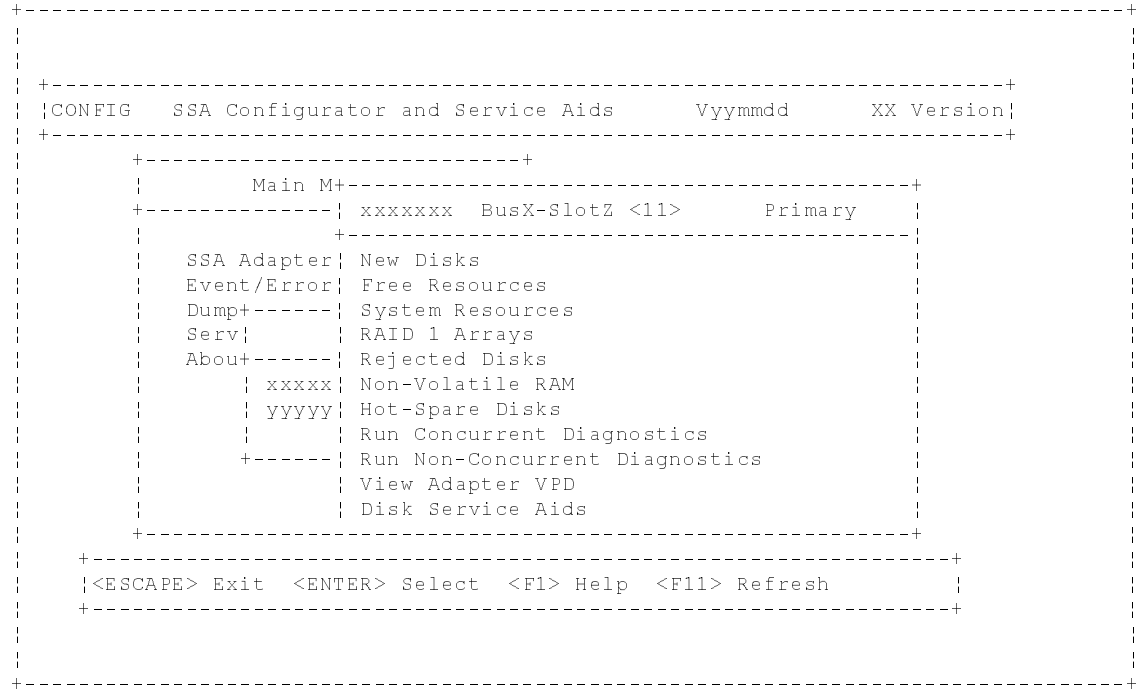
To define a disk drive as a hot spare:

1. From the Main Menu screen, select **SSA Adapter List**.
2. The SSA Adapter List window opens:



Select the primary adapter to which the disk drive that is to be the hot spare is attached. The hot spare can only be used by arrays defined on that adapter.

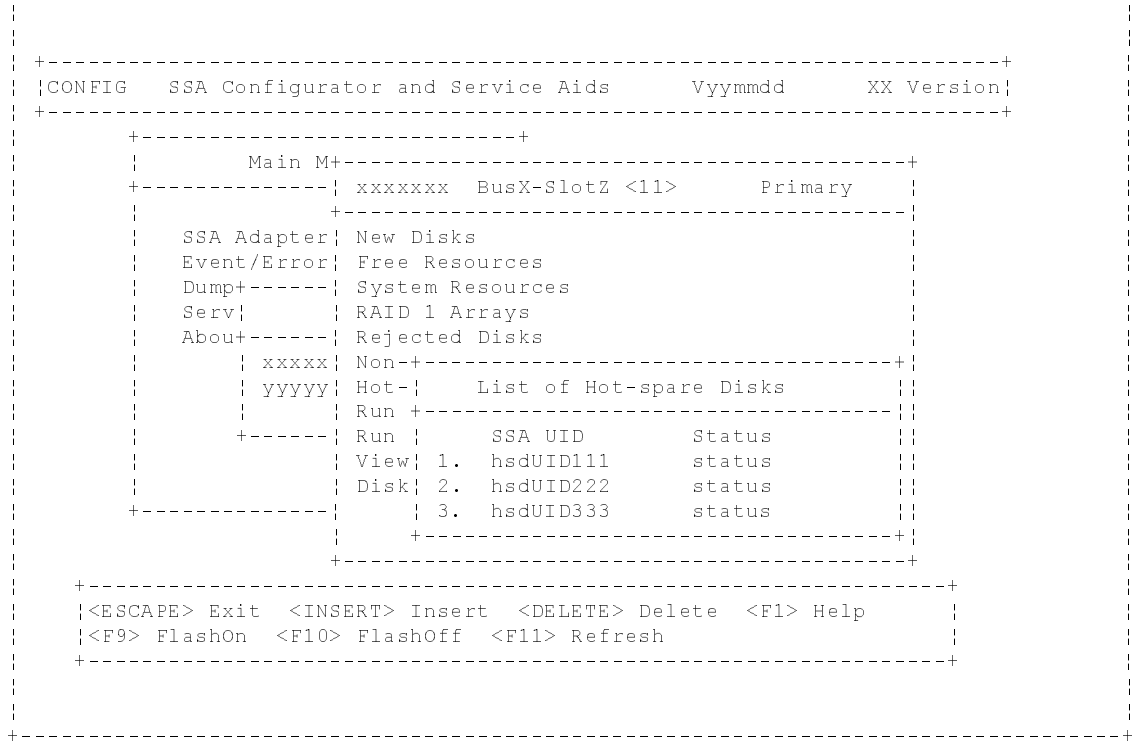
3. The Adapter Menu window opens:



Select **Hot-spare disks**.

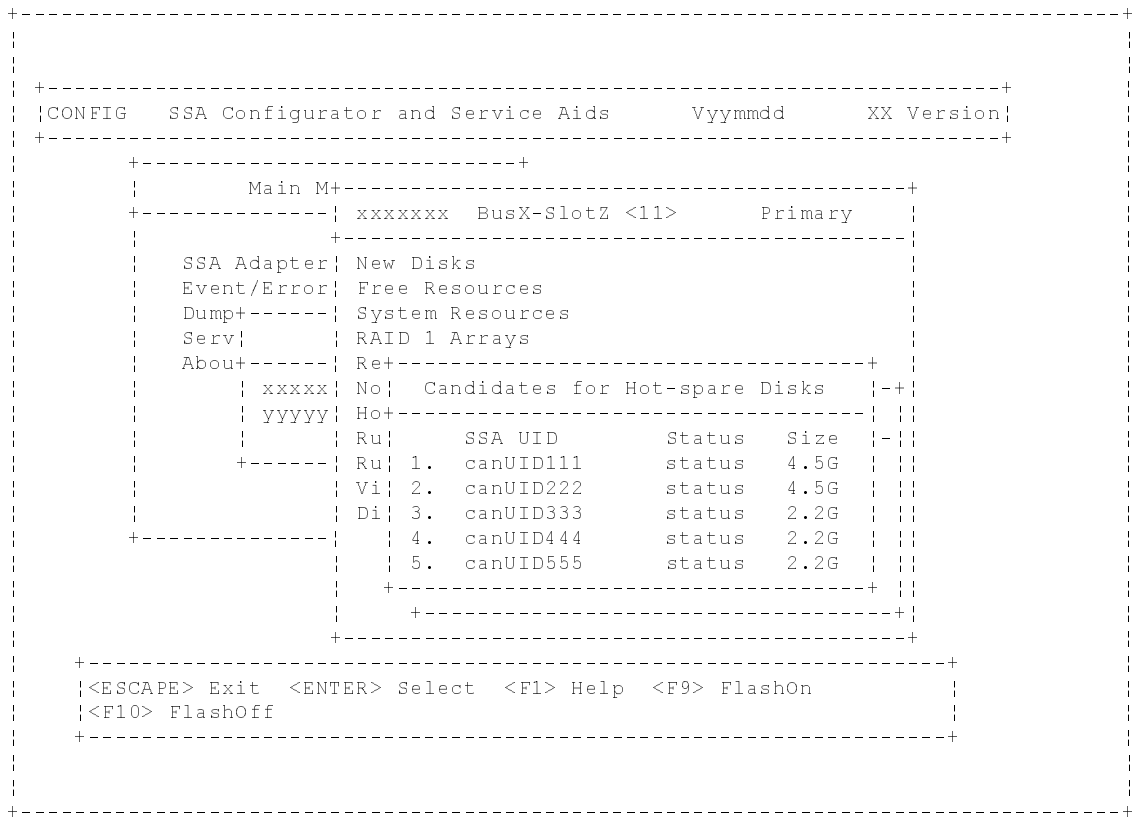
4. A list of the hot spare disk drives that are controlled by the adapter is displayed.

Note: The list might not contain any hot spares.



Press Insert to add a new hot spare disk drive.

5. A list of candidate disk drives is displayed:

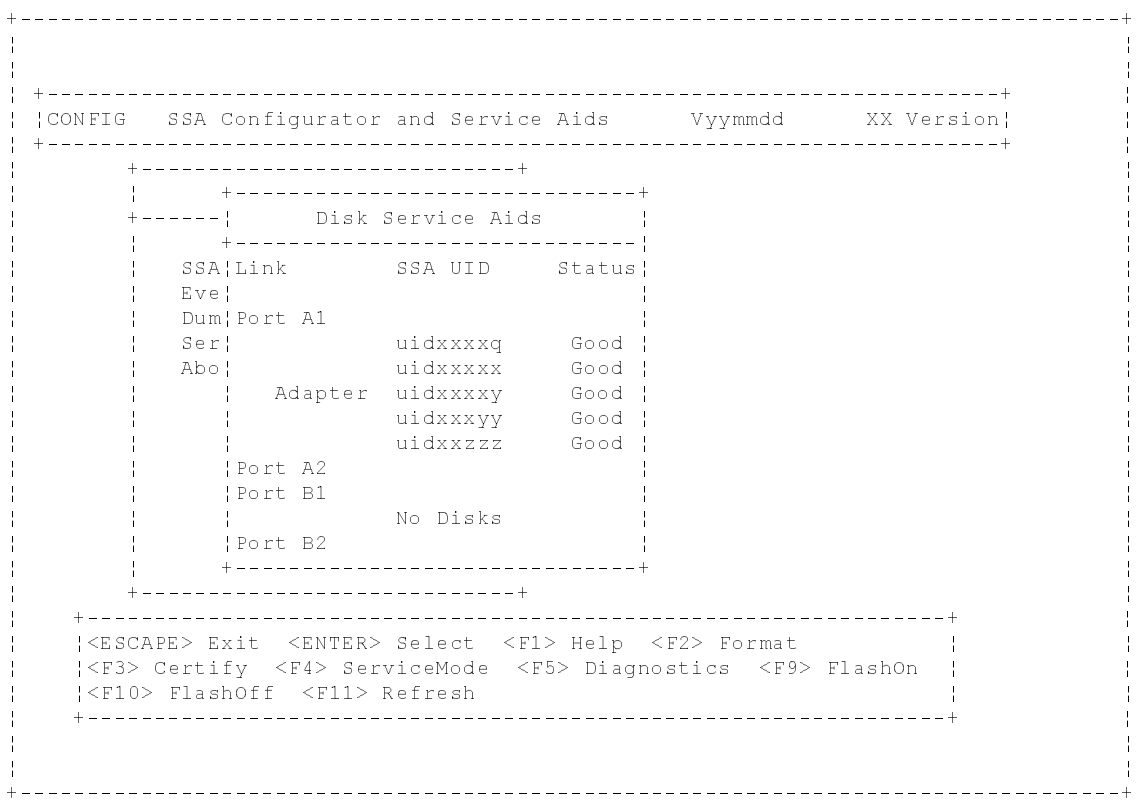


6. Highlight the entry for the disk drive that is to be the hot spare. (You can identify the disk drive by putting the cursor on its Unique ID in this list and pressing F9. This causes a light on the disk drive to flash. Pressing F10 stops the light flashing.) Press Enter to define this disk drive as a hot spare.

   The previous window is displayed with the new hot-spare added to the list.

5.2 Viewing the Physical Configuration

From the SSA Main Menu, select **SSA Adapter List**, the adapter, and then **Disk Service Aids**. A window opens showing the physical arrangement of the SSA disk drives attached to the adapter selected:

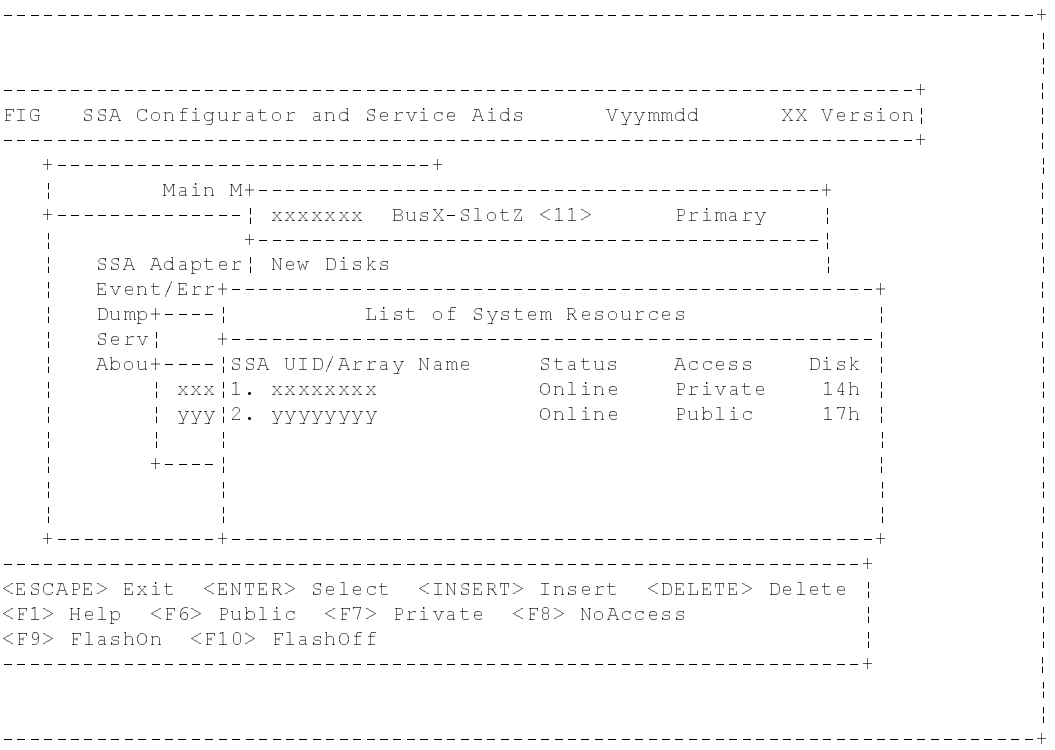


In this example, four disk drives are connected between ports A1 and A2 of this adapter, in a loop, in the order shown, with the SSA adapter in the other system. There are no disks connected to ports B1 and B2.

If a dashed line appears in the list of disk drives, it means that the SSA loop is broken at that point.

5.3 Viewing Resources and Their Attributes

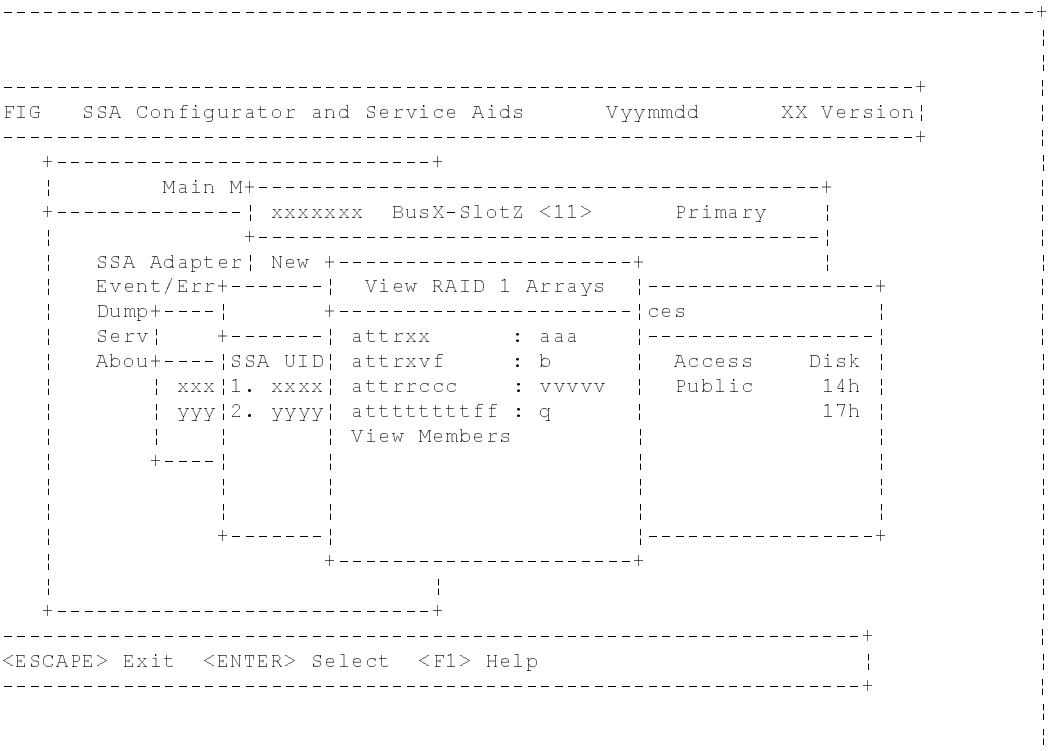
From the SSA Main Menu, select SSA Adapter List, the adapter, and **System Resources**. The following window opens:



Resources that are individual disk drives have their access mode described in the Access column. Access modes and how to change them are described in "Viewing and Changing Disk Drive Access Modes" in topic 5.6. Resources that are arrays always have an access mode of Public.

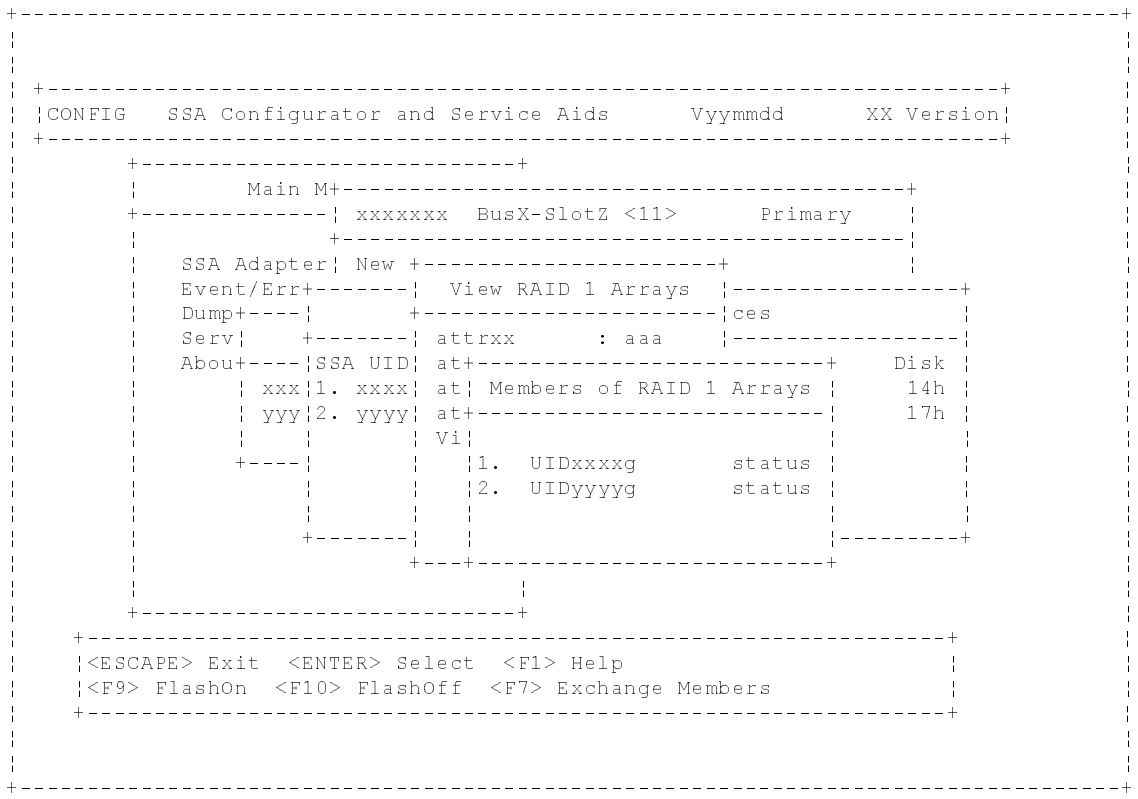
Select the resource you want to view.

If you select an array, a window opens showing the attributes of the array:

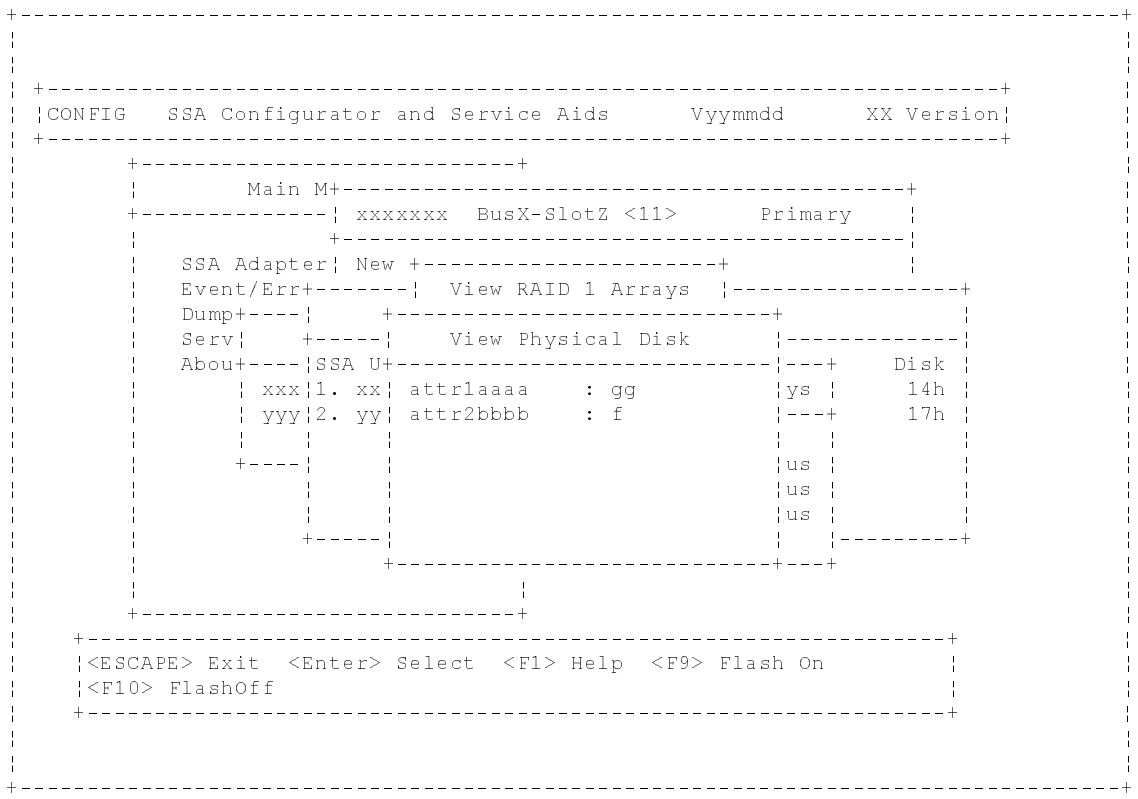


To see all the attributes of the array, use the arrow keys to scroll the window. If you select the last item in the list, **View Members**, a

window opens containing a list of the members of the array:



If you select a member in this window, a new window opens showing the attributes of that member:



If, from the System Resources window, you select a disk drive that is not a member of an array, the View Physical Disk window appears immediately.

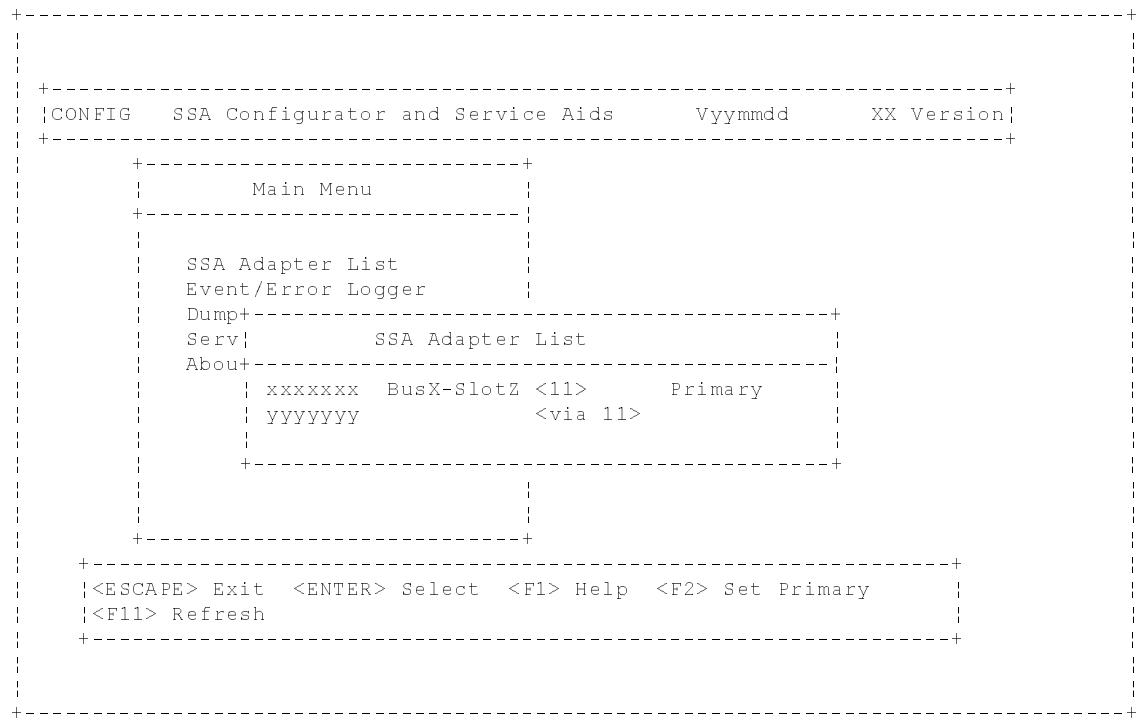
To see all the attributes of the disk drive, use the arrow keys to scroll the window.

5.4 Changing Array Attributes

To change one or more of the attributes of an existing array:

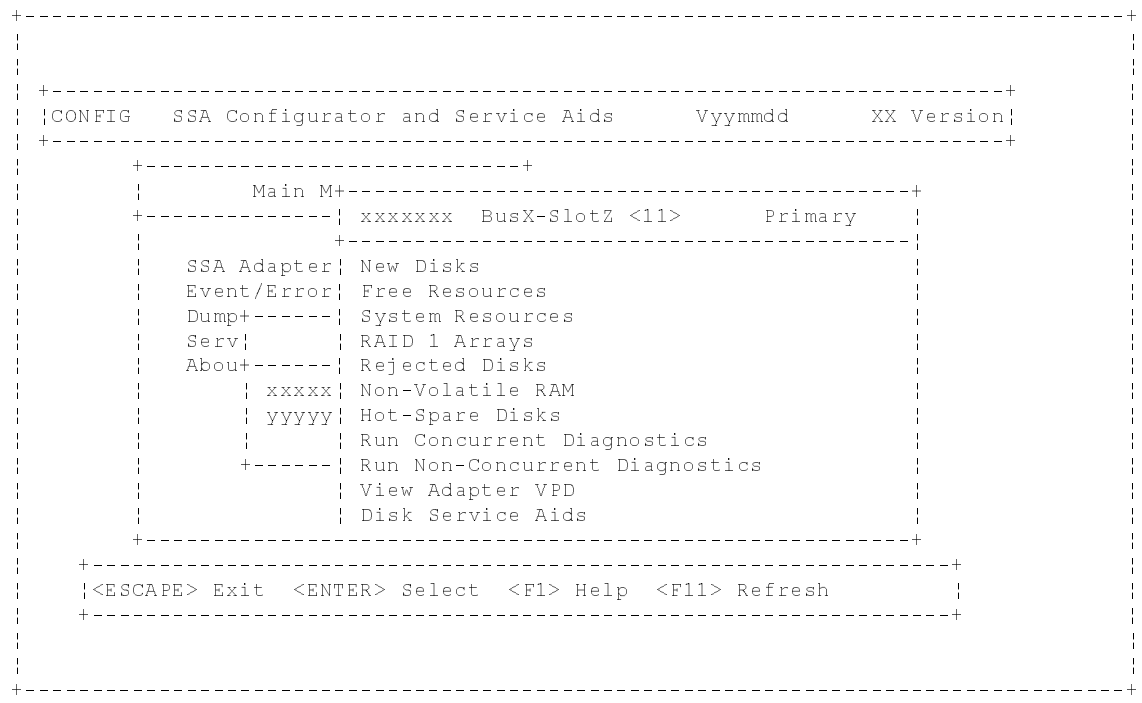
1. From the SSA Main Menu, select **SSA Adapter List**

2. The SSA Adapter List window opens:



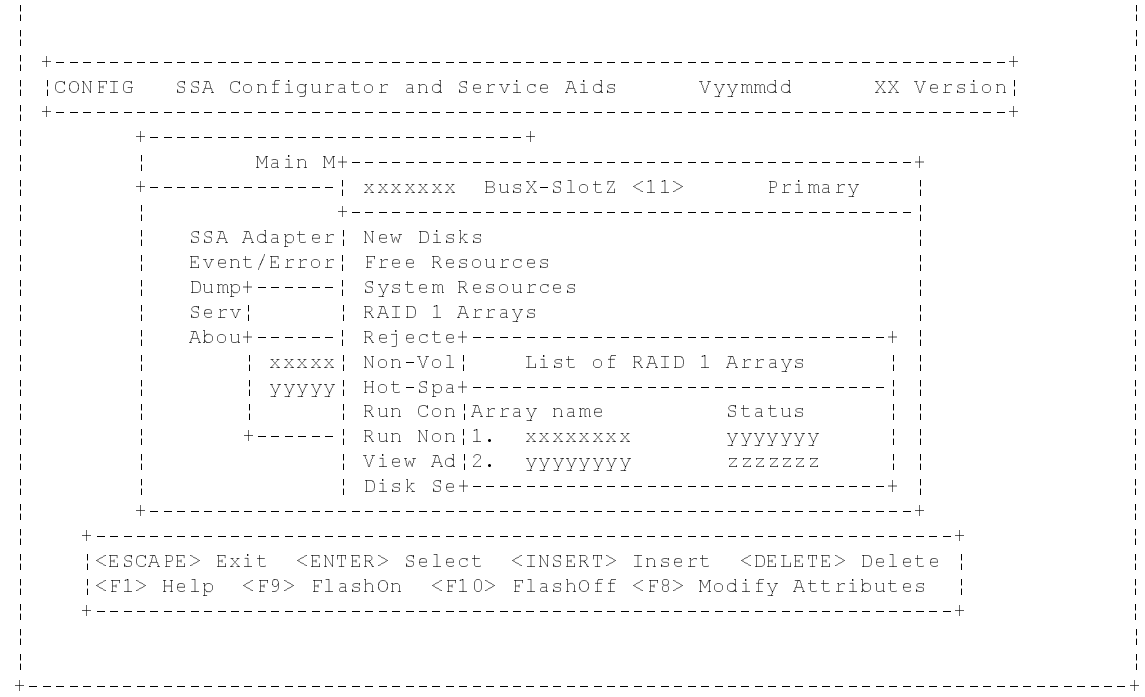
Select the primary adapter that controls the array.

3. The adapter-menu window opens:



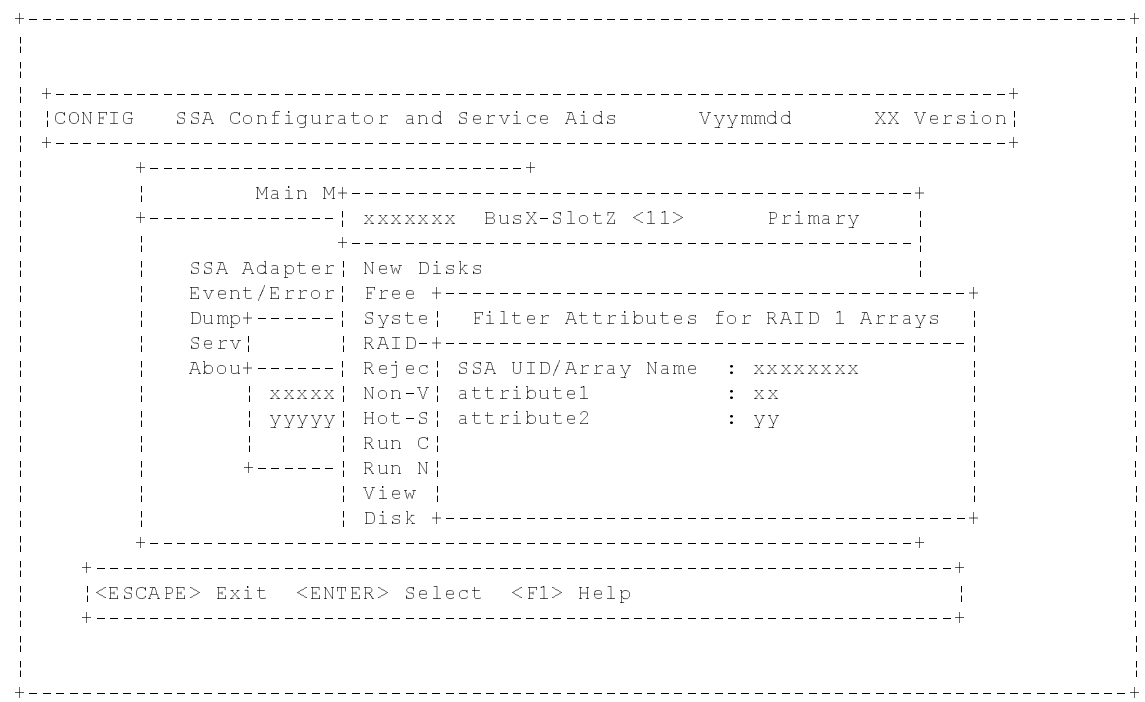
Select **RAID 1 Arrays**.

4. A list of the RAID 1 arrays controlled by the adapter appears in a new window:



Highlight the array whose attributes you want to change, and press F8.

5. A window opens showing the attributes for the array selected:



You can change the values of the attributes by overtyping them. (The Help screen provides details of the values that are allowed.) Use the arrow keys to scroll the contents of the window, if necessary, to ensure that you check all the attributes. Press Enter to set each attribute in turn.

5.5 Changing the Primary Adapter

One of the adapters in a cluster is considered the *primary adapter*. By default, this is the adapter with the higher SSA Unique ID. The performance of I/O operations to RAID-1 arrays is:

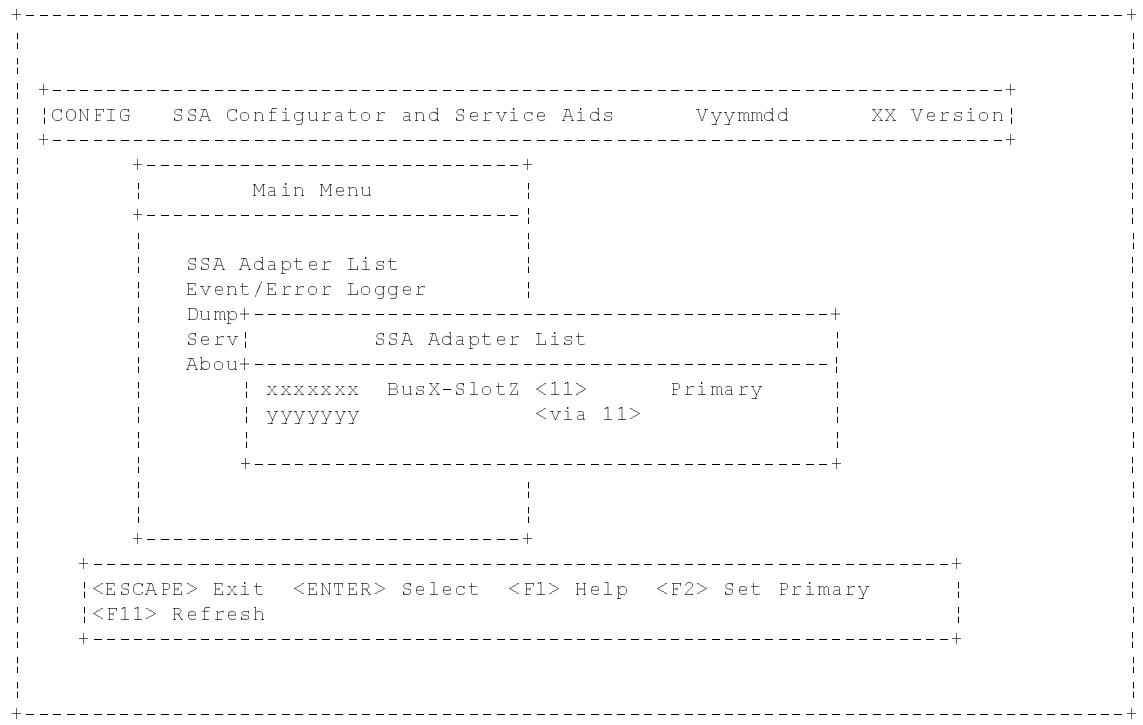
- Highest when the server that contains the primary adapter originates all the I/O operations
- Lowest when the server that contains the non-primary adapter originates all the I/O operations.

To improve the performance of your system, you might choose to make the other adapter in the cluster the primary adapter.

To change the primary adapter:

1. From the SSA Main Menu, select **SSA Adapter List**.

2. A window opens containing a list of the SSA adapters in the pair of clustered systems on which you are working:



Put the cursor against the adapter that is to become the primary adapter, and press F2.

5.6 Viewing and Changing Disk Drive Access Modes

Disk drives that are attached individually, rather than as members of an array, have one of four access modes:

Public The disk drive can be accessed through both adapters in the cluster

Local The disk drive can be accessed only through the adapter that you have selected from the SSA Adapter List menu

Private The disk drive cannot be accessed through the adapter that you have selected from the SSA Adapter List menu. The disk drive can be accessed only through the other adapter in the cluster

No Access The disk drive cannot be accessed through either adapter in the cluster

The default access mode is Public.

Arrays always have an access mode of Public.

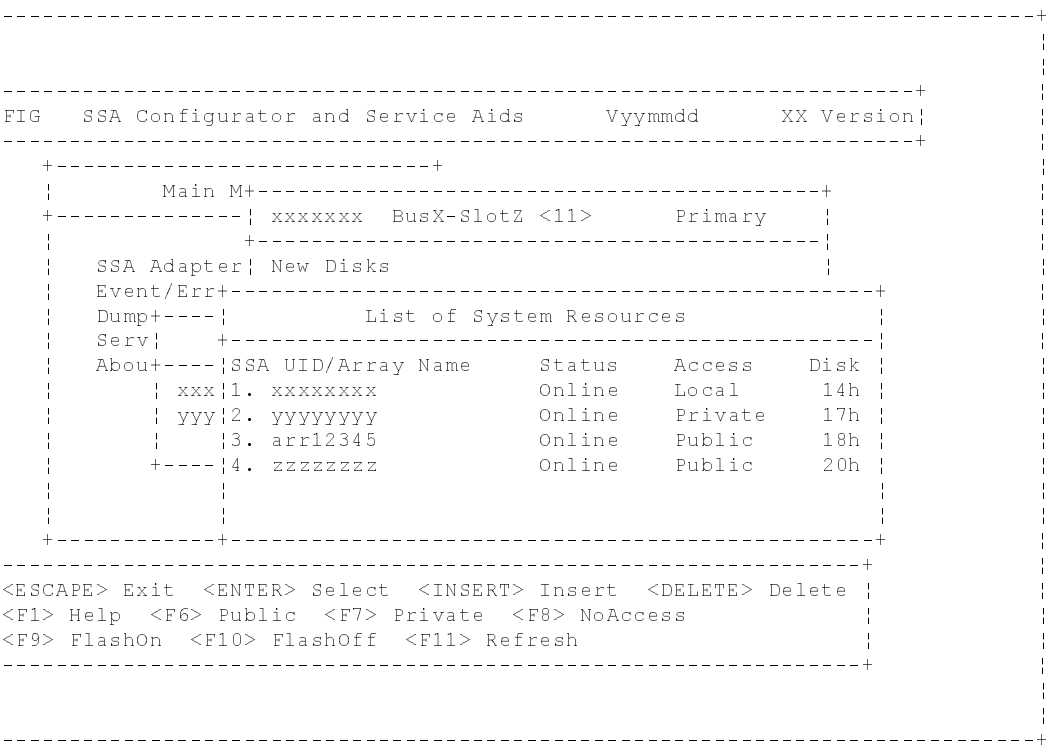
To view and change the access modes of individually attached disk drives:

1. From the SSA Main Menu, select **SSA Adapter List**,

2. Then select the adapter through which you want to view the resources

3. Then select **System Resources**.

The following window opens:



In this example, resource 1 is a disk drive that can be accessed only by the adapter that you selected in step 2. Resource 2 is a disk drive that can be accessed only by the other adapter in the same cluster. Resource 3 is an array and resource 4 a disk drive, both of which can be accessed by either adapter.

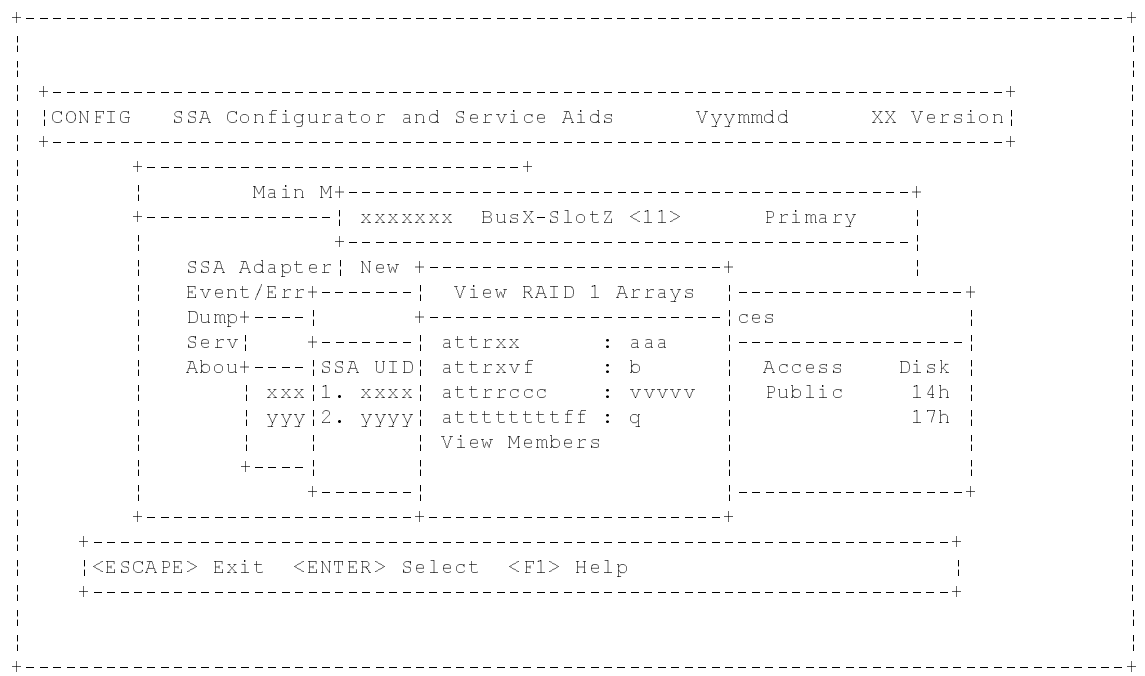
To change the access mode of a disk drive, highlight it in the list and press key F6, F7, or F8 as appropriate. Pressing F7 changes the access mode to Local, when viewed through the current adapter; it appears as Private when viewed through the other adapter in the cluster.

You must use this facility if you want to boot from an SSA disk. In this case, when you view the resources through the adapter that is installed in the system that you want to boot, the access mode of the boot disk must be Local.

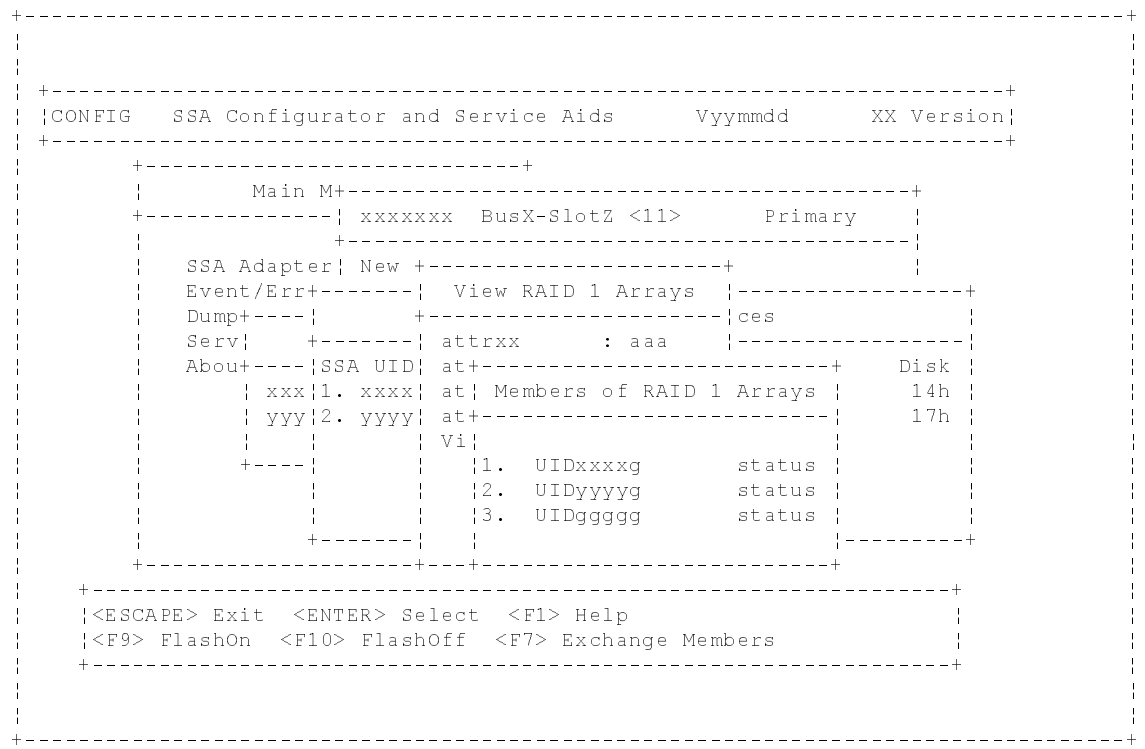
5.7 Exchanging a Member of an Array

To exchange a member of an array with another disk drive:

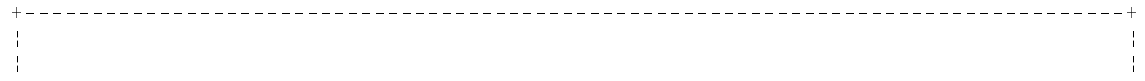
1. From the SSA Main Menu, select SSA Adapter List, the primary adapter that controls the array, **System Resources**, and then the array in which you want to exchange a member. A window will open showing the attributes of the array:

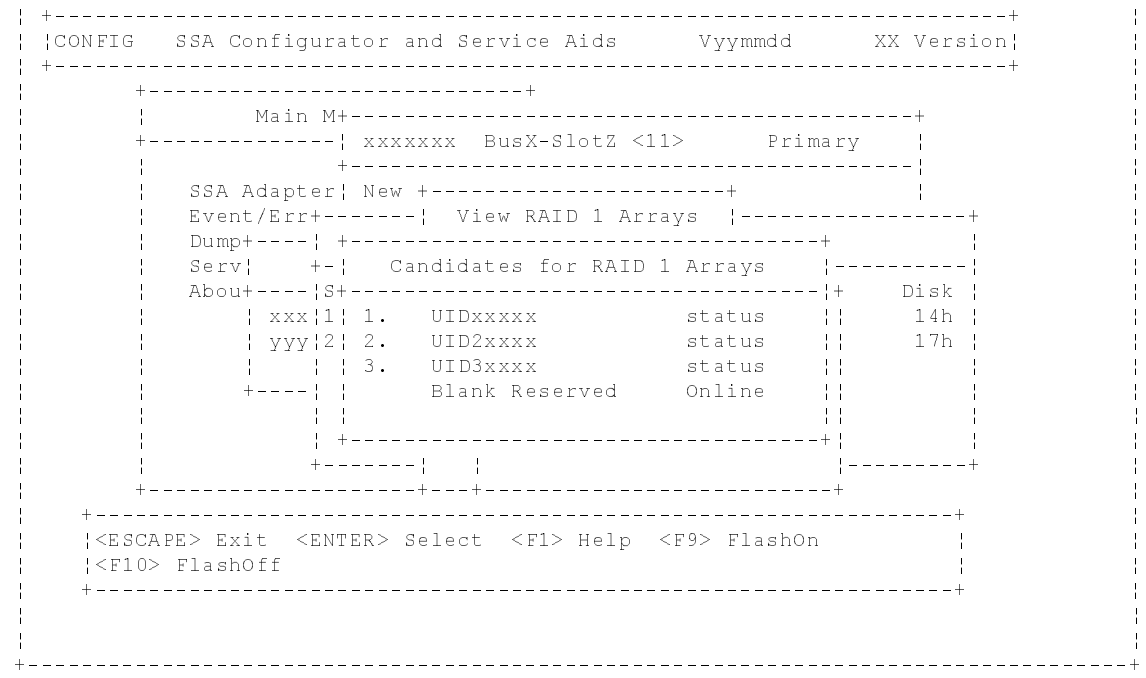


2. Use the arrow keys to scroll to the last item in the list, **View Members**, and press Enter. A window opens showing a list of the members of the array:

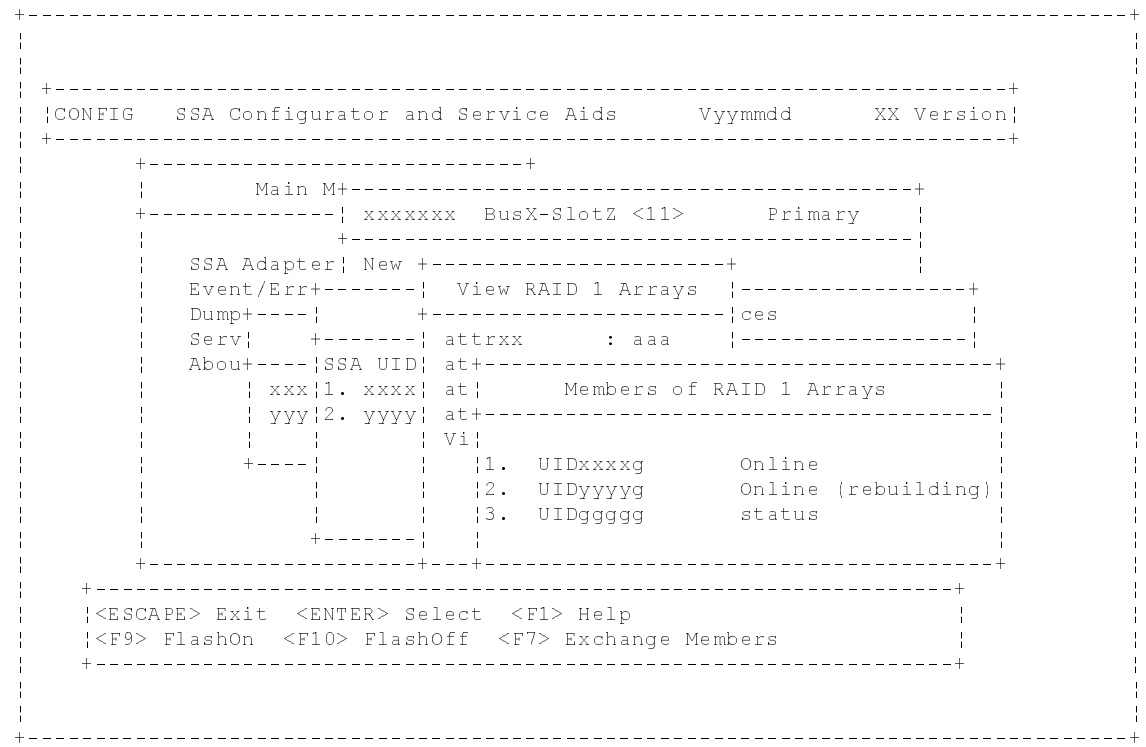


3. Select the member that you want to exchange and press F7. A window opens showing the disk drives that are candidates for exchange:





4. Select from this list the disk drive that you want to become the new member of the array. The window closes. The previous window now shows the new member, with the added status 'rebuilding' while the adapter rebuilds the data onto the disk drive from the rest of the array.



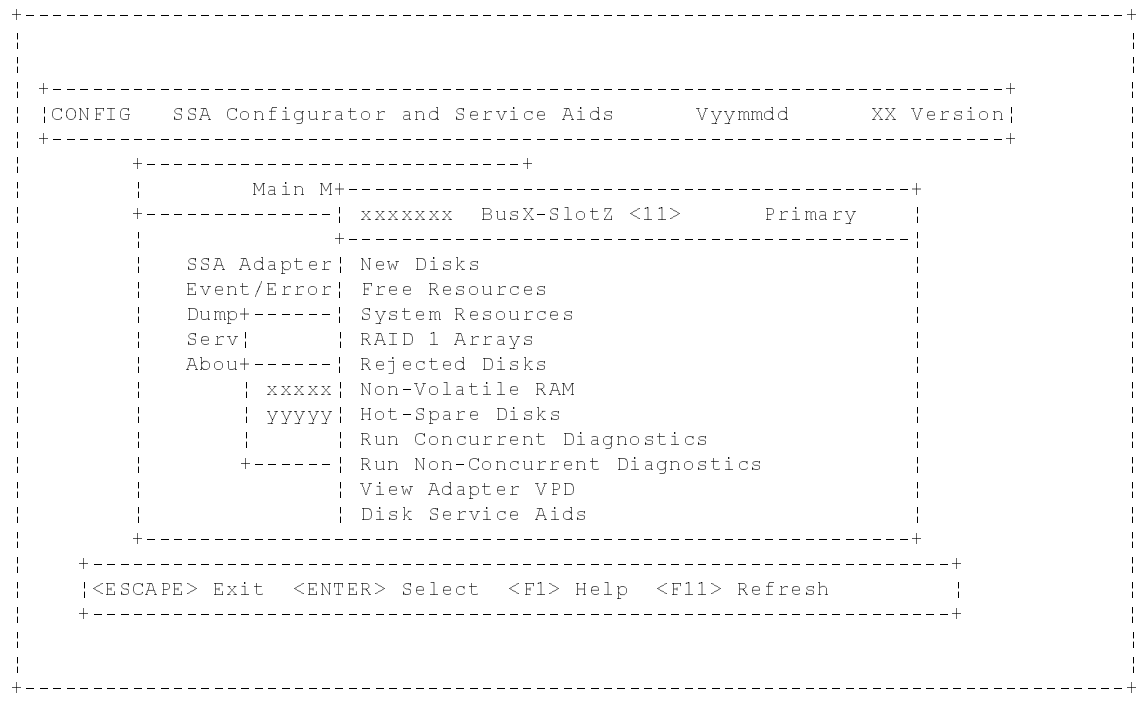
The old member returns to the free state.

5.8 Deleting an Array

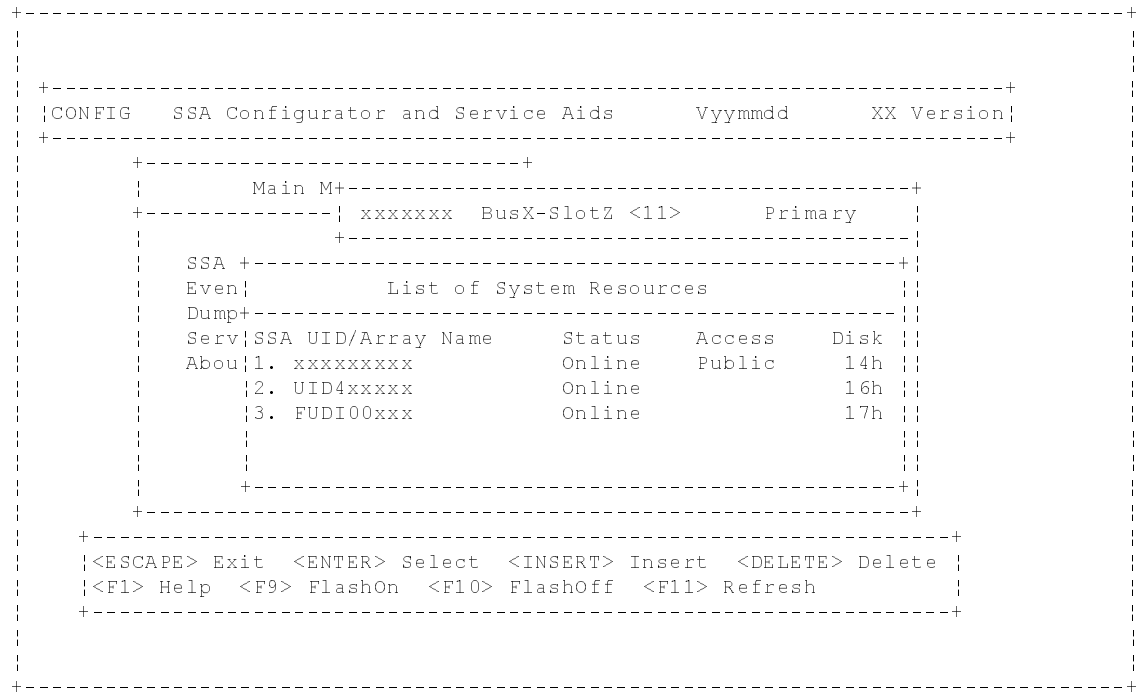
Before deleting an array, delete any operating-system-partition definitions that affect the array.

To delete the definition of an array from the system:

1. From the Main Menu, select SSA Adapter List and the primary adapter that controls the array. The adapter menu window opens:



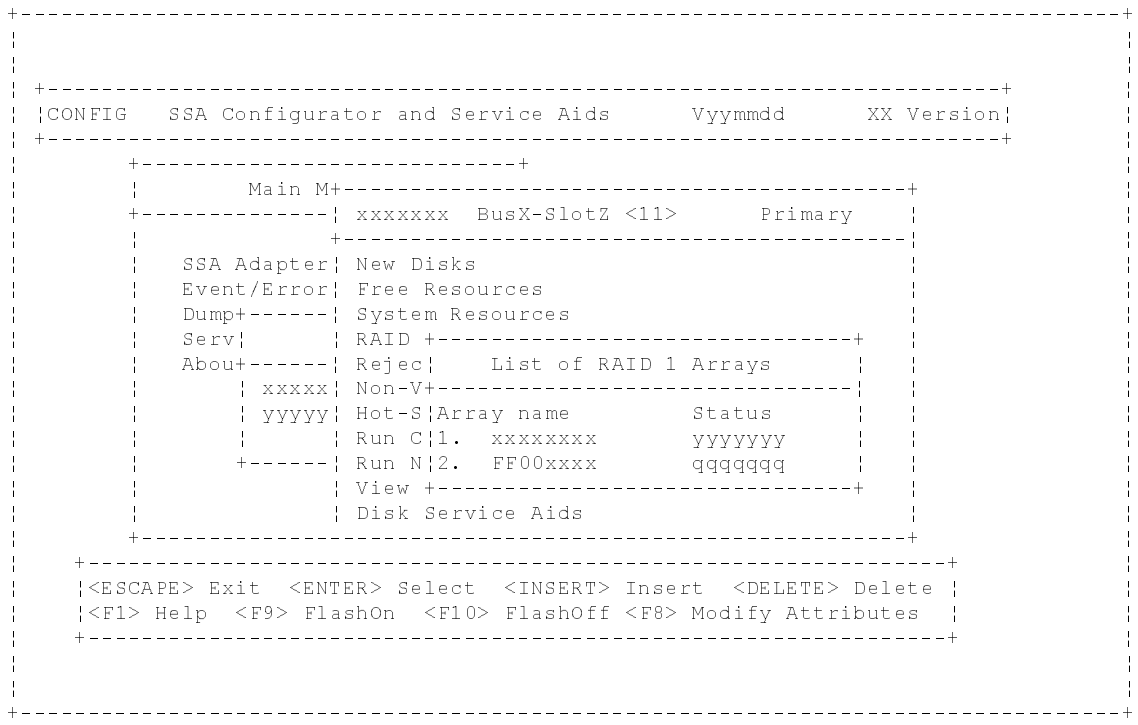
2. Select **System Resources**. A window opens showing the list of all resources currently defined to the system:



Highlight the entry for the array that you want to delete, make a note of its array name, press Delete, and confirm the deletion at the prompt.

3. The adapter-menu window reopens.

Select RAID 1 Arrays. You can scroll the contents of the window by using the arrow keys. A list of the RAID-1 arrays controlled by this adapter appears in a new window:



Put the cursor against the array to be deleted, press Delete, and confirm the deletion at the prompt.

These steps delete the array and return its member disk drives to the free state.

Shutdown and reboot your operating system.

6.0 Chapter 6. Getting the Latest Information

For the latest device drivers, firmware, and utility programs, refer to the IBM PC Company file search page at:

```
  http://www.us.pc.ibm.com/searchfiles.html
```

(use the keyword: SSA), or call the IBM PC Company Bulletin Board System at:

In the U.S.	1-919-517-0001
In Canada	In Markham: 905-316-4255
	In Montreal: 514-938-3022
	In Toronto: 416-492-1823
	In Vancouver: 604-664-6466

For new and helpful information about this and other SSA adapters and subsystems, refer to:

```
  http://www.ibm.com/storage
```

For detailed maintenance information on the adapter and its subsystem, refer to the *SSA RAID Cluster Adapter: Maintenance Information* manual, S32H-3817.

For detailed information on the operation of the adapter, refer to the *SSA RAID Cluster Adapter: Technical Reference* manual, SA33-3268.

For more information on IBM products or services, browse the IBM home page on the World Wide Web, its URL is:

```
  http://www.ibm.com
```

or, for information (such as Service & Support or new BIOS flashes) specifically about PC Servers, refer to:

```
  http://www.us.pc.ibm.com
```

A.0 Appendix A. SSA RAID Cluster Adapter Service Request Numbers

"Array Problems" in topic 4.2 describes how errors are reported and logged for the adapter and the disk drives attached to it. These reports and logs contain service request numbers (SRNs) which lead to detailed descriptions of the problems.

The following table lists the SRNs that apply to the adapter card, with descriptions of each problem and what you should do to solve the problem. The *SSA RAID Cluster Adapter: Hardware Maintenance Manual Supplement* provides more details of these SRNs; this information is primarily for service representatives.

Other SRNs refer to the disk drives that are attached to the adapter and to the unit in which those disk drives are installed. For details of those SRNs, refer to the *Installation and User's Guide* or the *Hardware Maintenance Manual Supplement* for that unit.

SRN	Description	Action
20PAA	An open SSA link has been detected.	Call for service
21PAA to 29PAA	An SSA 'Threshold exceeded' link error has been detected.	Call for service
2A002	Async code 02 has been received. Probably, a software error has occurred.	Call for service
2A003	Async code 03 has been received. Probably, a software error has occurred.	Call for service
2A004	Async code 04 has been received. Probably, a software error has occurred.	Call for service
2FFFF	An async code that is not valid has been received.	Call for service
40000	The SSA adapter card has failed.	Exchange the adapter for a new one or call for service.
40004	A 4 MB DRAM module in adapter card slot 0 has failed.	Call for service or exchange the DRAM for a new one.
40008	An 8 MB DRAM module in adapter card slot 0 has failed.	Call for service or exchange the DRAM for a new one.
40016	A 16 MB DRAM module in adapter card slot 0 has failed.	Call for service or exchange the DRAM for a new one.
40032	A 32 MB DRAM module in adapter card slot 0 has failed.	Call for service or exchange the DRAM for a new one.
40064	A 64 MB DRAM module in adapter card slot 0 has failed.	Call for service or exchange the DRAM for a new one.
40128	A 128 MB DRAM module in adapter card slot 0 has failed.	Call for service or exchange the DRAM for a new one.
41004	A 4 MB DRAM module in adapter card slot 1 has failed.	Call for service or exchange the DRAM for a new one.
41008	An 8 MB DRAM module in adapter card slot 1 has failed.	Call for service or exchange the DRAM for a new one.
41016	A 16 MB DRAM module in adapter card slot 1 has failed.	Call for service or exchange the DRAM for a new one.
41032	A 32 MB DRAM module in adapter card slot 1 has failed.	Call for service or exchange the DRAM for a new one.

41064	A 64 MB DRAM module in adapter card slot 1 has failed.	Call for service or exchange the DRAM for a new one.
41128	A 128 MB DRAM module in adapter card slot 1 has failed.	Call for service or exchange the DRAM for a new one.
42000	The SSA adapter has detected that both DRAM modules are failing.	Call for service or: 1. Check whether both DRAM modules are correctly installed on the adapter card. Make any necessary corrections. 2. If this problem has occurred immediately after an upgrade to the adapter card, check whether the correct type of DRAM modules have been installed. Make any necessary corrections. 3. If the problem remains, exchange the adapter card for a new one. *Do not exchange any DRAM modules yet.* 4. Install the DRAM modules from the original adapter card onto the new adapter card, then install the new adapter card. 5. If the problem remains, exchange the DRAM modules for new modules. 6. Install the new DRAM modules onto the original adapter card. Reinstall the original adapter card.
43PAA	An SSA device is preventing the completion of the loop configuration.	Call for service
45PAA	The SSA adapter has detected an open SSA loop.	Check that all the SSA cables are connected correctly. If the problem remains, call for service.
47000	An attempt has been made to store in the SSA adapter the details of more than 32 RAID arrays.	Call for service
47500	Part of the RAID array data might have been lost.	Call for service
48000	The SSA adapter has detected a loop configuration that is not valid.	Go to "SSA Loop Configurations that Are Not Valid" in topic A.1 or call for service
49000	A RAID array is in the Degraded state because a disk drive is not available to the array, and a write command	Call for service

	has been sent to that array. A disk drive might not be available for one of the following reasons: □ The disk drive has failed. □ The disk drive has been removed from the subsystem. □ An SSA link has failed. □ A power failure has occurred.	
49100	A RAID array is in the Exposed state because a disk drive is not available to the array. A disk drive can become not available for several reasons: □ The disk drive has failed. □ The disk drive has been removed from the subsystem. □ An SSA link has failed. □ A power failure has occurred.	Call for service
49500	No hot-spare disk drives are available for a RAID array that is configured for hot-spare disk drives.	Call for service
4C000	Unsupported configuration because there are disks that do not have failover protection.	Go to "SSA Loop Configurations that Are Not Valid" in topic A.1 or call for service
4C200	Corresponding adapters are not wired together.	Go to "SSA Loop Configurations that Are Not Valid" in topic A.1 or call for service
4C400	One host must be configured as A and the other as B.	Go to "SSA Loop Configurations that Are Not Valid" in topic A.1 or call for service
4C600	Failover has occurred: this adapter is now controlling the arrays.	Run the Disk Service Aids, and check the SSA configuration for correct connections and for correct SSA adapter operation. (See "Viewing the Physical Configuration" in topic 5.2)
4C800	One component of RAID-1 present and owning adapter serial number does not match that of this adapter.	Do one of the following: □ Install the other member of the array onto this SSA adapter □ Remove the array member from this adapter □ If you want to continue to use the one member on this SSA loop, go to "Changing Array Attributes" in topic 5.4 and set the Split

		Resolution field to the member number of the array member that you want to use.
4E000	Data scrubbing has reconstructed a data block and reassigned it.	If this SRN occurs three or more times in 24 hours, exchange the adapter for a new one or call for service.
4F000	The SSA adapter has detected duplicate disk attachment numbers.	The disk drive that has the duplicate attachment number has been designated as a new resource. Reattach the disk drive in the required position (see "Attaching Resources" in topic 3.4).
4F100	Both members of a RAID-1 array are indicating that they have been updated while the other member was not available. The array name is reported. (A corresponding SRN 4F101 is also logged.)	If you want to continue to use this array, you must specify one of the members as the member that contains good data, and update the data on the other member to match it. To do this, go to "Changing Array Attributes" in topic 5.4 and set the Split Resolution field to the member number of the array member that you want to use.
4F101	Both members of a RAID-1 array are indicating that they have been updated while the other member was not available. The UID/array name of the member that was not available is reported. (A corresponding SRN 4F100 is also logged.)	If you want to continue to use this array, you must specify one of the members as the member that contains good data, and update the data on the other member to match it. To do this, go to "Changing Array Attributes" in topic 5.4 and set the Split Resolution field to the member number of the array member that you want to use.
4F200	A member of a RAID-1 array has been rejected (array name reported).	None
4F201	A member of a RAID-1 array has been rejected (member serial number reported).	None
50000	The SSA adapter failed to respond to the device driver.	Exchange the adapter card for a new one or call for service
50001	A data parity error has occurred.	Exchange the adapter card for a new one or call for service
50002	An SSA adapter DMA error has occurred.	Exchange the adapter card for a new one or call for service
50004	An adapter error has been detected.	Exchange the adapter card for a new one or call for service
50005	A software error has occurred.	Call for service
50006	An adapter error has been detected.	Exchange the adapter card for a new one or call for service

50007	An adapter error has been detected.	Exchange the adapter card for a new one or call for service
50008	Unable to read or write the PCI registers.	Exchange the adapter card for a new one or call for service
50010	An SSA adapter or device drive protocol error has occurred.	Call for service
50012	The SSA adapter microcode has hung.	Call for service
D4000	The diagnostics cannot configure the SSA adapter.	Exchange the adapter card for a new one or call for service
D4100	The diagnostics cannot open the SSA adapter.	Exchange the adapter card for a new one or call for service
D4300	The diagnostics have detected an SSA adapter POST failure.	Exchange the adapter card for a new one or call for service
DFFFF	A command or parameter that has been sent or received is not valid. This problem is caused either by the SSA adapter, or by an error in the microcode.	Call for service

Subtopics
A.1 SSA Loop Configurations that Are Not Valid

A.1 SSA Loop Configurations that Are Not Valid

Note: This section is related to SRN 48000, 4C000, 4C200, or 4C400.

See "Rules for SSA Loops" in topic C.1.2 and "Example of a Clustered Configuration" in topic C.1.3 for details of the configuration requirements.

If the SRN occurred when you turned on the server:

1. Turn off the server.
2. Review the configuration that you are trying to make, and determine why that configuration is not valid.
3. Correct your configuration by reconfiguring the SSA cables or by removing the excess devices or adapters from the loop.
4. Turn on the server.

If the SRN occurred because additional devices or adapters were added to a working SSA loop:

1. Remove the additional devices or adapters that are causing the problem, and put the loop back into its original working configuration.

   Note: *It is important that you do these actions*, because they enable the configuration code to reset itself from the effects of the error.

2. Review the configuration that you are trying to make, and determine why that configuration is not valid.
3. Correct your configuration by reconfiguring the SSA cables or by removing the excess devices or adapters from the loop.

B.0 Appendix B. Disk Numbers

A disk number is assigned to a disk drive, or to an array, when the SSA configurator attaches that disk drive, or array, to the system. (That is, the disk drive, or array, becomes a system resource.)

The number that is assigned is related to the position in the System Resource List at which the resource (disk drive or array) is attached. The SSA configurator provides an option that allows the user to change the disk number to another number, if required. Valid numbers are 1 through 255.

Disk numbers are similar to the SCSI ID settings on SCSI disk drives. The system software uses the disk numbers to map the disk drives to a logical bus, target, and LUN.

The logical bus number to which a system resource is mapped is:

```
Disk number divided by 32
```

where 32 is the number of targets on each bus. Therefore, a disk number that is lower than 32 is mapped to logical bus 0.

The target address is the remainder that results from dividing the disk number by 32.

For example:

Disk Number	Mapping
2	Logical Bus 0 Target 2
32	Logical Bus 1 Target 0
37	Logical Bus 1 Target 5
65	Logical Bus 2 Target 1

The device is always mapped to LUN 0.

Microsoft Cluster Server requires that the boot device be on a different logical bus from any shared disks.

C.0 Appendix C. Introducing SSA and RAID

This chapter describes:

- Serial storage architecture (SSA)
- The RAID functions that are provided by the SSA RAID Cluster Adapter.

Subtopics

C.1 Serial Storage Architecture (SSA)

Serial Storage Architecture (SSA) is an industry-standard interface that provides high-performance fault-tolerant attachment of I/O storage devices. SSA is an open standard, and SSA specifications have been approved by the SSA Industry Association and are in the process of being approved as an ANSI standard through the ANSI X3T10.1 subcommittee.

In SSA subsystems, transmissions to several destinations are multiplexed; the effective bandwidth is further increased by spatial reuse of the individual links. Commands are forwarded automatically from device to device along a loop until the target device is reached. Multiple commands can be travelling around the loop simultaneously. SSA retains the SCSI-2 commands, queuing model, and status and sense bytes.

Subtopics

C.1.1 SSA Loops and Links

In the simplest SSA configuration, SSA devices are connected through two or more SSA links to an SSA adapter that is located in the system unit. The devices, SSA links, and SSA adapter are configured in loops. Each loop provides a data path that starts at one connector of the SSA adapter and passes through a link (SSA cable) to the devices. The loop continues through the devices, then returns through another link to a second connector on the SSA adapter.

The maximum permitted length for an external cable that connects two SSA nodes (for example, disk drives) is 25 meters (82 feet).

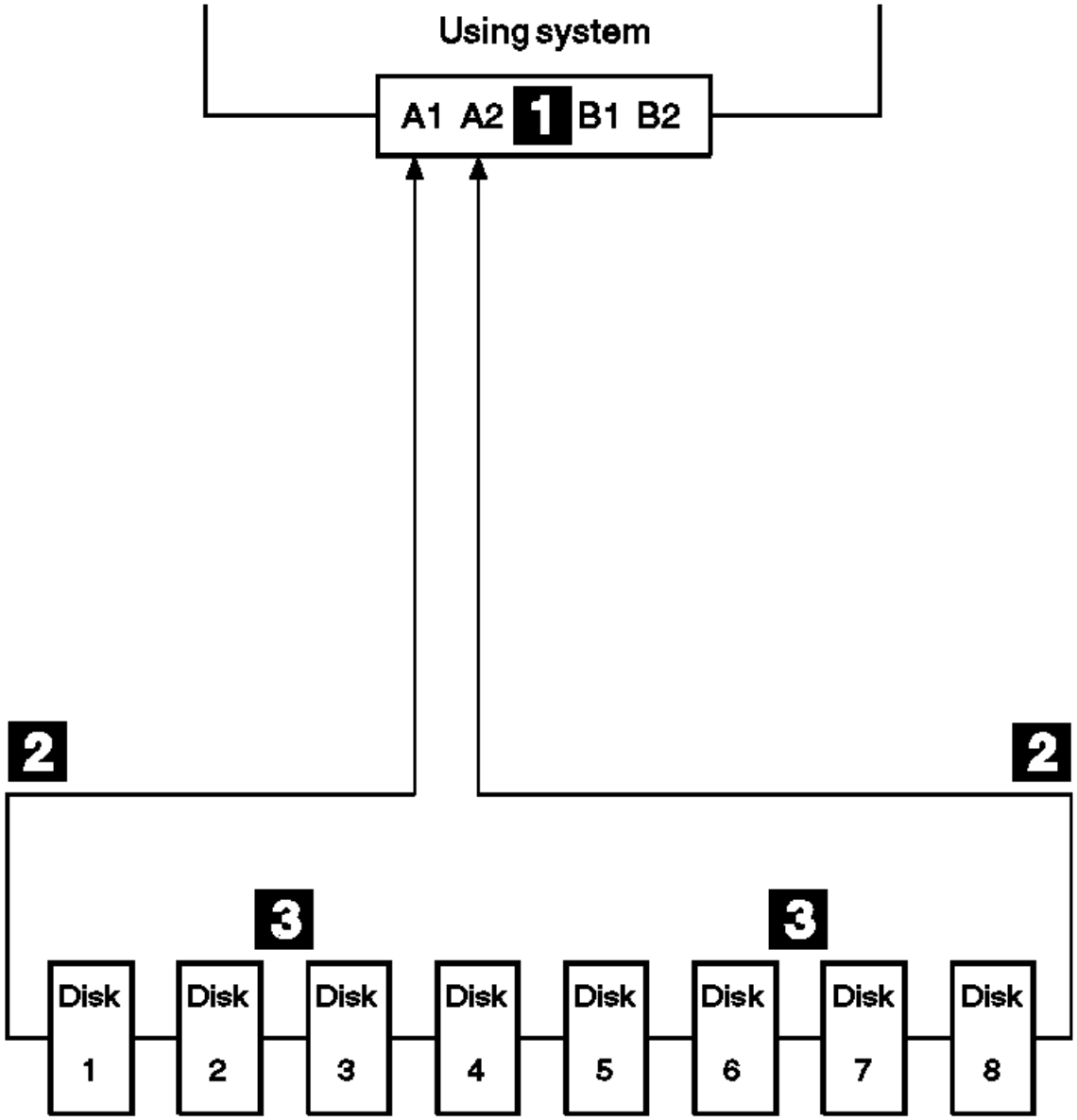
Details of the rules for configuring SSA loops are given for each SSA adapter in "Rules for SSA Loops" in topic C.1.2.

Subtopics
C.1.1.1 Loops and Data Paths

C.1.1.1 Loops and Data Paths

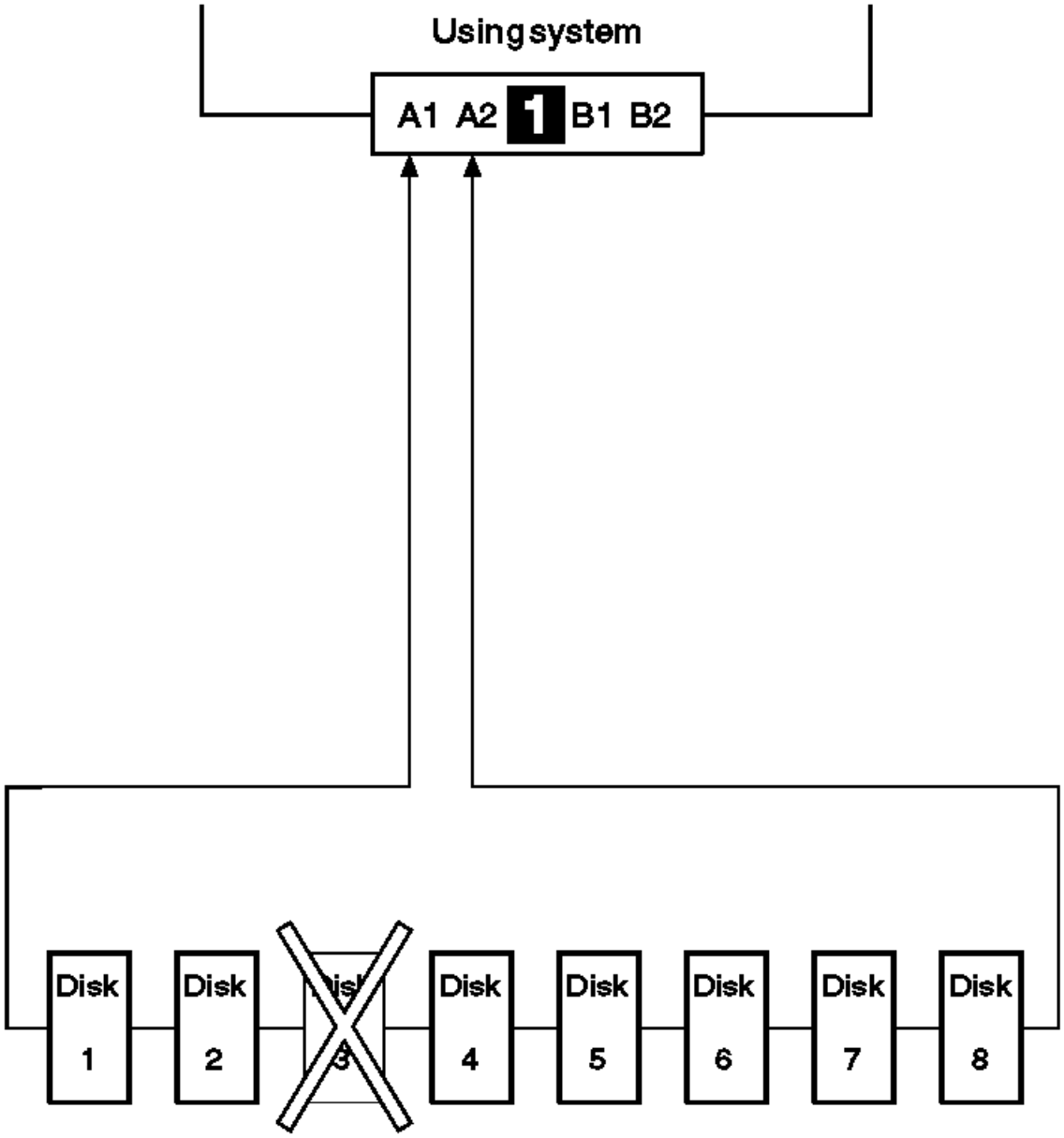
All devices that are attached to an SSA adapter card 1 are connected through SSA links 2. The SSA links are configured in loops. Data and commands to a particular device pass through all other devices on the link between the adapter and the target device.

Data can travel in either direction round a loop. The adapter can, therefore, get access to the devices 3 (disk drives in this example) through two data paths. The system cannot detect which data path is being used.



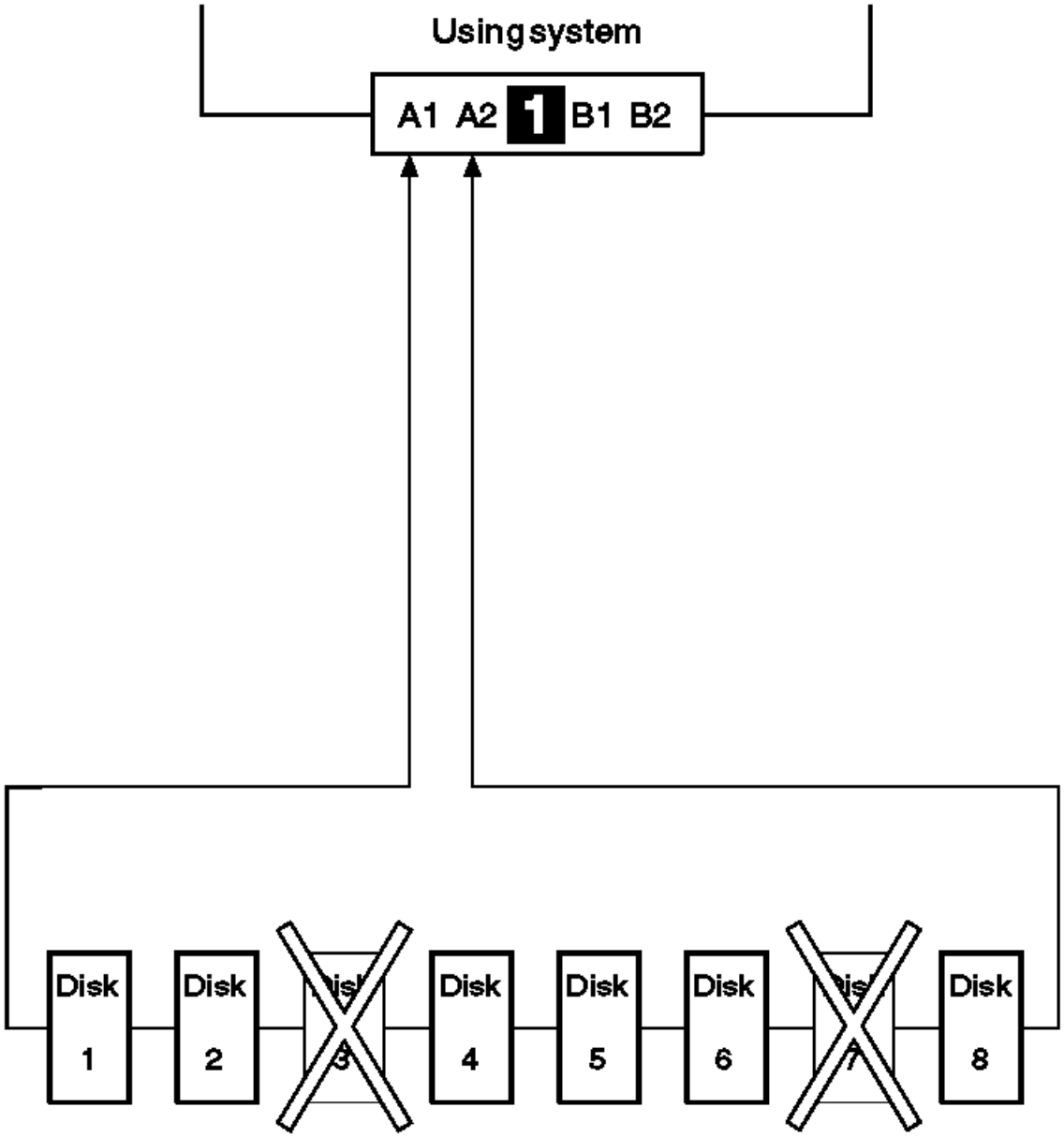
If a disk drive fails, or is turned off, the loop is broken, and one of the data paths to a particular disk drive is no longer available. The disk drives on the remains of the loop continue to work, but an error is reported to the system.

In the diagram, disk drive number 3 has failed. Disk drives 1 and 2 can communicate with the system only through connector A1 of the SSA adapter. Disk drives 4 through 8 can communicate only through connector A2 of the SSA adapter.



If two or more disk drives are turned off, fail, or are removed from the loop, some disk drives might become isolated from the SSA adapter.

In the diagram, disk drives 3 and 7 have been removed. Disk drives 1 and 2 can communicate with the system only through connector A1 of the SSA adapter. Disk drive number 8 can communicate with the system only through connector A2 of the SSA adapter. Disk drives 4, 5, and 6 are isolated from the SSA adapter.



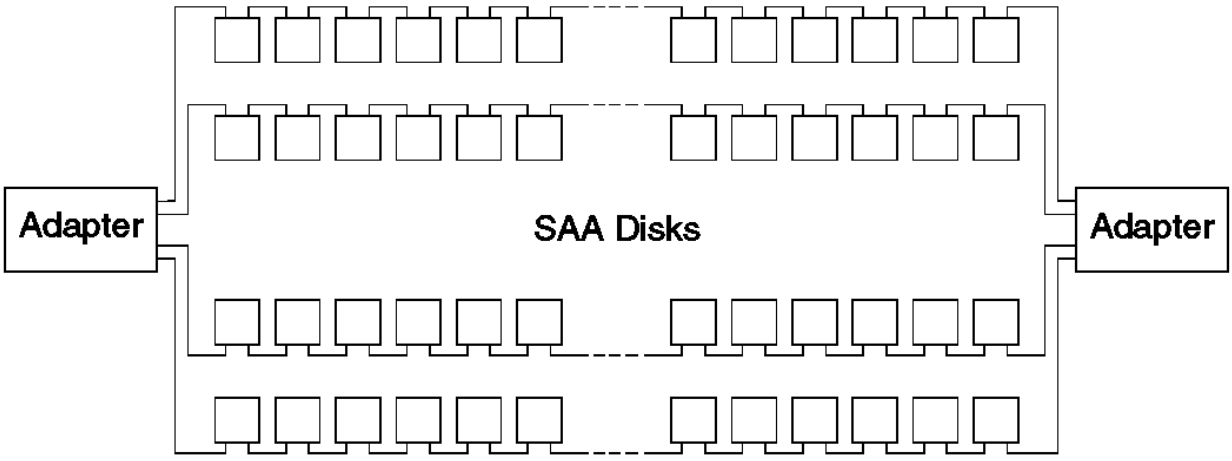
C.1.2 Rules for SSA Loops

For SSA loops that include the SSA RAID Cluster Adapter, the following rules apply:

- Each SSA loop must be connected to a valid pair of connectors on each SSA adapter (that is, either connectors A1 and A2, or connectors B1 and B2).
- A maximum of 48 devices can be connected in a particular SSA loop.
- Up to two pairs of adapter connectors can be connected in a particular SSA loop.
- If there are two adapters in a particular SSA loop, they must both be SSA RAID Cluster Adapters.
- If two SSA adapters are in a loop and there is a second loop attached to one adapter, it must be attached to the other adapter also.
- If multiple SSA RAID Cluster Adapters are installed in two systems sharing disk drives, the priority in each system of the adapters in each loop must be the same. For example, the first adapter (in slot-number order) in one system must be in an SSA loop with the first SSA adapter in the other system.
- Up to three SSA RAID Cluster Adapters can be installed in a supported PC Server.
- Neither of the two servers in an SSA cluster can share disk drives with a third server.

C.1.3 Example of a Clustered Configuration

The following diagram shows two SSA RAID Cluster Adapters in two loops:



C.2 Clustering Implementation

Two SSA RAID Cluster Adapters can be connected in one or two SSA loops with SSA disk drives. In this arrangement, the adapter with the higher SSA Unique ID is considered the *primary adapter* for all the arrays that are configured on the adapters. Commands for an array from the adapter that is not the primary adapter are automatically routed to the primary adapter to be implemented.

All the arrays are reported to both systems. The system software determines which server to use to communicate to each array.

If the non-primary adapter detects that it has lost access to the other adapter across the SSA loop, the non-primary adapter becomes the primary adapter. Commands sent to the old primary adapter are resent to the new primary adapter. This is *failover*.

Each adapter checks periodically that it can still communicate with its host. If it fails, it stops operating; this is detected by the other adapter and the network is reconfigured.

If write operations are in progress to an array (or have been received within the previous 20 seconds) when failover occurs, the array is rebuilt after the new primary adapter has taken control.

If an array has one of its members missing (that is, the array is in the exposed or degraded state) when a failover occurs, the status of the array becomes offline and an error is logged. Manual intervention is needed to resolve this error.

After a failover has occurred and a new adapter has been installed in place of the faulty one, the new adapter might have an SSA Unique ID that is higher than that of the remaining (currently primary) adapter. If this is the case, the new adapter becomes the primary adapter. This is *failback*.

The maximum configurations are:

- Under Microsoft Cluster Server, for a pair of servers, the total number of non-RAID disks and RAID-1 arrays can be up to 22. If no disk drives are configured as non-RAID disks, up to 44 disk drives can be configured as members of RAID-1 arrays, in addition to any disks that are configured as hot spares.
- Without Microsoft Cluster Server, for a pair of servers, up to 96 RAID-1 arrays can be configured; that is, up to 32 arrays on each of three pairs of adapters.

C.3 RAID Functions

Redundant Array of Independent Disks (RAID) technology gives you:

- Immediate availability and, depending on the RAID level, recovery of data
- Redundancy of data at a level that you can choose.

RAID technology stores data across groups of disk drives that are known as *disk arrays*. Subject to the level of RAID that you are using, this method of data storage provides the data redundancy that is needed for a secure system, and can allow faster retrieval of data through multiple channel access. Also, if a disk drive fails, you can normally exchange that disk drive without interruption of normal system operation.

The disk arrays can provide data redundancy that ensures that no data is lost if one disk drive in the array fails. The method that is used to write data to an array is related to the level of RAID that you are using. Disk arrays are contained in array subsystems. You can configure your subsystem with one or more arrays.

The SSA RAID Cluster Adapter provides RAID-1 facilities and also access to individual SSA disk drives that are not configured as members of an array.

Subtopics

C.3.1 RAID-1

RAID-1 is also known as mirroring or dual copy. It provides redundancy with better performance than a single disk, but requires real disk capacity of two times the data size.

A RAID-1 array has two disk drive members. If the members have different capacities, the resulting RAID-1 array has the capacity of the smaller member. Each data block of the array is written on each of the two members.

If one member fails, operations continue, to the good member. Performance is degraded for read operations (because read operations cannot now be shared between the two members), and improved for write operations (because only a single member is written). So a mixed workload may not show any change in overall performance. When a member returns or it is replaced (either manually or automatically by the hot-spare mechanism), a rebuild occurs. This rebuild is performed in parallel with any activity to the array.

C.3.2 Hot Spares

A hot-spare disk drive is a disk drive that is defined for automatic use if a disk drive within an array fails. The hot-spare must have a storage capacity greater than or equal to that of the smallest member of an array. You can define as many hot spares as you want.
Any RAID-1 array on an adapter can use the hot-spare disk drives on that adapter. For full clustering operations to continue, the hot-spare used by a RAID-1 array must be in an SSA loop between the same two servers as the array.

If a disk drive within an array fails, after an interval, the adapter automatically uses a hot spare instead of the failed disk drive, and rebuilds the data that was on the failed disk on to the hot spare.

C.3.3 Disk Array States

A disk array can be in one of the following states:

Subtopics

C.3.3.1 Good

The array is online and it can be read and written. Both member disk drives of the array are present. No data rebuilding is outstanding. The array is fully protected against the loss of one member.

C.3.3.2 Exposed State

One member is missing from the array. The first write operation causes the array to enter the degraded state.

After an interval, if a hot spare is available, it replaces the missing member and the array enters the rebuilding state.

C.3.3.3 Degraded State

One member is missing and a write operation has been received for the array. Read and write operations to the array are supported. If a hot spare disk drive is available, after an interval, the hot spare replaces the missing member and the array enters the rebuilding state.

The missing member is permanently excluded from the array.

C.3.3.4 Rebuilding State

The array is online and it can be read and written. Both members of the array are present but data is being rebuilt on one of the members.

C.3.3.5 Offline State

An array is in this state when one of the following conditions exists:

- Both members of the array are missing or have failed.
- One member of the array is missing when a failover occurs.
- The rebuilding of a replacement member is not complete when the remaining original member fails.

Read and write operations to the array are not supported.

D.0 Appendix D. Product Warranty and Notices

International Business Machines Corporation Armonk, New York, 10504

Subtopics

D.1 Statement of Limited Warranty

The warranties provided by IBM in this Statement of Limited Warranty apply only to Machines you originally purchase for your use, and not for resale, from IBM or an IBM authorized reseller. The term "Machine" means an IBM machine, its features, conversions, upgrades, elements, or accessories, or any combination of them. Machines are subject to these terms only if purchased in the United States or Puerto Rico, or Canada, and located in the country of purchase. If you have any questions, contact IBM or your reseller.

Machine: SSA RAID Cluster Adapter for PC Servers
Warranty Period*: One-year parts and labor
**IBM Options initially installed with the system carry the same warranty as the system. IBM Options installed after the initial installation carry the balance of the system warranty or one year, whichever is greater.*

Subtopics

D.1.1 Production Status

Each Machine is manufactured from new parts, or new and serviceable used parts (which perform like new parts). In some cases, the Machine may not be new and may have been previously installed. Regardless of the Machine's production status, IBM's warranty terms apply.

D.1.2 The IBM Warranty

IBM warrants that each Machine 1) is free from defects in materials and workmanship and 2) conforms to IBM's Official Published Specifications. IBM calculates the expiration of the warranty period from the Machine's Date of Installation. The date on your receipt is the Date of Installation, unless IBM or your reseller informs you otherwise.

During the warranty period, IBM or your reseller will provide warranty service under the type of service designated for the Machine and will manage and install engineering changes that apply to the Machine. IBM or your reseller will specify the type of service.

For a feature, conversion, or upgrade, IBM or your reseller may require that the Machine on which it is installed be 1) the designated, serial-numbered Machine and 2) at an engineering-change level compatible with the feature, conversion, or upgrade. Some of these transactions (called "Net-Priced" transactions) may include additional parts and associated replacement parts that are provided on an exchange basis. All removed parts become the property of IBM and must be returned to IBM.

Replacement parts assume the remaining warranty of the parts they replace.

If a Machine does not function as warranted during the warranty period, IBM or your reseller will repair or replace it (with a Machine that is at least functionally equivalent) without charge. If IBM or your reseller is unable to do so, you may return it to your place of purchase and your money will be refunded.

If you transfer a Machine to another user, warranty service is available to that user for the remainder of the warranty period. You should give your proof of purchase and this Statement to that user.

D.1.3 Warranty Service

To obtain warranty service for the Machine, you should contact your reseller or call IBM. In the United States, call IBM at **1-800-772-2227**. In Canada, call IBM at **1-800-565-3344**. You may be required to present proof of purchase.

Depending on the Machine, the service may be 1) a "Repair" service at your location (called "On-site") or at one of IBM's or a reseller's service locations (called "Carry-in") or 2) an "Exchange" service, either On-site or Carry-in.

When a type of service involves the exchange of a Machine or part, the item IBM or your reseller replaces becomes its property and the replacement becomes yours. The replacement may not be new, but will be in good working order and at least functionally equivalent to the item replaced.

It is your responsibility to:

1. obtain authorization from the owner (for example, your lessor) to have IBM or your reseller service a Machine that you do not own;

2. where applicable, before service is provided --

   a. follow the problem determination, problem analysis, and service request procedures that IBM or your reseller provide,

   b. secure all programs, data, and funds contained in a Machine,

   c. inform IBM or your reseller of changes in a Machine's location, and

   d. for a Machine with exchange service, remove all features, parts, options, alterations, and attachments not under warranty service. Also, the Machine must be free of any legal obligations or restrictions that prevent its exchange; and

3. be responsible for loss of, or damage to, a Machine in transit when you are responsible for the transportation charges.

D.1.4 Extent of Warranty

IBM does not warrant uninterrupted or error-free operation of a Machine.

Misuse, accident, modification, unsuitable physical or operating environment, improper maintenance by you, or failure caused by a product for which IBM is not responsible may void the warranties.

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Circumstances may arise where, because of a default on IBM's part (including fundamental breach) or other liability (including negligence and misrepresentation), you are entitled to recover damages from IBM. In each such instance, regardless of the basis on which you are entitled to claim damages, IBM is liable only for:

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2. the amount of any other actual loss or damage, up to the greater of $100,000 or the charge for the Machine that is the subject of the claim.

Under no circumstances is IBM liable for any of the following:

1. third-party claims against you for losses or damages (other than those under the first item listed above);

2. loss of, or damage to, your records or data; or

3. economic consequential damages (including lost profits or savings) or incidental damages, even if IBM is informed of their possibility.

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D.4 Communications Statements

The following statements apply to this product. The statements for other products intended for use with this product appear in their accompanying manuals.

Subtopics

D.4.1 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 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 (part numbers 07H9163, 07H8985, 32H1465, 88G6404, 32H1466, or 88G6406, or their equivalents) must be used in order to meet FCC emission limits. Neither the provider nor the manufacturer is 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 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.

電波障害自主規制　届出装置の記述

この装置は，第一種情報装置（商工業地域において使用されるべき情報装置）で商工業地域での電波障害防止を目的とした情報処理装置等電波障害自主規制協議会（VCCI）基準に適合しております。

従って，住宅地域またはその隣接した地域で使用すると，ラジオ，テレビジョン受信機等に受信障害を与えることがあります。

取扱説明書に従って正しい取り扱いをしてください。

D.4.2 VCCI Statement

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

```
+---------------------------------------------------------------------+
¦ This equipment is Type 1 Data Processing Equipment and is intended for ¦
¦ use in commercial and industrial areas.  When used in a residential    ¦
¦ area, or areas of proximity, radio and TV reception may be subject to  ¦
¦ radio interference.  VCCI-1.                                          ¦
+---------------------------------------------------------------------+
```

D.4.3 International Electrotechnical Commission (IEC) Statement

This product has been designed and built to comply with (IEC) Standard 950.

D.4.4 Avis de conformité aux normes de l'Industrie Canada

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

D.4.5 Industry Canada Compliance Statement

This Class A digital apparatus meets the requirements of the Canadian Interference-Causing Equipment Regulations.

D.4.6 United Kingdom Telecommunications Requirements

This apparatus is manufactured to the International Safety Standard EN60950 and as such is approved in the U.K. under approval number NS/G/1234/J/100003 for indirect connection to public telecommunications systems in the United Kingdom.

D.4.7 EC Council Directive

This product is in conformity with the requirements of the following EC directives:

- Council Directive 73/23/EEC on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.

- Council Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility.

Neither the provider or the manufacturer can accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product, including the fitting of option cards not supplied by the manufacturer.

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to CISPR 22 / European Standard EN 55022. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Attention: 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.

Properly shielded and grounded cables and connectors (part numbers 07H9163, 07H8985, 88G6403, 88G6404, 31H7962, or 88G6406, or their equivalents) must be used in order to reduce the potential for causing interference to radio and TV communications and to other electrical or electronic equipment. Such cables and connectors are available from the provider or manufacturer. Neither the provider or manufacturer can accept responsibility for any interference caused by using other than recommended cables and connectors.

D.4.8 Radio Protection for Germany

Dieses Gerät ist berechtigt in Übereinstimmung mit dem deutschen EMVG vom 9.Nov. das EG-Konformitätszeichen zu führen.

Der Aussteller der Konformitätserklärung ist die IBM Germany.

Dieses Gerät erfüllt die Bedingungen der EN 55022 Klasse A. Für diese Klasse von Geräten gilt folgende Bestimmung nach dem EMVG:

Geräte dürfen an Orten, für die sie nicht ausreichend entstört sind, nur mit besonderer Genehmigung des Bundesministers für Post und Telekommunikation oder des Bundesamtes für Post und Telekommunikation betrieben werden. Die Genehmigung wird erteilt, wenn keine elektromagnetischen Störungen zu erwarten sind.

(Auszug aus dem EMVG vom 9.Nov.92, Para.3, Abs.4)

Hinweis:

Dieses Genehmigungsverfahren ist von der Deutschen Bundespost noch nicht veröffeentlicht worden.