Intel® Integrated RAID Controller SRCU32

Technical Product Specification

Revision 1.0

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Enterprise Platforms and Services Marketing

Revision History

Date	Revision Number	Modifications
7/5/2002	1.0	Initial release.

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Contents

1. Introduction

1.1 Acronyms

The following acronyms are used throughout this document.

Table 1 Acronyms (Sheet 1 of 2)

Acronym	Description
API	Application Programmer Interface
BBU	Battery Backup Unit
SRCU32	Product code for this RAID controller
DLL	Dynamic Linked Library
DOS	Generic term to reference either MS-DOS* or ROM-DOS.
DMI	Desktop Management Interface – a system management specification.
ECC	Error Correction Code (also *error correcting code and error correcting circuits)*
FRU	Flash Recovery Utility
FUU	Flash Update Utility
FW	Firmware
HBA	Host Bus Adapter
IIR	Intel Integrated RAID
IOP	I/O Processor, the Intel® 80303 I/O processor
Kb	Kilobit
KB	Kilobyte
LVD	Low Voltage Differential SCSI
Mb	Megabit
MB	Megabyte
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
RAID	Redundant Array of Independent Disks
ROMB	RAID On Motherboard
SAF-TE	SCSI Accessed Fault Tolerant Enclosure
SE	Single Ended SCSI device. SCSI device type.
SCA	Single Connector Attachment – 80-pin SCSI connector on hot swappable SE and LVD hard disks.
SCSI	Small Computer Systems Interface
SNMP	Simple Network Management Protocol
StorCon*	Storage Console: A character-based, menu-driven tool used for setting up, monitoring and maintaining mass storage device subsystems based on IIR Controllers
StorCon+	Storage Console Plus: A GUI-based, menu-driven tool used for setting up, monitoring and maintaining mass storage device subsystems based on IIR Controllers. Runs only on Microsoft Windows-based systems.
XROM*	PCI Expansion ROM – BIOS utility accessed at system POST.

1.2 Documentation Conventions

The terms “RAID controller”, “RAID adapter”, “the controller”, and “the adapter” are used interchangeably throughout this document. Each term represents the physical PCB that integrates all the components of the RAID PCI add-in card.

1.3 Product Overview

The SRCU32 is a dual-channel, Ultra160 SCSI, 64bit/66MHz PCI, RAID adapter. The major components that make up the Intel Integrated RAID (IIR) Controller are: the Intel® 80303 I/O Processor, the LSI SYM53C1010* SCSI controller, and the Intel Integrated RAID software suite (referred to as the RAID software suite).

The SRCU32 was developed as a finished RAID adapter. A reference-manufacturing ROMB package may be offered based upon suitable OEM RFQs.

1.4 Operating System Support

The following operating systems (OS) are fully validated and supported:

- Microsoft* Windows* 2000 Advanced Server (service pack 2a or higher)
- Microsoft Windows NT* 4.0 Server Enterprise Edition (service pack 6a or higher)
- Novell* NetWare* 5.1 (support pack 2a or higher)
- SCO* UnixWare* 7.1.1
- Red Hat* Linux* 7.1 (2.4 kernel)
- Red Hat Linux 6.2 SBE2

The following operating systems are supported with limited compatibility validation:

- Windows 2000 Server and Professional
- Windows NT 4.0 Server, Terminal Server, and Workstation
- Novell NetWare 4.2 and 5.0

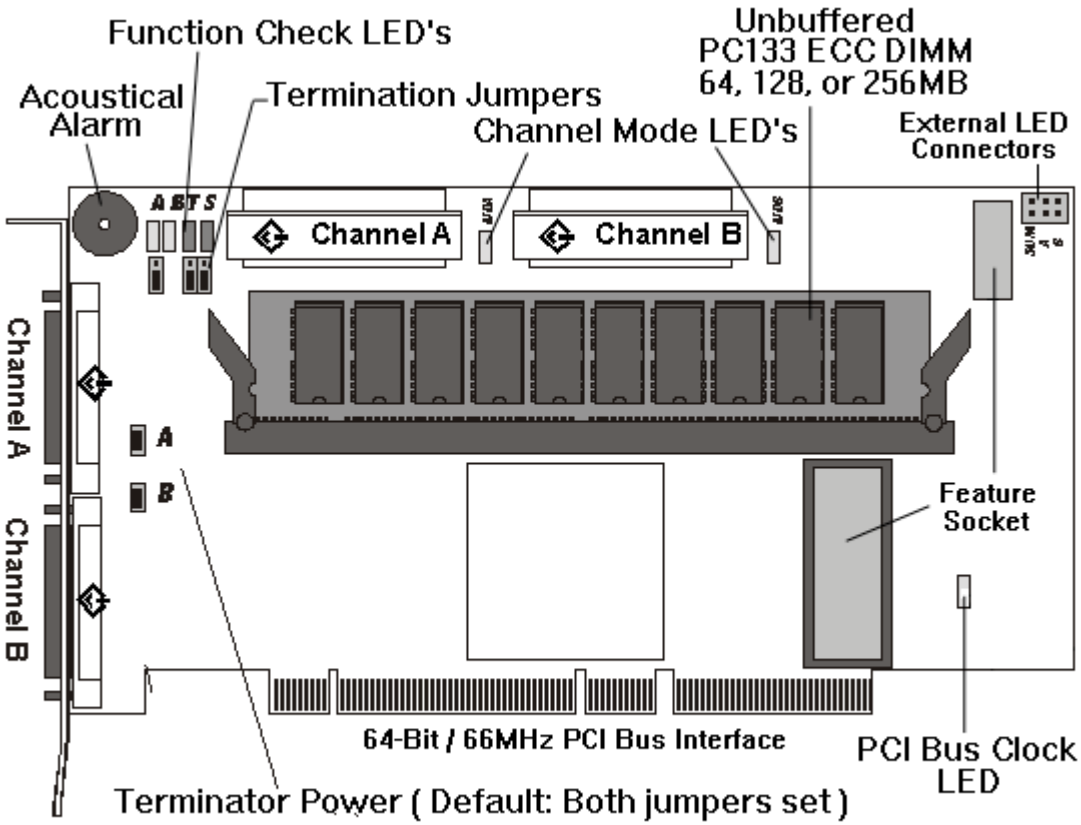
1.5 List of Features

- Supports RAID levels 0, 1, 4, 5, and 10
- Supports a dual channel, Ultra160 SCSI controller (160MB/second per channel)
- Online RAID level migration and capacity expansion without reboot
- RAID Array roaming
- Instant availability and background initialization
- Automatic rebuild with private (dedicated) or pooled (global) hot fix (spare) drives
- Variable data strip size configurable per array
- Non hard disk drive SCSI device support (tape, CD-ROM, etc.)
- From 64MB to 256MB of ECC SDRAM support
- Read/write controller and disk caching
- SAF-TE intelligent enclosure support
- Hot Plug auto detection configurable for non-intelligent enclosures
- Hot Plug drive support
- PCI Hot Plug

2. Hardware

2.1 Physical Layout

Figure 1 RAID Adapter Physical Layout



2.2 Major Components

2.2.1 Intel® 80303 I/O Microprocessor

The adapter features the Intel 80303 I/O processor (IOP). The major components of the 80303 IOP are: the processor core, PCI-to-PCI Bridge, Address Translation Units (ATU), Application Accelerator Unit (AAU), and Memory Controller Unit (MCU). The IOP's architecture is particularly useful in RAID applications. For more information on the Intel 80303 IOP, visit the 80303 IOP's website at http://developer.intel.com/design/iio/index.htm.

2.2.1.1 i960® Core

The 80303 IOP uses the 100MHz Intel 80960JT-100 core. The 80303 IOP uses a 64bit/ 66MHz internal bus that can pump 528 MB/sec of data to and from the IOP's internal peripherals. Among other features, it contains a 128bit register bus, 16KB two-way instruction cache, 4KB direct-mapped data cache, 1KB zero wait state data RAM, and single clock execution of most instructions.

2.2.1.2 PCI-to-PCI Bridge Unit

The primary and secondary PCI buses of the PCI-to-PCI bridge support 64bit/66MHz PCI. Data throughput is 528 MB/sec. The upstream delayed read completion queue is 256 bytes, optimizing the 66MHz PCI bus' performance.

2.2.1.3 Memory Controller Unit

The Memory Controller has been designed to use the latest, most cost effective, and highest performance SDRAM technology available. The SRCU32 adapter is validated with 64, 128 and 256 MB of 64bit 100MHz ECC SDRAM operating at 100MHz.

2.2.1.4 Address Translation Unit

The inbound R/W queues of the ATU are 256 bytes, twice that of the previous generation IOP's. The 80303 IOP can support up to 360 MB/sec for ATU inbound reads (initiated by a PCI master) and up to 520 MB/sec for ATU inbound writes and DMA transfers.

2.2.1.5 Application Acceleration Unit

The AAU, which is primarily used in RAID applications, is user-programmable for a 512 bytes or 1KB queue.

2.2.2 Intel® Advanced Boot Block Flash Memory

This 5v, 16Mb (2MB) flash memory chip is used to store the RAID firmware. This nonvolatile storage can be accessed for firmware updates and recovery. For firmware recovery, see Appendix A2 of the SRCU32 Hardware Installation and User Guide.

2.2.3 Cache Memory Modules

The adapter supports from 64MB to 256MB of 3.3v PC-100 ECC unbuffered CAS 2 and CAS 3 latency SDRAM DIMMs. A standard DIMM connector is provided to allow for upgrading the adapter's memory. It is connected directly to the memory controller interface bus of the IOP and serves as storage for the executable code transferred from the flash memory. It also serves as the controller cache memory. The IOP memory controller provides single-bit ECC error correction.

Note: The RAID adapter will not operate without a memory DIMM properly installed in the DIMM connector.

2.2.4 LSI Logic SYM53C1010 SCSI Controller

The SYM53C1010 is a dual-channel Ultra160 SCSI controller that supports a data transfer rate of up to 160 MB/sec per channel.

2.2.5 LVD SCSI Connectors

The adapter provides two external VHDCI 68-pin SCSI connectors and two internal 68-pin LVD SCSI connectors.

2.2.6 PCI Interface

The adapter has a 64bit/66MHz PCI interface. Although designed for this interface specification, it is compatible with both 32bit/33MHz and 64bit/33MHz PCI interfaces. The PCI interface is universally keyed for 3.3v and 5v slots and is PCI 2.2 specification compliant.

2.2.7 Adapter Jumpers

The IIR controller has a series of jumpers that allow for specific configuration of

the controller. See Figure 1 for location of each jumper block

2.2.7.1 SCSI Termination

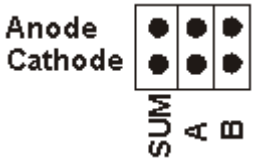
The onboard termination of the RAID controller can be changed within Storage Console, with termination jumpers in 'Soft-Switch mode or can be hardwired via the termination jumpers to force termination always ON or OFF regardless software settings or cables detected. See Figure 2 for details.

Figure 2. Termination Jumper Settings

2.2.7.1 External LED Connectors

The IIR Controller has a 6 pin header to allow for connection of additional LED's. An LED connected with header A lights up whenever there is activity on SCSI channel A. The same applies for header B. An LED connected with the SUM header lights up whenever there is activity on any of the two SCSI channels A and B. See Figure 3 for details.

Figure 3. External LED Connectors



2.2.7.1 Terminator Power

Determines whether termination power (per channel) is supplied by the controller. The Default is ON for both channels (both jumpers set).

2.2.8 LED indicators

There are a number of LED indicators on the RAID controller that indicate the various modes and/or states of the controller. See Figure 1 for location of LED's.

2.2.8.1 Function Check

Indicates the activity on the controller. See Table 1 for detail.

Table 1. Function Check

LED	Function
A	Indicates activity on SCSI channel A
B	Indicates activity on SCSI channel B
T	Indicates Bus Master DMA transfers (the brighter the light, the more DMA's)
S	When system is powered, indicates that controller is online (i.e. installed correctly)
	

2.2.8.2 Channel Mode

A yellow LED for each Ultra160 SCSI channel, indicates the current SCSI mode of the corresponding channel. If the LED is lit, the Ultra160 SCSI channel is operating in Low Voltage Differential (LVD) mode. If the LED is not lit, this channel is operating in Single-Ended (SE) mode. See Section 2.5 for an explanation of LVD and SE modes.

2.2.8.3 PCI Bus Clock

Indicates the clock speed of the PCI Bus interface. If the LED is not lit, the bus speed in 33MHz. If the LED is lit, the bus speed is 66MHz.

2.2.9 Acoustical Alarm

An acoustical (audible) alarm is present on the RAID controller to indicate any of the following events:

- State of controller upon boot-up
- Change in state of array
- Change controller environmental status (during normal operation)
- Hardware failure

If the cause of the event is resolved and/or removed, the audible alarm will cease. The audible alarm can also be turned off manually through StorCon or StorCon plus. If the audible alarm is silenced via management tools, it will only be disabled for the current event and will be ready to sound again at the next event.

2.2.10 Architecture Features (HW)

Table 5. Hardware Architecture

Component	Feature
I/O Microprocessor	The 80303 uses the 100MHz Intel 80960JT-100 core with a 100MHz/64bit internal bus with an internal throughput of up to 800MB/sec, to and from the internal IOP peripherals.
Cache Memory	The SRCU32 supports up to 256MB of 64bit ECC SDRAM operating at 100MHz. Memory is expandable to 64, 128, or 256MB.
Flash Memory	3.3v, 16Mb (2MB) flash memory chip is used to store the RAID firmware
I/O interface (PCI)	PCI 2.2 compliant, universally keyed for 3.3 and 5 volt PCI slots
PCI Transfer Rate	528MB/sec (Burst)
PCI Signaling	5 or 3.3 volt
SCSI Controller: LSI SYM53C1010	Dual channel Ultra160

2.3 Electrical Characteristics

Table 6. Electrical Specifications

Attribute	Measurements
Voltage Requirements	+5, 3.3V (all +/- 5% tolerance)
Power Consumption (5V, 12V)	Approximately 10 Watts

2.4 Environmental Specifications

Table 7. Environmental Test Results

Attribute	Condition
Thermal: Non-Operating	-10° C (Celsius) to 60° C
Humidity: Non-Operating	20% to 75% Relative Humidity, non-condensing
Operating Temperature & Voltage Margin	0° C to 55° C +/- 5% V_{cc}
Form Factor (physical dimensions)	Height: 98 mm (3.86 inches) Length: 200 mm (7.87 inches)
Weight	.35 kg (.77 lb)

2.5 Supported Hard Drive Technology

The IIR controller supports both Single-ended (SE) and Low Voltage Differential (LVD) devices but it is recommended that you use only one type of drive technology (SE or LVD) on any one channel at a time.

The IIR controller supports single-ended drives which operate at up to 40MB/sec depending upon the speed of the drives attached.

The IIR controller supports Ultra-2 LVD SCSI devices operating at up to 80MB/sec and Ultra160 LVD SCSI devices operating at up to 160MB/sec.

Note: If both SE and LVD devices are attached to the same channel/bus, the entire bus will

operate at the single ended speed of the slowest device. See Table 3-3 for the maximum cable length distances that apply to each mode.

The IIR controller is designed to use Ultra160 SCSI hard drives and is backward compatible with older SCSI hard drive specifications. See Table 3-3 for the SCSI standards supported.

Table 3-3. SCSI Drive Standards

SCSI Drive Standard	Speed (MB/Sec)	Bus Width (Bits)	Maximum Cable Length (meters) (1)		Adapter Maximum Devices per SCSI Channel
			Single-Ended	LVD	
SCSI-1 (2)	5	8	6	(3)	8
Fast SCSI (2)	10	8	3	(3)	8
Fast Wide SCSI	20	16	3	(3)	16
Ultra SCSI (2)	20	8	1.5	(3)	8
Ultra SCSI (2)	20	8	3	N/A	4
Wide Ultra SCSI	40	16	N/A	(3)	16
Wide Ultra SCSI	40	16	1.5	N/A	8
Wide Ultra SCSI	40	16	3	N/A	4
Ultra2 SCSI (2, 4)	40	8	(4)	12	8
Wide Ultra2 (4)	80	16	(4)	12	16
Ultra160 (Ultra3)	160	16	(4)	12	16

Notes:

1. May be exceeded in Point-to-Point and engineered specific applications.
2. Use of the word "Narrow", preceding SCSI, Ultra SCSI, or Ultra2 SCSI (for example, Narrow SCSI) is optional.
3. LVD was not defined in the original SCSI standards for this speed. If all devices on the bus support LVD, then 12-meters operation is possible at this speed. However, if any device on the bus is singled-ended only, then the entire bus switches to single-ended mode and the distances in the single-ended column apply.
4. Single-ended is not defined for speeds beyond Ultra.

After Ultra2 all new speeds are wide only.

2.6 Support for Non-Hard-Disk-Drive SCSI Devices (Non-Direct-Access Devices)

The RAID controller will pass through to the host operating system direct access to nondirect-access SCSI devices that are connected to a SCSI bus (channel) of the RAID controller. The RAID controller passes through all control of these devices to the host operating system.

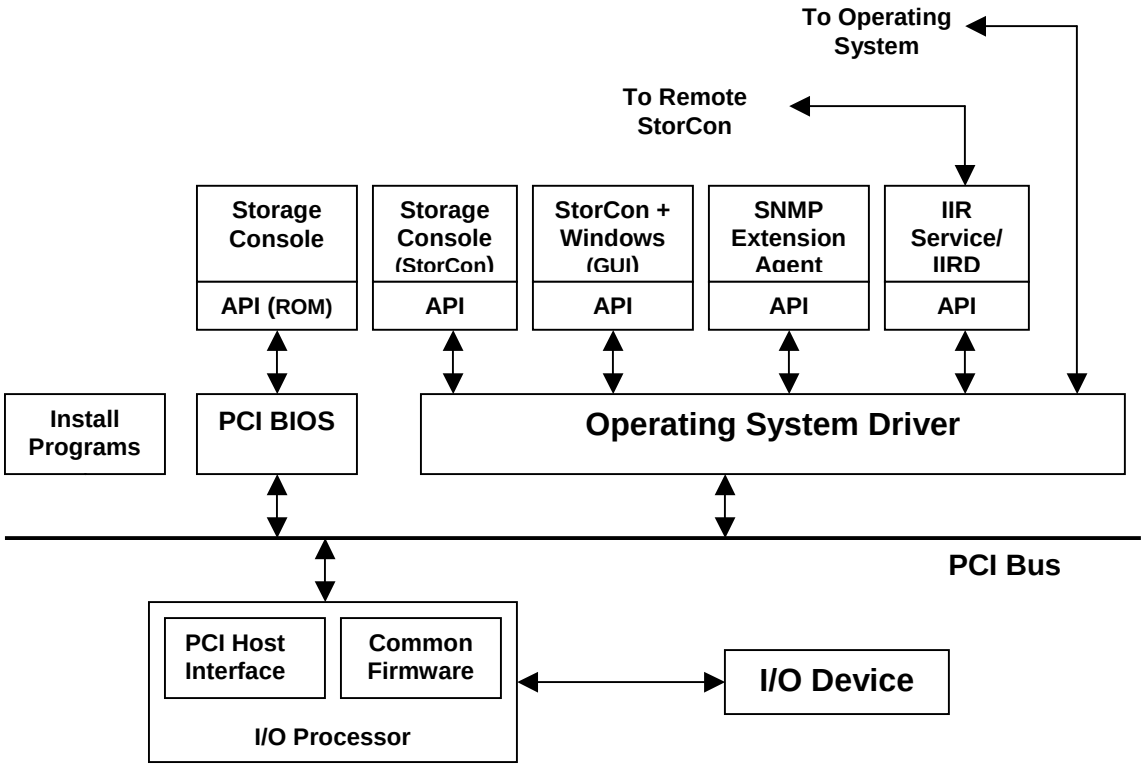
Types of supported non-Direct-Access SCSI devices (this does not cover specific vendors and models):

- SAF-TE Processors
- Tape Devices
- CD-ROMs

3.0 Software

3.1 Software Architecture Overview

Figure 4 RAID Software Stack Architecture Block Diagram



The RAID software stack is composed of two major component groupings: the RAID firmware embedded in the Flash memory and a set of host resident drivers and utilities installed on the host system. All host-based software contains an OS dependent portion and an OS independent portion. This allows for a consistent 'look and feel' across operating system platforms. A simple, custom messaging protocol is used to communicate between the host driver or utility and the embedded RAID firmware. The firmware is independent of the OS, I/O processor, and I/O bus through the use of abstraction layers. This layered RAID software executes on a custom, multi-tasking, realtime software executive and relies on the reuse of internal software communication 'building blocks' to incorporate new technology and provide for new products.

Note: The architecture block diagram in Figure 4 is a generalization. Its goal is to cover all OS implementations. Certain blocks may or may not be relevant to each specific OS.

3.1.1 User Interface

3.1.1.1 Storage Console

The Storage Console is a text-based user interface. It is a full-featured monitoring and configuration utility for managing all aspects of the RAID subsystem as well as many features of the RAID adapter. It can be accessed via two methods. The first is during system boot time when entering the adapter's BIOS by depressing the <Ctrl>+<G> keys when prompted. The utility is accessing the RAID subsystem via the PCI BIOS.

The other method of accessing the Storage Console is via launching the application from within the host operating system.

Storage Console communicates with the firmware via a common API both during system POST and from within the host OS. This unique feature allows for a common UI between both OS and pre-OS environments.

3.1.1.2 Storage Console+

Storage Console+ is a GUI implementation of the Storage Console. However, it runs only on Microsoft Windows-based systems and has the same features and functionality with only a few exceptions.

3.1.2 System Management

3.1.2.1 SNMP Extension Agent

The SNMP Extension Agent is the interface between SNMP and the IIR Management Information Base (MIB). It interacts with the host resident MIB as well as the IIR HBA (via the IIR API) to respond to SNMP requests.

3.1.3 Common Layers

3.1.3.1 PCI BIOS

The PCI BIOS is the Expansion ROM software as defined in the PCI specification. It performs IIR initialization from host system memory during POST.

3.1.3.2 IIR API

The IIR API is a C++ class library consisting of OS-independent classes and methods. This layer encapsulates sequences of lower level C library API functions and builds OS independent data structures used for communicating with the HBA. This API relies on an OS dependent layer that communicates with the local driver (if one is present) or a remote driver via the TCP/IP or IPX/SPX network protocol.

3.1.3.3 Operating System Driver

The IIR device driver is the OS specific driver that communicates between the host resident application and the IIR HBA using the IIR communications protocol.

3.1.3.4 RAID Configuration Service

The IIR Service / IIRD allows remote access to the IIR HBA. It runs as a service on Windows-based systems and as a daemon on Unix-based systems. In order to use the remote access capability, an administrator has to create user accounts. The passwords for these accounts are encrypted for security.

3.1.4 RAID Firmware

The IIR firmware is composed of multiple software layers allowing for maximum flexibility, re-use and maintainability. At the highest level is a host interface abstraction layer in the common firmware that is also composed of multiple internal layers of service and library modules. The firmware is common among all IIR products both internal and external allowing for a common disk data format across the entire IIR product line.

The IO Device pictured next to the firmware (Figure 2) also communicates over an abstraction layer allowing for elegant integration of multiple IO device types from different vendors.

4.0 RAID Functionality and Features

4.1 Hierarchy

A fundamental purpose of a RAID system is to present a usable (with some level of redundancy) data storage medium (or drive) to a host operating system. In accomplishing this, the Intel RAID firmware is based on a four level hierarchal model. Each level has its "own drives" associated with it. The basic rule is: to build drives on a given level in the hierarchy, the "drives" of the next lower level are used as components. So, in order to construct, create, a data drive (host drive/RAID volume) and present it to the host operating system, the following steps are typically followed by the RAID firmware to accomplish this:

- One or more physical drives are selected and initialized
- A logical drive is created for each physical device
- The logical drives are grouped and an array drive is created
- The RAID firmware designates the array drive as a host drive and presents it to the host OS

Level 1
Physical drives are located on the lowest level of the hierarchy. This includes hard disk drives, removable hard disks, and some Magneto Optical drives. They are the basic components of all "drive constructions". However, before they can be used by the firmware, these hard drives must be "prepared" by a process called initialization. During initialization each hard disk has configuration information written to its physical medium in non-user accessible redundant areas. This information allows a univocal identification even if the SCSI-ID or the controller is changed. For reasons of data coherency, this information is extremely important for any drive construction consisting of two or more physical drives.

Level 2
Logical drives are constructed to obtain full independence of the physical coordinates of a physical device. This is important because it allows one to rearrange the SCSI-IDs and channel location of the physical drives of a disk array without compromising the integrity of the RAID array disk. It also is what allows one to interchange disk arrays between compatible controllers. Logical drives always consist of physical drives.

The user can create a logical drive manually by using one or more available physical drives. A logical drive created manually in this way is presented directly to the host OS as a Host drive (see host drives in Level 4). However, it is not associated with any array drive (see array drives in Level 3).

Level 3

Array drives are located at this level in the hierarchy. Array drives always consist of logical drives and consist of the following drive types:

- RAID 0 drives
- RAID 1 drives
- RAID 4 drives
- RAID 5 drives
- RAID 10 drives

The user can manually create an array drive by using two or more logical drives that were manually created at level 2. This action combines the original host drives associated with each of the logical drives into a single host drive at a chosen RAID level.

Level 4

Host drives (RAID volumes) are created at the highest level of the hierarchy by the RAID firmware. This is done automatically upon the creation of an array drive. It is also done automatically upon the manual creation of a logical drive. Each host drive is assigned a drive number that matches the drive number of its array drive or logical drive. Host drives are the only hierarchal level drives that are detectable by the host operating system. The three lowest level hierarchal drives are transparent to the host operating system.

After a capacity expansion of a given array drive, the added capacity appears to the host OS as a new host drive on this level. It can then be configured as a separate host drive or, using the Merge feature in the Host Drive menu, be combined with the initial host drive of the array drive into one single host drive.

Note: Any data located on the original host drive will be lost using the Merge feature. Do not use this feature if the initial host drive already contains data that you do not wish to destroy.

Within the Storage Console utility, each level of hierarchy has its own special menu:

Level 1 - Menu: Configure Physical Devices
Level 2 - Menu: Configure Logical Drives
Level 3 - Menu: Configure Array Drives
Level 4 - Menu: Configure Host Drives

4.1.1 RAID Host/Array Drive Statuses

Table 10 lists the available states of *RAID Host and Array Drives.*

Table 10. Array Drive Statuses

Drive Status	Attribute	Drive Type	Redundant	Description
Idle	RW	RAID 4 / 5 / 10	No	Newly defined array prior to build process starting
Build	RW	RAID 1 / 4 / 5 / 10	No	The initial process of configuring redundancy information upon creation of drive
Ready	RW	RAID 1 / 4 / 5 / 10	Yes	The array drive is fully operational; its normal state
Rebuild	RW	RAID 1 / 4 / 5 / 10	No	Array drive assumes this status after the automatic activation of a Hot Fix or after manual replacement (hot-plug)
Expand	RW	RAID 4 / 5	Yes	This status indicates that the RAID level and or capacity are (is) being migrated
Fail	RW	RAID 1 / 4 / 5 / 10	No	This status indicates that a *logical drive* has failed
Error	RO	RAID 4 / 5 / 10	No	If a component of a disk array is missing during startup and *fail mode* is not activated, the array is set to read only.
OK (*RAID 1 only*)	RW	RAID 1	Yes	The RAID 1 array drive is fully operational; normal state
Patch	RW	RAID 4 / 5	Yes	This status indicates that the array drive has gone through a significant procedure or has been patched from the error status to fail status

NOTES: RW = Read Write
RO = Read Only
The drive *attribute* indicates the level of host OS access to the drive

4.1.2 Logical Drive Statuses

Table 11. Host Drive Statuses

Drive Status	Attribute	Description
OK	RW	The drive is operational and functioning normal Missing - The drive is missing or no longer detected by the RAID controller
Missing	-	The drive is missing or no longer detected by the RAID controller
Fault	RW	The drive is no longer operating within expected parameters
NOTES: RW = Read Write O = Read Only The drive *attribute* indicates the level of host OS access to the drive.		

4.1.3 RAID Controller Drive Limitations (Host, Array, Logical, and Physical)

The following are limitations assuming the following:

- U160 speed
- Dual channel SCSI controller
- Cabling that meets U160 specifications

Physical drives are limited by the number of SCSI channels being controlled by the RAID controller. The SCSI bus can support up to 15 SCSI devices per channel (14 if one SCSI ID is being occupied by an intelligent enclosure processor). Therefore this 2-channel RAID controller is able to connect up to 30 disks total. An **array** drive requires a minimum of two hard disk drives (or **logical** drives) and up to a maximum of 15 arrays can be configured with on the SRCU32 controller. The firmware supports 35 components per array - i.e. all 30 disks could form one large array. However, due to performance and drive failure issues (i.e. if so many disks are configured in one array, the possibility that a disk failure increases) the number of disks in one array should not exceed 10-12 disks. If more disks are connected to the controller, additional arrays should be configured. The firmware supports channel spanning where an array can consist of physical drives that are attached to either one or to both channels of the RAID controller. There is a minimum of at least one host drive per *array drive*. A **Host** drive (RAID Volume) can only be associated with (or reside on) a single *array drive*. Like *array drives*, host drives can reside on hard disk drives that are isolated to a single channel or span both of the channels of the RAID controller.

4.2 Utilities and Tools

Table 13. Utilities and Tools (Sheet 1 of 2)

Management/Monitoring	Description	Actions
Storage Console (StorCon)	This is a text-based UI that allows full management and monitoring of the RAID controller and its subsystem. Consistent look and feel across all supported operating systems.	• Can be launched during Boot up, <Ctrl>+<G>, or within host OS. • Can be ran locally or remotely using TCP/IP or SPX/IPX network protocols.
Storage Console+ (StorCon+)	GUI based version of the Storage Console with exception to a few functions. It only runs locally on Windows servers and clients.	• Can be ran locally or remotely using TCP/IP or SPX/IPX network protocols.
Monitoring/Reporting	**Description**	**Actions**
View Statistics	Allows the viewing of I/O activity of host, logical, and physical drives and cache activity	Accessed via the Storage Console menu, Express or Advanced Setup - > View Events. User can adjust sync rate and enable and disable logging
View Events	Allows the viewing and saving of all events regarding the adapter since it's last boot up.	Accessed via the Storage Console menu, Express or Advanced Setup - > View Events.
View Hard Disk Information	Lists all hard drives connected to the RAID adapter with information about each hard drive	Accessed via the Storage Console tools. User can select each drive individually to bring up a detailed list of information that includes detected defects since the drive was first detected by the RAID adapter
Diagnostics	**Description**	**Actions**
Save Information	Gives administrator the ability to save the configuration information of the RAID adapter in ASCII file for viewing.	Accessed via the Storage Console. User can save file to be used for troubleshooting or documentation.

Table 13. Utilities and Tools (sheet 2 of 2)

Memory Test .	Non-destructive tests are written to ECC memory and verified. The different modes determine type of pattern and quantity. Tests are not non-destructive for non-ECC memory.	Accessed via Storage Console menu Advanced Setup -> Configure Controller -> Controller Settings. User selected options are: No test, Standard, Double scan, and Intensive
Parity Verify	Selecting this feature causes the adapter to verify the parity on RAID level 4 and 5 arrays	Accessed via Storage Console menu Advanced Setup -> Configure Array Drives -> Select an array
Check Surface: Physical Disks .	A surface-check of the selected hard disk drive done. The controller writes and reads certain data patterns and checks them for correctness	Accessed via Storage Console menu Advanced Setup -> Configure Physical Devices ->Select Physical Drive -> Check Surface. **Warning!** This action destroys all data on the selected drive.
Firmware	**Description**	**Actions**
Firmware Update	Utility that allows the updating of the adapter's firmware using: DOS utility for major updates (e.g. major, 2.32.xx to 2.33.xx) or StorCon for minor updates (e.g. minor, 2.32.xx to 2.32.yz).	Firmware Update Is accessed via DOS utility Is accessed via the Storage Console during boot up (<Ctrl>+<G>) or from within the host OS menu Advanced Setup -> Configure Controller -> Firmware Update

4.3 RAID Features

4.3.1 RAID Level Support

Table 14. Supported RAID Levels

RAID Level	Description	Configuration Drives Requirements
0	Data striping	2 min, 30 max (2 channel limit)
1	Drive mirroring	2 min, 30 max (2 channel limit)
4	Data striping with dedicated parity drive	3 min, 30 max (2 channel limit)
5	Data striping with distributed parity	3 min, 30 max (2 channel limit)
10	Combination RAID 0 and 1, striped mirrors	4 min, 30 max (2 channel limit); drives must be added in pairs
Disk Pass-Through to Host		
Single Disk	Presented to host OS as a host drive	1
Chaining	Presented to host OS as a host drive	2 min, 30 max (2 channel limit)

4.3.2 Caching

There are two levels or modes of caching related to the adapter - each independent of the

other. Caching can be enabled on the controller, which sets caching on all the RAID array/host drives configured on the adapter. This mode of caching utilizes the memory that is located on the adapter (SDRAM that is either embedded or an inserted DIMM module). The other caching mode is enabling the caching feature of the actual hard disk drives themselves. In this method, the cache memory that is utilized is located on the disk drive and does not use the adapter's memory.

Note: In the event of power loss to the computer system, data located in disk cache is not protected by the battery backup unit of those controllers that support optional battery backup. The battery backup only protects data that is located in the controller cache.

4.3.2.1 Controller Cache Selections

- Caching on/off selectable (Read Ahead)
- Delayed Write on/off selectable (Write Back)

4.3.2.2 Physical Disk Cache Selections

- Read cache on/off selectable
- Write cache on/off selectable

Table 15. Supported Cache Settings

	Cache Setting		Cache Configuration Description
	Disk Cache	**Controller Cache**	
1	Write _ Read _	Cache _ Delayed Write •_	No cache
2	Write _ Read •	Cache _ Delayed Write •_	Disk Read
3	Write • Read _	Cache _ Delayed Write •_	Disk Write
4	Write • Read •	Cache _ Delayed Write •_	Disk Read Write
5	Write _ Read _	Cache • Delayed Write _	Controller Read
6	Write _ Read •	Cache • Delayed Write _	Disk Read, Controller Read
7	Write • Read _	Cache • Delayed Write _	Disk Write, Controller Read
8	Write • Read •	Cache • Delayed Write _	Disk Read Write, Controller Read
9	Write _ Read _	Cache • Delayed Write •	Controller Read Write
10	Write _ Read •	Cache • Delayed Write •	Disk Read, Controller Read Write
11	Write • Read _	Cache • Delayed Write •	Disk Write, Controller Read Write
12	Write • Read •	Cache • Delayed Write •	Disk Read Write, Controller Read Write

Legend: _ disabled/off
• enabled/on
•_ either

4.3.3 Hot Fix (Spare) Disks

There are two types of hot fix drives:

- **Private** (dedicated): This type of hot fix drive is assigned to a specific RAID 1, 4, 5, or 10 array drive. It cannot be used by any other RAID array drive configured on the controller.
- **Pooled** (global): This type of hot fix drive is available for any RAID 1, 4, 5, or 10 array drive that has been configured with Pooled Hot Fix Access enabled.

Note: When adding a Pool Hot Fix to a specific array, the access for this array will be automatically enabled, for other arrays this feature has to be manually activated with the Pool Hot Fix Access switch.

The capacities of Hot fix drives are required to be the same size or larger than the capacity of the smallest physical disk drive in the RAID array drives that they are protecting. Therefore, if you have two RAID arrays where Array_1 has all 9 GB drives and Array_2 has all 18 GB drives then Array_1 would require, at a minimum, a 9 GB hot fix drive and Array_2 would require, at a minimum, an 18 GB hot fix drive.

Also, when using a single pooled hot fix drive to protect several RAID array drives, the pooled hot fix drive must meet the proper capacity requirement to protect all of the arrays. To select the proper sized pooled hot fix drive, first determine the capacity of the smallest physical disk drive in each RAID array to be protected. Next, select a pooled hot fix drive that is equal to or larger than the capacity of the largest of these disk drives. For example, in Table 16, if the pooled hot fix drive for the four RAID arrays is 9GB, then it would only protect arrays 1 and 2. Therefore, the proper hot fix drive selection to protect all four of the array drives would have to be of a minimum capacity of 36GB (see note below).

Table 16. Example of a 9GB Pooled Hot Fix Drive Selected to Protect Four RAID Array Drives

Array (smallest disk)	Array_1 (4GB)	Array_2 (9GB)	Array_3 (18GB)	Array_4 (36GB)
Protected by Pooled Hot Fix?	Yes	Yes	**No**	**No**

NOTE: This is an example of how the pooled hot fix drive feature works. It would not be practical to use only one pooled hot fix drive to protect all four of the arrays in this example unless a hardware configuration limitation only allowed for one extra drive as a pooled hot fix (adding the pooled hot fix drive brings the total number of hard disk drives to the maximum supported by the controller).

4.3.4 Hot-Plug Disk Drive Support

This feature allows the ability to remove and replace SCA (single connect adapter) drives while I/O activity is taking place on the same SCSI bus, provided that both the hard disk drive and backplane fully support hot-swap, without interruption of operations on any other drives. It supports the hot-plug of new drives in intelligent (SAF-TE) and non-intelligent enclosures.

4.3.5 Non-Intelligent Drive Enclosure Auto-detection of Hot-Plug Disk Drives

This is a special feature that allows the use of non-intelligent disk enclosures (requires truly hot-pluggable disk drives and backplane connectors) as though they were intelligent enclosures. This feature is configurable and allows the user to set up non-intelligent enclosures to detect the insertion or removal of hot-plug disk drives and report the event to the RAID firmware. The RAID configuration is automatically updated to the new configuration. Access this feature through the Advanced Setup menu of Storage Console.

4.3.6 Auto-declare Hot Fix (Spare) Drive

If the RAID controller has a RAID array drive that is in failed (degraded) state, and you connect to the controller a new hard disk drive that is the same size or larger than the smallest disk drive in that failed (degraded) RAID array then the RAID firmware will automatically mark this new disk drive as a hot fix (spare) drive for the failed (degraded) RAID array drive. Rebuild will then automatically commence. If the new hard disk is smaller than the smallest hard disk drive in the failed (degraded) RAID array drive, the new disk drive will not be marked as a spare and the failed (degraded) RAID array drive will remain failed (degraded). With an intelligent SAF-TE enclosure (or a non-intelligent enclosure that is configured to auto-detect insertion of hot-plug disk drives), a bus scan occurs automatically when the hard disk drive is inserted. No manual intervention is required. When a non-intelligent enclosure that has not been configured for auto-detection of hot-plug disk drives is used, a bus scan or reboot is required for the Auto Declare Hot Fix feature to commence.

A new hard disk drive may have the same or a different SCSI ID as the failed hard disk drive that it replaces.

4.3.7 Array Roaming Compatibility

Array Roaming allows the user the ability to move a complete RAID array from one computer system to another computer system and preserve the RAID configuration information and user data on that RAID array. ††Compatible RAID controllers must control the RAID subsystems of the two computer systems (see list of compatible controllers in this section). The transferred RAID array may be brought online while the target server continues to run if the hard disk drives and disk enclosure support hot-plug capabilities. The hard disk drives are not required to have the same SCSI ID in the target system that they did in the original system that they are removed from. The RAID array drive that is being roamed must not be of type Private. This includes all non-private host, array, and logical drives.

Warning: **†† The SRCU32 adapter, with firmware 2.32.xx, is not compatible with some**

previous versions of IIR RAID FW running on IIR controllers. Only the versions listed below are compatible. Do not attempt RAID Array Drive Roaming between RAID controllers that are not compatible with the SRCU32 adapter. Unpredictable behavior may include, but is not limited to, data loss or corruption.

Compatible adapters include:

- GSU31 - Firmware version 2.32.xx
- BNU31 - Firmware version 2.32.xx
- SRCU32 - Firmware version 2.32.xx
- PZMR - Firmware version 2.32.xx

Note: Compatibility refers only to how data and RAID configuration information are written to the hard disks. Compatible adapters have the same data file format.

4.3.8 On-line RAID Array Configurations

4.3.8.1 Capacity Expansion Without Reboot

On-line capacity expansion refers to the ability of the RAID controller to present new storage space to the host OS without requiring that the computer system must be taken off-line and rebooted (for those Operating systems that support this feature). The host OS is able to detect the new capacity and format and partition it for immediate use. The RAID controller offers several ways of creating additional capacity while on-line.

Creating new RAID array drives from available physical hard disk drive:
This is the simplest method. The user just creates a new host drive from available physical disk drives that are connected to the RAID controller (the assumption here is that there were disk drives that were already connected but unused or there were new disk drives inserted into open slots in a hot-plug drive enclosure already connected to the RAID controller).

Creating new capacity to existing RAID array components (Expand Array Drive):
Using this method you are allowed to do one of the following:

- Convert unused free space on the existing logical drives of the RAID array drive into a separate host drive, or
- Add additional physical disk drives to the existing RAID array drive

4.3.8.2 RAID Level Migration

RAID level migration is accomplished using the Expand Array Drive feature. To expand a RAID 0 drive to a RAID 4 or 5, requires that you add at least one additional drive to the array. Migrating from RAID 4 or 5 to RAID 0 frees one disk. The RAID controller allows the following RAID level migrations of a given array drive:

- RAID 0 → RAID 4: add new disk, parity is calculated and written to new disk.
- RAID 0 → RAID 5: add new disk, parity calculated and written to new disk, then parity is distributed over all disk.
- RAID 5 → RAID 0: parity written to one disk, parity disk freed and removed.
- RAID 4 → RAID 0: parity disk freed and removed.

- RAID 4 → RAID 5: parity distributed over all disk.
- RAID 5 → RAID 4: parity written to one disk.

Basic migration process: RAID 0 ↔ RAID 4 ↔ RAID 5

To initiate a migration the RAID array must be have a status of ready.

4.3.8.3 Data Strip Size Configurable per RAID Array

The strip size for each RAID array can be configured at the time of creation of the RAID array. This is a one-time configuration and cannot be changed or migrated once the array has been created. For RAID 0, 4, 5, and 10 arrays the following Strip Sizes are possible:

- 16KB
- 32KB
- 64KB
- 128KB

4.3.9 Background Initialization and Instant Availability

The initialization of RAID array drives is done in the background. Array drives have a status of **build** during this process and are immediately accessible to the host OS if the host OS supports online capacity expansion.

There are two build modes available when creating RAID arrays, Standard and Destructive. Destructive is much faster than the standard build mode. When in destructive build mode, the firmware writes a pattern of zeros across all disks. If this build process is interrupted by rebooting the computer, the build process will continue in the much slower standard non-destructive build mode. The destructive build mode is only available from within the BIOS version (<Ctrl>+<G>) of the Storage Console.

4.3.10 Configurable SCSI Parameters

When a SCSI hard disk drive is initialized the first time by the RAID controller, its SCSI parameters are automatically set to their optimal settings. Manual configuration is not required. However, the RAID controller allows for the custom configuration of several

SCSI parameters on a hard_disk_drive-by-hard_disk_drive basis. There are several settings that can be configured by using the Storage Console menu Advanced Setup → Configure Physical Devices → Select Physical Drive → SCSI Parameter/Initialize:

Table 17. Configurable Disk Drive SCSI Parameters

Parameter	Setting/Value	Description
Synch. Transfer	Enabled / Disabled	This setting when enabled allows the controller to operate in synchronous transfer mode
Synch. Transfer Rate	Speed MB/sec	Allows for the setting of the speed for the SCSI hard disks (160MB/sec for U160 drives). No matter the setting, the SCSI bus will negotiate the fastest speed up to this setting. Lowering the setting will force the disk drive to transfer at the lower speed.
Disconnect	On / Off	Enabling this setting allows for the disk drive to disconnect from the SCSI bus when it's not participating in a transfer. This allows for optimal bus utilization by all devices on the bus.
Tagged Queues	On / Off	When enabled, this feature allows the SCSI disk drive to execute more than one command at a time.
Disk Read and Write Cache	On / Off	For performance reasons, the *Read Ahead* and *Write* cache of the hard disk drives should always be on.
Domain Validation	On / Off	Using the <F4> key while in this menu accesses this parameter. When this is set to *On*, Domain validation allows for a cyclical check of the correct data transfer at a given rate.

4.3.11 PCI Hot Plug

The SRCU32 adapter supports PCI Hot Plug under the following OS's:

- Windows 2000 Advanced Server SP2, Windows 2000 Server, Windows 2000 Professional
- NetWare 5.1 SP2a

This IIR Controller supports the PCI Hot Plug functionality for the Hot Replacement of an adapter. Hot Replacement assumes that the drivers for the adapter being replaced are already loaded.

5.0 Certifications and Supported Technologies

5.1 OS Certifications

The product will be validated with the latest vendor OS certification test suites. Pre-submission tests will be passed and the certifications listed in Table 18 will be submitted to the proper submission process as required per OS. The pre-submission test will be run on the final gold production release candidate of the RAID software suite OS drivers and RAID firmware. The product will not be held up from shipping while awaiting final passing notification from the OS vendors (and in the case of Windows 2000, the digitally signed versions of the OS driver).

Table 18. OS Certification Requirements

OS Vendor	Details	Test Suite Version
Microsoft	The product shall be **WHQL** Certified as a **RAID Adapter** for the following: • Windows 2000 Advanced Server	HCT ver. 9.502 or latest available
Novell	The product shall be certified to receive "**Yes Tested and Approved"** with the Storage Access Tests for the following: • NetWare 5.1	Test kit ver. 3.1 or latest available
SCO	The product shall be certified to receive "**Works with SCO**" certification for the following: • UnixWare 7.1.1	PLT ver. 8.13 and HBACert ver. 7.1 or latest available
Red Hat Linux	The product shall be certified to receive "**Red Hat Ready**" certification for the following: • Red Hat Linux 7.1 (the 2.4 kernel)	Test suite ver. 1.6.9 or latest

5.2 Electronic Regulatory Agencies Certifications (Hardware)

Table 19. Electronic Equipment Regulatory Certifications (Sheet 1 of 2)

Applicable Specification	Country/ Region	Agency Certifications	Product Labeling	Manual Statements
FCC parts 2 and 15, Class B as applicable for peripheral device	U.S.	Intel to test at A2LA or NIST NVLAP accredited lab in support of FCC doc	FCC DoC "Tested to Comply" artwork on PCB	FCC DoC required statements in manual
ICES-003, Class B Digital Apparatus	Canada	Same as FCC above	Same as FCC above	Canadian required statements in manual (i.e. Canadian DOC statement in English and French)
EN55022 Class B (EMI)	European Union	EU Declaration of Conformity (based on being component having "direct function")	CE mark on PCB and/or product packaging	Installation instructions necessary to ensure EMI compliance in manual
EN55024:1992 (Immunity), including IEC 801-2, -3, -4	European Union	Same as EN55022 B (EMI) requirements above	Same as EN55022 B (EMI) requirements above	Same as EN55022 B (EMI) requirements above
AS/NZS 3458 (similar to CISPR 22 Class B)	Australia, New Zealand	C-Tick Declaration of Conformity (DoC approved by D Bolt)	C-Tick mark and Intel supplier code on PCB or box	None

Table 19. Electronic Equipment Regulatory Certifications (Sheet 2 of 2)

UL Listing to UL1950 and CUL C22.2 No 950-95 (Canada Listing) EN60950 evaluation and CB report (optional)	USA and Canada	UL1950 3rd edition listing and cUL listing for Canadian requirements Intel to test at A2LA or NIST NVLAP accredited lab	UL and cUL marks UL fabricator mark on PCB and Flame rating	UL required safety tips
CNS 13438 (CISPR22) Information Technology Equipment	Taiwan		BSMI Logo	http:// www.moeabciq.gov.tw/ english/e_n_hpg.htm
RLL Class B	Korea	NEMKO Canada	RLL Logo	None
IEC61000-4-2, ESD	IEC	Intel to test at A2LA or NIST NVLAP accredited lab	N/A	None
IEC61000-4-3, Radiated Immunity	IEC	Intel to test at A2LA or NIST NVLAP accredited lab	N/A	None
IEC61000-4-4, EFT	IEC	Intel to test at A2LA or NIST NVLAP accredited lab	N/A	None
IEC61000-4-5, Surge	IEC	Intel to test at A2LA or NIST NVLAP accredited lab	N/A	None
IEC61000-4-6, Conducted Immunity	IEC	Intel to test at A2LA or NIST NVLAP accredited lab	N/A	None

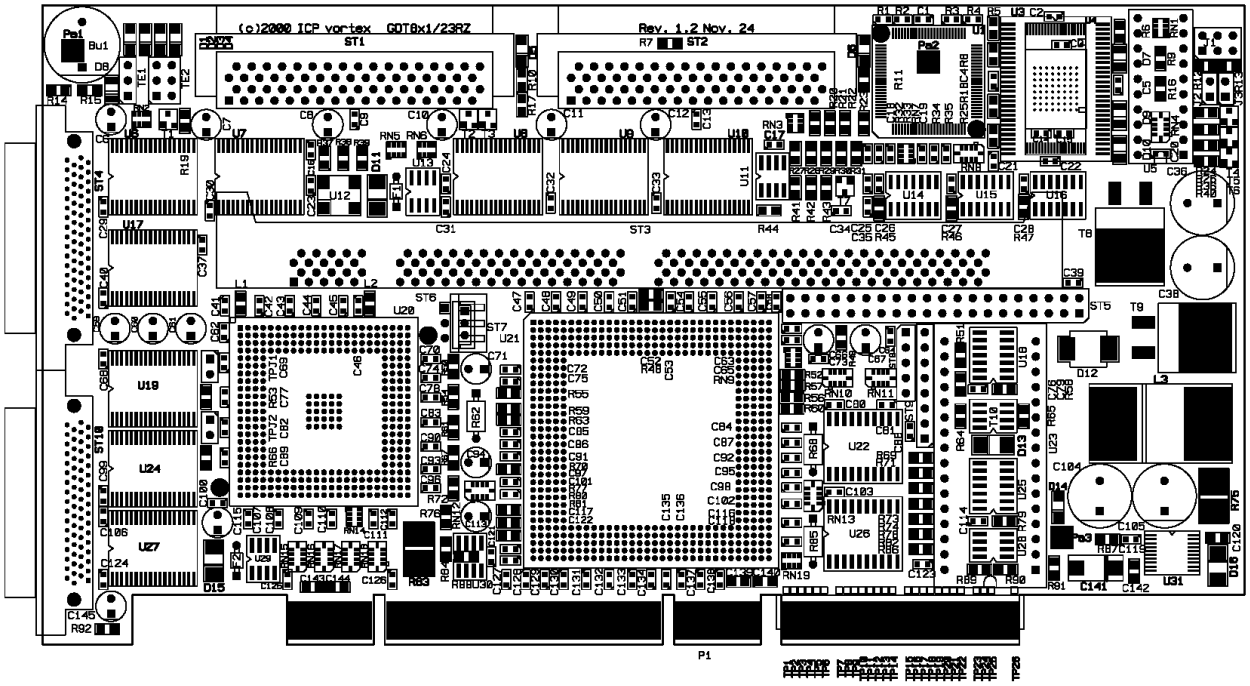
5.3 Supported Specifications and Standards

Table 20. Supported Standards and Specifications

Specification/Standard	Details
SAF-TE specification 1.0	The product supports SAF-TE Backplane processors, including: processing/reporting/logging of messages and issuing of commands per SAF-TE specification. http://www.nstor.com/support/whitepapers/safte_spec.doc
ACPI Power Management (Windows 2000)	• The product supports power states D0, and D3 as defined by Storage Device Class Power Management Reference Specification, Microsoft, Version 1.0A, February 1997.
Bootable CD-ROM	• The product supports booting from a CD-ROM based on the "El Torito" Bootable CD-ROM Format Specification, version 1.0, http://www.phoenix.com/PlatSS/PDFs/specs-cdrom.pdf • The product supports a bootable CD-ROM from a PCI 2.2 Plug and Play compliant BIOS. • The product supports No Emulation mode with PnP BIOS's

6.0 Technical Drawings and Diagrams

Figure 3 Adapter PBA Drawing Front



7.0 Appendices

7.1 Referenced Documentation

Table 21. Referenced Documentation

Document Title	Order #
SRCU32 Hardware Installation and User's Guide	273478-001
Software Installation and User's Guide	273479-001

7.2 BIOS Boot Messages

When booting the IIR Controller, the boot message in Figure 4 appears. In this example, an IIR Controller has been detected in PCI slot 14, and it has 64MB of RAM installed on the controller. A detailed explanation of the boot message follows.

Figure 5 BIOS Boot Message

Note: Because each SCSI channel has its own scan process running in parallel, the POST scan of SCSI devices does not display in sequential order.

BIOS at 0x000C9000 - 0x000CE7FFF

Unlike ISA or EISA computers where the BIOS address of a peripheral expansion card is set manually (ISA, jumpers) or with the help of a configuration file (EISA, cfg file) and the address space is determined by the user, the PCI system-BIOS automatically maps the BIOS of a PCI compatible peripheral expansion card to a memory address. At each cold or warm boot, it determines which address space to assign to the BIOS of an expansion card. The message shown in Figure 5 reports the physical address occupied by the IIR firmware BIOS.

[PCI 7/14]

PCI device, bus system 7, slot 14. The PCI 2.x specification allows several PCI bus systems to be present in one PCI computer. All IIR Controllers have been designed to support multiple PCI bus system computers. The slot number indicated in the message above does not refer to the 14th PCI slot, but indicates that the IIR Controller is plugged into a slot which is the 14th one the PCI chipset that the PCI computer can access. To

determine which physical PCI slot this corresponds to, consult the system manual of your PCI computer.

DPMEM (B) at 0xFA0000000 - 0xFA003FFF INT A = IRQ 11

DPMEM stands for dual ported memory. The IIR Controller needs this address space of the PCI Computer for the command communication. As with the IIR Controller BIOS, this mapping is also automatically carried out by the PCI system-BIOS. This information is essential when installing Expanded Memory Managers under DOS and Windows. The IIR DPMEM address space has to be excluded from the control of such a manager. Furthermore, this message tells us that the PCI INT A of the IIR Controller has been assigned to the system IRQ 11. This assignment is also carried out automatically if the PCI system-BIOS is 100% PCI 2.X compatible.

SRCU32 -- HWL0 -- 64 MB SDRAM / ECC - 2048kB Flash-RAM

SRCU32 -- HWL0 stands for the type of IIR Controller found by the IIR firmware BIOS. (HWL means hardware level.) 64 MB SDRAM /ECC indicates that the installed DIMM is a 64MB ECC SDRAM module. 2048kB indicates the size of the installed Flash-RAM. Depending on the size of the installed RAM the following messages are possible (xx = 64,128, 256):

xx MB SDRAM/ECC

xx MB ECC-SDRAM-Module

async

SCSI devices are indicated as ‘async’ until they have been initialized by the IIR Controller.

SCSI-B

Indicates SCSI devices which have been detected on the controller's SCSI channels.

Press <CTRL><G> to enter INTEL(R) Storage Console

After pressing <Ctrl>+<g>, the message ..... Please wait... appears. The IO bus scan is completed and the built-in StorCon configuration program is loaded. You are now free to configure RAID array drives.