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# **Intel<sup>®</sup> RAID Controller SRCAS18E**

## ***Technical Product Specification***

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**Enterprise Platforms and Services Marketing**

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Date	Revision Number	Modifications
May 10, 2006	1.0	Initial Release
October 11, 2006	1.01	Correct minor grammatical errors

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# 1. Introduction

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## 1.1 Purpose of this Document

This document provides a detailed description of the Intel® RAID Controller SRCSAS18E and the software required to support it.

## 1.2 Product Overview

The Intel® RAID Controller SRCSAS18E is the first Intel® RAID controller that supports serial-attached SCSI (SAS) and serial ATA (SATA) disk drives. Supporting dual architectures allows solutions to be customized for performance, reliability, system expansion flexibility and hard disk drive capacity. The RAID Controller SRCSAS18E provides flexibility and helps lower total cost of ownership with a standardized server and storage infrastructure. It is designed with eight internal SAS ports and utilizes an 8X PCI Express\* server board slot.

## 1.3 Operating System Support

The following operating systems are fully validated and supported at product launch. The latest service pack/update available at start of the test run will be tested:

- Microsoft Windows Server 2003\* 32-bit
- Microsoft Windows Server 2003 x86-64
- Red Hat\* Linux 3.0 32-bit
- Red Hat Linux 3.0 x86-64
- Red Hat Linux 4.0 32-bit
- Red Hat Linux 4.0 x86-64
- SuSE\* Linux Enterprise Server 9 32-bit
- SuSE Linux Enterprise Server 9 x86-64

The following operating systems will be tested with a baseline installation of the operating system. The latest service pack/update available at start of the test run will be tested.

- Microsoft Windows 2000\* Server
- Microsoft Windows XP\* 32-bit
- Microsoft Windows XP x86-64

The following operating systems will be validated as a baseline operating system installation post launch:

- SuSE Linux Enterprise Server 10 32-bit
- SuSE Linux Enterprise Server 10 x86-64
- Novell\* NetWare 6.5 32-bit
- Novell NetWare 6.5 x86-64

## 1.4 List of Features

- Supports SAS devices at speeds up to 300MB/second per port
- Supports SATA II protocol over SAS transport
- Eight internal SAS ports
- Supports RAID Levels 0, 1, 5, 10, and 50.
- Online capacity expansion
- Online RAID level migration
- Physical drive roaming
- RAID controller migration
- Fast virtual drive initialization
- Hot spare drive configuration, both private and global
- SAS/SATA drive hot plug
- Auto rebuild
- Variable data stripe size configured per virtual drive
- Non hard disk drive device support (CD-ROM support post launch)
- 256 MB to 1 GB ECC DDR2 SDRAM support (compatible 1 GB modules not currently available)
- Read and write cache policy
- SAF-TE intelligent enclosure support
- PCI hot plug support
- Background media test (Patrol Read)
- Background data integrity test

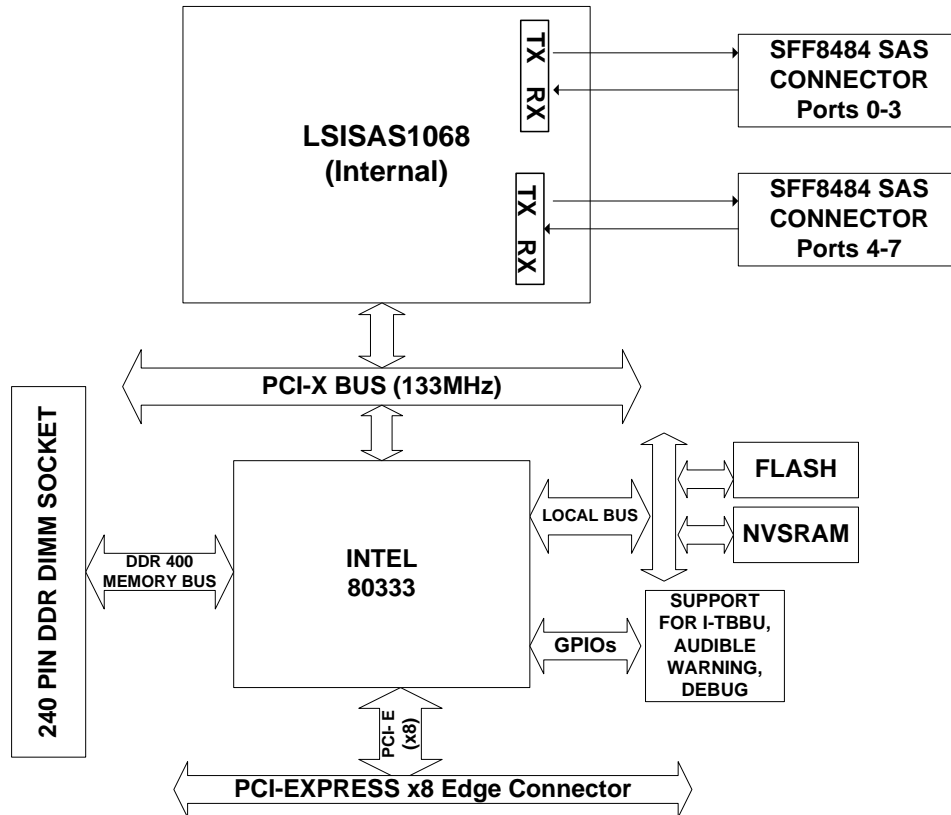


## 2. Hardware

### 2.1 Hardware Architectural Overview

#### 2.1.1 Block Diagram

Figure 1. Hardware Block Diagram



## 2.2 Physical Layout

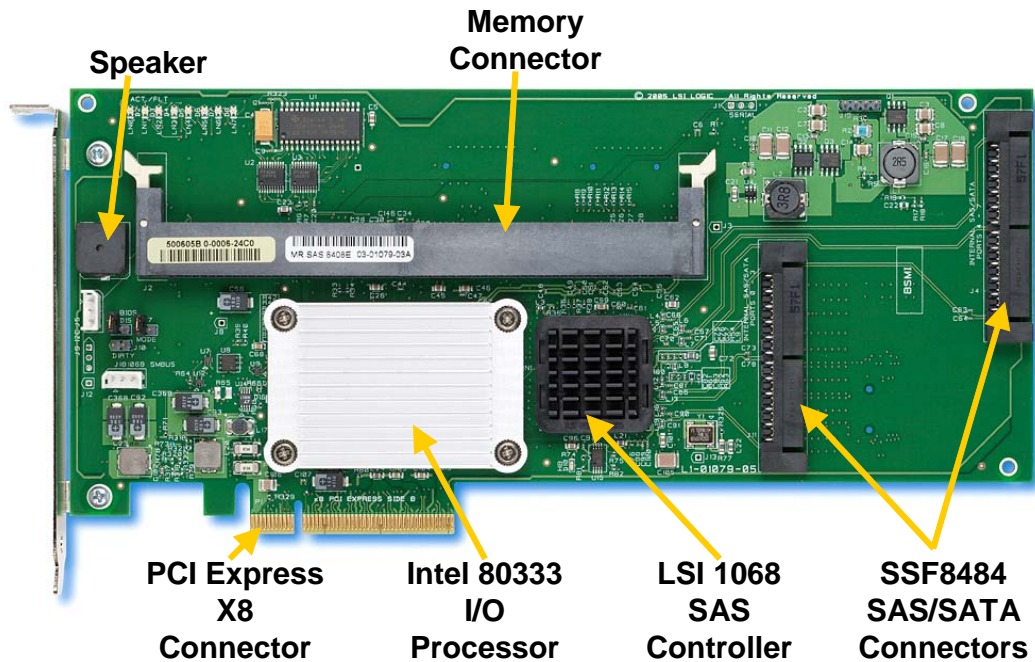


Figure 2. Intel® RAID Controller SRCAS18E Physical Layout

## 2.3 Major Components

### 2.3.1 Intel® 80333 Intelligent I/O Processor

The RAID Controller SRCAS18E features the Intel® IOP333 I/O processor, operating at 500 MHz. The Intel IOP333 features a high-performance internal bus, dual-ported memory controller, high-bandwidth PCI Express to PCI-X bridge, and an improved interrupt controller to provide a high-performance, highly integrated processor solution. See <http://developer.intel.com/design/iio/iop333.htm> for information.

#### 2.3.1.1 Processor Core

The Intel® IOP333 continues to build on Intel's strength in delivering high-performance, low-power Intel XScale® microarchitecture processors. It integrates Intel® Super-Pipelined RISC Technology with a 7-stage integer / 8-stage memory Super-Pipelined core, 32 kbyte data and instruction caches. The version selected for this RAID controller operates at 500 MHz. The internal bus operates at 333 MHz and offers internal bandwidth of up to 2.7 GB/sec.

### 2.3.2 Flash Memory

The Intel® Advanced+ Book Block Flash Memory (C3) device, manufactured on Intel's latest 0.13 µm and 0.18 µm technologies, represents a feature-rich solution for low-power applications. The C3 device incorporates low-voltage capability (3 V read, program, and erase) with high-speed, low-power operation. Flexible block locking allows any block to be independently locked or unlocked. Additional information on this product can be obtained from the Intel® Flash Memory website at <http://www.intel.com/design/flash>.

This non-volatile storage can be accessed for firmware updates and recovery. For firmware recovery, set the IOP mode-select jumper J7 to 0 Mode. Mode 0 firmware recovery requires the use of a firmware recovery utility and a firmware image file.

### 2.3.3 SDRAM (Cache)

The Intel® RAID Controller SRCSAS18E includes a memory DIMM site and supports DDR2 400 ECC SDRAM registered memory with capacities from 256 MB to 1 GB (compatible 1 GB modules not currently available). This memory is connected directly to the memory controller interface bus of the IOP, and serves as storage for the executable code transferred from the flash. It also serves as cache during RAID transactions. Cache mode selection takes immediate effect while the server is online and is available on a per virtual drive basis. The IOP memory controller provides single-bit ECC error correction with multi-bit detection support. 1GB memory modules that are compatible with the memory controller configuration are not currently in production.

The Intel® Portable Cache Module 2 provides memory integrated with battery control logic and a memory board battery. This module provides operational and cache memory needed to operate the controller as well as a battery backup option for data cached in the memory.

### 2.3.4 SAS Controller

The LSI Logic\* LSISAS1068 eight-port controller provides 1.5 and 3 Gb/s data transfer rates per port (with 8 to 10-bit encoding this translates to about 150MB/s and 300MB/s), the controller also leverages an electrical and physical interface that is compatible with Serial ATA technology. The controller has the following features:

- 8-port SAS/SATA controller
- 1.5 and 3 Gb/s SAS and SATA data transfer rates per port, full duplex
- Port independent auto-negotiation
- Point to point SAS/SATA drive connection
- Supports SATA II
- Native command queuing (Post Launch)
- Port selector for dual-port drives
- 64-bit, 133-MHz PCI-X\* host interface
- Backward compatible with 33/66-MHz PCI
- Supports 3.3 volt signaling levels
- Hot plug/hot swap support

- PCI power management
- Interrupt coalescing
- Flash and local memory interface

## **2.3.5 Diagnostic Features**

### **2.3.5.1 Audible Alarm**

The audible alarm will beep when a drive has failed and it will beep during a rebuild. The drive failure alarm beeps as follows:

- Degraded array: Short tone, one second on, one second off.
- Failed array: Long tone, three seconds on, one second off.
- Hot spare commissioned: Short tone, one second on, three seconds off.

The drive failure tones repeat until the problem is corrected or until the alarm is silenced or disabled. The alarm can be silenced or disabled on the controller's properties page in the BIOS Console or by using the failed drive options pane in the Intel® RAID Web Console 2.

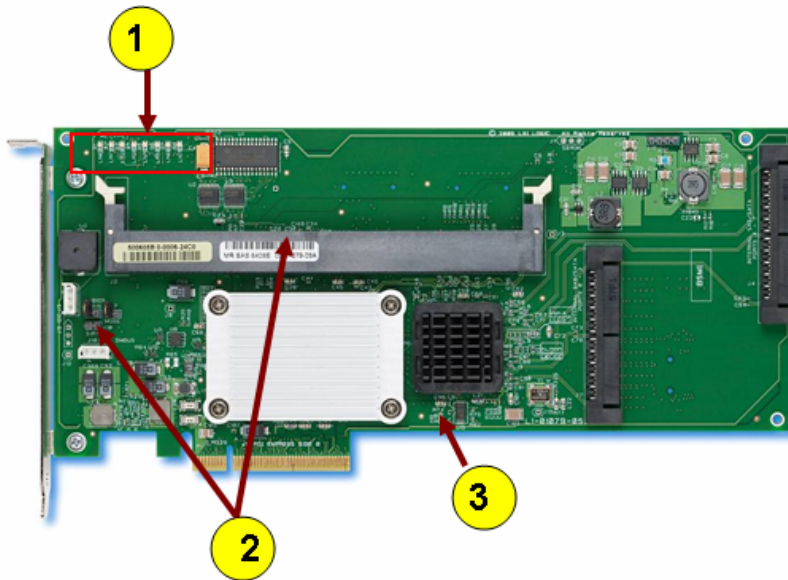
- Silencing the alarm is temporary, the alarm will sound again when an additional failure is detected or when the system is rebooted and the failure still exists.
- Disabling the alarm is persistent across errors and reboots, the alarm will remain disabled until it is re-enabled.

The build alarm tone functions differently. It remains on during the rebuild. After the rebuild completes, an alarm with a different tone will sound, signaling the completion of the rebuild. This is a one-time, non-repeating, tone.

**2.3.5.2 LED Placement and Function**

Two functional LED sets are incorporated into the Intel® RAID controller SRCAS18E, and one set is incorporated into the optional battery.

**Figure 3. Intel® RAID Controller SRCAS18E LED Locations**



Callout	Description
1	Functional code LEDs are for factory use. No decode of these LEDs will be provided.
2	Dirty Cache: LED connector at J10 and LED on the Intel® Portable Cache Module 2 (battery) signifies that data in memory has not been written to disk. Data will be held in memory until it is written to disk.
3	Host bus LED signals that the controller is operational.

### 2.3.5.3 SAS Connectors

The Intel® RAID Controller SRC SAS18E provides two SSF8484 SAS/SATA signal connectors. Each SSF8484 connector provides support for four SAS/SATA ports. Sideband signals are not used with this controller.

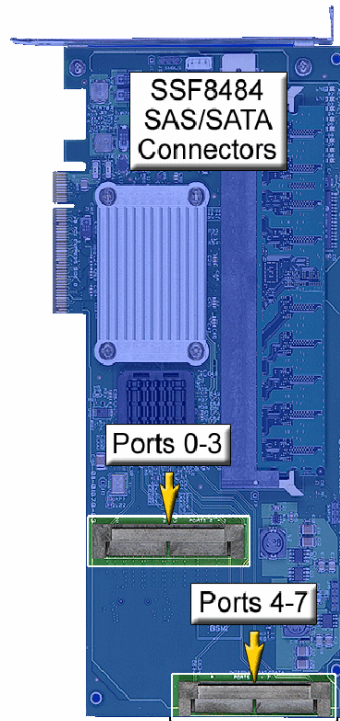


Figure 4. SAS Connectors

Signal names are with respect to the host, the device connected to the host reverses the signal names. Transmit pins connect to receive pins on the other device. The SAS/SATA connector is keyed at pin 1. These pin-outs for the serial ATA connector are not compatible with the legacy PATA connector.

**Table 1. SFF8484 Connector Pin-out**

SFF8484 Connector to 4 Single Port Connectors Pinout				
Controller Pinout		Backplane Pinout		
GND	32	1	GND	Key Port 0
TX3+	31	2	RX3+	
TX3-	30	3	RX3-	
GND	29	4	GND	
RX3-	28	5	TX3-	
RX3+	27	6	TX3+	
GND	26	7/1	GND	Key Port 1
TX2+	25	2	RX2+	
TX2-	24	3	RX2-	
GND	23	4	GND	
RX2-	22	5	TX2-	
RX2+	21	6	TX2+	
GND	20	7	GND	
Sideband 5	19			
Sideband 4	18			
Sideband 3	17			
Sideband 2	16			
Sideband 1	15			
Sideband 0	14			
GND	13	1	GND	Key Port 2
TX1+	12	2	RX1+	
TX1-	11	3	RX1-	
GND	10	4	GND	
RX1-	9	5	TX1-	
RX1+	8	6	TX1+	
GND	7	7/1	GND	Key Port 3
TX0+	6	2	RX0+	
TX0-	5	3	RX0-	
GND	4	4	GND	
RX0-	3	5	TX0-	
RX0+	2	6	TX0+	
GND	1	7	GND	

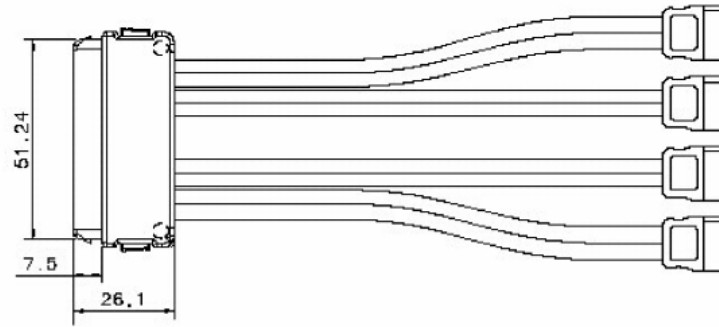


Figure 5. SFF8484 to Four-port Cable Example

### 2.3.5.4 PCI Interface

The Intel® RAID Controller SRCAS18E requires a x8 or larger PCI Express\* slot for installation. The controller is backward-compatible with x8 or larger slots that are wired with x1, x2, and x4 PCI Express lanes.

### 2.3.6 Intel® RAID Controller SRCAS18E Jumpers

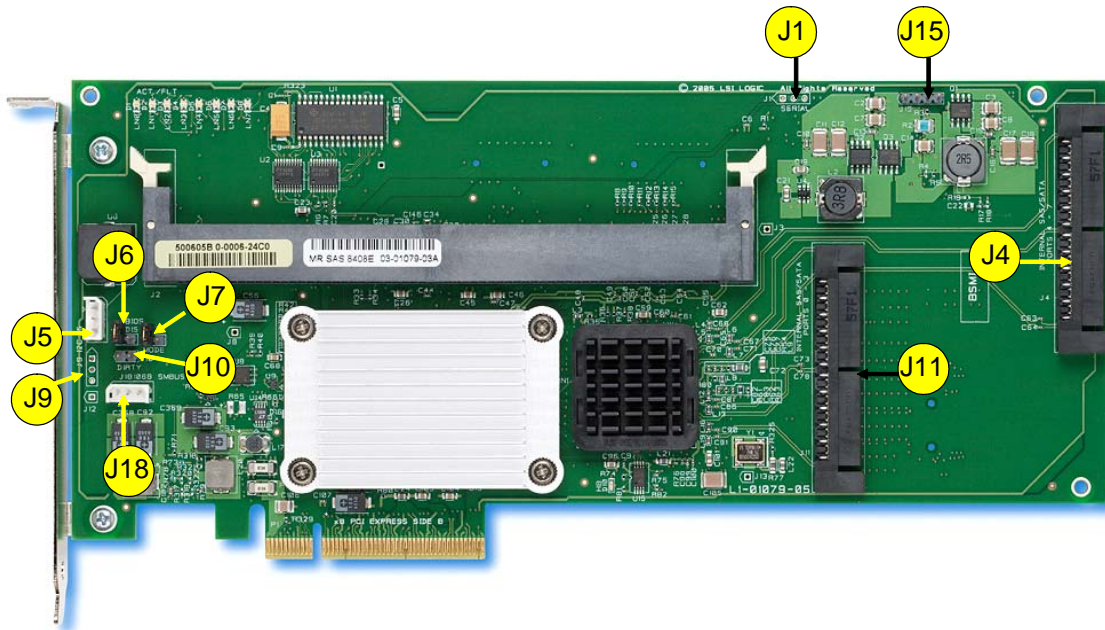


Figure 6. Jumper Locations



Table 2. SRCSAS18E Jumper Table

Jumper	Description	Type	Comments
J1	Universal Asynchronous Receiver/Transmitter (UART)	3-pin connector	For factory and debug use
J4	SAS/SATA port connector, ports 4-7	SFF8484	Connection to SAS/SATA devices.
J5	Keyed I <sup>2</sup> C connector	3-pin keyed connector	Out of Band Enclosure Management (SAF-TE)
J6	BIOS disable	2-pin connector	The BIOS function is enabled or disabled control in software depending on the status of this jumper. No jumper = The BIOS is enabled or disabled in firmware using a software utility. The firmware default is enabled). Jumper = The BIOS function is disabled.
J7	Mode 0 select	2-pin connector	Setting the controller to Mode 0 holds the I/O processor in reset for firmware recovery. No Jumper = Normal operational mode. Jumper = Mode 0 for firmware recovery, requires a firmware recovery utility and firmware image file.
J9	Unkeyed I <sup>2</sup> C connector	3-pin connector	Not stuffed
J10	Dirty Cache LED	2-pin connector	For connection to enclosure LED. When lit indicates the data in the cache has not been written to disk.
J11	SAS/SATA Port connector, Ports 0-3	SFF8484	Connection to SAS/SATA devices.
J15	Controller Debug Header	4-pin connector	Factory debug
J18	Keyed I <sup>2</sup> C connector	4-pin keyed connector	Out of Band Enclosure Management (SES2)

## 2.4 Hardware Architectural Features

Table 3. Hardware Architectural Feature

Feature	Intel® RAID Controller SRCSAS18E
RAID Levels	0, 1, 5, 10, 50 6, 60 available post launch via a firmware update
# of Devices	Up to 120 devices per controller
Device Types	SAS or SATA hard drives
Data Transfer Rate	300 MB/s per port
PCI Bus	X8 PCI Express*
Memory	256 MB to 1 GB ECC DDR2 400 SDRAM (compatible 1 GB modules not currently available)
Battery Backup	Intel® Portable Cache Module 2
SAS Connector	Two SFF8484 connectors, four SAS/SATA cables ganged in each connector.
IOP	Intel® 80333 I/O Processor, which performs Hardware Exclusive OR (XOR) Assistance

## 2.5 Electrical Characteristics

Table 4. Electrical Characteristics

Storage Adapter	PCI Express* +12V	PCI Express +5.0V	PCI Express +3.3V	PCI Power
SRCSAS18E	115 mA if battery is present	1.5 A	N/A	15W

## 2.6 Environmental Specifications

Table 5. Environmental Specifications

Specification	Description
Operating temperature	0 degrees Centigrade to 55 degrees Centigrade. (The maximum operating temperature decreases to +45 degrees C when the Intel® Portable Cache Module 2 is installed)
Relative Humidity Range	5% to 90% noncondensing
Maximum dew point temperature	32 degrees C
Airflow	300 linear feet per minute (LFPM)

Table 6. Storage and Transit Specifications

Specification	Description
Temperature Range	-40 Degrees C to +105 Degrees C (dry bulb)
Relative Humidity Range	5% to 90 % noncondensing

### 2.6.1.1 Safety Characteristics

The Intel® RAID Controller SRC SAS18E meets or exceeds the requirements of UL flammability rating 94 V0. Each bare board is also marked with the UL flammability rating. For boards installed in a PCI bus slot, all voltages are lower than the SELV 42.4 V limit.

## 2.7 Supported Device Technology

### 2.7.1 Support for Hard Disk Drive Devices

The Intel® RAID Controller SRC SAS18E integrates eight high-performance SAS/SATA ports that provide support for both SAS and SATA hard disk drives. Each port supports SAS and SATA devices using the SAS Serial SCSI Protocol (SSP), Serial Management Protocol (SMP), and Serial Tunneling Protocol (STP). The SSP protocol enables communication with other SAS devices. STP allows the SAS RAID controller to communicate with SATA devices via SATA commands.

### 2.7.2 SAS Expander Support

The RAID Controller SRCSAS18E supports LSI Logic\* expanders and Vitesse\* SAS expanders that are used as a component in Intel enclosures. Other expanders may be supported post launch, based on market conditions and customer requirements.

### 2.7.3 Support for Non Hard Disk Drive Devices

For information on the SRCSAS18E support for non hard disk drive devices, such as CD-ROM drives (Post Launch), please refer to the *Intel® RAID Controller SRCSAS18E Tested Hardware and Operating System*.

### 2.7.4 Enclosure Management Support

The Intel® RAID Controller SRCSAS18E supports the following enclosure management protocols.

- SAF-TE enclosure management out-of-band via an I<sup>2</sup>C cable from the RAID controller to the backplane.
- SES2 enclosure management in-band to expander-based backplanes and out-of-band to direct-connect backplanes.
- SGPIO enclosure management is supported out-of-band via an I<sup>2</sup>C cable from the RAID controller to the backplane.

## 3. Software

### 3.1 Software Architecture Overview

The software stack described below is referred to as the *SAS Software Stack* and is planned for use with the current SAS RAID controllers and future RAID controllers that are compatible with SAS and SATA technology. This software stack includes software pieces used in RAID controller firmware, RAID controller BIOS, and RAID controller drivers and utilities. The graphic below shows the inter-relationship of these software pieces.

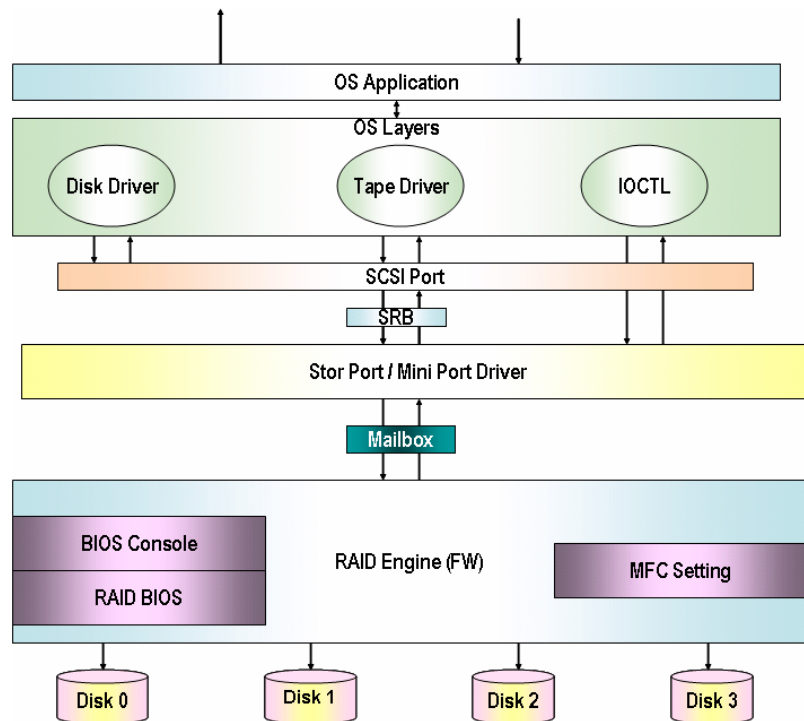


Figure 7. Software Block Diagram

### 3.1.1 Common Layers

#### 3.1.1.1 Firmware

The firmware is composed of multiple software layers allowing for maximum flexibility, reuse and maintainability. These layers are described below.

##### 3.1.1.1.1 MFC Settings

These are default settings that are programmed at the factory and consist of two types of settings.

- Settings that are not modifiable in the field. These include the PCI IDs.
- Settings that can be modified using a utility. These include default cache settings, rebuild rates, and other BIOS and operational defaults. Access to the MFC modification utility is restricted.

Additional information on MFC definition and default settings is available upon request.

##### 3.1.1.1.2 RAID BIOS

The RAID BIOS is the expansion ROM software defined in the PCI specification. It performs the RAID controller initialization from host system memory during POST.

##### 3.1.1.1.3 Intel® RAID BIOS Console Configuration Utility

The Intel® RAID BIOS Console Configuration utility provides a graphical user interface. It is a full-featured monitoring and configuration utility for managing all aspects of the RAID subsystem and many features of the RAID controller. The utility is accessed by pressing the <Ctrl>+<G> keys during system boot time. See the *Software User Guide: Intel® RAID Controller SRCAS18E* for details about this utility.

##### 3.1.1.1.4 RAID Firmware Engine

The RAID firmware contains the algorithms for mapping physical to virtual devices, RAID level algorithms, data redundancy calculation algorithms, and error detection, logging, and reporting capabilities.

#### 3.1.1.2 API

To configure the Intel® RAID Controller SRCAS18E, a set of interfaces known as the IOCTL interface has been developed to allow an application to issue commands to the controller through the driver. Commands that determine adapter properties and change the parameter settings can be issued. The API package defines a higher level of commands and functions for developers who want to configure the RAID adapters from their own utility. This is implemented as a 32-bit dynamic link library (DLL) for Windows\* operating systems and through a set of binaries for other operating systems. Access to the API libraries is restricted.

### 3.1.1.3 Operating System Driver

The operating system driver is the specific driver that communicates between the host resident application and the RAID controller using specific communications protocol.

## 3.1.2 User Interface

### 3.1.2.1 Intel® RAID BIOS Console 2 Configuration Utility

The Intel® RAID BIOS Console 2 Configuration utility is an X-ROM based utility that can be accessed by pressing the <Ctrl>+>G> keys during POST. This utility will usually start at the completion of POST, but it may expand and operate during POST if sufficient PMM memory is available.

This utility is GUI-based and is most easily used with a mouse. The utility enables the user to easily configure the RAID controller properties, manage physical devices attached to the RAID controller, create and manage virtual drives, and manage the battery backup module. The RAID BIOS Console 2 Configuration utility includes a configuration wizard that simplifies the process of creating disk arrays and virtual drives. The table below provides a synopsis of available options.

**Table 7. Intel® RAID BIOS Console 2 Configuration Utility Options**

Option	Description
Adapter Properties	When you select the Adapter Selection option on the Main screen, The RAID BIOS Console 2 displays a list of the Intel® RAID adapters in the system. The Adapter Properties screen allows you to view and configure the software and hardware of the selected adapter.
Scan Devices	When you select the Scan Devices option on the Main screen, the RAID BIOS Console 2 checks the physical and virtual drives for any changes of the drive status. The RAID BIOS Console 2 displays the results of the scan in the physical and virtual drive descriptions.
Virtual Disks	The Virtual Disks screen provides options to Fast Initialize or Slow Initialize Virtual Disk, Check Consistency, Display Virtual Disk properties, and Set Boot Drive as specified virtual disk. <b>Warning:</b> Initializing a virtual drive deletes all information on the physical drives that compose the virtual drive.
Physical Drives	This screen displays the physical drives for each port. From this screen, you can rebuild the physical arrays or view the properties for the physical drive you select.
Configuration Wizard	This option enables you to clear a configuration, create a new configuration, or add a configuration.
Adapter Selection	This option allows you to choose an Intel RAID adapter installed in the system.
Physical view	This option toggles between Physical View and Virtual View.
Events	This option displays the events generated by virtual disks, physical devices, enclosure, the Intel® Portable Cache Module 2, and SAS controller.

### 3.1.2.2 Intel® RAID Web Console 2

The Intel® RAID Web Console 2 utility runs within the operating system. It is Java\* GUI-based and enables the user to easily configure the RAID controller, disk drives, battery backup module, and other storage related devices connected to the RAID controller or embedded on the server board.

The utility is used the most easily with a mouse, and standard right and left mouse clicks are functional based on the operating system mouse configuration.

The RAID Web Console 2 includes a Configuration Wizard that simplifies the process of creating disk arrays and virtual drives. Within the Configuration Wizard, the user can select from several options:

- The Auto Configuration mode automatically creates the best possible configuration based on options configurable with available hardware.
- The Guided Configuration mode asks a few brief questions about the configuration, and then creates the configuration based on the answers provided.
- The Manual Configuration mode provides complete control over all aspects of the storage configuration.

A Reconstruction Wizard is available to increase or reduce the size of a virtual disk and to change the RAID level of an array.

See the *Software User Guide: Intel® RAID Controller SRCAS18E* for detail description of these functions. The table below provides a synopsis of available options.

**Table 8. Intel® RAID Web Console 2 Options**

Option	Description
Menu Bar	Provides specific menu options including exit, rescan, operations, log and online help.
Physical / Virtual View Panel	Shows the hierarchy of physical / virtual devices in the server.
Properties / Operations / Graphical View Panel	Displays information about the selected device and the operations that can be performed on the selected device.
Event Log Panel	Displays the event log entries for the selected RAID controller.
Adapter Properties	Configure adapter properties. The configuration of these properties within the Intel® RAID Web Console 2 is limited to those properties that can be performed without a reboot of the controller or that are not data destructive.
Physical Drive Properties	View physical drive properties including drive model, serial number, defect tables, and association with virtual drives.
Virtual Disk Properties	View virtual disk properties including drive size, stripe size, disk cache policy, array cache policy, virtual disk name and status.
Configuration Wizard	Clear a configuration, create a new configuration, or add a configuration.

### 3.1.3 Command Line Utility

The Command Line Utility (CLU) is an operating system based text utility that allows the configuration of the RAID controller properties, configuration of disk arrays and virtual drives, configuration of cache settings, firmware update, and error reporting. The CLU is available for DOS, Windows\*, and Linux operating systems. For a list of all command line options see the *Command-Line User Guide*. The table below provides a synopsis of available options.

**Table 9. Command Line Utility Options**

Option	Description
Help	Command-line tool option to command help is embedded.
Controller Information	Provides information about controller properties and configuration.
Configuration information	Provides information on physical and virtual drives attached to the controller.
Configuration management	Allows configuration of the RAID controller, virtual drive properties, and hard disk drive cache configuration.
Configuration creation/deletion	Allows configuration or deletion of virtual drives including RAID level configuration, cache policy configuration, and hot spare configuration.

### 3.1.4 Flash Utility

This utility is an operating system based utility that allows you to update RAID controller firmware. It is available for DOS, Microsoft Windows\*, and Linux. It is designed for use with a separate firmware update file. For a complete list of options, see the utility version release notes.

### 3.1.5 SNMP Support

The SNMP support includes MIB files that are available for recompilation compatibility with existing SNMP enabled monitoring applications. An SNMP agent is also available. For operational details please refer to the release notes that accompany these files.



## 4. RAID Functionality and Features

### 4.1 Hierarchy

A fundamental purpose of a RAID system is to present a usable data storage medium (virtual drive) with some level of redundancy to a host operating system. The Intel RAID firmware is based on the concept of associating physical drives in arrays and then creating a virtual drive from that array that includes a functional RAID level. To create a virtual drive and present it to the host operating system, the RAID firmware typically follows these steps:

1. One or more physical drives are selected and associated as an array.
2. One or more arrays are associated and given a RAID level. This process creates a virtual drive and provides an option to initialize the virtual drive. Virtual drives can be given the following RAID levels:
3. The RAID firmware presents the virtual drive to the operating system.

#### 4.1.1 RAID Physical Drive Status

Table 10. RAID Physical Drive Status

Drive State	Code	Description
Unconfigured Good	Unconfigured Good	The drive is functioning normally, but is not part of a configured virtual drive and is not a hot spare.
Online	ONLN	The drive is online, is part of a configured virtual drive, and is functioning normally.
Hot Spare	HOTSP	A physical disk that is configured as a hot spare.
Failed	FAILED	A physical disk that was originally configured as Online or Hot Spare, but on which the firmware detects unrecoverable error.
Rebuilding	REBUILD	A physical disk to which data is being written to restore full redundancy for a virtual disk.
Unconfigured Bad	Unconfigured Bad	A physical disk on which the firmware detects an unrecoverable error; the physical disk was Unconfigured Good or the physical disk could not be initialized.
Missing;	Missing	A physical disk that was Online, but which has been removed from its location.
Offline	Offline	A physical disk that is part of a virtual disk but which has invalid data as far as the RAID configuration is concerned.
None	None	A physical disk with an unsupported flag set. An Unconfigured Good or Offline physical disk that has completed the prepare for removal operation.

## 4.1.2 RAID Virtual Drive Status

Table 11. RAID Virtual Drive Status

Drive State	Code	Description
Optimal	Optimal	The drive operating system is good. All configured drives are online.
Degraded	Degraded	The drive operating condition is not optimal because one of the configured drives has failed or is offline.
Offline	Offline	The drive is not available to the operating system and is unusable.

## 4.1.3 RAID Controller Drive Limitations

Only drives complying with the SAS and SATA specifications extensions are supported.

## 4.2 SAS Bus and ID Mapping

Devices on a SAS bus may be mapped in one of several methods:

- Physically mapped based on the physical location (the controller phy they are connected to).
- Persistent mapping based on a SAS address.
- A combination of the two methods.

Intel has chosen to physically map SAS devices.

### 4.2.1 Direct-attached Physically Mapped Devices

Physically mapped direct attached devices are mapped based upon the controller PHY that they are connected to. If the device is removed and a different device is inserted into that location, the new device will have the same bus/ID that the previous device had. This method more closely follows the legacy SCSI numbering method.

## 4.3 RAID Features

### 4.3.1 RAID Level Support

The following RAID levels are supported on the Intel® RAID Controller SRC SAS18E.

**Table 12. RAID Levels**

RAID Level	Description
RAID 0	Data is striped to one or more physical drives. If using more than one disk, each stripe is stored on the drives in a “round robin” fashion. RAID 0 includes no redundancy. If one hard disk fails, all data is lost.
RAID 1	Disk mirroring: all data is stored twice, making each drive the image of the other. Missing data on one drive can be recovered from data on the other drive. RAID 1 requires two drives for each mirrored array.
RAID 5	Data striping with parity: data is striped across the hard disks and the controller calculates redundancy data (parity information) that is also striped across the hard disks. Missing data is rebuilt from parity. RAID 5 requires a minimum of three drives in the array but can be expanded to the capacity of the controller.
RAID 10	RAID 10 is accomplished by striping data across two or up to eight RAID 1 arrays. Missing data is rebuilt from redundant data stripes. RAID 10 requires a minimum of four drives.
RAID 50	RAID 50 is accomplished by striping data across two or up to eight RAID 5 arrays. Missing data is rebuilt from redundant data stripes. RAID 50 requires a minimum of six drives.

### 4.3.2 Cache Policies

RAID cache can be used to temporarily store data so it can be more quickly accessed, or to await drive readiness. Cache is available both on the RAID controller and on hard disk drives. The RAID controller read and write cache policy is set on a virtual drive level. This policy is set at the time the virtual drive is created, but it can be changed using the Intel® RAID BIOS Console 2 Configuration utility, the Command Line Utility, or the Intel® RAID Web Console 2 utility.

It may be unwise to enable some cache policies if a battery is not installed on the RAID controller. Drive cache is managed through a user configurable RAID controller option. However, the RAID controller battery does not protect data in drive cache in the event of a power interruption. Caution should be exercised in enabling drive cache.

**Table 13. Cache Policies**

Array Cache Policy	Cache Option	Description
Cache Policy	Direct I/O	When possible, no cache is involved for both reads and writes. The data transfers will be directly from host to disk and from disk to host.
	Cached I/O	All reads will first look at cache. If a cache hit occurs, the data will be read from cache; if not, the data will be read from disk and the read data will be buffered into cache. All writes to drive are also written to cache.
Read Policy	No Read Ahead	The controller does not use read-ahead.
	Read Ahead	Specifies that additional consecutive data stripes are read and buffered into cache.
	Adaptive Read Ahead	Specifies that the controller begins using read ahead if the two most recent disk accesses occurred in sequential sectors.
Write Policy	Write Through	The controller sends a data transfer completion signal to the host after the disk subsystem receives all the data in a transaction and the data is successfully written to disk.
	Write Back	The controller sends a data transfer completions signal to the host when the controller cache receives all the data in a transaction and the data is then written to disk as the drive becomes available.
Hard Drive Cache	Read and Write Cache	Memory located on the hard disk drive is use to cache data going to or coming from the drive. Enabling hard drive cache can result in a performance improvement but data held in drive cache is not protected by the RAID controller.

### 4.3.3 Stripe Size

Stripe size determines the size of each data stripe on each hard disk drive. The options are 4, 8, 16, 32, 64, and 128 KB. The stripe size option is set during the virtual drive creation and cannot be changed without removing the virtual drive configuration and all data contained on the virtual drive.

### 4.3.4 Hot Spare Drives

Hot spare drives are drives designated to automatically replace a failed drive. Hot spare drives must be the same size or larger than the drives they may replace. They can be designated as a private hot spare drive assigned to one virtual drive, or they may be a global hot spare that is assigned to all virtual drives attached to the RAID controller. Hot spare drives can be designated using the Intel® RAID BIOS Console 2 utility, the Intel® RAID Web Console 2 utility, or the Command Line utility.

### **4.3.5 Hot-Plug Drive Support**

Hot plug support allows hard disk drives to be inserted or removed from an enclosure without rebooting the system, as long as both the hard disk drive and server system backplane support hard drive hot plug functions.

The RAID controller will immediately recognize that a drive is removed and will put it into a virtual status of “Missing” until an I/O to the drive fails. The drive will then be changed to the status of “Failed.” A drive inserted into an attached intelligent enclosure will be recognized as present. A drive inserted into an attached non-intelligent enclosure may require a bus scan to be detected. Hot plug of new drives is supported in both intelligent (SAF-TE) and non-intelligent enclosures.

### **4.3.6 Auto-declare Hot Spare Drive**

If the RAID controller has a RAID array drive that is in a failed (degraded) state and the failed drive is removed and a new hard disk drive of the same size or larger is inserted into the same slot, the new drive will automatically be marked as a hot spare drive and a rebuild will begin automatically. A bus scan may be required in a non-intelligent enclosure.

### **4.3.7 Physical Drive Roaming**

This feature allows the user to move drives to any port on the RAID controller without loss of configuration.

### **4.3.8 Virtual Drive Roaming**

This feature allows the user to move a Virtual drive from one controller to another system/controller without loss of configuration or data. All virtual drives attached to the RAID controller must be moved as a unit.

### **4.3.9 RAID Controller Migration**

This feature allows a defective RAID controller to be removed and replaced by a compatible RAID controller without loss of configuration or data. To avoid a configuration mismatch, it is wise to reset the new controller configuration prior to attaching the array drives. If a configuration mismatch occurs care must be taken to use the configuration on the drives or all data may be lost.

### **4.3.10 Online Capacity Expansion**

Online capacity expansion (OCE) allows additional drives to be added to an array and the added capacity can be added to the virtual drive. OCE is available as an option in BIOS Console 2 utility, RAID Web Console 2 utility, or Command Line utility.

### 4.3.11 RAID Level Migration

RAID level migration allows for the migration of one raid level to another. Raid level migration may require the addition of additional physical drives as part of the process. RAID level migration is an option in BIOS Console 2 utility, RAID Web Console 2 utility, or Command Line utility.

## 4.4 Operating Certifications

Microsoft Windows\* Winqual certification (WHQL).

## 4.5 Safety and Regulatory Certifications

### 4.5.1 Product Safety Compliance

- UL approval or acceptable NRTL (e.g. ETL) approval
- EN60950 (Europe)
- IEC60950 (International)
- CB Certificate & Report, IEC60950 (report to include all country national deviations)
- CE - Low Voltage Directive 73/23/EEE (Europe)

### 4.5.2 Product EMC Compliance – Class A Compliance

- FCC /ICES-003 - Emissions (USA/Canada) Verification
- CISPR 22 – Emissions (International)
- EN55022 - Emissions (Europe)
- EN55024 - Immunity (Europe)
- CE – EMC Directive 89/336/EEC (Europe)
- VCCI Emissions (Japan)
- AS/NZS 3548 Emissions (Australia / New Zealand)
- BSMI CNS13438 Emissions (Taiwan)
- RRL MIC Notice No. 1997-41 (EMC) & 1997-42 (EMI) (Korea)

### 4.5.3 Certifications / Registrations / Declarations

- CE Declaration of Conformity (CENELEC Europe)
- FCC/ICES-003 Class B Attestation (USA/Canada)
- C-Tick Declaration of Conformity (Australia)
- MED Declaration of Conformity (New Zealand)
- BSMI Certification (Taiwan)
- RRL Certification (Korea)

## 4.6 Supported Specifications and Standards

Table 14. Specifications and Standards

Standard	Description
SAS Specification 1.1	
Serial ATA specification 1.0a	
Extensions to Serial ATA specification 1.0a	
PCI Express Base Specification 1.0	
SAFTE	Enclosure management
SSP	Serial SCSI Protocol [SSP] which maps in SCSI, supporting multiple initiators and targets
STP	Serial ATA Tunneled Protocol [STP] mapping Serial ATA, supporting multiple initiators and targets
SMP	Serial Management Protocol [SMP] a management protocol.





## Appendix A: Event Messages and Error Codes

This appendix lists the Intel® RAID Web Console 2 events that may appear in the event log.

The Intel® RAID Web Console 2 utility monitors the activity and performance of all controllers in the server and the devices attached to them. When an “event” occurs—such as the completion of a consistency check or the removal of a physical drive—an event message is displayed in the log displayed at the bottom of the Intel® RAID Web Console 2 screen. The messages are also logged in the Windows Application log (Event Viewer). Error event levels are:

- **PROGRESS:** This is a progress posting event. Progress events are not saved in NVRAM.
- **INFO:** Informational message. No user action is necessary.
- **WARNING:** Some component may be close to a failure point
- **CRITICAL:** A component has failed, but the system has not lost data
- **FATAL:** A component has failed, and data loss has occurred or will occur
- **DEAD:** A catastrophic error has occurred and the controller has died. Seen only after the controller has been restarted.

The following table lists all of the Intel® RAID Web Console 2 event messages.

Number	Type	Description
0	Info	Firmware initialization started (PCI ID %04x/%04x/%04x/%04x)
1	Info	Firmware version %s
2	Fatal	Unable to recover cache data from TBBU
3	Info	Cache data recovered from TBBU successfully
4	Info	Configuration cleared
5	Warning	Cluster down; communication with peer lost
6	Info	Logical drive %s ownership changed from %02x to %02x
7	Info	Alarm disabled by user
8	Info	Alarm enabled by user
9	Info	Background initialization rate changed to %d%%
10	Fatal	Controller cache discarded due to memory/battery problems
11	Fatal	Unable to recover cache data due to configuration mismatch
12	Info	Cache data recovered successfully
13	Fatal	Controller cache discarded due to firmware version incompatibility
14	Info	Consistency Check rate changed to %d%%
15	Dead	Fatal firmware error: %s
16	Info	Factory defaults restored
17	Info	Flash downloaded image corrupt
18	Caution	Flash erase error
19	Caution	Flash timeout during erase
20	Caution	Flash error
21	Info	Flashing image: %s

Number	Type	Description
22	Info	Flash of new firmware image(s) complete
23	Caution	Flash programming error
24	Caution	Flash timeout during programming
25	Caution	Flash chip type unknown
26	Caution	Flash command set unknown
27	Caution	Flash verify failure
28	Info	Flush rate changed to %d seconds
29	Info	Hibernate command received from host
30	Info	Event log cleared
31	Info	Event log wrapped
32	Dead	Multi-bit ECC error: ECAR=%x
33	Warning	Single-bit ECC error: ECAR=%x
34	Dead	Not enough controller memory
35	Info	Patrol Read complete
36	Info	Patrol Read paused
37	Info	Patrol Read Rate changed to %d%%
38	Info	Patrol Read resumed
39	Info	Patrol Read started
40	Info	Rebuild rate changed to %d%%
41	Info	Reconstruction rate changed to %d%%
42	Info	Shutdown command received from host
43	Info	Test event: '%s'
44	Info	Time established as %s; (%d seconds since power on)
45	Info	User entered firmware debugger
46	Warning	Background Initialization aborted on %s
47	Warning	Background Initialization corrected medium error (%s at %lx
48	Info	Background Initialization completed on %s
49	Fatal	Background Initialization completed with uncorrectable errors on %s
50	Fatal	BI detected uncorrectable double medium errors (%s at %lx on %s)
51	Caution	Background Initialization failed on %s
52	Progress	Background Initialization progress on %s is %s
53	Info	Background Initialization started on %s
54	Info	Policy change due to BBU on %s from %s to %s
55	Info	Policy change due to user on %s from %s to %s
56	Warning	Consistency Check aborted on %s
57	Warning	Consistency Check corrected medium error (%s at %lx
58	Info	Consistency Check done on %s
59	Info	Consistency Check done with corrections on %s
60	Fatal	CC detected uncorrectable double medium errors (%s at %lx on %s)
61	Caution	Consistency Check failed on %s
62	Fatal	Consistency Check failed with uncorrectable data on %s
63	Warning	Consistency Check found inconsistent parity on %s at strip %lx
64	Warning	CC inconsistency logging disabled on %s (too many inconsistencies)
65	Progress	Consistency Check progress on %s is %s

Number	Type	Description
66	Info	Consistency Check started on %s
67	Warning	Initialization aborted on %s
68	Caution	Initialization failed on %s
69	Progress	Initialization progress on %s is %s
70	Info	Fast initialization started on %s
71	Info	Full initialization started on %s
72	Info	Initialization complete on %s
73	Info	LD Properties updated to %s (form %s)
74	Info	Reconstruction complete on %s
75	Fatal	Reconstruction of %s stopped due to unrecoverable errors
76	Fatal	Reconstruct detected uncorrectable double medium errors
77	Progress	Reconstruction progress on %s is %s
78	Info	Reconstruction resumed on %s
79	Fatal	Reconstruction resume of %s failed due to configuration mismatch
80	Info	Reconstructing started on %s
81	Info	State change on %s from %s to %s
82	Info	PD Clear aborted on %s
83	Caution	PD Clear failed on %s (Error %02x)
84	Progress	PD Clear progress on %s is %s
85	Info	PD Clear started on %s
86	Info	PD Clear completed on %s
87	Warning	Error on %s (Error %02x)
88	Info	Format complete on %s
89	Info	Format started on %s
90	Caution	Hot Spare SMART polling failed on %s (Error %02x)
91	Info	PD inserted: %s
92	Warning	PD %s is not supported
93	Warning	Patrol Read corrected medium error on %s at %lx
94	Progress	Patrol Read progress on %s is %s
95	Fatal	Patrol Read found an uncorrectable medium error on %s at %lx
96	Caution	Predictive failure: CDB: %s
97	Fatal	Patrol Read puncturing bad block on %s at %lx
98	Info	Rebuild aborted by user on %s
99	Info	Rebuild complete on %s
100	Info	Rebuild complete on %s
101	Caution	Rebuild failed on %s due to source drive error
102	Caution	Rebuild failed on %s due to target drive error
103	Progress	Rebuild progress on %s is %s
104	Info	Rebuild resumed on %s
105	Info	Rebuild started on %s
106	Info	Rebuild automatically started on %s
107	Caution	Rebuild stopped on %s due to loss of cluster ownership
108	Fatal	Reassign write operation failed on %s at %lx
109	Fatal	Unrecoverable medium error during rebuild on %s at %lx

Number	Type	Description
110	Info	Corrected medium error during recovery on %s at %lx
111	Fatal	Unrecoverable medium error during recovery on %s at %lx
112	Info	PD removed: %s
113	Warning	CDB: %s
114	Info	State change on %s from %s to %s
115	Info	State change by user on %s from %s to %s
116	Warning	Redundant path to %s broken
117	Info	Redundant path to %s restored
118	Info	Dedicated Hot Spare PD %s no longer useful due to deleted array
119	Caution	SAS topology error: Loop detected
120	Caution	SAS topology error: Unaddressable device
121	Caution	SAS topology error: Multiple ports to the same SAS address
122	Caution	SAS topology error: Expander error
123	Caution	SAS topology error: SMP timeout
124	Caution	SAS topology error: Out of route entries
125	Caution	SAS topology error: Index not found
126	Caution	SAS topology error: SMP function failed
127	Caution	SAS topology error: SMP CRC error
128	Caution	SAS topology error: Multiple subtractive
129	Caution	SAS topology error: Table to table
130	Caution	SAS topology error: Multiple paths
131	Fatal	Unable to access device %s
132	Info	Dedicated Hot Spare created on %s (%s)
133	Info	Dedicated Hot Spare %s disabled
134	Caution	Dedicated Hot Spare %s no longer useful for all arrays
135	Info	Global Hot Spare created on %s (%s)
136	Info	Global Hot Spare %s disabled
137	Caution	Global Hot Spare does not cover all arrays
138	Info	Created %s}
139	Info	Deleted %s}
140	Info	Marking LD %s inconsistent due to active writes at shutdown
141	Info	Battery Present
142	Warning	Battery Not Present
143	Info	New Battery Detected
144	Info	Battery has been replaced
145	Caution	Battery temperature is high
146	Warning	Battery voltage low
147	Info	Battery is charging
148	Info	Battery is discharging
149	Info	Battery voltage is normal
150	Fatal	Battery needs to be replacement
151	Info	Battery relearn started
152	Info	Battery relearn in progress
153	Info	Battery relearn completed

Number	Type	Description
154	Caution	Battery relearn timed out
155	Info	Battery relearn pending: Battery is under charge
156	Info	Battery relearn postponed
157	Info	Battery relearn will start in 4 days
158	Info	Battery relearn will start in 2 day
159	Info	Battery relearn will start in 1 day
160	Info	Battery relearn will start in 5 hours
161	Info	Battery removed
162	Info	Current capacity of the battery is below threshold
163	Info	Current capacity of the battery is above threshold
164	Info	Enclosure (SES) discovered on %s
165	Info	Enclosure (SAF-TE) discovered on %s
166	Caution	Enclosure %s communication lost
167	Info	Enclosure %s communication restored
168	Caution	Enclosure %s fan %d failed
169	Info	Enclosure %s fan %d inserted
170	Caution	Enclosure %s fan %d removed
171	Caution	Enclosure %s power supply %d failed
172	Info	Enclosure %s power supply %d inserted
173	Caution	Enclosure %s power supply %d removed
174	Caution	Enclosure %s SIM %d failed
175	Info	Enclosure %s SIM %d inserted
176	Caution	Enclosure %s SIM %d removed
177	Warning	Enclosure %s temperature sensor %d below warning threshold
178	Caution	Enclosure %s temperature sensor %d below error threshold
179	Warning	Enclosure %s temperature sensor %d above warning threshold
180	Caution	Enclosure %s temperature sensor %d above error threshold
181	Caution	Enclosure %s shutdown
182	Warning	Enclosure %s not supported; too many enclosures connected to port
183	Caution	Enclosure %s firmware mismatch
184	Warning	Enclosure %s sensor %d bad
185	Caution	Enclosure %s phy %d bad
186	Caution	Enclosure %s is unstable
187	Caution	Enclosure %s hardware error
188	Caution	Enclosure %s not responding
189	Info	SAS/SATA mixing not supported in enclosure; PD %s disabled
190	Info	Enclosure (SES) hotplug on %s was detected, but is not supported
191	Info	Clustering enabled
192	Info	Clustering disabled
193	Info	PD too small to be used for auto-rebuild on %s
194	Info	BBU enabled; changing WT virtual disks to WB
195	Warning	BBU disabled; changing WB virtual disks to WT
196	Warning	Bad block table on PD %s is 80% full
197	Fatal	Bad block table on PD %s is full; unable to log block %lx

Number	Type	Description
198	Info	Consistency Check Aborted Due to Ownership Loss on %s
199	Info	Background Initialization (BGI) Aborted Due to Ownership Loss on %s
200	Caution	Battery/charger problems detected; SOH Bad
201	Warning	Single-bit ECC error: ECAR=%x, ELOG=%x, (%s); warning threshold exceeded
202	Caution	Single-bit ECC error: ECAR=%x, ELOG=%x, (%s); critical threshold exceeded
203	Caution	Single-bit ECC error: ECAR=%x, ELOG=%x, (%s); further reporting disabled
204	Caution	Enclosure %s Power supply %d switched off
205	Info	Enclosure %s Power supply %d switched on
206	Caution	Enclosure %s Power supply %d cable removed
207	Info	Enclosure %s Power supply %d cable inserted
208	Info	Enclosure %s Fan %d returned to normal
209	Info	BBU Retention test was initiated on previous boot
210	Info	BBU Retention test passed
211	Caution	BBU Retention test failed!
212	Info	NVRAM Retention test was initiated on previous boot
213	Info	NVRAM Retention test passed
214	Caution	NVRAM Retention test failed!
215	Info	%s test completed %d passes successfully
216	Caution	%s test FAILED on %d pass. Fail data: errorOffset=%x goodData=%x badData=%x
217	Info	Self check diagnostics completed
218	Info	Foreign Configuration Detected
219	Info	Foreign Configuration Imported
220	Info	Foreign Configuration Cleared

## Appendix B: Glossary

This appendix contains important terms used in the preceding chapters. For ease of use, numeric entries are listed first (e.g., “82460GX”) with alpha entries following (e.g., “AGP 4x”). Acronyms are then entered in their respective place, with non-acronyms following.

**Table 15. Glossary of Terms**

Word / Acronym	Definition
API	Application Programming Interface
ECC	Error Correction Code
FUU	Flash Update Utility
FW	Firmware
Gb	Gigabit
GB	Gigabyte
HBA	Host Bus Adapter
Kb	Kilobit
KB	Kilobyte
LVD	Low Voltage Differential
Mb	Megabit
MB	Megabyte
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
POST	Power On Self Test
RAID	Redundant Array of Independent Disks
SAF-TE	SCSI Accessed Fault Tolerant Enclosure, Enclosure management that supports SCSI devices
SAS	Serial Attached SCSI
SCSI	Small Computer Systems Interface
SES2	SCSI Enclosure Services 2nd generation, Enclosure management that supports SAS devices
SGPIO	Serial General Purpose Input Output, Enclosure management that supports SATA devices
SNMP	Simple Network Management Protocol
XROM	PCI Expansion ROM, a BIOS utility accessed at system POST.
POST	Power On Self Test

## ***Appendix C: Reference Documents***

Refer to the following documents for additional information:

- SRCAS18E RAID Controller Hardware User Guide, document number D26788-001
- SRCAS18E RAID Controller Software User Guide, document number D29305-002.
- SRCAS18E RAID Controller Command Line User Guide, Version 1.0.