



SuperTrak SX6000TM

User Manual

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Manual Conventions

Common identifiers:

- ↵ - Press the Enter key
- [Key]** - Press the key(s) shown within the brackets
- Note:** - *Supplementary note containing important information*

Common expressions:

- Left-click - Move the mouse cursor over the specified target then click once with the left mouse button.
- Right-click - Move the mouse cursor over the specified target then click once with the right mouse button.
- Double-click - Move the mouse cursor over the specified target then click twice rapidly with the left mouse button.
- Drag and drop - Position the mouse cursor over the indicated icon, depress and hold the left mouse button while moving the cursor. Release the left mouse button to drop the icon at the new location.

Notes

Introduction

1.1 Promise Technology, Inc.

Promise Technology, Inc. was founded in San Jose, California in 1988 and established a proven track record for leading edge storage controller products. With an innovative product line, the company has pioneered ATA RAID storage, allowing users to configure RAID arrays using low cost Ultra ATA drives. Promise Technology was the first to introduce caching controllers to MFM, and then IDE drives, first to fully support Ultra ATA/33/66 and Ultra ATA/100 drives, and the first to develop a RAID 0, 1 card for Ultra ATA drives.

1.2 What is SuperTrak SX6000?

SuperTrak SX6000 is a hardware-based RAID controller and a software management suite that provides an enterprise-wide ATA RAID solution. The SuperTrak SX6000 controller card uses the I₂O architecture and employs Intel's i960RM RISC processor. When used with its companion software management suite, SuperTrak SX6000 offers a feature-rich, secure, versatile, and expandable RAID environment that allows users and administrators to configure, manage, and monitor everything from single arrays on local systems to array networks residing in offsite locations.

At its core, SuperTrak SX6000 provides advanced RAID management functions: creating arrays, monitoring them, keeping them online and operating at optimum efficiency. SuperTrak SX6000 can also perform many other tasks, such as:

- Create arrays at various RAID levels (0, 1, 0+1, 3, 5), depending on the application being used
- Set up a network of SuperTrak SX6000 RAID servers (all running under different RAID levels) and monitor those servers from any workstation on the network
- Create a series of SuperTrak SX6000 RAID networks at any number of offsite locations
- Monitor and/or repair SuperTrak SX6000 RAID arrays using the Internet from an offsite location -- all without compromising the integrity of secure servers

The SuperTrak SX6000 controller card features Intel's i960RM microprocessor moves much of the I/O workload off the main CPU and transfers it to the controller card's processor, boosting the performance of the entire system. Each SuperTrak SX6000 card can support up to six (6) Ultra ATA/100 hard drives configured as RAID levels (0, 1, 0+1, 3, or 5). Attached drives can be "hot swapped," when used with the optional SuperSwap drive housing.

On the software side, Promise Array Management (PAM) comprises three *modules*: Console, Message Server, and Message Agent. These modules use TCP/IP connections to communicate with one another, allowing communication across a network. This allows system administrators to monitor and rebuild the SuperTrak RAID system from a local console or a remote workstation over the Internet. With controlled user group administration, secure data encryption, and flexible control options, SuperTrak SX6000's PAM software package is an all -in-one modular solution.

1.3 Key Features

The following are key features of the Promise SuperTrak SX6000 RAID system:

Drive Types

- Supports standard IDE drives (Ultra ATA, Ultra DMA)
- Supports Ultra ATA/100, Ultra ATA/33/66 (UDMA 5/4/3/2/1/0, PIO 5/4/3/2/1/0, and DMA 2/1/0)

RAID Technology

- Data striping (RAID 0), mirroring (RAID 1), striping & mirroring (RAID 0+1), parity (RAID 3), and parity striping (RAID 5) at hardware level
- Supports automatic background rebuilds for mirrored arrays

Cache

- Read/write cache management
- Onboard controller card memory enhances cache size
- Supports 16MB minimum, 128MB maximum, 168-pin SDRAM memory
- Implements read and write back caching

Hot Swap Support

- Hot swappable hard drives, allowing for easy repair/replacement

Automatic Functions

- Drive fault detection
- Transparent rebuild of fault tolerant arrays in the event of drive fault

Graphical User Interface

- Remote monitoring of all arrays from network stations
- Local maintenance of arrays with drag-and-drop support

Optional Enclosure Management (SuperSwap)

- Monitors enclosure temperature, fan, and power (SuperSwap only)

1.4 System Requirements

- 1 bus mastering PCI slot (PCI v. 2.2 or 2.1 compliant)
- 16MB (up to 128 MB) 168-pin DIMM for cache RAM (ECC or non-ECC, unbuffered)

- One to Six Ultra ATA/100, Ultra ATA/33/66 hard drive(s) for dedicated use in the RAID array
- Windows NT 4.0, or Windows 2000 on server stations; Windows NT 4.0, Windows 2000, Windows 9x, or Window Me on remote monitoring stations

1.5 Operating System Support

While SuperTrak SX6000 was designed to specifically support Windows NT 4.0, Windows 2000 and later, users may employ other operating systems to access many of its operational features. What follows is a brief description of the different support levels available for each operating system:

Windows NT/Windows 2000

The SuperTrak SX6000 is fully functional in a Windows NT 4.0 or Windows 2000 operating system. Promise Technology supplies and supports the necessary SuperTrak SX6000 drivers for this environment. The SuperTrak SX6000 Message Server and Message Agent are Windows NT/Windows 2000 Services, and will only function on a Windows NT/2000 system. Properly installed Message Server and Message Agents are needed by the PAM utility to support remote maintenance and configuration of your RAID systems.

Linux

The SuperTrak SX6000 supports certain versions of Linux. For the latest Linux information and drivers, please visit the Technical Support area at www.promise.com. Please note that the PAM utility does not run in Linux, nor can a SuperTrak SX6000 running in Linux be monitored by the PAM utility.

Windows 95/Windows 98/Windows Me

The SuperTrak SX6000 drivers do not support the Windows 95/ Windows 9x/Windows Me operating system, therefore the controller card should not be installed in this environment. However, the PAM remote utility may be installed if the WIN32 interface is available and your system is connected to a network.

MS DOS

Using the SuperTrak SX6000 int 13h BIOS interface, it is possible to access the drive data on an array to partition, format, copy files, etc., using DOS 7 or later. DOS versions earlier than 7.0 have a 8.4GB drive size limit which cannot be changed.

Notes

Getting Started

This chapter is designed to help you prepare SuperTrak SX6000 for installation into Windows NT 4.0 or Windows 2000 system servers. Please read through this chapter carefully before attempting to install SuperTrak SX6000. Users should record their current CMOS (system setup) settings before making any changes. This preventative measure is aimed at protecting such information from loss, which may happen unpredictably and/or periodically during any hardware installation.

2.1 Unpacking SuperTrak SX6000

The SuperTrak SX6000 package should contain the following items:

- SuperTrak SX6000 controller card
- SuperTrak SX6000 User Manual
- SuperTrak SX6000 OS drivers & utility diskettes (3)
- Internal 18" Ultra ATA/100 80-wire/40-pin hard drive cables (6)
- Y-power cable (3)

If any of the items are missing or appear damaged, please contact your dealer or distributor immediately.

NOTE: *The SuperTrak SX6000 controller card ships with a removable protective label that covers the audible alarm buzzer device (see Figure 1). This label must be removed prior to installing the card.*

SuperTrak SX6000 Controller Card

Seen in Figure 1, the SuperTrak SX6000 controller card has several physical features of interest for purposes of installation: A DIMM socket for memory (minimum 16MB required), 6 IDE channel connections (1 "master" drive per channel), an alarm buzzer, a battery, and 4 LEDs on the card's backplane.

NOTE: *The SuperTrak SX6000 controller card, like every other valuable part of your PC, is sensitive to static electricity. Be sure that you are properly grounded (Promise recommends that you wear an anti-static strap, or place a free hand on a grounded object), and that your PC is unplugged before installing any of the SuperTrak SX6000 components.*

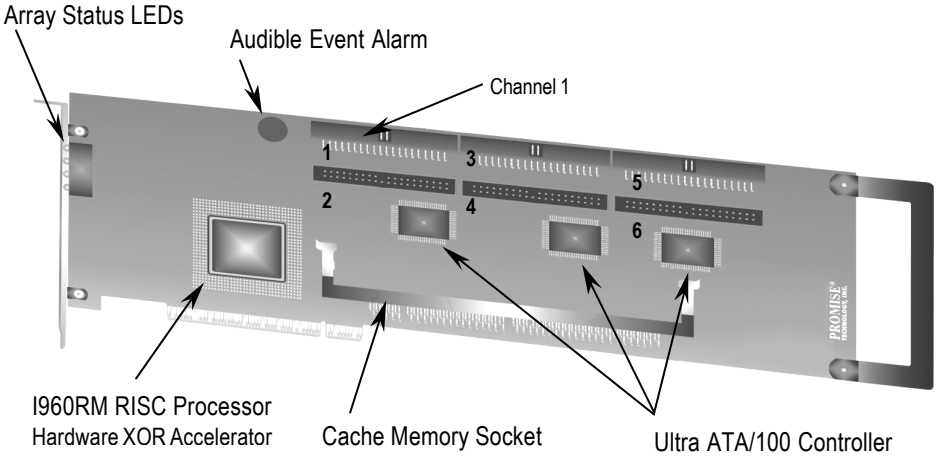


Figure 1 SuperTrak SX6000 controller card

Cables

Ultra ATA/100 drive cables are provided with the SuperTrak SX6000 controller card. These cables must be used with Ultra ATA/100 and Ultra ATA/66 drives in order to realize full Ultra ATA/100 and/or Ultra ATA/66 specs. They differ from older 40-wire/40-pin IDE cables by adding an extra ground wire between each data wire, resulting in an 80-wire/40-pin cable.

NOTE: Do not use cables that are longer than 18". Such cables are out of spec and can cause data integrity problems.

2.2 Quick Installation Checklist

Refer to this checklist to ensure that all hardware and software components necessary for your SuperTrak SX6000 to operate efficiently are installed.

Hardware Installation

- At least one drive set at *Master* and is attached to the controller.
- SuperTrak SX6000 controller card is fully inserted into a bus mastering PCI slot and mounted with a bracket screw.
- Minimum of 16MB RAM is inserted into the DIMM slot on the controller card.

Software Installation

- Promise SuperTrak SX6000 BIOS is loading correctly at system boot.
- At least one array has been created with the drive(s) attached to the SuperTrak SX6000 using SuperBuild or PAM.
- If the array is to be a system drive, it is partitioned & formatted appropriately.
- SuperTrak SX6000 Message Agent is installed (automatically installs I₂O driver component).
- If this system is to be a monitoring gateway or server, the SuperTrak SX6000 Message Server is installed.
- If this system is to be used for monitoring SuperTrak SX6000 server systems, SuperTrak SX6000 PAM utility is installed.

2.3 Hardware Installation

- (1) Install memory into the DIMM slot at DIMM1 (see Figure 1). The minimum memory requirement is 16MB. You may use up to 128 MB ECC or non-ECC, unbuffered 168-pin PC100 or higher SDRAM.
- (2) Remove protective label for audible alarm buzzer (see Figure 1).

Figure 2 Typical controller card installation

- (3) Install the controller card into an available PCI slot on the system motherboard and secure it in place.
- (4) Set the hard drives to "Master", "Cable-Select", or "Single" (depending on drive specification).
- (5) Next, install hard drives into the PC chassis. Attach black end of Ultra ATA/100 cable and power cable to back of each drive.
- (6) Connect the blue end of the Ultra ATA/100 cable to any IDE channel available on the SuperTrak SX6000.

NOTE: Device support for drives is provided by the SuperTrak SX6000 system. No changes are necessary in the motherboard CMOS/BIOS Setup for resources or drive types regarding hard drive configuration. Changes may or may not be necessary for PCI device setup.

2.4 Software Installation

This section covers various software-related installation issues for SuperTrak SX6000. These include: BIOS Utility, Network Connection, Driver Installation, and Application Installation.

BIOS Utility

The SuperTrak SX6000 BIOS utility called SuperBuild must be used to create the first array(s) on the SuperTrak SX6000. Arrays may subsequently be created through the PAM utility. You must have an array on SuperTrak SX6000 in order to use the drives for data storage. See Chapter 1, for more information about using the SuperBuild BIOS utility to create an array.

Network Connections

SuperTrak SX6000 may be monitored over a network. The following topics require attention during the configuration. If you will not be monitoring SuperTrak SX6000 via a network, you may skip this particular section. *Please note that this is NOT intended as a thorough networking/troubleshooting reference for LAN or WANs.*

Firewall

For remote connection to a LAN on which a SuperTrak SX6000 Message Server is installed, it is very possible that you may be required to communicate through a firewall. To do this, you must have a communication port open for the IP address on which the Message Server resides, or the IP address must be fully open for communication.

The network administrator should either: a) open port 711 (decimal) on the IP address; or, b) open all ports for the IP address. This will allow the PAM software to initiate a TCP/IP connection from the remote location through the firewall port 711 to the Message Server located at the destination IP.

TCP/IP

Proper TCP/IP setup is crucial for the SuperTrak SX6000 software package to function correctly. Without TCP/IP installed and configured correctly, the software will not be able to make connections to the SuperTrak SX6000 RAID server(s) for remote access and maintenance.

NOTE: For further information on IP addressing, and TCP/IP configuration consult the documentation for your specific operating system.

Notes

SuperBuild™

This chapter contains a *Setup Task Quick Reference* that is a checklist of tasks needed to initialize your SuperTrak SX6000 system, followed by a step-by-step instructional breakdown of each task. The second half of this chapter is a visual and technical description reference including software screen shots.

3.1 Setup Task Quick Reference

Use this reference to make sure you have completed all the tasks necessary to get your SuperTrak SX6000 server running. See Chapter 4 for visual references and technical descriptions of the SuperBuild utility. See Appendix C, Technology Background for more information on RAID arrays.

NOTE: *The following checklist is primarily intended for those who require SuperTrak to provide support for an array as a system or bootable drive. If the array is only to be used for data storage, then this checklist should be skipped. Use the PAM utility to create and manage your arrays. It is recommended that you still read over the “Common Tasks” (below) to familiarize yourself with the functionality of the BIOS SuperBuild utility.*

Setup Checklist

- Power up the system and watch for the “Promise SuperTrak SX6000 BIOS” messages.
- Enter the “SuperBuild” utility (press [Ctrl-F]).
- For easiest configuration, use the “Auto Setup” to create a single array using all drives attached to the SuperTrak SX6000; otherwise, use the “View/Define Array” menu to create a new, custom array.
- If you are defining more than one array and booting from one of these arrays, make sure to select the appropriate array as the “boot array” from the “View/Define Array” menu. Use the up/down arrow keys to highlight the array and press the [Spacebar].
- Restart the system for the changes to take effect.
- Watch for the “Promise SuperTrak SX6000 BIOS” messages, ensuring that the messages reflect the array(s) you have created.

Common Tasks

The following portion of the “Quick reference setup” is a listing of steps necessary to complete each type of task required for setting up the SuperTrak SX6000 system through the SuperBuild BIOS utility. The tasks are not intended to be a complete, step-by-step guide to setting up the SuperTrak SX6000 system successfully.

NOTE: *There are some advanced RAID array configuration options, such as cache settings, which require the PAM utility to set up.*

Entering the BIOS SuperBuild utility

When the system boots, you will see the “Promise SuperTrak SX6000 BIOS” sign-on banner appear on the screen. Once the BIOS identifies the arrays attached to the SuperTrak SX6000 controller, it will offer an option to enter the SuperBuild utility.

Press [Ctrl-F] to initialize SuperBuild and display the “Main Menu”.

Creating a disk array from the Auto Setup screen

- (1) In the “Main Menu” press [1] to display the “Auto Setup” screen.
- (2) In the “Auto Setup Options Menu”, use the [Spacebar] to choose an option in the “Optimize array for” field. The choices offered are RAID 0 (striping), RAID 1 (mirroring), RAID 3 (striping with dedicated parity), and RAID 5 (data striping with striped parity), and JBOD (spanning array).
- (3) Press the [Ctrl-Y] keys to save the changes. SuperBuild will build an array automatically from the hard drives connected to the SuperTrak SX6000 controller.

Creating an array from the View/Define Array screen

- (1) In the “Main Menu” press [3] to display the “View/Define Array” screen.
- (2) In the “View/Define Array” screen, select the array number you want to define using the arrow keys, and press [Enter] to display the “Define Array Definition Menu” screen.
- (3) In the “Define Array Definition Menu”, highlight the “RAID Level” column using the [Tab] key, and then cycle through the choices using the [Spacebar] to select the RAID level you wish to use for the new array.
- (4) In the “Drive Assignments” menu, use the [Down Arrow] to select from the available drives to assign them as members of the new array. Use the [Spacebar] to toggle between “Yes” or “No” or press [Y] under the “Assignment” column to assign the drive; [N] unassigns the drive.
- (5) When you are finished assigning drives as array members, press the [Ctrl-Y] keys to save the array member assignment. The utility will return to the “Define Array Definition Menu” screen and the new array will now be visible in the list.

Deleting an array from the Delete Array screen

- (1) From the “Main Menu” press [4] to display the “Delete Array Menu”.
- (2) From the “Delete Array Menu”, highlight the array you wish to delete using the [Up Arrow] or [Down Arrow] keys and press the [Del] key.
- (3) Press the [Ctrl-Y] keys to confirm deletion.

Setting the Halt On Error option

- (1) In the “Main Menu” press [5] to display the “Controller Configuration” screen.
- (2) In the “Controller Configuration – Options” screen, use the [Spacebar] to toggle the “Enable/Disable” option of the “Halt On Error” feature.
- (3) Press the [Ctrl-Y] keys to save the changes.

OS Selection

- (1) In the “Main Menu” press [5] to display the “Controller Configuration” screen.
- (2) In the “Controller Configuration – Options” screen, use the [Spacebar] to toggle through the OS Selection options to
- (3) NT – Choose this if you are using Windows NT 4.0 or Window 2000
- (4) Linux – Choose this if you are using Linux
- (5) Other – Choose this if you are using an OS other than Windows or Linux
- (6) Press the [Ctrl-Y] keys to save the changes.

3.2 SuperTrak BIOS Reference

When the SuperTrak SX6000 BIOS loads during system boot time, it displays pertinent information about the RAID arrays that it finds, then displays “Press <Ctrl-F> to enter Array BIOS Configuration Utility” (see below).

```

SuperTrak SX6000 (tm) BIOS Version 1.10.0 (Build 7)
(c) 2001 Promise Technology, Inc. All rights reserved.

ID      MODE          SIZE      TRACK-MAPPING    STATUS
-----
1       1x2 Mirror      8629M    1108/255/63     Functional
Press <Ctrl-F> to enter Array BIOS Configuration Utility...

```

Figure 3 SuperTrak SX6000 BIOS Startup

The information displayed in the form of a small table contains the following properties:

ID

These represent a unique ID number assigned to each RAID array identified by the BIOS.

Mode

This identifies the RAID mode configuration that the array is defined as.

Size

This is the MB (Megabyte) data size of the indicated array.

Track-Mapping

This is the CHS (Cylinder/Head/Sector) equivalent of the array geometry as hosted by the SuperTrak SX6000 BIOS int 13h disk services.

Status

Shows one of three possible array status conditions:

Functional

The array is fully operational, and no problems are present.

Critical

The array is operational, but has lost its fault tolerance. For RAID array levels 1, 0+1, 3 and, 5 the array contains a failed drive. The user should identify and replace the failed drive.

Offline

The array is no longer operational and the SuperBuild utility cannot rebuild the array. The array must be rebuilt from the last tape backup or other device. The user should identify and replace the failed drives. For RAID levels 1, 3, and 5, at least two or more drives in the array have failed. For a RAID 0 array, at least one drive has failed.

Main Menu

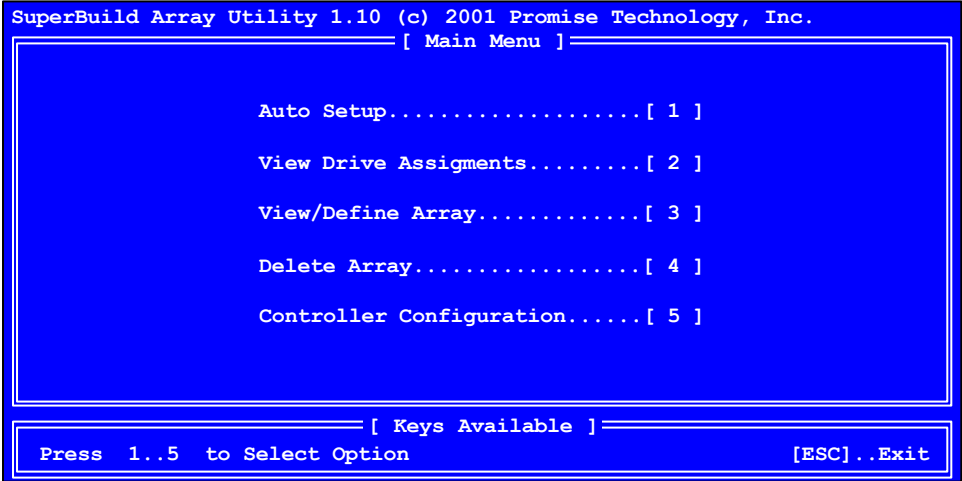


Figure 4 SuperBuild Array Utility Main Menu

Note: This menu uses number keys 1 through 5 to select options. Many of the subsequent menu windows use arrow-pad keys to highlight options. Use the spacebar to cycle through choices for the selected option. Enter (return) to select a highlighted option. ESC (Escape) to exit the menu.

3.3 Auto Setup

By pressing the [1] key while in the “Main Menu” screen, the “Auto Setup” screen is displayed (see below). It is divided into sections: “Auto Setup Options Menu”, “Auto setup configuration”, and “Keys Available”.

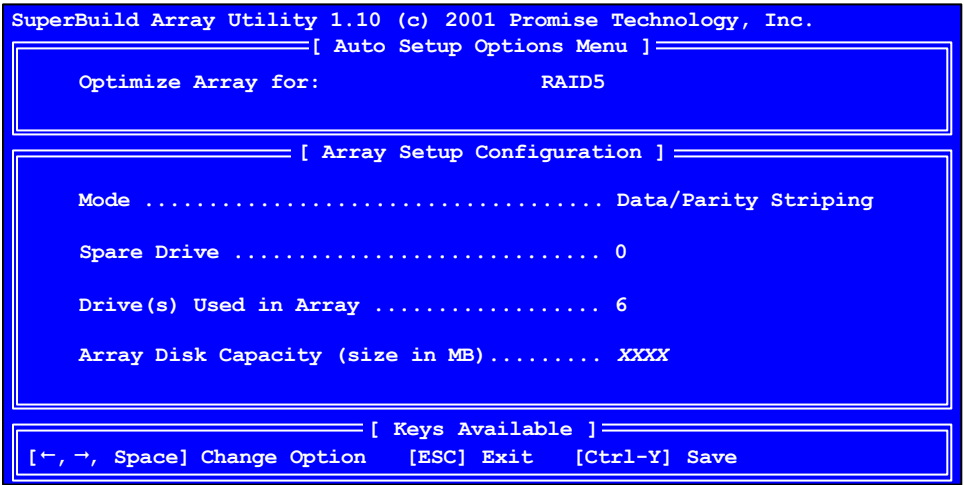


Figure 5 Auto Setup Screen

Auto Setup Options Menu

This section of the screen is the only selectable portion. Depending on the number of drives recognized by SuperTrak SX6000, the “Auto Setup Options Menu” may limit the number of array types available. You choose a RAID level in the “Optimize array for” field. The choices that may be offered are: RAID 0 (striping), RAID 1 (mirroring), RAID3 (striped data + parity drive), RAID5 (data and parity striping), and JBOD (spanning).

Optimize Array for:

Selections in this field correspond to the items found in the “Mode” field in the “Array Setup Configuration” section (see table below).

RAID Level	Mode
RAID 0	Stripe
RAID 1	Mirror (2 drives)
RAID 0+1 (requires 4 or 6 drives)	Stripe + Mirror (4 or 6 drives)
JBOD	Spanning
RAID 3 (needs 3 drives min.)	Stripe Data + Parity
RAID 5 (needs 3 drives min.)	Data/Parity Striping

Auto Setup Configuration

This section of the “Auto Setup Menu” contains four information fields:

Mode

Items in this field correspond to the selections found in the “Optimize Array for” field in the “Auto Setup Menu” section (see table on page 15).

Spare Drive

Auto setup does not allow configuring a hot spare drive. If you wish to have a spare drive, you must use the “View/Define Array Menu” (see page 18) and manually assign the exact number of drives you want included. Any attached drive not configured in a fault tolerant array will be recognized as a spare drive and will be automatically added to the array when a failed drive is detected. An automatic data rebuild will be performed to restore fault tolerance as quickly as possible. At a later time, the failed drive can be physically removed and an extra drive added in its place to function as the new spare drive.

Drive(s) Used In Array

This field displays the number of drives used in the array. This does not include the spare drive(s).

Array Disk Capacity

This field displays the capacity available in the entire array in MB (megabytes), not counting spare drives.

When you have completed your selections, press the [Ctrl-Y] keys. SuperBuild will create an array automatically from the hard drives connected to the SuperTrak SX6000 controller. SuperBuild will then ask to reboot the system.

3.4 View Drive Assignments

By pressing [2] on the "Main Menu" screen, the "View Drive Assignments" screen is displayed (see below). This screen does not allow modifications to any of the four fields.

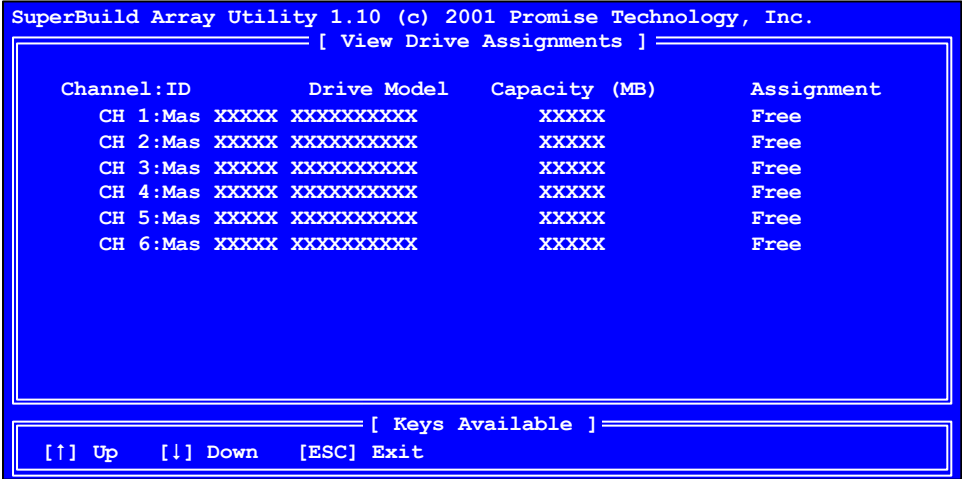


Figure 6 View Drive Assignments screen

Channel: ID

This field shows the SuperTrak SX6000 controller channel ID (1-6) to which a particular drive is attached.

Drive Model

This field identifies the manufacturer, model, and model number (if applicable) of each drive installed on the SuperTrak SX6000 card.

Capacity (MB)

This field reflects the capacity in MB (megabytes) of each drive.

Assignment

This field identifies the array to which each drive belongs. Assigned drives are labeled with their disk array (1, 2, 3, etc...). Unassigned drives are labeled "free," and are considered "hot spares" to provide fault tolerance. Unassigned drives may also be used to create a new array at any time.

1.1 View/Define Array

By pressing [2] on the “Main Menu” screen, the “Define Array Menu” screen is displayed (see below). This screen may already display existing arrays. The “Define Array Menu” screen allows users to manually begin the process of defining both drive elements and RAID levels for each disk array. Users will commonly create one or two drive arrays with SuperTrak SX6000.

To manually create arrays from the “Define Array Menu” below, use the arrow keys to highlight an array number you wish to define, and press [Enter] to select. The “Define Array Definition Menu” will next appear that allows drive assignments to the disk array (see Page 19).

NOTE: Promise recommends that if you are creating a single array using SuperTrak without a “hot” spare drive, do so through the “Auto Setup” screen under selection [1] of the “Main Menu”.

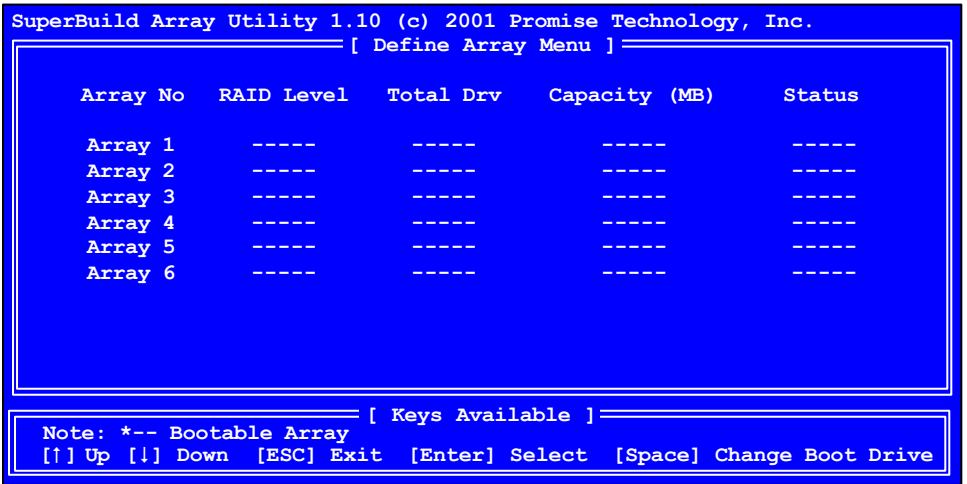


Figure 7 Define Array Menu screen

Array No.

The Array Number column displays all arrays (defined or undefined) addressable by the SuperTrak SX6000.

RAID Level

This column indicates the RAID type applied to a particular array.

Total Drv

This column displays the number of drives configured for array.

Capacity (MB)

The values in this column reflect the total capacity in MB (megabytes) for that array.

Status

This column displays the state information for each array. Status definitions can be found at the beginning of Section 3.2.

Define Array Definition Menu

Selecting an Array # from the “Define Array Menu” brings up the “Define Array Definition Menu” screen (see Figure 8 below).

You must first assign the type of “RAID Level” you want. In the “Define Array Definition Menu” section, use the [Spacebar] to cycle through array types: RAID 0 (Striping), RAID 1 (Mirroring), RAID 3 (Stripe Data + Parity), RAID 5 (Data/Parity Striping) or JBOD (Spanning). See Chapter 5 about RAID levels.

NOTE: Promise recommends the use of identical drives when creating a new array for best results.

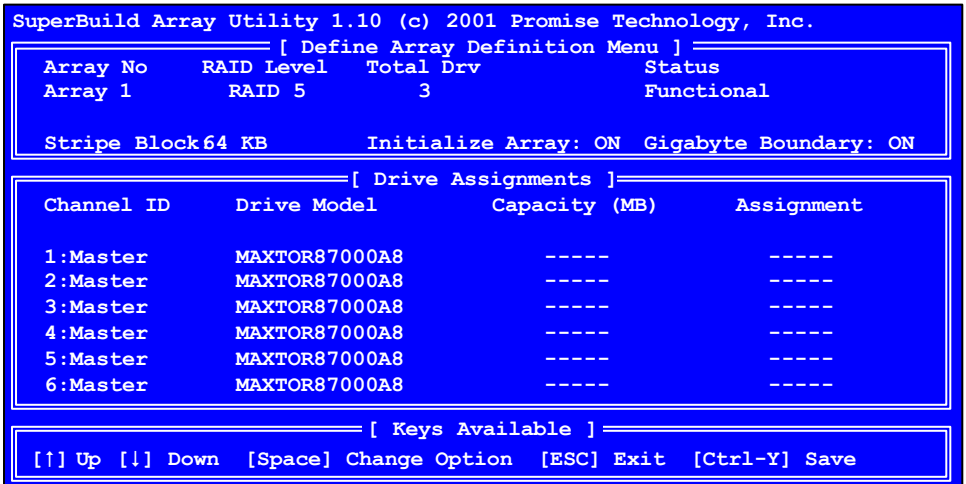


Figure 8 Define Array Definition Menu screen

Initialize Array

This writes zeroes and calculates parity throughout the entire array. This option is only available for fault tolerant arrays (RAID 1, 0+1, 3, and 5). For maximum data integrity, Promise recommends to initialize all fault tolerant arrays.

Gigabyte Boundary

The Gigabyte Boundary feature is designed for fault tolerant arrays (RAID 1, 0+1, 3, and 5) in which a drive has failed and the user cannot replace the drive with the same capacity or larger. Instead, the Gigabyte Boundary feature permits the installation of a replacement drive that is slightly smaller (within 1 gigabyte) than the remaining working drive (for example, a 20.5 GB drive would be rounded down to 20 GB). This can be helpful in the event that a drive fails and an exact replacement model is no longer available. Without this feature enabled, SuperTrak SX6000 will NOT permit the use of a replacement drive that is slightly smaller than the remaining working drive.

For the Gigabyte Boundary feature to work, the Gigabyte Boundary feature must be set to "ON" when the original array is created. When enabled, the Gigabyte Boundary feature rounds the drive capacity of all drives to the common whole GB drive size. For example, with the Gigabyte Boundary feature enabled, the remaining working drives can be 20.5 GB and the replacement drive can be 20.3, since all are rounded down to 20GB. This permits the smaller drive to be used. Please note that users will lose a small amount of available storage capacity from each drive in order to arrive at a common drive size.

NOTE: *The Gigabyte Boundary feature is automatically disabled when creating a mirrored array (RAID 1) from an existing drive (versus using two brand new drives). This protects the existing drive's partition table in order to maintain data integrity.*

Creating a RAID 0 Array

In the "Define Array Definition Menu" section (see Figure 8), use the [Spacebar] to cycle through array types and select "RAID 0" for RAID Level. You will be joining the drives you assign to this array together and splitting (or striping) data writes among the members of the array. Each member of such an array will no longer be readable as an independent drive if removed from the array. The capacity of the array will equal the capacity of the smallest drive multiplied by the number of drives within the array.

Changing Stripe Block Size

For RAID 0 arrays, SuperTrak SX6000 will allow you to change the stripe block size. The default is 64K. However, certain application environments may perform optimally with different. To change the block size, use the [Arrow] keys to highlight the field and the [Spacebar] to cycle through the available size selections (4, 8, 16, 32 or 64K).

NOTE: *you cannot change the block size after the array has been created.*

Assigning Drives to a RAID 0 Array

Under the "Drive Assignments" section, highlight a drive and, with the [Spacebar], change the "Assignment" option to "Y" to add the drive to the

disk array. Press [Ctrl-Y] to save the disk array information. The initial "Define Array Menu" screen will appear after you have pressed [Ctrl-Y]. You will see the array defined. You may select another Array number to define or you may [ESC] to exit and return to the "Main Menu" of SuperBuild.

Setting the Initialize Function

For RAID 0 arrays, SuperTrak SX6000 sets "Initialize" to "OFF".

Setting the Gigabyte Boundary

For RAID 0 arrays, SuperTrak SX6000 sets the "Gigabyte Boundary" to "OFF".

Creating a RAID 1 Array

In the "Define Array Definition Menu" section, use the [Spacebar] to cycle through array types and select "RAID 1" for RAID Level. You will be creating two drives or two pairs of striped drives (4 or 6 drives total) with identical data on them. The capacity of the array will be half that of the total number of mirrored drives within the array. No stripe block size option is available when mirroring 2 drives. In a 4-drive RAID 0+1 or 6 drive array, you can set the stripe size for the two pairs of striped drives.

If you are creating a Mirroring array containing two drives only, you will use either two brand new drives, or one drive that contains existing data and a second drive that you wish to mirror data. There is an additional window that will appear in order to create such an array.

Creating a Mirroring Array with Two New Drives

As described above, if you select a mirroring array and wish to use two new assigned drives, follow the directions here. Under the "Drive Assignments" section, assign both new drives to the array and save the information with [Ctrl-Y]. The following window will appear in order to create the array. Confirm "N" or "Create Only" to the message shown in order to proceed.

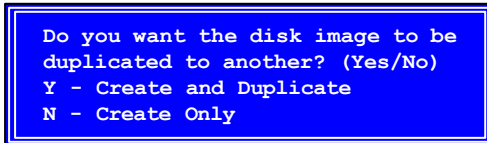


Figure 9 Two-Drive Mirroring Dialogue Window

Once the process is complete, you will be returned to the Define Array Menu where the array will be shown as defined.

NOTE: you may choose to attach an unassigned third drive to SuperTrak SX6000 to act as a "hot spare" replacement (see Page 26).

Creating a Mirroring Array with an Existing Data Drive

SuperBuild will create a mirrored array using an existing drive with data. In the “Drive Assignments” section, you must assign the existing data drive and another drive of the same or larger capacity to the Mirroring array. Press [Ctrl-Y]. Create the array by confirming “Y” or “Create and Duplicate” to the message window that appears (same message as in Figure 9 above).

You will be prompted to select the Source drive from the two available drives. [Arrow] down to the drive that has existing data to be mirrored and press [Enter] to select at the message window below:

Channel:ID	Drive Model	Capacity (MB)
1:Mas	MAXTOR87000A8	6522
2:Mas	MAXTOR87000A8	6522

Figure 10 Source Disk Window for Mirroring Existing Data

When prompted, press [Y] to confirm “Yes” to start duplicating the existing source data to the target drive.

NOTE: all target drive data will be erased. Make sure you choose the correct drive.

After the process is complete, SuperBuild will ask you to reboot the system. You may then return to the Define Array Menu to create an additional array.

NOTE: you may choose to attach an unassigned third drive to SuperTrak to act as a “hot spare” replacement (see page 26).

Changing the Stripe Block Size

For RAID 1 arrays, SuperTrak SX6000 does permit the user to change the Stripe Block size. This feature is not available for RAID 1 arrays.

Setting the Initialize Function

For RAID 1 arrays, SuperTrak SX6000 will allow you to toggle the “Initialize” “ON” or “OFF”. The default is “ON”. To toggle “Initialize”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Setting the Gigabyte Boundary

For RAID 1 arrays, SuperTrak SX6000 will allow you to toggle the “Gigabyte Boundary” “ON” or “OFF”. The default is “ON”. To toggle “Gigabyte Boundary”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Creating a RAID 0+1 Array

Four or six drives must be assigned to an array before this feature becomes available.

Assigning Four or Six Drives to a RAID 0+1 Array

Under the “Drive Assignments” section, highlight a drive and, with the [Spacebar] bar, change the “Assignment” option to “Y” to add the drive to the disk array. Continue to add drives to the array until you assigned either four or six drives. Press [Ctrl-Y] to save the disk array information.

Defining the Array as a RAID 0+1

In the “Define Array Definition Menu” section, use the [Spacebar] to cycle through array types and select “RAID 0+1” for RAID Level. You will be creating two pairs of striped drives (4 or 6 drives total) with identical data on them. The capacity of the array will be half that of the total number of mirrored drives within the array. In a 4-drive RAID 0+1 or 6 drive array, you can set the stripe size for the two pairs of striped drives.

Save the information with [Ctrl-Y]. SuperBuild automatically creates the RAID 0+1 array and returns you to the “Define Array Menu” where the array will be shown.

NOTE: *If you choose to use 4 drives, an additional unassigned drive can be your “hot” spare drive in case of drive failure (see Page 26).*

Changing the Stripe Block Size

For RAID 0+1 arrays, SuperTrak SX6000 will allow you to change the stripe block size. The default is 64K. However, certain application environments may perform optimally with different. To change the block size, use the [Arrow] keys to highlight the field and the [Spacebar] to cycle through the available size selections (4, 8, 16, 32, or 64K).

Setting the Initialize Function

For RAID 0+1 arrays, SuperTrak SX6000 will allow you to toggle the “Initialize” “ON” or “OFF”. The default is “ON”. To toggle “Initialize”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Setting the Gigabyte Boundary

For RAID 0+1 arrays, SuperTrak SX6000 will allow you to toggle the “Gigabyte Boundary” “ON” or “OFF”. The default is “ON”. To toggle “Gigabyte Boundary”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Creating a RAID 3 Array

In the “Define Array Definition Menu”, use the [Spacebar] to cycle through array types and select “RAID 3” for RAID Level. You must configure such an array using a minimum of three drives since additional parity information must be calculated and stored on a dedicated *parity* drive.

You will be joining either two (if 3 drives are assigned), three (if 4 drives are assigned), four (if 5 drives are assigned), or five (if 6 drives are assigned) of the drives together and splitting (or striping) data among them. Each member of such an array will no longer be readable as an independent drive if removed from the array. The capacity of the array will equal the capacity of the smallest drive multiplied by the total number of drives assigned to the array minus one.

NOTE: *If you choose to use less than 6 drives, an additional unassigned drive can be your “hot” spare drive in case of drive failure (see Page 26).*

Changing Stripe Block Size for RAID 3 Array

For RAID 3 arrays, SuperTrak SX6000 will allow you to change the stripe block size. The default is 64K. However, certain application environments may perform optimally with different. To change the block size, use the [Arrow] keys to highlight the field and the [Spacebar] to cycle through the available size selections (4, 8, 16, 32, or 64K).

NOTE: *you cannot change the block size after the array has been created.*

Assigning Drives to a RAID 3 Array

Under the “Drive Assignments” section, highlight a drive and with the Spacebar change the “Assignment” option to “Y” to add the drive to the disk array. Press [Ctrl-Y] to save the disk array information. The initial “Define Array Menu” screen will appear after you have pressed [Ctrl-Y]. You will see the array defined. You may [ESC] to exit and return to the “Main Menu” of SuperBuild.

Setting the Initialize Function

For RAID 3 arrays, SuperTrak SX6000 will allow you to toggle the “Initialize” “ON” or “OFF”. The default is “ON”. To toggle “Initialize”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Setting the Gigabyte Boundary

For RAID 3 arrays, SuperTrak SX6000 will allow you to toggle the “Gigabyte Boundary” “ON” or “OFF”. The default is “ON”. To toggle “Gigabyte Boundary”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Creating a RAID 5 Array

In the “Define Array Definition Menu” section, use the [Spacebar] to cycle through array types and select “RAID 5” for “RAID Mode”. You must configure such an array using a minimum of three drives because of parity data generation.

You will be joining either, two (if 3 drives are assigned), three (if 4 drives are assigned), four (if 5 drives are assigned), or five (if 6 drives are assigned) of the drives together and splitting (or striping) data among them. Each member of such an array will no longer be readable as an independent drive if removed from the array. The capacity of the array will equal the capacity of the smallest drive multiplied by one less than the total number of drives assigned to the array.

NOTE *If you choose to use less than 6 drives, an additional unassigned drive can be your “hot” spare drive in case of drive failure (see Page 26).*

Changing Stripe Block Size for RAID 5 Array

For RAID 5 arrays, SuperTrak SX6000 will allow you to change the stripe block size. The default is 64K. However, certain application environments may perform optimally with different values. To change the block size, use the [Arrow] keys to highlight the field and the [Spacebar] to cycle through the available size selections.

NOTE: *you cannot change the block size after the array has been created.*

Assigning Drives to a RAID 5 Array

Under the “Drive Assignments” section, highlight a drive, and, with the [Spacebar], change the “Assignment” option to “Y” to add the drive to the disk array. Press [Ctrl-Y] to save the disk array information. The initial “Define Array Menu” screen will appear after you have pressed [Ctrl-Y]. You will see the array defined. You may [ESC] to exit and return to the “Main Menu” of SuperBuild

Setting the Initialize Function

For RAID 5 arrays, SuperTrak SX6000 will allow you to toggle the “Initialize” “ON” or “OFF”. The default is “ON”. To toggle “Initialize”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Setting the Gigabyte Boundary

For RAID 5 arrays, SuperTrak SX6000 will allow you to toggle the “Gigabyte Boundary” “ON” or “OFF”. The default is “ON”. To toggle “Gigabyte Boundary”, use the [Arrow] keys to highlight the field and the [Spacebar] to toggle between “ON” and “OFF”.

Creating a Spanning Array

In the “Define Array Definition Menu” section, use the [Spacebar] to cycle through array types and select “JBOD” for RAID Level. You will be joining the drives you assign to this array together as a single *virtual* drive grouping. Data will be stored to the first drive until it is physically full. SuperTrak SX6000 then will save data on to the next drive in sequence. Each member of an array will no longer be readable as an independent drive if removed from the array. The capacity of the Spanning array will equal the total capacity of all drives assigned.

NOTE: *Since spanning uses the full capacity of each assigned drive, different capacity drives may be used without adversely affecting the performance of the array. No other RAID benefits are provided (see Chapter 4).*

Assigning Drives to a Spanning Array

Under the “Drive Assignments” section, highlight a drive, and, with the [Spacebar], change the “Assignment” option to “Y” to add the drive to the Spanning array. Press [Ctrl-Y] to save the disk array information. The initial “Define Array Menu” screen will appear after you have pressed [Ctrl-Y]. You will see the array defined. You may press the [ESC] key to exit and return to the “Main Menu” of SuperBuild.

Creating a Single Drive Array

A single drive may be made a RAID 0 array. Follow the procedure for creating a RAID on page 20.

Hot Spare Drives

Any extra drive (designated as “Free” in the SuperBuild “View Drive Assignments” screen) that is not assigned to a fault tolerant disk array (RAID 1, 0+1, 3, or 5) will be recognized as a Spare Drive. Such a drive is automatically added to an array once a disk member of the array has been detected as “failed.” To restore fault tolerance as quickly as possible, SuperTrak SX6000 begins to perform an automatic data rebuild on the “spare” drive in the background without the need to restart the system. At a later time, the failed drive can be physically removed and an extra drive added in its place to function as the “spare” drive.

Setting a Disk Array As Bootable

You may select which defined array will be used as the bootable array from the “Define Array Menu” (press [3] in the “Main Menu”). Highlight the desired array and press the [Spacebar]. The system will now recognize this as the first array and an * asterisk will appear next to the array number indicating it as bootable (see below).

NOTE: *Your PC or server must be configured to use SuperTrak SX6000 as the bootable controller. The system will then use the bootable array as the (fixed) boot C: drive.*

```

SuperBuild Array Utility 1.10 (c) 2001 Promise Technology, Inc.
[ Define Array Menu ]

```

Array No	RAID Level	Total Drv	Capacity (MB)	Status
Array 1	RAID0	2	13044	Functional
*Array 2	RAID1	2	6522	Functional
Array 3	-----	-----	-----	-----
Array 4	-----	-----	-----	-----
Array 5	-----	-----	-----	-----
Array 6	-----	-----	-----	-----

```

[ Keys Available ]
Note: *-- Bootable Array
[↑] Up [↓] Down [ESC] Exit [Enter] Select [Space] Change Boot Drive

```

Disk Array Recognition Order

During startup, the disk arrays on the SuperTrak SX6000 are recognized in this order:

- (1) The array set to bootable in the SuperBuild setup
- (2) By the Array number (i.e. Array 1, Array 2...). This would be involved in determining which drive letters will be assigned to each disk array.

Saved Disk Array Information

NOTE: Promise suggests that users record their disk array information for future reference.

All disk array data is saved within the reserved sector of each arrayed drive.

Another feature of the SuperTrak SX6000 disk array system is to recognize drive members even if drives are moved to different IDE channels on SuperTrak SX6000. Since each drive's array data identifies itself to the array, it is possible to reorder the drives without modifying the array status. This is valuable when adding drives or

```

SuperBuild Array Utility 1.10 (c) 2001 Promise Technology, Inc.
[ Delete Array Menu ]

```

Array No	RAID Level	Total Drv	Capacity (MB)	Status
Array 1	RAID0	2	13044	Functional
Array 2	RAID1	2	6522	Functional
Array 3	-----	-----	-----	-----
Array 4	-----	-----	-----	-----
Array 5	-----	-----	-----	-----
Array 6	-----	-----	-----	-----

```

[ Keys Available ]
Note: *-- Bootable Array

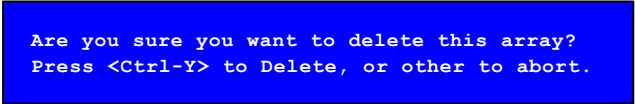
```

Figure 12 Delete Array Menu

NOTE: Deletion of an existing disk array could result in the loss of all data from the hard drives of the affected array. Record all array information, including array type, disk members, and stripe block size, in case you wish to undo a deletion. Arrays may possibly be recovered after deletion by immediately re-defining the array with information identical to the original configuration.

To delete an array, highlight the Array you wish to delete and press the Del key.

Confirm yes to the following warning (see Figure 13 message using the Ctrl-Y keys to continue array delete. Press any other key to abort the deletion process.



```
Are you sure you want to delete this array?  
Press <Ctrl-Y> to Delete, or other to abort.
```

Figure 13 Delete Array Dialogue Box

3.6 Controller Configuration

By pressing [5] on the "Main Menu" screen displays the "Controller Configuration – Options" screen (see below).

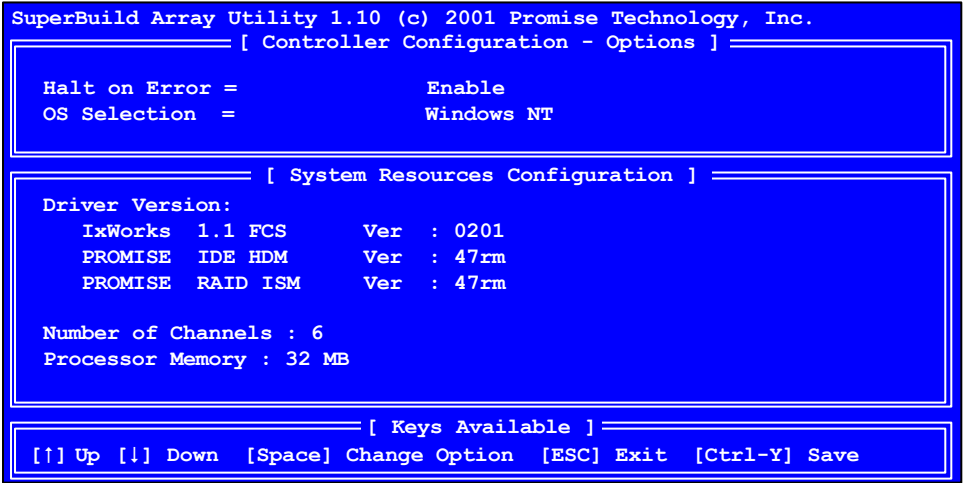


Figure 14 Controller configuration screen

This screen allows you to modify the "Halt On Error" option (enable/disable) by pressing the [Spacebar]. "Halt On Error" is enabled if you want the system to halt processing during bootup if the SuperTrak SX6000 BIOS determines that there is an array error. The OS Selection option should be selected based on the operating system you will be using. All other information in the System Resources Configuration section is for display only. The information presented here is as follows:

Driver Version

Shows the driver software version of the IxWorks operating system, the Promise Hardware Driver Module (HDM), and the Promise Intermediate Software Module (ISM).

Number of Channels

Shows the number of channels attached to the SuperTrak SX6000 controller that may be used to connect one drive each for use in RAID arrays.

Processor Memory

Shows the size of the DIMM plugged into the SuperTrak SX6000 controller card.

Installing Drivers

4.1 Windows NT 4.0

Installing Driver in Existing Windows NT 4.0 System

The following procedure details the installation of the SuperTrak SX6000 drivers on a Windows NT version 4.0 or later system. Under Windows NT 4.0, insert the included "SuperTrak SX6000 Driver" diskette in drive A: when prompted for the drivers.

- (1) From the "Start" menu, point to "Settings" then click "Control Panel".
- (2) From the "Control Panel", double-click the "SCSI Adapters" icon.
- (3) From the "SCSI Adapters" window, choose the "Drivers" tab then click "Add".
- (4) From the "Install Driver" window, choose "Have Disk" and insert Driver diskette. Enter the directory location of the driver in the text box. Or use "Browse" and select filename "sprak.inf" and click "Open".
- (5) From the "Select OEM Option" window, select "WinNT Promise SuperTrak SX6000 (tm) IDE RAID Controller" and click "OK".
- (6) From the "Select SCSI Adapter Option" window click "Install" to initiate the installation operation.

After a successful installation, the "SCSI Adapter Setup" dialog box will appear which states that the, "WinNT Promise SuperTrak SX6000 (tm) IDE RAID Controller" has been installed.

- (7) Save all the settings, shut down, and restart the server.

To check if the driver installation was successful, perform the following steps:

- (1) After restarting the system, return to "Control Panel".
- (2) From the "Control Panel", double-click the "SCSI Adapters" icon.
- (3) From the "SCSI Adapters" window, choose the "Devices" tab. You should now see "WinNT Promise SuperTrak SX6000 (tm) IDE RAID Controller" listed.

Installing Driver During New Install of Windows NT 4.0

Under Windows NT 4.0, insert the included "SuperTrak SX6000 Driver" diskette in drive A: when prompted for the drivers.

- (1) Installation:
 - **Floppy Install:** Boot the computer with the Windows NT installation diskettes.
 - **Floppyless Install:** Boot from floppy and type "WINNT /B". After files have been copied, the system will reboot. On the reboot, press [F6] when the

- message "Setup is inspecting your computer's hardware configuration" appears.
- **CD-ROM Install:** Boot from the CD-ROM and press [F6] when the message "Setup is inspecting your computer's hardware configuration."
- (2) When the "Welcome to Setup" window appears, press [Enter].
 - (3) When the "Setup Method" dialog box appears, press [Enter] to confirm Express Setup.
 - (4) Press "S" to add the SuperTrak SX6000 controller.
 - (5) Select "Other" (requires disk provided by hardware manufacturer).
 - (6) Specify "a:\", insert the Promise driver diskette into drive A: and press [Enter].
 - (7) Select the "WinNT Promise SuperTrak SX6000 (tm) Controller" and click " OK".

NOTE: for CD installations, you must also specify the driver for your CD-ROM adapter (i.e. if using an ATAPI CD-ROM, specify the IDE 2.1 controller)

- (1) Follow the normal setup installation procedure.

To check if the driver installation was successful, perform the following steps:

- (2) After restarting the system, return to "Control Panel".
- (3) From the "Control Panel", double-click the "SCSI Adapters" icon.
- (4) From the "SCSI Adapters" window, choose the "Devices" tab. You should now see "Promise SuperTrak SX6000 (tm) Controller" listed.

4.2 Windows 2000

Installing Driver in Existing Windows 2000 System

After installing the SuperTrak SX6000 card and rebooting your system, Windows 2000 setup will show a “New Hardware Found” dialog box.


- (1) In the “New Hardware Found” dialog box, click “Driver from disk provided by hardware manufacturer” and insert the SuperTrak SX6000 driver diskette into the A: drive.
- (2) In the “Install from Disk” window, type “a:\win2000” in the text box and click “OK”.
- (3) In the “Select OEM Option” window, choose the “Win2000 Promise SuperTrak SX6000 (tm) IDE RAID Controller” then click “OK”.

The Windows 2000 Setup screen will display the message: “Setup will load support for the following mass storage devices – Win2000 Promise SuperTrak SX6000 (tm) IDE RAID Controller” The Ultra100 driver will now be copied on to the system and entered into the Windows 2000 driver database.

- (4) In the “System Settings Change” dialog box click “Yes” to restart the system. Remove the floppy diskette.

Windows 2000 will then restart for the driver installation to take effect.

Confirming Windows 2000 Installation

- (1) From the Windows 2000 desktop right-click on “My Computer” then click “Properties”.
- (2) From the “System Properties” window, choose the “Hardware” tab then click “Device Manager”.
- (3) From the “Device Manager” window, click the  symbol in front of “SCSI and RAID controllers.” “Win2000 Promise SuperTrak SX6000 (tm) IDE RAID Controller” should appear.

Installing Driver During New Windows 2000 Installation

- (1) Installation:
 - **Floppy Install:** Boot the computer with the Windows 2000 installation diskettes.
 - **Floppyless Install:** Boot from floppy and type “WINNT”. After files have been copied, the system will reboot. On the reboot, press [F6] after the message “Press F6 if you need to install third party SCSI or RAID driver” appears.
 - **CD-ROM Install:** Boot from the CD-ROM. Press [F6] after the message “Press F6 if you need to install third party SCSI or RAID driver” appears.

- (2) When the “Windows 2000 Setup” window appears, press “ S” to Specify an Additional Device(s).
- (3) Insert the Promise Technology Driver diskette into drive A: and press [Enter] key.
- (4) Choose “Win2000 Promise SuperTrak SX6000 (tm) Controller” from the list that appears on screen then press the [Enter] key.
- (5) The “Windows 2000 Setup” screen will appear again saying “ Setup will load support for the following mass storage devices:” The list will include “ Win2000 Promise SuperTrak SX6000 (tm) Controller”

NOTE: *If you need to specify any additional devices to be installed do so at this time. Once all devices are specified continue to step 6.*

- (6) From the “Windows 2000 Setup” screen, press the [Enter] key. Setup will now load all device files and then continue the Windows 2000 installation.

4.3 Promise Array Management Installation

There are several layers of the Promise Array Management (PAM) software installation that must be installed on the appropriate network servers/workstations. Make sure the SuperTrak SX6000 device driver is installed before moving on to install the PAM utility software.

See the *Promise Array Management User Manual* for complete installation procedures.

RAID Setup

This chapter discusses the various types of RAID arrays, their applications, including performance and reliability considerations, and general maintenance information. Given the variety of applications for RAID systems, the various RAID levels each have advantages and disadvantages.

Determining what RAID level to use for your system is an important step. To help guide you, we have divided this chapter into two parts:

- *RAID Management and Operations* covers various fault scenarios, rebuilding/synchronization of drives, and drive partitioning/formatting, which may be encountered during typical use.
- *Configuration Ideas* cover organizational models of array systems that use the previously documented array types. It also points out additional advantages of various options.

This is certainly not intended as a complete, nor definitive reference on RAID technology applications, but merely serves as a first step to understanding the principles and proper usage of RAID. Please see *Appendix A: Technology Background* for more details on the functionality of RAID systems.

5.1 RAID Management and Operation

This segment covers issues pertaining to general RAID system management, operation, and terminology.

Critical and Offline Arrays

A fault tolerant array goes "critical" when a drive is removed or fails. Due to the fault tolerance of the array, the data is still available and online. However, once the array goes critical, the array has lost its fault tolerance, and performance may be adversely affected. If the fault was caused by a drive that was removed, the drive should be replaced by another drive, either identical or larger, in order for the RAID system to rebuild and restore optimal configuration. Only a failed drive should be removed from the array. Removing any other drive may cause the array to become unavailable.

When notified either by the SuperTrak SX6000 BIOS or the PAM utility that a drive has failed, note the channel number of the failed drive to determine the physical location of the failed drive. Figure 1 on page 6 shows the channel numbers for the SuperTrak SX6000.

In arrays where a hot spare is already installed, the hot spare automatically replaces the failed drive. When the failed drive is replaced, the new drive becomes the new hot spare.

A non-fault tolerant array goes "offline" when a drive is removed or fails. Since the array is not fault tolerant, the data stored in the array is no longer accessible. If the drive was removed, then it should be replaced to restore accessibility to the array. If

the drive failed, then the entire array must be deleted and re-initialized since all data is considered lost.

Rebuilding/Synchronizing Fault Tolerant Arrays

Though a critical array can continue storage operations, it no longer offers fault tolerance and should be addressed as soon as possible by replacing the missing or failed drive(s).

Rebuild takes a replacement drive, assigns it to the array and then writes the redundancy data to it. Once the rebuild process is complete, the array status is upgraded from "critical" to "functional" and fault tolerance is restored.

Synchronization is a preventative maintenance measure used to avoid problems with data integrity. Synchronizing simply recalculates redundant data (similar to the rebuild process) and matches the data on the drive(s). Synchronization is a process that may be manually initialized or can be scheduled. You may choose to synchronize your array once per hour, day, week, or month.

Partitioning & Formatting Arrays

Like any other type of fixed disk media in your system, a RAID array must be partitioned and formatted before use. Depending on the operating system you use, there may or may not be various capacity limitations applicable for the different types of partitions. Use the same method of partitioning and formatting on an array as you would any other fixed disk.

5.2 Configuration Ideas

This part of the chapter covers additional ideas that are helpful to bear in mind while considering RAID configurations.

Fault Tolerance

Hard drives aren't the only things that can fail in a server room full of equipment, PCs, hard drives, cables, connections, and power supplies. There are literally hundreds of things that *could* go wrong on any given day. Although this is a disturbing thought that has led some to seriously question their career in computers and networking, there are some additional ways to prevent a server's RAID storage downtime and perhaps extend one's livelihood.

Since SuperTrak SX6000 maintains six independent data channels and assigns just one drive per channel, users are protected in case a single drive or an entire data channel fails. This provides an added level of protection than other RAID controllers, such as those that allow connecting two (or more) drives to the same channel connector.

Hot Spare Drive(s)

A good precaution to protecting your array integrity in the event of drive failure is maintaining a hot spare drive. A hot spare is a drive that is connected to the array system, but is not assigned as a member of the array. In the event of the failure of a drive within a functioning fault tolerant array, the hot spare is activated as a member of the array. The spare drive effectively takes the place of the failed drive and the RAID system immediately begins to rebuild data on the drive. When the rebuild is complete, the array is returned to fault tolerant status. Once the failed drive is replaced, the new drive is automatically recognized as a hot spare in the event of a subsequent drive fault.

Some possibilities for making use of hot spares can include:

- A 2-drive mirrored array with 2 hot spare drives. This allows for triple drive fault tolerance before the array would be set offline.
- A 4 drive RAID 0+1 with 1 hot spare drive.
- A 3, 4 or 5 drive RAID 3 array with 1 hot spare for double fault tolerance under RAID 3.
- A 3, 4 or 5, drive RAID 5 array with 1 hot spare for double fault tolerance under RAID 5.

Notes

Troubleshooting

This chapter provides information on how to interpret error conditions as reported by the SuperTrak SX6000. This includes buzzer alarms, LED display codes, SuperTrak BIOS Error Messages, and Installation & Runtime Problems. The information contained here covers the most common error conditions that occur with SuperTrak SX6000 installations.

6.1 Buzzer Alarms

Audible alarm indicators are triggered by various error events. The alarm itself may be constant or consist of a series of pulsed beeps.

Event: Buzzer occurs immediately from power-on, will not disengage, and the monitor will not turn on.

Cause : No memory exists or an unsupported memory type is installed on card. Check to ensure that the memory module is properly seated.

Event: Pulsing alarm occurs after the SuperTrak BIOS loads, accompanied by some error messages.

Cause : This is an indication of a problem with one or more drives in a RAID array under SuperTrak SX6000 control. Look into the error message(s) that are displayed by the BIOS.

Event: Pulsing alarm begins when the PAM utility accesses information on the drive housing.

Cause : This is an indication of a problem with a housing sensor. Either the operational temperature is out of nominal range, a cooling fan is not operational or there appears to be a power failure.

Event: Pulsing alarm begins when the PAM utility is running.

Cause : This is likely an indication of an array problem. Check the status of all the arrays that are being monitored by the PAM utility to verify their status.

6.2 LED Display Codes

LED displays appear on the backplane of the SuperTrak SX6000 controller.

NOTE: The LEDs on the backplane of the SuperTrak SX6000 controller go through various patterns throughout the power-on and initialization process. However, only three different conditions remain constant.

Event: LEDs on the card backplane turn on a few seconds after system power-on and show a pattern of ON-OFF-OFF-ON (1001).

Cause : This is the normal condition of the LEDs after power-on indicating that the SuperTrak SX6000 firmware loaded properly on the controller, and that the cache memory DIMM is functioning. This pattern requires no special attention.

Event: LEDs on the card backplane turn on a few seconds after power-on and move in a back and forth pattern.

Cause : This is the operational mode of the LEDs after the card has been initialized at power up. This indicates that the HDM thread is loaded and running correctly.

Event: LEDs on the card backplane turn on a few seconds after system power-on and show a pattern of ON-OFF-ON-OFF (1010).

Cause : This condition is caused by the DIMM memory on the SuperTrak SX6000 controller. It is either not installed correctly, has problems with the connections, or may be an unsupported type of memory DIMM. Make sure the DIMM is seated correctly before trying an alternate memory module to correct the problem.

6.3 SuperTrak SX6000 BIOS Error Messages

On boot-up, the SuperTrak SX6000 BIOS will initialize. Should an error be detected, the following messages will appear on screen and the boot-up process halted.

Message No Array is defined...

:

Cause Either no drives are detected, or the drives detected are not assigned to an array. The SuperTrak SX6000 BIOS only provides int 13h support for defined arrays. If there are no drives detected, or the detected drives are not assigned to an array, then the BIOS has nothing to support for int 13h. You must use the SuperBuild utility to define an array using drives attached to the SuperTrak SX6000.

Message Problem is detected with Array: X

:

Cause There is a critical or offline array. A fault tolerant array will require one of the drives to be replaced (if a hot spare has not already been invoked). A non-fault tolerant array will be pulled completely offline, and is no longer accessible.

6.4 Installation & Runtime Problems

This segment covers certain problems that may be encountered during SuperTrak SX6000 installation, configuration and run-time.

Event: SuperTrak SX6000 BIOS does not show up.

Cause Being fully PnP compatible, the SuperTrak SX6000 controller card offers no means of overriding the assigned memory address at which the BIOS will appear. It is entirely dependent upon the system BIOS being able to properly allocate a memory address resource for it. Make sure that your system PnP/PCI configuration allows for the BIOS to have a memory address between 640K and 1MB (more specifically, anywhere from 0xC8000 to 0xE8000, a total of 64KB). If your system BIOS supports ROM shadowing, you can disable ROM shadowing for a particular address at which the SuperTrak SX6000 BIOS will then load.

Event: No LEDs on card light up.

Cause The SuperTrak SX6000 card is not connecting with the computer. Make sure the card is fully seated in the PCI slot and that the data

cable ground straps are properly secured.

Notes

SuperTrak SX6000 Technical Specifications

Performance-Related Features

- True hardware-based RAID
- Single IRQ per RAID I/O
- Intelligent cache dynamically configures itself
- Support for up to 128MB (minimum of 16MB required) of RAM in one 168-pin DIMM socket
- Microprocessor offloads tasks to reduce system CPU utilization
- User-configurable cache parameters for each array: write policy, and flush policy
- User-configurable RAID stripe sizing allows controller to optimize operations for operating systems and applications
- Multi-threaded command processing and disk operations
- Supports Tagged Command Queuing for optimal disk performance
- Advanced load balancing and elevator seek for optimal disk performance
- Hardware scatter gather DMA engine reduces CPU overhead
- Intelligent algorithm to optimize RAID 5 writes

Data Protection Features

- Support for RAID levels 0, 1, 0+1, 3, 5 and Spanning
- Meets all of the RAID Advisory Board's standards for RAID levels
- Automatic failed drive detection and transparent disk drive rebuild
- Onboard buzzer sound audible alarms in the event of failure
- Supports S.M.A.R.T. capable drives for predictive failure analysis messaging through PAM GUI
- Hot swap capability
- Hot spare capability
- Configuration is stored on all disks in the array. This allows configuration to be restored to a new controller in case of controller failure

Host Interface

- On board 32-bit Intel i960RM RISC microprocessor
- I₂O version 1.5 compliant
- Supports up to 33MHz PCI bus speed
- Supports up to 133MB per second burst data transfer rate across PCI bus
- Provides 32-bit PCI bus mastering with 0 wait states.
- PCI Local Bus version 2.2 compliant
- Onboard 64K Flash BIOS
- Firmware Flash EEPROM
- NVRAM for error log for fast recovery

O/S support

- Windows NT 4.0/Windows 2000
- RedHat Linux 7.0 & 7.1
- Turbolinux 6.0 & 6.1
- SuSe Linux 7.0 & 7.1

Monitoring tools

- Windows-based monitoring utility
- Remote monitor capable through Internet or LAN
- Notification of problems through email
- Monitors temperature, power and fan operation of enclosures*, as well as status of drives and array

Physical & environmental

- SuperTrak SX6000 card size: Size: 13.5" x 4.2" (34.3cm x 10.7cm)
- Operating temperature: 32 - 122°F (0 - 50°C)
- Relative humidity: 5 - 95% non-condensing
- Voltage: 5V±5%

* When used with Promise Technology SuperSwap Enclosures.

Frequently Asked Questions

This section lists frequently asked questions involving pre-installation, drive issues, installation, and post-installation.

Pre-Installation

(Speed, Device Types, Capacity, Cabling)

- Q:** What kind of hard drives can I use with a SuperTrak SX6000 array?
- A:** You can use any Ultra ATA/100, or Ultra ATA/33/66 hard drive(s) to create arrays on the SuperTrak SX6000. However, you should use matching drives for multiple-drive arrays to maximize capacity usage as well as performance. Ultra ATA/100 drives are recommended for highest performance.
- Q:** Can I run the SuperTrak SX6000 controller at greater than 33Mhz PCI bus speed?
- A:** The SuperTrak SX6000 controller is designed around the PCI specification for 33Mhz PCI bus speed. In most cases, a higher PCI bus speed will result in a variety of different errors. Some users have been able to get higher speeds to work. However, since such usage is out of specification, we do not support it. Any damage resulting from such implementation will void the warranty.
- Q:** Can I use ATAPI devices on the SuperTrak SX6000 controller?
- A:** No. There is no driver layer on the SuperTrak SX6000 controller that will support ATAPI packet messages.
- Q:** Can I substitute any other type of Ultra ATA/100 or IDE cables for SuperTrak SX6000 cables if I need to use a longer data cable?
- A:** No! The SuperTrak SX6000 data cables are made to Ultra ATA/100 data transfer requirements with special shielding and a maximum IDE specification length of 18 inches.
- Q:** Does the SuperTrak SX6000 controller work with my system's ACPI?
- A:** Yes. The SuperTrak SX6000 controller supports ACPI S1-S4 standby

modes.

Drive Issues

- Q:** Can I add a drive to a SuperTrak SX6000 RAID array via hot-swap and dynamically adjust the array size/configuration?
- A:** No. The SuperTrak SX6000 system does not support dynamically adjustable RAID size/configurations.
- Q:** Can I take a set of drives which make up an array created on one SuperTrak SX6000 controller and move it to another SuperTrak SX6000 controller?
- A:** Yes. All SuperTrak SX6000 controllers read the arrays the same way. Once the drives are all connected, you must restart the system for it to recognize the newly inserted array configuration.
- Q:** Can I take a drive used in a SuperTrak SX6000 array and access it directly with a different controller, such as the one integrated on the motherboard?
- A:** Yes, but only under certain configurations. The following array configurations will allow the drive(s) to be accessed individually on another controller: mirror (RAID 1), single drive striped (RAID 0), or single drive spanned array. Multiple drives striped or spanned will not work. Also, the other controller must address the drives as LBA, not CHS.
- Q:** If I have a problem with one of the drives on the SuperTrak SX6000, how can I low level format it to correct the problem?
- A:** **Do not do this!** Low-level formatting IDE drives is unnecessary and generally does not correct problems that might be experienced during use. Errors such as bad sectors or ECC/CRC failure are best remedied by completely replacing the drive. For this reason, drives attached to the SuperTrak SX6000 controller should not be low-level formatted.
- Q:** Do I have to install disk management software on my array in order to access the full storage capacity of drives?
- A:** No! The purpose of disk management software is to provide support for hard drives larger than 504MB to those systems that have no intrinsic support. Since the SuperTrak SX6000 provides all the large disk support

you need to access your array(s), this software is unnecessary, and in some cases may even cause accessibility problems.

Q: What system BIOS CMOS settings do I use for the drives on the SuperTrak SX6000 controller?

A: None. The drives on the SuperTrak SX6000 controller are supported by the SuperTrak BIOS and/or operating system drivers, not by your system BIOS.

Installation Issues

(NT, Drive Capacity, Booting, IRQ Settings)

Q: Why doesn't Windows NT/2000 see my SuperTrak SX6000 controller?

A: You need to install the SuperTrak SX6000 drivers to be able to see the card and the attached drives (arrays).

Q: Why are some drives recognized by the SuperTrak SX6000 Array Setup utilities with only partial capacity?

A: Some hard drive models are shipped with a jumper that reduces the addressable capacity of the drive. This is to prevent problems with older systems that won't support larger drives. Consult the documentation accompanying the hard drive to set the jumper appropriately in order to utilize the full capacity of the drive.

Q: Can I make an array on the SuperTrak SX6000 bootable?

A: Yes. The SuperTrak SX6000 BIOS provides minimal system-level support for the array as an int 13h drive. Use the BIOS SuperBuild setup utility to create an array in the Array 1 slot position. Then partition and format the new array accordingly for the operating system to boot. Make sure the boot sequence assigns the SuperTrak SX6000 array as the boot device if you have drives running from the motherboard or another controller card.

Q: How can I change the system boot sequence in order to boot from the SuperTrak SX6000 array or SCSI?

A: The boot sequence is controlled by the system BIOS. As far as the system BIOS is concerned, the SuperTrak SX6000 controller and attached arrays are categorized as a "SCSI" device (even though the BIOS will not attempt to access the SuperTrak as any type of SCSI device). This allows

you to set the boot sequence in your BIOS CMOS setup utility to boot from “SCSI” (an add-in controller like the SuperTrak SX6000) first, rather than “IDE” (an IDE controller built onto the motherboard or one which effectively replaces it). If there are multiple SCSI add-in controllers in the system, then the boot sequence among them will be determined exclusively by their PCI slot priority. PCI slot #1 will be first, slot #2 second, etc. Put the SuperTrak SX6000 controller in the PCI slot where it will be accessed ahead of other SCSI controllers if you want to boot from the array.

Q: How can I change the IRQ setting for the SuperTrak SX6000 controller?

A: The SuperTrak SX6000 controller is fully PCI PnP. This means all the resources that it uses are assigned by the PCI BIOS on the motherboard. While SuperTrak SX6000 supports the IRQ sharing feature, this will only work if all the PCI devices used support it. If your motherboard allows you to control the assignment of these resources, you may be able to change them manually (see motherboard BIOS documentation for how to perform this task). If not, resource assignments may otherwise be changed by switching the PCI slot that the controller is in.

Post-Installation

(Power Up, BIOS Initialization, Memory Managers, Caching, Booting)

Q: Why does my SuperTrak SX6000 take so long to power up and get a signal to the VGA monitor now that the SuperTrak SX6000 card is installed?

A: The process should only take a few seconds at most. The SuperTrak SX6000 controller performs an intensive memory check each time at power-up. This assures the integrity of your system data during normal data caching operation. The greater the amount of RAM installed on the controller, the longer this process takes to verify memory. The memory-scan places a hold on the PCI bus and suspends system boot temporarily until the scan is complete.

Q: Why does the SuperTrak SX6000 BIOS take so long to initialize the card? Is there a problem?

A: Generally, this does not indicate a problem. The SuperTrak SX6000 card initialization is a rather involved process. The BIOS sends a few messages to the SuperTrak SX6000 controller during the initialization and spends most of the time waiting for the card to complete the requested task. The tasks initialize the hardware device layer (which performs hard drive detection), the RAID engine (which detects and sets up multiple tables and buffers for RAID operation), the cache module, device attachment messages, and system control information (including controller

card, driver and operating system version control information). The amount of time required for initialization is not an indication of a problem.

Q: How can I be sure that write-back cache has flushed before I reboot after partitioning and formatting an array?

A: A cache flush is always triggered immediately following any write from the int 13h BIOS. This level of array support is what FDISK and FORMAT use to access the drive from MSDOS. With no delay in the write operation, there is no cached data waiting to be written. If you are running from NT or other operating system, as usual, make sure to shut down the operating system properly so that the operating system can trigger and flush the cache as necessary.

NOTE: powering off before a proper shutdown is complete may result in the loss of unwritten data in cache, possibly causing problems in a subsequent boot or access to the data that was unwritten.

Q: Why can't I see the drives on the SuperTrak SX6000 under FDISK?

A: If you have not created an array, the physical drive(s) attached to the SuperTrak SX6000 card will not be recognized by the operating system. The SuperTrak SX6000 controller is dedicated to RAID array management and does not provide any means of addressing individual hard drives through the int 13h interface used by FDISK. In order to access drives on the SuperTrak SX6000 from MSDOS at all, you must first create a RAID array.

Q: Why can't I see the array I just created with PAM under the Windows NT Disk Administrator?

A: Since Windows NT does not yet support any method of dynamically adding and/or removing logical devices to/from the system, you must restart Windows NT. The next boot will show the new array under Disk Administrator.

Notes

Technology Background

Introduction to RAID

RAID (Redundant Array of Independent Disks) allows multiple hard drives to be combined together to form one large logical drive or "array." As far as the operating system is concerned, the array represents a single storage device, and treats it as such. The RAID software and/or controller handles all of the individual drives on its own. The benefits of a RAID can include: higher data transfer rates for increased server performance, increased overall storage capacity for a single drive designation (such as, C, D, E, etc.), data redundancy/fault tolerance for ensuring continuous system operation in the event of a hard drive failure.

Different types of arrays use different organizational models and have varying benefits. The following outline breaks down the properties for each type of RAID array:

RAID 0 – Striping

When a disk array is striped, the read and write blocks of data are interleaved between the sectors of multiple drives (see Figure 15). Performance is increased, since the workload is balanced between drives (or "members") that form the array. Identical drives are recommended for performance as well as data storage efficiency. The disk array's data capacity is equal to the number of drive members multiplied by the smallest array member's capacity.

For example, one 10GB and three 20GB drives will form a 40GB (4 x 10GB) disk array instead of 70GB. The stripe block size value can be set logically from 4KB, 8KB, 16KB, 32KB, or 64KB [*Default*]. This selection will directly affect performance. Larger block sizes are better for random disk access (like email, POS, or web servers), while smaller sizes are better for sequential access.

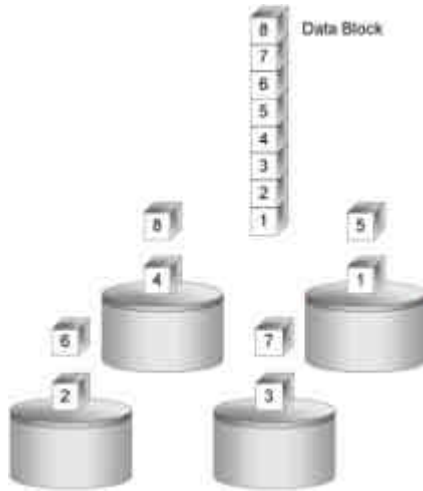


Figure 15 Raid 0 Striping Interleaves Data Across Multiple Drives

RAID 1 – Mirroring

When a disk array is mirrored, identical data is written to a pair of drives, while reads are performed in parallel. The reads are performed using elevator seek and load balancing techniques where the workload is distributed in the most efficient manner. Whichever drive is not busy and is positioned closer to the data will be accessed first.

With RAID 1, if one drive fails or has errors, the other mirrored drive continues to function. This is called *Fault Tolerance*. Moreover, if a spare drive is present, the spare drive will be used as the replacement drive and data will begin to be mirrored to it from the remaining good drive.

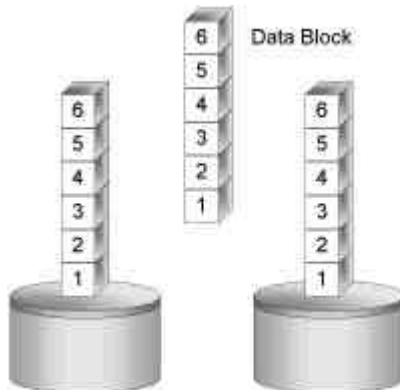


Figure 16 Raid 1 Mirrors Identical Data to Two Drives

Due to the data redundancy of mirroring, the drive capacity of the array is only the size of the smallest drive. For example, two 10GB drives which have a combined capacity of 20GB instead would have 10GB of usable storage when set up in a mirrored array. Similar to RAID 0 striping, if drives of different capacities are used, there will also be unused capacity on the larger drive.

RAID 0+1 – Striping/Mirror

Striping/mirroring combines both of the previous array types. It can increase performance by reading and writing data in parallel while protecting data with duplication. At least four drives are needed for RAID0+1 to be installed. With a four-drive disk array, drive pairs are striped together with one pair mirroring the first pair. The data capacity is similar to a standard mirroring array, with half of the total storage capacity dedicated for redundancy. An added plus for using RAID 0+1 is that, in many situations, such an array offers double fault tolerance. Double fault tolerance may allow your data array to continue to operate depending on which two drives fail.

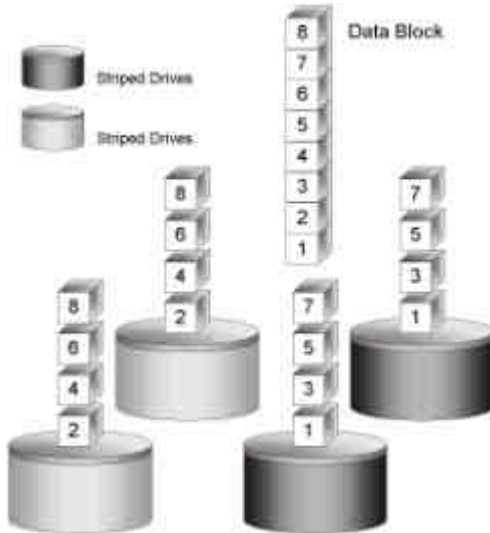


Figure 17 Raid 0+1 Striping and Mirroring of Two Drive Pairs

RAID 3 – Block Striping with Parity Drive

RAID level 3 organizes data across the physical drives of the array, and stores parity information onto a drive dedicated to this purpose. This organization allows increased performance by accessing multiple drives simultaneously for each operation, as well as fault tolerance by providing parity data. In the event of a hard drive failure, data can be re-calculated by the RAID system based on the remaining drive data and the parity information.

The adjustable block size of the RAID 3 array allows for performance-tuning based on the typical I/O request sizes for your system. The block size must be set at the time it is created and cannot be adjusted dynamically. Generally, RAID Level 3 tends to exhibit lower random write performance due to the heavy workload going to the dedicated parity drive for parity recalculation for each I/O.

The capacity of a RAID 3 array is the smallest drive size multiplied by the number of drives less one. Hence, a RAID 3 array with (4) 1.0 GB hard drives will have a capacity of 3.0GB. An array with (2) 1.2GB hard drives and (1) 1.0GB hard drive will have a capacity of 2.0GB.

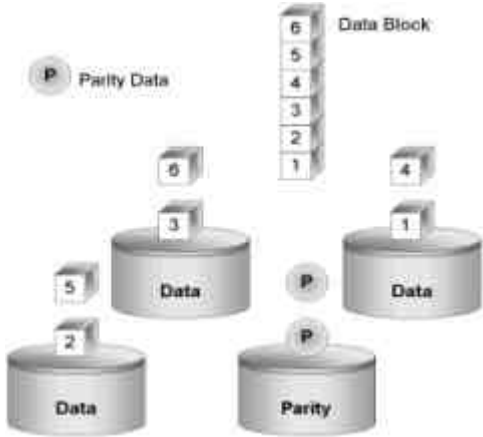


Figure 18 Raid 3 Multiple Drives Stripe Data with One Parity Drive

RAID 5 – Block and Parity Striping

RAID 5 is similar to RAID 3 as described above except that the parity data is rotated across the physical drives along with the block data. Having the parity data striped across all the physical drives in this manner removes the random write performance bottleneck of RAID 3. The total capacity of a RAID 5 array is calculated the same as a RAID 3 array.

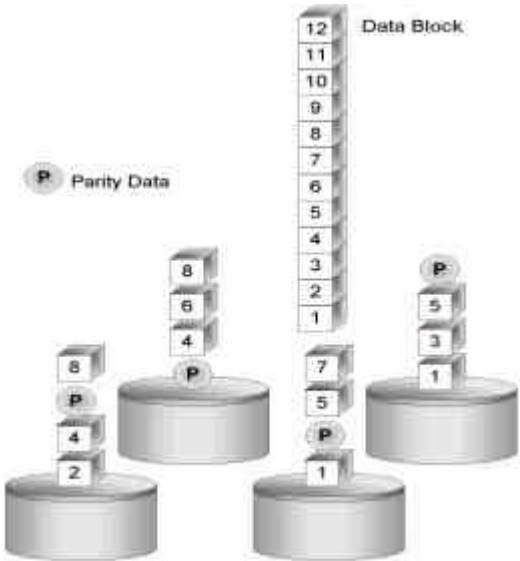


Figure 19 Raid 5 Stripes All Drives with Data and Parity Information

Spanning

In a Spanning array, the disk array capacity is equal to the sum of all drives, even if the drives are of different capacities. Spanning stores data onto a drive until it is completely filled then proceeds to store data onto the next drive in the array. There are no performance or fault tolerance array features in this type of array. When a disk member fails, the entire array is offline.

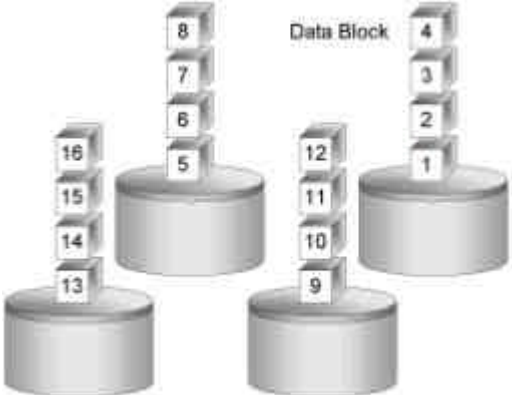


Figure 20 Spanning Uses Full Capacity of Drives

Notes

Contacting Technical Support

Promise Technical Support provides several support options for Promise users to access information and updates. We encourage you to use one of our electronic services, which provide product information updates for the most efficient service and support.

If you decide to contact us, please have the following information available:

- Product model and serial number
- BIOS and driver version numbers
- A description of the problem / situation
- System configuration information, including: motherboard and CPU type, hard drive model(s), IDE/ATAPI drives & devices, and other controllers.

Technical Support Services

Promise Online™ Web Site	http://www.promise.com (tech documents, drivers, utilities, etc.)
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USA Tech Support Center

E-mail Support	support@promise.com
Fax Technical Support	(408) 228-6401 Attention: Technical Support
Phone Technical Support	(408) 228-6402 7:30-5:00pm M-F Pacific Standard Time
If you wish to write us for support:	Promise Technology, Inc. Attn: Technical Support 1745 McCandless Drive Milpitas, CA 95035, USA

Promise Euro

E-mail Support	support@promise.nl
Fax Technical Support	+31 (0)40 256 94 63 Attention: Technical Support
Phone Technical Support	+31 (0)40 256 94 61 8:30-5:00pm The Netherlands Time
If you wish to write us for support:	Promise Technology Europe B.V. Attn: Technical Support 1European Business Centre, Unit 1.25 Luchthavenweg 81 5657 EA Eindhoven, The Netherlands

Promise Taiwan

E-mail Support	support@promise.com.tw
Fax Technical Support	+886 3 578 23 90 Attention: Technical Support
Phone Technical Support	+886 3 578 23 95 9:00-6:00pm Taiwan Time
If you wish to write us for support:	Promise Technology, Inc. Attn: Technical Support 2F, No. 30, Industry E. Rd. IX Science-Based Industrial Park Hsinchu, Taiwan, R.O.C

Promise China

E-mail Support	support-china@promise.com
Fax Technical Support	+86 (0) 10 6872 3940 Attention: Technical Support
Phone Technical Support	+86 (0) 10 6872 3942 9:00-6:00pm China Time
If you wish to write us for support:	Promise Technology China Attn: Technical Support Room 3213, No. 11 South Zhong Guan Cun Street Hai Dian District, Beijing 100081 P.R. China

Limited Warranty

Promise Technology, Inc. ("Promise") warrants that for two (2) years from the time of the delivery of the product to the original end user:

- a) the product will conform to Promise's specifications;
- b) the product will be free from defects in material and workmanship under normal use and service.

This warranty:

- a) applies only to products which are new and in cartons on the date of purchase;
- b) is not transferable;
- c) is valid only when accompanied by a copy of the original purchase invoice.

This warranty shall not apply to defects resulting from:

- a) improper or inadequate maintenance, or unauthorized modification(s), performed by the end user;
- b) operation outside the environmental specifications for the product;
- c) accident, misuse, negligence, misapplication, abuse, natural or personal disaster, or maintenance by anyone other than a Promise or a Promise-authorized service center.

Disclaimer of other warranties

This warranty covers only parts and labor, and excludes coverage on software items as expressly set above.

Except as expressly set forth above, Promise disclaims any warranties, expressed or implied, by statute or otherwise, regarding the product, including, without limitation, any warranties for fitness for any purpose, quality, merchantability, non-infringement, or otherwise. Promise makes no warranty or representation concerning the suitability of any product for use with any other item. You assume full responsibility for selecting products and for ensuring that the products selected are compatible and appropriate for use with other goods with which they will be used.

Promise does not warrant that any product is free from errors or that it will interface without problems with your computer system. It is your responsibility to back up or otherwise save important data before installing any product and continue to back up your important data regularly.

Promise's sole responsibility with respect to any product is to do one of the following:

- a) replace the product with a conforming unit of the same or superior product;
- b) repair the product;
- c) recover the product and refund the purchase price for the product.

Promise shall not be liable for the cost of procuring substitute goods, services, lost profits, unrealized savings, equipment damage, costs of recovering, reprogramming, or reproducing of programs or data stored in or used with the products, or for any other general, special, consequential, indirect, incidental, or punitive damages, whether in contract, tort, or otherwise, notwithstanding the failure of the essential purpose of the foregoing remedy and regardless of whether Promise has been advised of the possibility of such damages. Promise is not an insurer. If you desire insurance against such damage, you must obtain insurance from another party.

Some states do not allow the exclusion or limitation of incidental or consequential damages for consumer products, so the above limitation may not apply to you.

This warranty gives specific legal rights, and you may also have other rights that vary from state to state. This limited warranty is governed by the State of California.

Returning Product For Repair (USA and Canada Only)

If you suspect a product is not working properly, or if you have any questions about your product, contact our Technical Support Staff through one of our Technical Services, making sure to provide the following information:

- Product model and serial number (required);
- Return shipping address;
- Daytime phone number;
- Description of the problem;
- Copy of the original purchase invoice.

The technician will assist you in determining whether the product requires repair. If the product needs repair, the Technical Support Department will issue an RMA (Return Merchandise Authorization) number.

Return only the specific product covered by the warranty (do not ship cables, manuals, diskettes, etc.), with a copy of your proof of purchase to:

Promise Technology, Inc.
Customer Service Dept.
Attn.: RMA # _____
1745 McCandless Drive
Milpitas, CA 95035

You must follow the packaging guidelines for returning products:

- Use the original shipping carton and packaging
- Include a summary of the product's problem(s)
- Write an attention line on the box with the RMA number
- Include a copy of proof of purchase

You are responsible for the cost of insurance and shipment of the product to Promise. Note that damage incurred due to improper transport or packaging is not covered under the Limited Warranty.

When repairing returned product(s), Promise may replace defective parts with new or reconditioned parts, or replace the entire unit with a new or reconditioned unit. In the event of a replacement, the replacement unit will be under warranty for the remainder of the original warranty term from purchase date, or 30 days, whichever is longer.

Promise will pay for standard return shipping charges only. You will be required to pay for any additional shipping options (such as express shipping).

Your Responsibilities

You are responsible for determining whether the product is appropriate for your use and will interface with your equipment without malfunction or damage. You are also responsible for backing up your data before installing any product and for regularly backing up your data after installing the product. Promise is not liable for any damage to equipment or data loss resulting from the use of any product.

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