Micro Channel SSA RAID Adapters

Technical Reference

SA33-3270-02

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Note!: Before using this information and the product it supports, be sure to read the general information under “Appendix B. Notices” on page 223.

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Conventions

Bits

The SSA 4-Port RAID Adapter and Micro Channel SSA Multi-Initiator/RAID EL Adapter use the standard convention for numbering the bits within bytes and words. Bit 0 is the least-significant bit; the number of the most-significant bit is 1 less than the width of the data.

Bit values are represented like this: 010b

Hexadecimal values are represented like this: 7Ah

Bytes

Except as noted below, the adapters' host interface uses the Little-endian convention, that is, it assumes that the least-significant byte of a number or an address is stored at the lowest byte address.

The Power processors in RS/6000 use the Big-endian convention. Therefore, AIX device drivers must take specific action to reverse the byte order that is naturally generated by the processor. PowerPC processors can operate in either Big-endian or Little-endian mode.

When using an SSA adapter in SCSI pass-through mode, it is important to note that parallel SCSI, and hence SSA-SCSI, sends the most-significant byte of a number first. This means that numbers in command-descriptor blocks, sense data and mode parameters appear in Big-endian format in memory.

Words

In an SSA adapter, a **word** is 4 bytes.

Registers

When defining the reset state of a register the character **U** indicates a portion of the register that is undefined. For example, 0100 UUUUb indicates that the 4 low-order bits are undefined after the reset. Similarly the character **S** indicates a portion of the register that is unchanged after the reset.

All register bits are read/write unless explicitly noted in the description of a bit.

Serial links

When an SSA adapter transfers information over a serial link, the bytes are normally sent and received in strict order of ascending storage addresses. This guarantees that customer data can be retrieved correctly when an SSA disk drive is interchanged between different host systems. (However an attached device may explicitly request out-of-order data transfers, for example, for a split read/write.)

Chapter 1. Description

Introduction to the Adapter

The SSA 4-Port RAID Adapter and Micro Channel SSA Multi-Initiator/RAID EL Adapter are Micro Channel bus-master adapters that serve as the interface between systems using the Micro Channel architecture and devices using the Serial Storage Architecture (SSA). The adapters provide high-performance implementation of RAID-5 arrays of 2 to 15 member disk drives plus one for parity. Up to 32 arrays can be controlled by one SSA 4-Port RAID Adapter or Micro Channel SSA Multi-Initiator/RAID EL Adapter.

The adapters include:

- A DRAM data buffer with a storage capacity of 8MB on a SSA 4-Port RAID Adapter, and 32MB on a Micro Channel SSA Multi-Initiator/RAID EL Adapter.
- Hardware XOR capability
- A nonvolatile parity store of 8KB with checking implemented by firmware; this is used to record details of parity updates in progress on the disk drives.

The adapters provide 4 SSA ports for the attachment of storage devices such as hard disk drives. Each port operates at 20MB/s full-duplex using point-to-point copper cables up to 25 meters long. As an alternative to copper cables, fiber optic cables can be used to link SSA nodes. Nodes linked by fiber optic cables can be up to 2.4 km (7874 ft) apart. Fibre-Optic Extenders, which are features of SSA units, connect the fiber optic cables to the SSA nodes.

SSA retains the SCSI-2 commands, queuing model, status, and sense bytes; it is an industry-standard interface.

Each of the 2 pairs of SSA ports can attach up to 48 dual-port devices in a closed loop. If the loop is broken by a fault, the two ports continue to access the devices using the remaining connections as a string; however, it is not intended that the devices should be configured as a string initially. These SSA features support fault-tolerant applications. One pair of SSA ports can be accessed from inside or outside of the system unit for use by internal or external devices. The other pair can be accessed by external devices only.

Only a single SSA 4-Port RAID Adapter is permitted in an SSA loop. The number of SSA Multi-Initiator/RAID EL adapters permitted in an SSA loop depends on how the disks are configured and the level of the adapter code. Adapter code at, or later than, level 50 supports:

- Only one adapter in a loop if the fast-write facility is configured active for any disk drive or RAID-5 array.
- Up to 2 adapters in a loop if any disk drive is configured as a member of a RAID-5 array and no array is configured for the fast-write facility.
- Up to 8 adapters in a loop if no disk drives are configured for the fast-write facility or as a member of a RAID-5 array.

Adapter code before level 50 supports:

- Only one adapter in a loop if the fast-write facility is configured active for any disk drive or if any disk drive is configured as a member of a RAID-5 array.
- Up to 2 adapters in a loop if the fast-write facility is not configured active for any disk drive and no disk drive is configured as a member of a RAID-5 array.

Note: The adapter microcode level is contained in the Vital Product Data (VPD) record as the first byte in the ROS Level and ID field.

The Micro Channel SSA Multi-Initiator/RAID EL Adapter has an optional SSA Fast-Write Cache Option Card. When this feature is installed, data that is to be written to a disk drive is first written to a nonvolatile cache. This cache has a capacity of 4MB (plus ECC) and is on a removable daughter card. A battery on the daughter card enables it to retain data for up to 10 years. The daughter card can be moved to another Micro Channel SSA Multi-Initiator/RAID EL Adapter if the original adapter fails.

The Micro Channel SSA Multi-Initiator/RAID EL Adapter supports SSA target-mode operations. In these, 512 bytes of data are transmitted from one host to another. The device driver supports transfers of larger amounts of data, but only by breaking it into 512–byte blocks. Target-mode operations are optimized for small data transfers; they are intended to allow systems to enquire about each other's health or for synchronizing purposes, rather than for large data transfers or high performance.

The adapters have a Micro Channel interface. I/O transactions are transferred between the host system and the adapters using control blocks and full-duplex delivery pipes in shared memory. The adapters are capable of streaming data transfers at 40 or 80MB/s on the Micro Channel.

The device driver for the adapters and their subsystems handle SCSI commands, status, and sense. The adapters also deal with the SSA protocols and they recover link errors and some disk errors internally.

The device drivers and adapters communicate with each other by means of a logical client-server network called the Independent Packet Network (IPN). IPN provides a consistent application programming interface (API) independent of the environment. This produces a software environment that allows new functions to be added easily as additional servers or filters.

The array function is implemented as an IPN filter in the adapter cards. This means that the interface to the device driver for I/O operations to an array is the same as the interface for a normal disk drive. The system can boot from a disk drive that is not

configured as a member of an array. The system cannot boot through an adapter on which an SSA Fast-Write Cache Option Card is installed.

Additional IPN transactions are provided to configure arrays. A configuration-manager utility program provides a user interface for array configuration.

The performance of the adapters takes full advantage of the SSA links. A single adapter can support at least 200 overlapped I/O requests at any time; these might result from, for example, 105 RAID-5 I/O requests. Operations to array filters are processed by the adapters and result in operations being sent to the disk drives attached to the filter. The adapter can execute up to 1000 operations per second to arrays, assuming a typical mix of read and write operations. For operations to devices that are not in arrays, the adapter overhead for an I/O operation is typically less than 125 microseconds; and the adapters can execute up to 3000 short read/write operations per second, depending on the attached devices. The maximum bandwidth is 35MB/s for data transfers to disk drives that are not in arrays and 26MB/s for data transfers to arrays, depending on the capabilities of the system bus.

Using an SSA Fast-Write Cache Option Card enhances performance in two ways:

- By reducing the adapter service time to less than 1 millisecond for write operations that use the cache (that is, for those operations that are not too long and for which there is space in the cache).
- By joining split sequential write operations into larger data transfers when destaging to the disk drives.

Both of these are particularly helpful for RAID-5 arrays because write operations to RAID-5 arrays involve first reading the old data and then merging the new data with it before writing to the disk drives (“RAID-5” on page 47 describes this in more detail). Even more advantage can be gained if there is sufficient new data to write a complete stripe of data to a disk drive (as described on 48); this removes the need to read the old data first.

Using an SSA Fast-Write Cache Option Card might reduce performance because:

- Additional firmware overhead for moving data from the disk drive to the cache and back reduces the number of operations per second possible.
- Longer internal bus cycles are needed when moving data from the disk drive to the cache; this reduces the available internal bandwidth.

Configurations

An example of an SSA subsystem that can be attached to an SSA adapter is the **7133 SSA Subsystem**. Each 7133 unit contains up to 16 SSA disk drives with fault-tolerant power and cooling. It is available either as a 19-inch rack-mounted unit (4 EIA units) or as a deskside unit.

Adapter Functions

The principal functions of an SSA 4-Port RAID Adapter or Micro Channel SSA Multi-Initiator/RAID EL Adapter are:

- The adapter performs a power-on self-test (POST) to verify correct operation of the hardware.
- The adapter configures the SSA network. It can act as the master node if required.
- When interrupted by the host processor, the adapter fetches IPN transactions by Direct Memory Access (DMA) from host memory.
- The adapter translates each transaction into SCSI commands and issues them to the addressed device over a serial link. A pass-through mode is also provided to allow any SCSI command to be issued.
- When requested by a device, the adapter fetches write data from host memory by DMA and transmits it to the device. Similarly the adapter receives read data from the device and stores it in host memory by DMA.
- For disk drives that are not in an array, data is transferred between the host memory and the devices without using the data buffer. For RAID-5 operations, data is transferred through the data buffer; read operations after the first might be satisfied from the data buffer without a further operation to the device. The adapter can scatter and gather the data to or from noncontiguous regions of host memory.
- The adapter receives SCSI status from the device. If there is an error the adapter issues a SCSI Request Sense command to the device. It may then attempt to recover the error. In all cases the adapter interrupts the host processor to present the result of the transaction.

Supported Standards

The SSA 4-Port RAID Adapter and Micro Channel SSA Multi-Initiator/RAID EL Adapter implement the standards described in the following documents:

- Micro Channel Architecture portion of the *IBM Personal System/2 Hardware Technical Reference*, first edition, October 1990, part number 84F8933.
- *Serial Storage Architecture - 1995 Physical (SSA-IA/95PH)*, October 1995.
- *Serial Storage Architecture - 1995 SCSI-2 Protocol (SSA-IA/95SP)*, October 1995.
- *Small Computer System Interface - 2 (SCSI-2)*, X3.131.199X, Revision 10m.

Introduction to the Independent Packet Network (IPN)

The device drivers and adapter communicate with each other by means of a logical client-server network called an Independent Packet Network (IPN).

IPN is a logical network of **services**. A client can access a service by specifying its address in the IPN network, without being concerned where the service is physically located. In IPN terminology, the client is a **master** and the Service is a **slave**.

The unit of work in IPN is a **transaction**. The routing layer of IPN establishes a connection between the master and slave for the duration of each transaction. A master may queue multiple transactions in the same slave. However, the slave can execute the transactions in any order it chooses and even execute several transactions concurrently.

An IPN **node** is a hardware unit that runs the IPN kernel, a host system or the adapter are examples of nodes. In addition to network routing, the IPN kernel also performs such tasks as scheduling, memory management, and timer functions.

The adapter provides a **disk service** to give basic read/write access to each attached disk drive. Additional services can be added, such as a RAID service.

The host device driver is an IPN master and also provides an **error logger**, which is a service for logging subsystem errors.

Every IPN node also contains a **registry** service. The registry keeps a list of all services running on its node and all other nodes that are directly accessible through a gateway on that node. The registry also forwards errors detected by the services running on its node to the error logger.

IPN spans the device driver and the adapter. IPN uses a **gateway** to cross a physical interface such as the Micro Channel. The gateway is transparent to the master and slave and it incorporates the specific features of the physical interface.

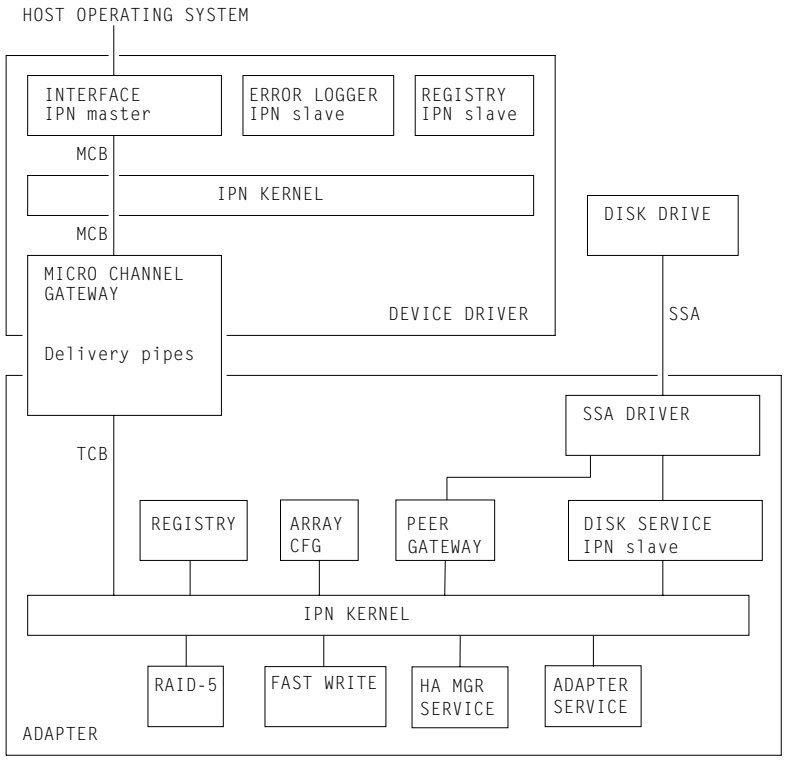


Figure 1. IPN Components

The SSA 4-Port RAID Adapter contains a Micro Channel gateway, a disk service, a registry service, an SSA driver, the IPN kernel, and a RAID-5 filter and an array-configuration service. The Micro Channel SSA Multi-Initiator/RAID EL Adapter also has a peer-gateway service and a fast-write filter. The relationships between these functions is shown in Figure 1. A typical transaction to read data from a RAID-5 array would be processed as follows:

1. The device driver contains a master process that generates IPN transactions. The master calls the host IPN kernel with a pointer to a **master control block (MCB)** for the transaction. The MCB is addressed to the disk service.
2. The host IPN kernel calls the Micro Channel gateway with a pointer to the MCB.
3. The host side of the Micro Channel gateway creates a **gateway transaction control block (GTCB)** in host memory. This is a form of the TCB that is optimized for the gateway function.

   The Micro Channel gateway writes a pointer to the GTCB into the adapter incoming **delivery pipe**. This is a circular queue in adapter memory. The hardware automatically raises an interrupt to the adapter when the host writes to the delivery pipe.

4. The adapter side of the Micro Channel gateway fetches the GTCB by DMA. The gateway then creates a **transaction control block (TCB)** in the adapter address space. A TCB is a subset of an MCB. Finally the gateway calls the adapter IPN kernel to submit the TCB.
5. IPN calls the RAID-5 service for the addressed resource with a pointer to the TCB.
6. The RAID-5 service generates IPN transactions for each of the disk drives and sends these transactions to the disk service using the IPN kernel.
7. The disk service generates the appropriate SSA_SCSI read commands and passes them to the SSA driver.
8. The SSA driver issues the SCSI commands to the disk drives using the SSA protocol.
9. When the disk drives offer the requested data, the SSA driver transfers the data to DRAM. The data is transferred to host memory through the Micro Channel gateway.
10. When the drive returns good-completion status, the disk service calls IPN with the result of each transaction generated by the RAID-5 service.
11. When all the transactions have completed, the RAID-5 service informs the host that the original read transaction to the array has completed. It does this by using the Micro Channel gateway to put a pointer to the GTCB into the adapter outgoing delivery pipe in adapter memory.

Chapter 2. System-to-Adapter Interface

IPN Transactions

The device driver issues IPN transactions to the adapter to access the attached devices. Occasionally, the adapter issues a transaction to the device driver to log an error. Each transaction is created as an MCB, transferred over the Micro Channel in a GTCB and finally delivered to the destination service as a TCB. The GTCB format is described here.

All references to the adapter memory are seen by the host as *offsets* into the Micro Channel window; that is, the host must add the base address of the window to get the Micro Channel address.

Gateway Transaction Control Block (GTCB)

Each transaction passed over the Micro Channel is described by a GTCB. The GTCB is located by a pointer in a delivery pipe. The GTCB has a fixed length of 96 bytes and it is aligned on a 16-byte boundary. The GTCB is built by the master side of the gateway in its local memory. It remains allocated from the time the transaction request is issued to the gateway until the gateway returns a reply for the transaction.

Table 1. Format of a GTCB

Byte	3	2	1	0
0	Destination_node			
4	Destination_service			
8	Reserved = 00h	Major_function	Minor_function	
12 through 27	Parameter_DDR			
28 through 43	Transmit_DDR			
44 through 59	Receive_DDR			
60 through 75	Status_DDR			
76	Result_pointer			
80 through 95	Parameters			

Destination_node

This field contains a 32-bit unsigned integer to identify the destination adapter card. The device driver assigns each card a unique number based on the host system and physical bus slot occupied by that card.

Destination_service

This field contains a 32-bit unsigned integer to identify the destination service.

The registry has a fixed service number of 0000 0001h. The service number for the disk service is dynamically allocated and can be obtained from the registry. The error logger connects itself to the registries during initialization.

Major_function

This byte is coded as follows:

02h **Application**. These transactions are defined separately by each service. See “Disk Service” on page 89 for the transactions supported by the adapter disk service, “Registry Service” on page 59 for the transactions supported by the registry service, and “Array-Configuration Service” on page 151 for the transactions supported by the array-configuration service.

All other values are reserved.

Minor_function

These 2 bytes select a particular transaction.

Parameter_DDR

This 16-byte field contains the data descriptor for the transaction parameters. See “Data Descriptor (DDR)” on page 11 for the format of a data descriptor. If the length of the parameter is less than, or equal to, 16 bytes, the parameter must be in bytes 80 through 95 of the GTCB and the type, address, and offset fields of the DDR are ignored.

Transmit_DDR
This 16-byte field contains the data descriptor for data to be transmitted from the master to the slave.

Receive_DDR
This 16-byte field contains the data descriptor for data to be received by the master from the slave.

Status_DDR
This 16-byte field contains the data descriptor for the transaction status. The status, if any, is defined by the particular transaction.

Result_pointer
This field points to the result word for the transaction. (See “Result Word” on page 12.)

For transactions from the host this field contains a Micro Channel address. For transactions from the adapter it contains an offset into the Micro Channel window.

Parameters
This field can contain up to 16 bytes of parameters for the transaction. This space is sufficient for all performance-critical transactions.

If a transaction requires more than 16 bytes of parameters then the additional bytes are appended following the GTCB. Alternatively, all of the parameters can be stored separately from the GTCB. Both alternatives require the adapter to perform an additional DMA operation after fetching the GTCB.

The parameters are defined separately for each particular transaction.

Data Descriptor (DDR)

A DDR is a component of the GTCB that provides the parameters, the receive data area, the transmit data, or the status area for a transaction.

Table 2. Format of a Data Descriptor

Byte	3	2	1	0
0	Type	SG_length	Reserved = 0000h	
4	Address			
8	Offset			
12	Data_length			

Type This field is coded to select one of the following types:

0Bh DT_Null. No data is present.

0Ch DT_Microchannel. The address field points to the data.

0Dh DT_MicrochannelScatGat. The address field points to a scatter/gather list whose entries point to the data.

Note: This function is provided by the device driver.

All other values are reserved.

SG_length
This 1-byte field is only used when the type field is 0Dh. It contains an unsigned integer that specifies the number of entries in the scatter/gather list.

Address
This field points to the data or a scatter/gather list. For transactions from the host the Address field contains a Micro Channel address. For transactions from the adapter it contains an offset into the Micro Channel window.

Offset This unsigned integer allows a *logical* offset to be added to locate the first byte of data. It is used mainly when the data is located by a scatter/gather list.

Data_length
This unsigned integer specifies the maximum length of the data in bytes.

Scatter/Gather List

The scatter/gather list is a variable-length list which allows data to be relocated in a virtual-memory environment. The list entries describe the data fragments in turn. Each entry specifies the physical address and length of a fragment.

Table 3. Format of a scatter/gather list

Byte	3	2	1	0
0	Address 1			
4	Length 1			
8	Address 2			
...	...			
8N-1	Length N			

Address
This field contains the physical address of a fragment of data. The address may be on any byte boundary.

Length This field contains an unsigned integer that is the length of the fragment in bytes. The length may be any number of bytes.

Result Word

The result word is used to return the results of a transaction. It is aligned on a 4-byte boundary.

Table 4. Format of a Result word

Byte	3	2	1	0
0	Reserved = 00h	Network_result	Application_result	

Network_result
This field is reserved for reporting errors in IPN networks. The master process preformats this field with 00h, indicating no error. This avoids the need for the slave to update it when there is no error.

Application_result
This field contains errors reported by the destination service. The master process preformats this field with 0000h, indicating successful completion.

The specific errors reported are defined in “Application Results” on page 195.

Delivery Pipes

The Micro Channel gateway uses two delivery pipes for communication between the host and the adapter. The two pipes flow in opposite directions to provide a full-duplex interface. One pipe delivers control **elements** from the host to the adapter and the other pipe delivers elements from the adapter to the host. Each pipe is a circular queue in which each element is a 4-byte pointer to a GTCB, as shown in Figure 2.

For transactions from the host, the GTCB pointers are Micro Channel addresses. For transactions from the adapter, they are offsets into the Micro Channel window.

The host and adapter outgoing pipes are located in adapter memory and the host accesses them using programmed I/O through a window in Micro Channel address space.

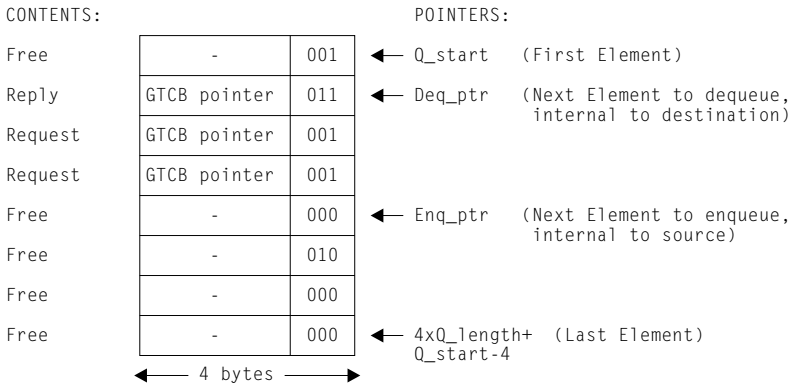


Figure 2. Delivery Pipe

Because a GTCB is aligned on a 16-byte boundary, the 4 low-order bits of each element can be used for identification. When bits 2 through 0 indicate Transaction Reply:

- If bit 3 is 1b, no Status_DDR data was transferred during the transaction.
- If bit 3 is 0b, Status_DDR data was transferred.

Bit 3 has no meaning for other types of element. The meanings of bits 2 through 0 are:

BB Transaction Request (Phase 0)

BB Transaction Request (Phase 1)

BB Transaction Reply (Phase 0)

BB Transaction Reply (Phase 1)

The low-order bit is a phase flag which prevents the dequeue agent from fetching elements not yet stored by the enqueue agent. The gateway is designed so that every request element eventually results in a reply element in the opposite pipe.

The host issues the Initialize command to the adapter to specify the total number of words in each pipe, *Q_length*, and the maximum number of outstanding requests that the host is allowed to originate, *Host_max_requests*. The start address of the host outgoing pipe, *Host_Q_start*, and that of the adapter outgoing pipe, *Adapter_Q_start*, are provided by the adapter.

Each agent must always leave at least one free element in its outgoing pipe and sufficient elements for replies to the maximum number of outstanding requests from the other agent. So, the maximum number of outstanding request elements that the adapter is allowed to originate is

Adapter_max_requests = Q_length - (1 + Host_max_requests)

Initially each agent fills its *incoming* pipe with dummy phase 1 request elements and sets its local variables as follows:

Enq_ptr = _Q_start
Set enqueue pointer to start of outgoing pipe

Deq_ptr = _Q_start'
Set dequeue pointer to start of incoming pipe

Enq_phase = 0
Phase of enqueue elements

Deq_phase = 0
Expected phase of dequeue elements

Av_requests = _max_requests
Available number of outstanding requests

To enqueue an element an agent proceeds as follows:

1. If enqueuing a request, it checks that *Av_requests* ► *0*.
2. If enqueuing a transaction request, it builds the GTCB and initializes the result word to 0000 0000h.
3. If enqueuing a transaction, it replies with a non-zero result, and stores the result word.
4. It stores the GTCB pointer at *Enq_ptr*, setting the three low order bits as previously defined.
5. It interrupts the other agent. (An adapter interrupt is generated automatically when the host stores an element in its outgoing pipe.)
6. It advances *Enq_ptr* to the next free element. If *Enq_ptr* wraps around to the beginning of the pipe, it toggles *Enq_phase*.
7. If enqueuing a request, it decrements *Av_requests*.

When an agent is interrupted, it repeats the following procedure until the pipe is empty:

1. It fetches the element addressed by *Deq_ptr*. If the phase flag does not match *Deq_phase*, the pipe is empty.
2. Otherwise, if the element is a reply, it increments *Av_requests*.
3. It advances *Deq_ptr* to the next element. If *Deq_ptr* wraps around to the beginning of the pipe, it toggles *Deq_phase*.
4. It processes the element dequeued.

This protocol ensures that:

1. Elements are not over-written by the enqueue agent before they have been dequeued.
2. Each agent always has space in its outgoing pipe to reply to all outstanding requests in its incoming pipe. Hence the pipes cannot dead-lock.
3. The host can enqueue a transaction request with one programmed I/O. The adapter dequeues the transaction request using a simple load instruction and fetches the GTCB in one DMA operation. It enqueues a transaction reply in one DMA operation if there is no error and in two DMA operations otherwise. The host can dequeue the reply using simple load instructions.
4. There are no dynamic shared variables to control the pipes.

The adapter fetches GTCBs from host memory in the order that the transaction requests were enqueued in the host outgoing pipe.

Timeouts

The adapter times a GTCB from arrival to reply. If the reply is not sent within two minutes and the transaction is not FN_REGY_TestResrcReady, the adapter sets the error register with the error code SS_TIMEOUT, interrupts the host and waits to be reset. While waiting to be reset, the adapter does not respond to heartbeats or accept any transactions from the host.

Commands

The adapter command set provides a low-level interface to the adapter, for initialization for example. Only one command can be in progress at a time.

The command interface uses the following protocol:

1. The host should ensure that the busy bit in the Status register is off. Normally, this is guaranteed if the host has received an interrupt for the previous command and followed the protocol below.
2. If necessary the host writes the Parameter register with the parameters or the physical address of a parameter block, as required by the particular command. A parameter block must be aligned on a 4-byte boundary.
3. The host writes the command code to the Command register.

Writing the Command register sets the busy bit in the Status register and generates an interrupt to the adapter.

4. The adapter reads the Command register and, if necessary, the Parameter register. The adapter then resets the busy bit.
5. When the adapter completes a command it writes the Status register to present status and interrupt the host.
6. The host then reads the Status register to determine the source of the interrupt and receive the status. As the clear-on-read bit is set in the Control register, the interrupt is automatically reset.
7. After a Download command has been issued, no further commands can be issued unless the adapter is reset. A Download command must be immediately preceded by a reset.

Initialize

The Initialize command configures the delivery pipes used by IPN transactions and allocates an IPN node number to the adapter.

Command register
30h

Parameter register
Physical address of the parameter block.

Exceptions
The following exceptions can be indicated in the code field of the Status register:

111b Catastrophic Error. Further details of the error are provided in the error code in the error register.

Table 5. Parameter block for Initialize

Byte	3	2	1	0
0	Adapter_Q_start			00
4	Q_length		Host_max_requests	
8	Reply Packet Pointer			
12	Node			

Q_Length
This field contains a 2-byte unsigned integer specifying the number of elements allocated to each pipe.

The only valid setting is 256 elements.

Host_max_requests
This field contains an unsigned integer specifying the maximum number of outstanding requests that the host is allowed to originate. *Host_max_requests < Q_length - 1.*

The host-max-requests field must be set to 200, otherwise the adapter reports an exception for Invalid Parameter.

Reply Packet Pointer
This field contains the Micro Channel address of a 2-word buffer allocated by the host. The adapter loads the first word of the buffer with a pointer to the host outgoing delivery pipe, *Host_Q_start*. The adapter loads the second word of the buffer with a pointer to the adapter outgoing delivery pipe, *Adapter_Q_start*. The pointers contain the offset of the region allocated to the pipe in the Micro Channel window.

Node This field contains the IPN node number assigned to the adapter by the device driver.

Download

The Download command allows updated microcode to be down-loaded into the adapter. The Download command must be immediately preceded by a reset.

Command register
31h

Parameter register
Physical address of the parameter block.

Exceptions
The following exceptions may be indicated in the code field of the Status register:

111b Catastrophic Error. Further details of the error are provided in the error code in the error register.

Table 6. Parameter Block for Download

Byte	3		2	1	0
0	G	Reserved = 0000000b	Reserved = 00h	SG_length	
4	Address				
8	Length				
12	LRC				
16 through 23	ROS level				

Gather (G)
If byte 3 bit 7 is set to 1b then the Address parameter points to a scatter/gather list. Otherwise Address points to the microcode itself.

SG_length
This 2-byte field is only used when the gather bit is set to 1b. It contains an unsigned integer which specifies the number of entries in the scatter/gather list.

Address
This field contains the Micro Channel address of the microcode or a scatter/gather list which locates the microcode. Addresses are aligned on a 4-byte boundary.

Length This field contains a 32-bit unsigned integer which specifies the length of the microcode in bytes. Length is a multiple of 4.

LRC This word contains a Longitudinal Redundancy Check (LRC) to ensure integrity of the microcode. The LRC is formed by adding each word of the microcode to the constant AAAA AAAAh, using 32-bit arithmetic.

ROS Level
This is an 8-digit ASCII-coded field that describes the level of the flash EPROM after the download. This is the level reported in the RL field of the VPD.

The updated microcode is downloaded as follows:

1. The host sets the boot-control bit to 1b in the POS subaddress registers. This prevents the adapter from executing the changeable sectors of the Flash EPROM following an adapter reset.
2. The host sets the adapter-reset bit in the Control register, waits at least 50 microseconds and resets the adapter-reset bit.
3. The adapter disables the SSA ports and boots from the protected sectors of the Flash EPROM only. In this state it only accepts the Download command.
4. The host issues the Download command.
5. The adapter fetches the microcode to RAM. If the LRC is good the adapter writes the new microcode to Flash EPROM.
6. The adapter generates a host interrupt to present status for the Download command.
7. The host sets the boot-control bit to 0b.
8. The host sets the adapter-reset bit, waits at least 50 microseconds, and resets the adapter-reset bit.
9. The adapter boots from the Flash EPROM, including the new microcode, and enables the SSA ports.

Execute I/O

The Execute I/O command provides a simple synchronous I/O interface to support system IPL and software installation. In a system running AIX, it is not permitted to send an IPL operation to an array or a device that is a member of an array; the adapter implements this restriction by reporting only those disk drives that are not members of RAID-5 arrays in response to a Ready Test operation, when the mode bit is 1b.

Execute I/O can perform only one I/O operation at a time.

Command register
32h

Parameter register
Physical address of the parameter block in host memory.

Exceptions
The following exceptions may be indicated in the code field of the Status register with further details of the error in the Error register:

100b The command could not be successfully completed because of an I/O error or an attachment error. The system may be able to recover by using an alternative device.

111b The command could not be successfully completed because of a catastrophic error. The code in the Error register defines the reason for the error.

Table 7. Parameter Block for Execute I/O

Byte	3	2			1	0
0	Operation	M	P	Reserved = 000000b	Reserved = 0000h	
4	Disk					
8	LBA					
12	Length					
16	Buffer_address					

Operation

This byte is coded as follows to specify the function to be performed:

01h Inquiry. This operation checks that the disk is ready. If it is, the following 24-byte descriptor is stored in host memory at the address in the buffer-address field.

Block_size
A 4-byte unsigned integer specifying the block size in bytes.

Capacity
A 4-byte unsigned integer specifying the disk capacity in blocks.

Serial_number
16 bytes containing the ASCII serial number of the resource.

02h Ready Test. The command completes successfully when all the attached resources are ready or when the time period in seconds defined in the length field has expired, whichever is the shortest time. The value of the physical (P) bit determines if these are logical or physical resources. If the mode bit (M) is 0b, the logical resources are of owning-module type DriverManualDisk; if the mode bit is 1b, they are of type DriverAutomaticDisk. A 4-byte unsigned integer that specifies the number of attached resources that are ready is stored in host memory at the address provided in the buffer-address field. A list of resources is kept in the adapter. When the mode bit is 1b, RAID-5 resources are not included in the list of resources. A Ready Test operation must be issued before any other Execute I/O operations that have the mode bit set to 1b are issued.

03h Execute DC_StartTransaction IPN directive. The type of DDR must be either DT_Microchannel, DT_MicrochannelScatGat or DT_Null.

10h Read.

11h Write.

Mode (M)

The mode bit controls the definition of the disk field and the type of resources reported to a Ready Test operation.

If the mode bit is 0b, the disk field contains a resource ID.

If the mode bit is 1b then the disk field contains an index into a list of configured disks starting at zero, created at the last Ready Test Execute I/O operation.

If the operation is Ready Test and the mode bit is 0b, the logical resources listed are all of owning module type DriverManualDisk and can be RAID-5 or non-RAID resources.

If the operation is Ready Test and the mode bit is 1b, the logical resources listed are all of owning module type DriverAutomaticDisk and are all non-RAID resources.

Physical (P)

The physical bit value is only used during the Ready Test operation. If the physical bit is 0b, the disk field identifies a logical resource ID and the Ready Test operation refers to logical resources. If the physical bit is 1b, the disk field identifies a physical resource ID and the Ready Test operation refers to physical resources. If the physical resources attached to the adapter are configured into arrays, the number of logical resources may not be the same as the number of physical resources.

The physical bit is 0b for normal IPL operations to ensure that logical resources are used to find the required resource from which to read IPL data. The physical bit is set to 1b to obtain the serial number of each physical resource using Ready Test and Inquiry operations. This is executed after an unsuccessful completion of the Diagnostic operation to compare the serial numbers of good physical resources with those reported after a successful IPL process.

Disk An unsigned integer to select a particular resource according to the specified mode field (see the definition of the mode field for more details).

LBA An unsigned integer specifying the starting logical block address for a read or write request.

Length An unsigned integer specifying the number of blocks to be accessed in a read or write operation. It is assumed that the host memory buffer is large enough for the read data.

When the Ready Test operation is specified, the length field defines the number of seconds allowed for all the resources to become ready.

Buffer_address

The Micro Channel address of a buffer in host memory for read/write data or IPN directive or System Reference Number.

Resets

The actions taken for the various resets of the adapter are defined in this section.

Table 8. SSA Adapter Reset Actions

	Channel Reset or Power-on Reset	**Command Reset**	**Total Reset (note1)**	**Absolute Reset (note 5)**	**Link Reset**
Wrap/unwrap links during reset	Both SSA loops	Both SSA loops	No	Both SSA loops	No
POSTs	Yes	No	No	No	No
Reset configuration table	Both SSA loops	Both SSA loops	One SSA loop	Both SSA loops	No
Internally purge SSA commands (note 2)	Both SSA loops	Both SSA loops	One SSA loop	Both SSA loops	No
Async Alerts sent (note 3)	Yes	Yes	Yes	Yes	No
Reconfigure SSA network (note 4)	Yes	Yes	Yes	Yes	No

Notes:

1. The device-reset SSA message is not supported.
2. SSA commands purged internally are reissued after the links have been reconfigured.
3. An Async_alert type code Remote Port Disabled is sent by the adjacent node when the link is wrapped. The master initiator should send a Master_alert to all other initiators to unconfigure this node from its configuration table.

   An Async_alert type code port now operational is sent by the adjacent node when the link is unwrapped and ready. The master initiator should send a Master_alert to all other initiators to reconfigure this node into its configuration table.
4. Reconfiguration

   After unwrapping each port, the initiator:

   - Issues a Query_node to all nodes from that port to walk the network and build the configuration table.
   - Issues Quiesce to all nodes that support SSA-SCSI upper level protocol to purge all commands from this initiator and remove old return_paths in the target's initiator table.
   - Issues Query_node again to each node to add the return_path to the target's initiator table.
   - If the Query_node_reply responses indicate that this initiator should be the master, issues Configure_port specifying 'set normal mode' to all ports that are operational and a Master_alert specifying 'Port now operational' to each other primary initiator.

   If, after reconfiguration for a Channel Reset operation, this is the only initiator in the network for an SSA loop, a Clear_queue message is issued to all the nodes

attached to that SSA loop before any commands are issued, to ensure that all commands issued previously from any initiator are purged.

While the port is wrapped, another initiator may have detected this condition and elected to be a master initiator and issued Configure_port to nodes informing them it is the master. If the initiator completing its reset determines that it should be the master, it issues Configure_ports and Master_alerts as described above and becomes the master again.

5. For the SSA 4-Port RAID Adapter, absolute resets are treated as total resets.

   For the Micro Channel SSA Multi-Initiator/RAID EL Adapter, when the adapter receives an absolute reset, the firmware stops execution, sets a showstop error code, and interrupts the host. If a command reset is not received from the device driver during a period of time, the actions shown in the table are taken; these actions are equivalent to a command reset.

IPL

The Execute I/O command is provided to allow the system to IPL by means of a small program in ROS, rather than one that implements the full ISAL transaction interface for reading from the disk.

IPL is not allowed from a RAID-5 resource because, if such an IPL were to fail, servicing of the components that might have caused the failure would not be possible. Service of these components requires the use of the array configurator, which depends on the AIX system already being available.

Chapter 3. Micro Channel Interface

Characteristics

The SSA 4-Port RAID Adapterand Micro Channel SSA Multi-Initiator/RAID EL Adapter are level 'C' Micro Channel adapters. Each adapter's hardware interface provides the following facilities:

- 4 bytes of address and 4 bytes of data, with parity on both. The adapter *must* be plugged into a 32-bit slot and programmed by a 32-bit processor.
- The adapter is a bus slave for access to I/O registers, Basic Input/Output Subsystem (BIOS) memory and the shared memory window.

  The adapter is a bus master for data transfer. Data is transferred over the Micro Channel in the order that it is requested by the attached devices. Normally the adapter does not buffer data internally. For optimum performance, data transfers should start on a 4-byte boundary in host memory.

  Note: The adapter does not support operation as a bus slave for *data* transfer.

  The adapter is capable of 100 nanosecond streaming cycles and 8-byte multiplexed streaming, both as a bus master and as a slave. This gives a peak bandwidth of 80 MB/second, subject to the capabilities of the system bus.
- Programmable Option Select (POS) registers control the I/O base address, BIOS segment address, memory window address, arbitration level and interrupt level.

The following protocols are implemented by the adapter microcode:

- A register-based command protocol is provided for initializing the adapter and down-loading updated microcode.
- A transaction protocol is provided for normal read/write access to the attached disk drives. Multiple transactions can be queued in the adapter and the attached devices. Each transaction is controlled by a GTCB and full-duplex delivery pipes in shared memory.

I/O Registers

In normal operation, the host communicates with the adapter through the following registers on the adapter card:

Table 9. Adapter I/O registers

Register	Width	Function	I/O address
Parameter	32 bits	Read/write	Base + 0h
Command	8 bits	Read/write	Base + 4h
Control	8 bits	Read/write	Base + 5h
Error	8 bits	Read-only	Base + 6h
Status	8 bits	Read-only	Base + 7h

The registers are mapped into the Micro Channel I/O space. The base address of the registers is programmable on any 1KB boundary using Base_high in POS register 5 and Base_low in POS subaddress 256. All I/O addresses in this section are relative to the base address.

Parameter Register

The Parameter register is a 32-bit I/O register which is used by the adapter command protocol. It contains either the command parameters or a pointer to a parameter block. The parameter block must be aligned on a 4-byte boundary in host memory.

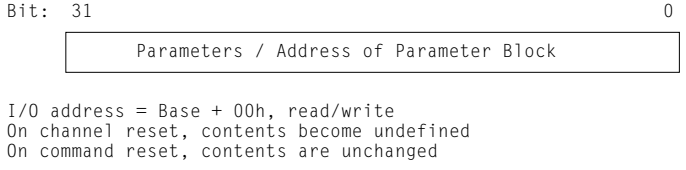


Figure 3. Parameter Register

Writes to the Parameter register are gated by the busy bit in the Status register. If the busy bit is set, the write is blocked and the contents of the Parameter register are not changed.

Command Register

The Command register is an 8-bit I/O register which is used by the adapter command protocol. It is written by the host to initiate a command.

I/O address = Base + 04h, read/write
On channel reset, contents become undefined
On command reset, contents remain the same

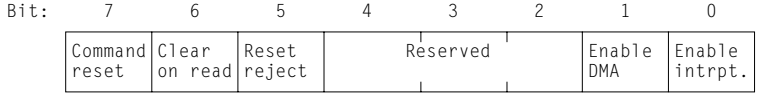
Figure 4. Command Register

Writes to the Command register are gated by the busy bit in the Status register. If the busy bit is set, the write is blocked and the contents of the Command register are not changed.

Writing the Command register normally also generates an adapter interrupt to initiate the command. However, the interrupt is blocked if the busy bit is set and the first digit of the command code is not equal to Dh.

Control Register

The Control register is an 8-bit register that controls certain adapter functions.



I/O address = Base + 05h, read/write
On channel reset, contents become 00h
On command reset, contents become 80h

Figure 5. Control Register

Command_reset
The host can reset the adapter by setting this bit to 1b, waiting at least 50 microseconds, and then resetting the bit. The adapter sets the busy bit in the Status register during the adapter reset.

Clear_on_read
The host must initialize this bit to 1b so that the interrupt bit is cleared implicitly when the host reads the Status register.

Reset_reject
This bit is not used.

Enable_DMA
The host must set this bit to 1b to enable the adapter to operate as a bus master.

Enable_interrupt
The host must set this bit to 1b to enable the interrupt bit in the Status register to generate a Micro Channel interrupt.

Error Register

The Error register is an 8-bit I/O register which identifies an error detected by the adapter, for example, host programming errors, adapter microcode errors, and adapter hardware errors.

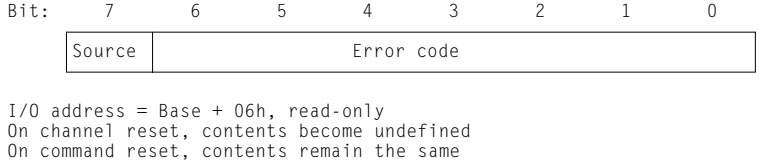


Figure 6. Error Register

If the source bit is 1b, the error code originated from the IPN kernel; if the source bit is 0h, the error originated from microcode other than the kernel.

The error codes, in hexadecimal, are:

01 SS_INSANE
Adapter error: out-of-control error trap (should be preceded by trace point)

02 SS_WRONG_INT
Host error: an unexpected adapter interrupt occurred

03 SS_WRONG_INI_PARMS
Host error in Initialize command parameters

04 SS_NOT_INIT_CMD
Host error: command was not Initialize

05 SS_PARMS_NOT_INLINE
Host error: all parameters should be in-line

06 SS_TOO_MANY_REQS
Host error: too many simultaneous requests

07 SS_MIAMI_DMA_FAILED
Host error: host disabled DMA in process

08 SS_NOT_IMPLEMENTED
Microcode not implemented

0B SS_PARMDDRTYPE_INVALID
Parm DDR should be DT_MicroChannel or DT_Null

0C SS_NOT_DNLD_CMD,
Not Download command (during download reset)

0D SS_DNLD_TOO_BIG,
Code download length too big

0E SS_DNLD_TOO_MANY_SG_ELS
Download has too many scatter/gather elements

0F SS_DNLD_SGLN_MISMATCH
Download scatter/gather fragments don't add up

10 SS_DNLD_LRC_FAILURE

11 SS_SIC_CLASS1
An SSA loop interface indicated a class 1 problem

12 SS_WRONG_XIO_OPCODE
Invalid operation requested in Execute I/O

13 SS_ASSERT
An assert has been hit

14 SS_DBG_STOP
Showstop because of debug service

15 SS_XIL_ERROR
Adapter detected error

16 SS_XIL_INSANE
Error in adapter error handler

17 SS_SIC_DMA_FAILED

1F SS_STORAGE
Watchdog failed to get storage before timeout

20 SS_VSC
TransferToHost transaction timeout

21 SS_POST2A_FAIL
POST2A error while checking first 1MB of DRAM and NVRAM

22 SS_TIMEOUT
Timeout on transaction from host (> 2 minutes)

23 SS_SENSE
Additional trace information is available in POS subaddresses 228 through 229 and a dump might be written to a disk with the address given in POS subaddresses 230 through 243

24 SS_THIRD_PARTY_RESET
SSA absolute total reset received from another adapter

25 SS_LINK_CONFIG_FAILED
SSA link configuration failed

40 XER_NoPrecedingReadyTest
All Execute I/O operations must be preceded by a Ready test after a reset or power on

41 XER_M1DiskGTResourceCount
Disk field is too large when mode field is 1b

42 XER_IpnBadResult
IPN transaction failed

43 XER_M0ResourceNotInList
Resource not available when mode field is 0b

44 XER_ResourceNotRecognised

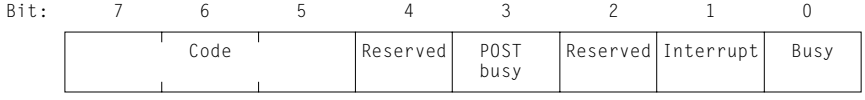
45 XER_DevNoLongerAccessible
Resource no longer accessible

46 XER_ReadWriteFailed

47 XER_OpenFailed

Status Register

This 8-bit I/O register contains adapter status.



I/O address = Base + 07h, read-only
On channel reset, contents become 0000 0001b
On command reset, contents become SSS0 SS01b
S means that the bit is unchanged

Figure 7. Status Register

Code When the interrupt bit is 1b, bits 7 through 5 contain a code that indicates the source of the interrupt from the adapter:

001b Reserved.

010b The adapter has successfully executed a command.

011b The adapter has enqueued one or more elements in the adapter outgoing pipe.

100b The adapter could not successfully execute a command because of an error in the I/O device or an attachment error. The error code in the Error register defines the error.

111b The adapter has detected a catastrophic error. The error code in the Error register defines the error.

All other codes are reserved.

POST_busy
When set to 1b, bit 3 indicates that the adapter is currently executing the POST2 checkout. The POST1 phase will have been executed as the card ID is not stored in POS registers 0 and 1 until POST1 has completed.

Commands and transactions can be executed before POST2 is complete. Failures detected during POST2 are reported when a health check is requested.

Interrupt
When set to 1b, bit 1 indicates that the adapter is generating a host interrupt. The source of the interrupt is indicated in the code field. The host can reset the interrupt by reading the Status register.

Busy When set to 1b, bit 0 indicates that the adapter is processing a command or that a reset is in progress. The adapter sets the busy bit when the Command register is written and resets it when the command has been processed. Writes to the Command and Attention registers are blocked while the busy bit is set.

POS Registers

After power-on, the host system must configure the adapter using the Programmable Option Select (POS) registers. These registers are accessed by activating the Micro Channel '−CD SETUP' signal. The host must reset the adapter using the adapter-reset bit in the Control register after any POS register is changed.

All POS registers are 8 bits wide and reset only by a '+CHRESET' signal. (They are unchanged by adapter reset.)

POS Registers 0 and 1

POS registers 0 and 1 store a 16-bit card ID that identifies the adapter.

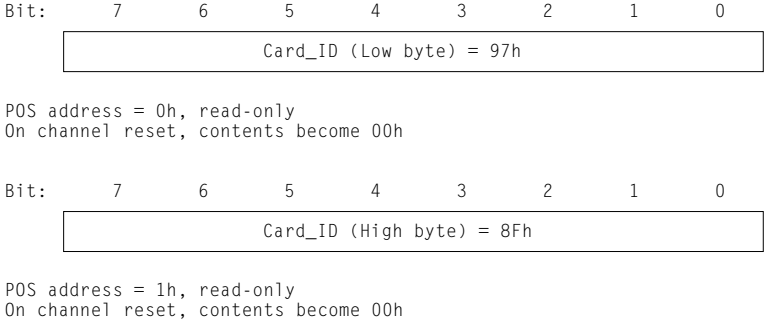


Figure 8. POS Registers 0 and 1

Immediately after the '+CHRESET' signal is activated, the card ID is set to 0000h. The adapter then loads the microcode from flash EPROM and runs the POST. When the

adapter is ready, it sets the card ID to 8F97h. This is a maximum of 1 second after the '+CHRESET' line becomes inactive. The host should not access any other POS or I/O register until the card ID is valid.

POS Register 2

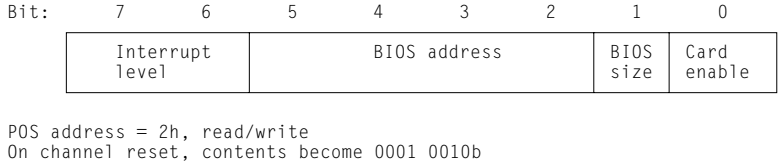


Figure 9. POS Register 2

Interrupt_level

Bits 7 through 6 are coded to select the Micro Channel interrupt level used by the adapter as follows:

00b Level 9
01b Level 10
10b Level 11
11b Level 12

BIOS_address

Bits 5 through 2 are coded to select the starting address of the adapter BIOS in Micro Channel memory space:

0000b C0000h
0001b C2000h
0010b C4000h
0011b C6000h
0100b C8000h
0101b CA000h
0110b CC000h
0111b CE000h
1000b D0000h
1001b D2000h
1010b D4000h
1011b D6000h
1100b D8000h
1101b DA000h
1110b DC000h
1111b DE000h

When the starting address is programmed on an odd 8-KB boundary the BIOS-size field must be set up for an 8-KB window. The BIOS window is disabled if the BIOS-address field is 0100b, which is the reset value.

BIOS_size

Bit 1 selects the size of the adapter BIOS window in Micro Channel memory space. When it is set to 0b, the window size is 8 KB; when it is set to 1b, the window size is 16 KB.

Card_enable
When bit 0 is reset to 0b, the adapter Micro Channel interface is disabled, except for accesses to the POS registers. The host system must set this bit to 1b to enable the interface.

POS Register 3

POS register 3 is used to read and write the subaddressed byte addressed by POS registers 6 and 7.

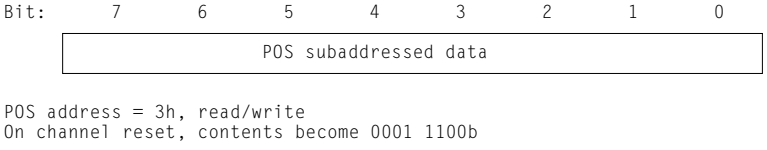


Figure 10. POS Register 3

POS Register 4

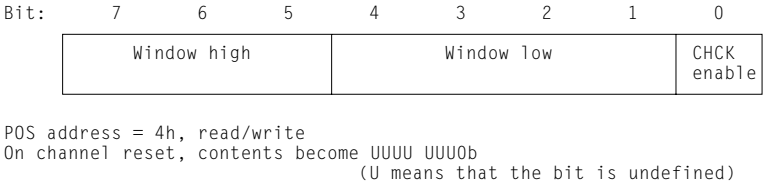


Figure 11. POS Register 4

Window_high
Bits 7 through 5 are used in conjunction with the window-middle and window-low fields to program the starting address of a window into adapter memory. (The window-middle field is in POS subaddress 256.)

POS register 4 bits 7 through 5 correspond to memory address bits 31 through 29 respectively of the Micro Channel window.

Window_low
POS register 4 bits 4 through 1 correspond to memory address bits 23 through 20 respectively of the Micro Channel window.

CHCK_enable
When bit 0 is set to 1b, the adapter is enabled to activate the '−CHCK' signal for errors other than address and data parity errors.

POS Register 5

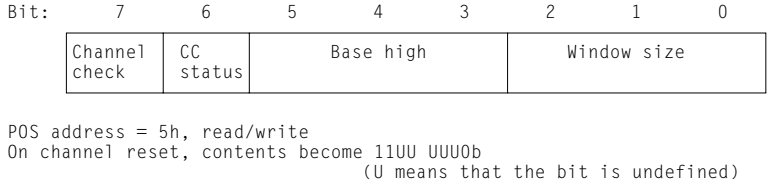


Figure 12. POS Register 5

Channel_check
Bit 7 is normally set to 1b. It is reset to 0b when the adapter raises the '−CHCK' signal as a slave. The host may then clear the '−CHCK' signal by writing 1b to the channel-check field. Writing 0b to the channel-check field has no effect.

CC_status
Bit 6 is normally set to 1b. It is reset to 0b to indicate that POS register 6 contains channel-check status when the adapter asserts the '−CHCK' signal as a slave. The CC-status field is set to 1b when the host clears the '−CHCK' signal by writing 1b to the channel-check field. It is read-only from the Micro Channel.

Base_high
Bits 5 through 3 program bits 15 through 13 of the base address which selects the adapter I/O registers.

In conjunction with the base-low field in POS subaddress 256, these bits allow the I/O registers to be located on any 1KB boundary.

Window_size
Bits 2 through 0 are coded to determine the size of the Micro Channel window into adapter memory:

000b 512 KB
001b 1 MB
010b 2 MB
011b 4 MB
100b 8 MB
101b 16 MB
110b 32 MB
111b 64 MB

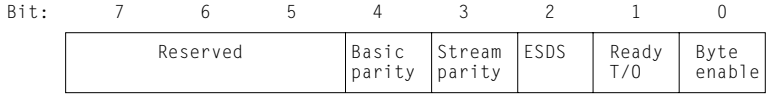
This field is read-only from the Micro Channel. The setting for the initial version of the adapter is 000b.

POS Register 6

When the adapter raises the '−CHCK' signal, POS register 6 provides channel-check status. All reserved bits are set to 0b when a channel check occurs. The host should read the status and reset it by writing 00h to this register.

POS register 6 also functions as bits 7 through 0 of the address for accessing POS subaddressed data.

When the '−CHCK' signal is raised (POS register 5 bit 7, channel check, = 0), POS register 6 has the following definition:



POS address = 6h, read/write
On channel reset, contents become 00h

Figure 13. POS Register 6 Channel Check Status

Basic_parity
The adapter sets bit 4 to 1b when it detects a parity error on data received during a basic transfer cycle.

Streaming_parity
The adapter sets bit 3 to 1b when it detects a parity error on data received during a streaming transfer cycle.

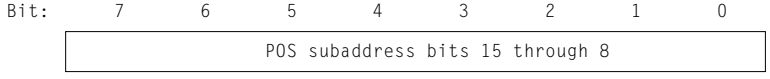
ESDS Extra Streaming Data Strobe. The adapter sets bit 2 to 1b when it receives an extra streaming data strobe after it has terminated streaming as a slave.

Ready_timeout
The adapter sets bit 1 to 1b if it detects that it has negated the '+CD CHRDY' signal as a slave for more than 3 microseconds.

Byte_enable
The adapter sets bit 0 to 1b if it detects an invalid combination of the '−BE0' through '−BE3' signals when it is receiving data as a slave. This applies to both basic and streaming cycles.

POS Register 7

POS register 7 contains the high-order byte of the address for accessing POS subaddressed data.



POS address = 7h, read/write
On channel reset, contents become 00h

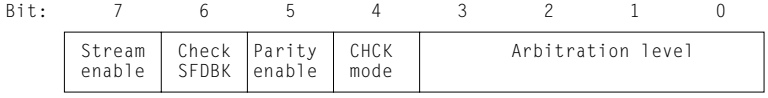
Figure 14. POS Register 7

POS Subaddressing

The adapter uses POS subaddressing to access additional configuration data. In this mode POS register 3 acts as window to the subaddressed byte selected by POS registers 6 and 7.

All undefined subaddresses are reserved and they should not be referenced.

POS Subaddress 0



POS subaddress = 0000h, read/write
On channel reset, contents become 0001 1100b

Figure 15. POS Subaddress 0

Stream_enable
When set to 1b, bit 7 enables 100-nanosecond streaming data transfers. When it is reset, the adapter will only use basic transfer cycles.

Check_SFDBK
When bit 6 is set to 1b, the adapter checks that the '−SFDBKRTN' signal is active during bus master cycles. When it is reset the adapter ignores the '−SFDBKRTN'.

Parity_enable
When bit 5 is set to 1b, the adapter generates and checks parity on the address and data busses. The adapter also activates the '−APAREN' and '−DPAREN' signals when it is a bus master.

CHCK_mode
Bit 4 controls the reporting of channel-check status. When it is reset to 0b, the adapter activates the '−CHCK' signal synchronously with the current bus cycle. When it is set to 1b, the adapter activates the '−CHCK' signal asynchronously.

Arbitration_level
Bits 3 through 0 are binary coded to select the Micro Channel arbitration level for the adapter. Bit 3 is the most-significant bit.

POS Subaddresses 16 through 155

POS subaddresses 16 through 155 contain Vital Product Data (VPD) for the adapter card. They are capable of read/write access but the host should only perform read accesses to avoid corrupting the VPD.

Vital Product Data is information that uniquely defines each hardware and microcode element in the subsystem.

The VPD fields supported are:

Part Number
This is the 8-digit ASCII-coded part number of the adapter card as a field-replaceable unit (FRU). If less than eight digits are used the leading digits are padded with zeros.

Serial Number
This is an 8-digit ASCII-coded FRU serial number. This serial number is unique for the FRU part number but no requirement exists for it to match the manufacturing serial number printed on the card. The serial number is in the range 00000000 through ZZZZZZZZ.

Engineering Change Level
This is a 10-digit ASCII-coded Engineering Change (EC) level number. This number is updated whenever a hardware or microcode change is made on the card. If less than ten digits are used, the leading digits are padded with zeros.

Manufacturing Location
This 6-digit ASCII-coded field indicates the plant of manufacture.

ROS Level
This 8-digit ASCII-coded field indicates the ROS level of the card. A value of 00000000 in this field indicates that the POST code has detected a check-sum error in the code and a new version of code must be downloaded before the adapter can become fully operational. The SSA Adapter Microcode diskette, which is shipped with each adapter card, contains a version of adapter microcode that recovers this error in the event of the host system being unable to IPL because of this failure.

Loadable Microcode Level
This 2-digit ASCII-coded field (decimal numbers only) indicates the version of loadable microcode required for satisfactory operation of this card.

02 SSA 4-Port RAID Adapter

04 Micro Channel SSA Multi-Initiator/RAID EL Adapter

Device Driver Level
This 2-digit ASCII-coded field indicates the minimum level of device-driver program required for this level of card.

Description of Function
This ASCII-coded field describes the function of this adapter card. For a SSA 4-Port RAID Adapter or a Micro Channel SSA Multi-Initiator/RAID EL Adapter, this is ‘SSA-ADAPTER’.

DRAM Size (Z0)
This ASCII-coded field contains the characters ‘DRAM=’ followed by three characters indicating the size of the installed DRAM FRU in megabytes.

Fast-Write Cache Size (Z1)
This ASCII-coded field contains the characters ‘CACHE=’ followed by a character indicating the size of the installed Fast-Write cache card in megabytes. If no cache is installed, the size character is ‘0’. This item appears in the VPD only for the Micro Channel SSA Multi-Initiator/RAID EL Adapter.

Adapter ID (Z2)

This field contains the 8–byte AdapterID reported as 16 ASCII characters. This is the same as the SSA-UID of the modules that control the SSA links, with the least-significant bit = 0.

An example of the layout of the adapter card VPD is:

```
V P D (00) L X X
* P N (06) 1 2 3 4 5 6 7 8
* S N (06) 1 2 3 4 5 6 7 8
* E C (07) 1 2 3 4 5 6 7 8 9 A
* M F (05) I B M 9 0 2
* R L (06) 0 0 0 0 0 0 0 1
* L L (03) 0 4
* D D (03) 0 0
* D S (08) S S A - A D A P T E R
* Z 0 (06) D R A M = 0 0 8
* Z 1 (06) C A C H E = 1
* Z 2 (10) 1 2 3 4 5 6 7 8 9 A B C D E F 0
```

The decimal number in () is the inclusive descriptor length divided by 2. Each descriptor field including the first 4 identification characters must be an even length. Some fields, for example, the *DS field, may have to be padded with a null character to make it an even length.

L is the inclusive VPD field length divided by 2, starting at the eighth byte, that is the first *.

XX is the CRC value. Starting from address `X'00 08'` to the end of the data field and calculated using the polynomial of `1 + X(exp 5) + X(exp 12) + X(exp 16)` where CRC is initialized to 1s (this is the same as the CRC polynomial used for most diskette records). This CRC field is not set on this adapter.

An example of the data as addressed by POS registers 6 and 7 is:

```
Hex Address    Data
(POS 6 & 7)    (POS 3)

0010           56 50 44 00 2B (CRC)
0017           2A 50 4E 06 31 32 33 34 35 36 37 38
0023           2A 53 4E 06 31 32 33 34 35 36 37 38
002F           2A 45 43 07 31 32 33 34 35 36 37 38 39 41
003D           2A 4D 46 05 49 42 4D 39 30 32
0047           2A 52 4C 06 30 30 30 30 30 30 30 31
0053           2A 4C 4C 03 30 34
0059           2A 44 44 03 30 30
005F           2A 44 53 08 53 53 41 2D 41 44 41 50 54 45 52 20
006F           2A 5A 30 06 44 52 41 4D 3D 30 30 38
007B           2A 5A 31 06 43 41 43 48 45 3D 31 20
0087           2A 5A 32 10 31 32 33 34 35 36 37 38 39 41 42 43 44 45 56 30
```

POS Subaddresses 220 through 255

POS subaddresses 220 through 255 contain the adapter error code when a command had terminated with SS_POST2A_FAIL in the error register. These error codes report failures that prevent the adapter from being used normally.

The host can read the information in these subaddresses, but should not write to them because this would corrupt error information.

If the error register contains SS_SENSE, the trace address is returned in subaddresses 228 through 229.

If the dump-status field in POS subaddress 230 indicates that a dump has been saved to disk, the disk is identified in POS subaddresses 232 through 239 and the location of the dump in POS subaddresses 240 through 243.

Byte	3	2	1	0
220	Reserved = 0			Template
224	Reserved = 0	Adapter Error Code		
228	Reserved = 0	Dump Status	Trace Address	
232 through 236	Disk Unique Identifier			
240	Dump Start LBA			
244 through 252	Reserved = 0			

Template

POS subaddress 220 describes the template to be used for logging the error. The template is SSA_HDW_ERROR (0Ah) for all failures detected during POST2A that report SS_POST2A_FAIL in the error register.

Adapter Error Code

POS subaddresses 224 through 226 provide details of the error detected in POST2A. The adapter error codes are defined in “Adapter Error Logging Data” on page 204

Trace Address

POS subaddresses 228 and 229 provide trace information when the error register contains SS_SENSE.

Dump Status

POS subaddress 230 indicates the presence of a dump on disk.

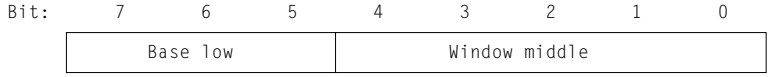
Disk Unique ID

POS subaddresses 232 through 239 contain the unique ID of the disk that holds the adapter dump following a showstop.

Dump Start LBA

POS subaddresses 240 through 243 contain the location of the dump on disk.

POS Subaddress 256



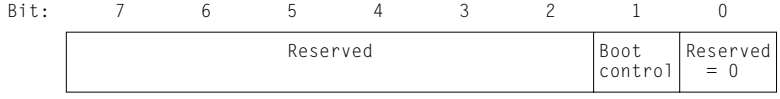
POS subaddress = 0100h, read/write
On channel reset, contents become 1110 0000b

Figure 16. POS Subaddress 256

Base low
The base-low field programs bits 12 through 10 of the base address for the adapter I/O registers.

Window middle
Bits 4 through 0 correspond to memory address bits 28 through 24 respectively of the Micro Channel window.

POS Subaddress 257



POS subaddress = 0101h, read/write
On channel reset, contents become 000U UUU0b
U means that the bit is undefined

Figure 17. POS Subaddress 257

Boot control
Bit 1 controls execution of the adapter microcode after an adapter reset. It should normally be 0b.

When the boot-control bit is set to 1b during an adapter reset, the adapter does not branch out of the protected sectors of the flash EPROM into the changeable sectors. In this state the adapter only accepts the Download command. Following the Download command, the host should reset the boot-control bit to 0b and then perform an adapter reset. This activates the new microcode and ensures that the adapter resets itself correctly after a type-1 error.

If the host is not issuing a Download command after an adapter reset, POS subaddress 257 should be set to zero to allow other commands to be executed.

Chapter 4. Adapter-to-Device Interface

Except where noted below the SSA ports conform fully with the SSA architectures described in “Supported Standards” on page 4.

The SSA 4-Port RAID Adapter and Micro Channel SSA Multi-Initiator/RAID EL Adapter cards each have 4 SSA ports which always operate as 2 dual-port nodes. The adapters do not operate as SSA switches or as single-port nodes.

Each dual-port node is an initiator with its own SSA unique ID. These differ only in the low order bit.

The initiators always use the shortest available path to the addressed device.

Upper Level Protocol

The upper level protocol returned by a Micro Channel SSA Multi-Initiator/RAID EL Adapter in the query-node-reply message is FCh (Vendor Unique).

The protocol—list field in query_protocol_reply contains the following information:

Byte	Contents	
0	FCh	
1 through 3	000629h	(Bytes 1 through 3 are part of the unique ID number identifying IBM)
4	01h	Adapters with code before level 50 that support up to 2 adapters in a loop
	02h	Adapters with code at or later than level 50 that support up to 8 adapters in a loop

Data Transfers

Each SSA port can sustain 10 concurrent data transfers.

The adapter hardware can only perform SSA data transfers that contain an even number of data bytes. This imposes the following requirements on the target:

- If the target needs to return an odd number of data bytes (for example, for an Inquiry command), it must append a pad byte and the byte count in the previous data-ready message must be an even number.
- The byte count in data-request messages must be an even number.

Master Functions

Either or both of the initiators on the adapter card can function as an SSA master. When an SSA loop contains more than one adapter, the adapter with the highest unique ID, of the highest master-priority field returned in a reply to a query-node message, is the master. (All of the unique IDs are already known to each initiator in the SSA configuration table, which is built by walking the network with query-node messages.)

Port Configuration

When it is operating as a master the adapter issues a configure-port message to each port in the network:

- The port is allocated a tag, port, and return path for use by subsequent async-alert messages.
- The A and B SAT quotas are configured according to the guide-lines in the SSA standard.

  Note: The adapter does not support multiple SAT regions. All ports are configured to propagate SAT tokens.
- The routing of user-defined characters through the master node in a loop is blocked to avoid continuous circulation.

  Note: The adapter does not originate or use spindle-sync characters.

Asynchronous Alerts

When it is operating as a master, the adapter is responsible for:

- Propagating an asynchronous alert by sending a Master_alert message to each initiator
- Performing a third-party quiesce on behalf of a missing initiator
- Returning the affected ports to normal mode after a transient unrecoverable error.

Configurations

The SSA adapter supports string and loop networks only. The following restrictions are imposed to ensure good performance:

- To be fault-tolerant and allow concurrent maintenance, all networks should be installed as loops rather than strings.
- No more than 48 disk drives can be connected in the same SSA loop.
- Both the initiators of an adapter must not be connected in the same SSA loop.
- A single SSA loop can contain only one adapter if:
  1. The adapter is a MicroChannel SSA 4-Port RAID Adapter, or
  2. The adapter is a Micro Channel SSA Multi-Initiator/RAID EL Adapter and any disk or RAID array is configured for Fast-write active, or
  3. The adapter is a Micro Channel SSA Multi-Initiator/RAID EL Adapter with code before level 50 and any disk is configured as a member of a RAID/5 array.
- A single SSA loop can contain up to two adapters if:
  1. Either adapter is a PCI or MicroChannel SSA Multi-Initiator/RAID EL adapter with code before level 50 and no links are configured as members of a RAID array or for fast-write active, or
  2. Both adapters are PCI or MicroChannel SSA Multi-Initiator/RAID EL adapters with code at, or later than, level 50 and whose disks are configured as disks or members of RAID-5 arrays with no disks or RAID-5 arrays configured for fast-write active.
- A single SSA loop can contain up to eight adapters if all the adapters are PCI or MicroChannel SSA Multi-Initiator/RAID EL adapters with code at, or later than, level 50 and no disks are configured as members of RAID-5 arrays or with fast-write active.
- No more than 4 SSA adapters should be plugged into the same Micro Channel.
- All member disks of an array configured on a Micro Channel SSA Multi-Initiator/RAID EL Adapter must be in the same SSA loop. The member disks of an array configured on an SSA 4-Port RAID Adapter can be in any loop.

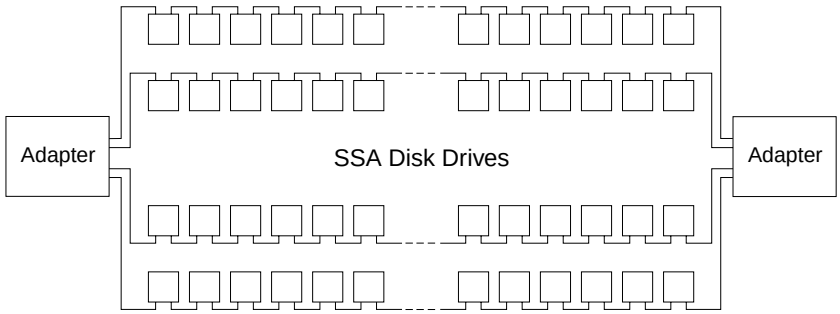


Figure 18. An Example of Two Adapters Sharing Two SSA Loops

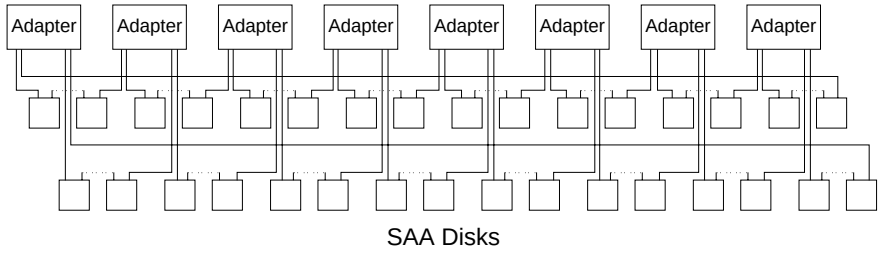


Figure 19. An Example of Eight Adapters Sharing Two SSA Loops

Adapter Card

The SSA 4-Port RAID Adapter and Micro Channel SSA Multi-Initiator/RAID EL Adapter are type 5 Micro Channel cards. The cards measure 333 mm long by 114 mm high, excluding the Micro Channel connector.

The SSA Fast-Write Cache Option Card is a separate card with a PCMCIA connector that can be plugged in to a Micro Channel SSA Multi-Initiator/RAID EL Adapter. The SSA Fast-Write Cache Option Card has 4MB of nonvolatile memory and supporting logic. A SSA Fast-Write Cache Option Card can be removed from a failed adapter and installed on a replacement adapter.

Figure 20 on page 43 shows a SSA 4-Port RAID Adapter card. Figure 21 on page 44 shows a Micro Channel SSA Multi-Initiator/RAID EL Adapter card with an SSA Fast-Write Cache Option Card installed on it.

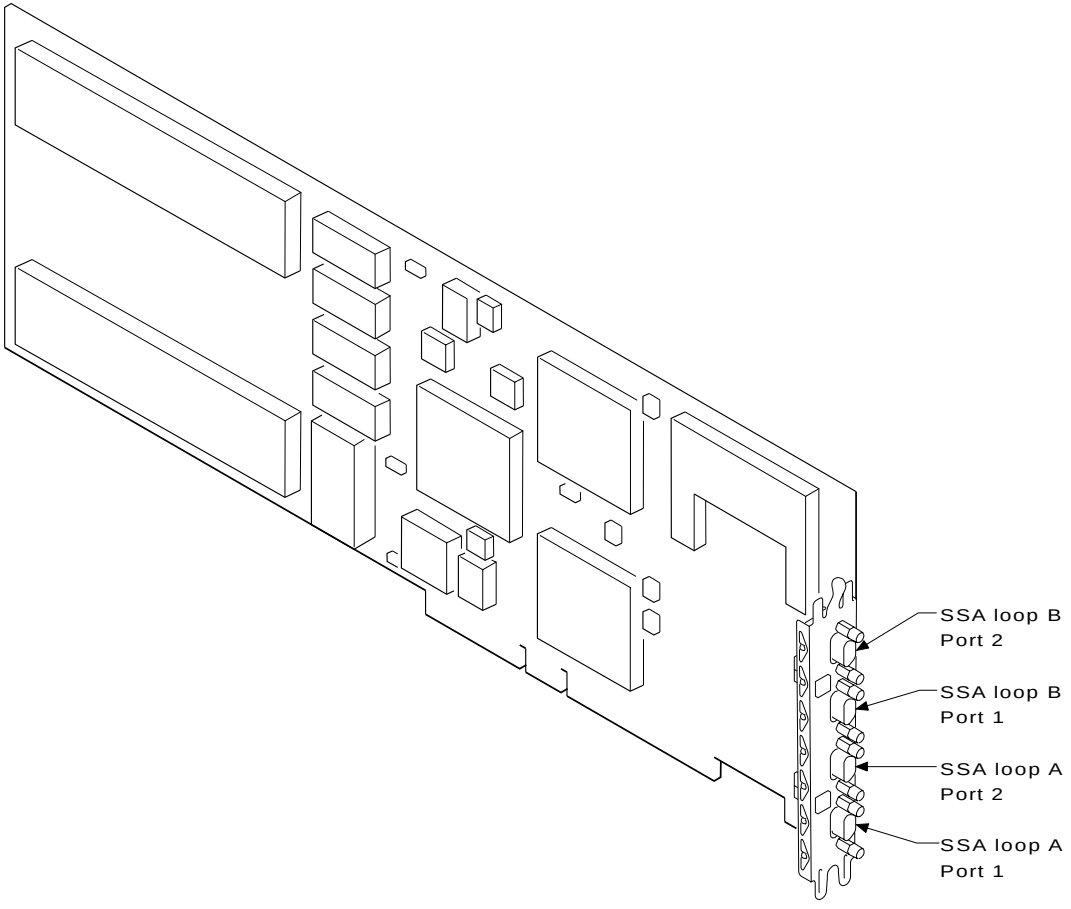


Figure 20. SSA 4-Port RAID Adapter Card Layout

SSA Connectors

The adapter card has 2 internal SSA connectors and 4 external connectors. This allows one of the 2 dual-port SSA nodes to be connected either internally or externally to the system unit. The internal connectors are 2 x 3 pin SSA connectors.

The ports are clearly numbered ‘A1’, ‘A2’, ‘B1’, and ‘B2’ at the connectors. Ports B1 and B2 have both internal and external connectors. The marking also indicates that ports A1 and A2 are paired, that is, they are connected to the same SSA loop interface chip. Similarly, ports B1 and B2 are paired.

+5 V power is available on the connector to power an external optical extender.

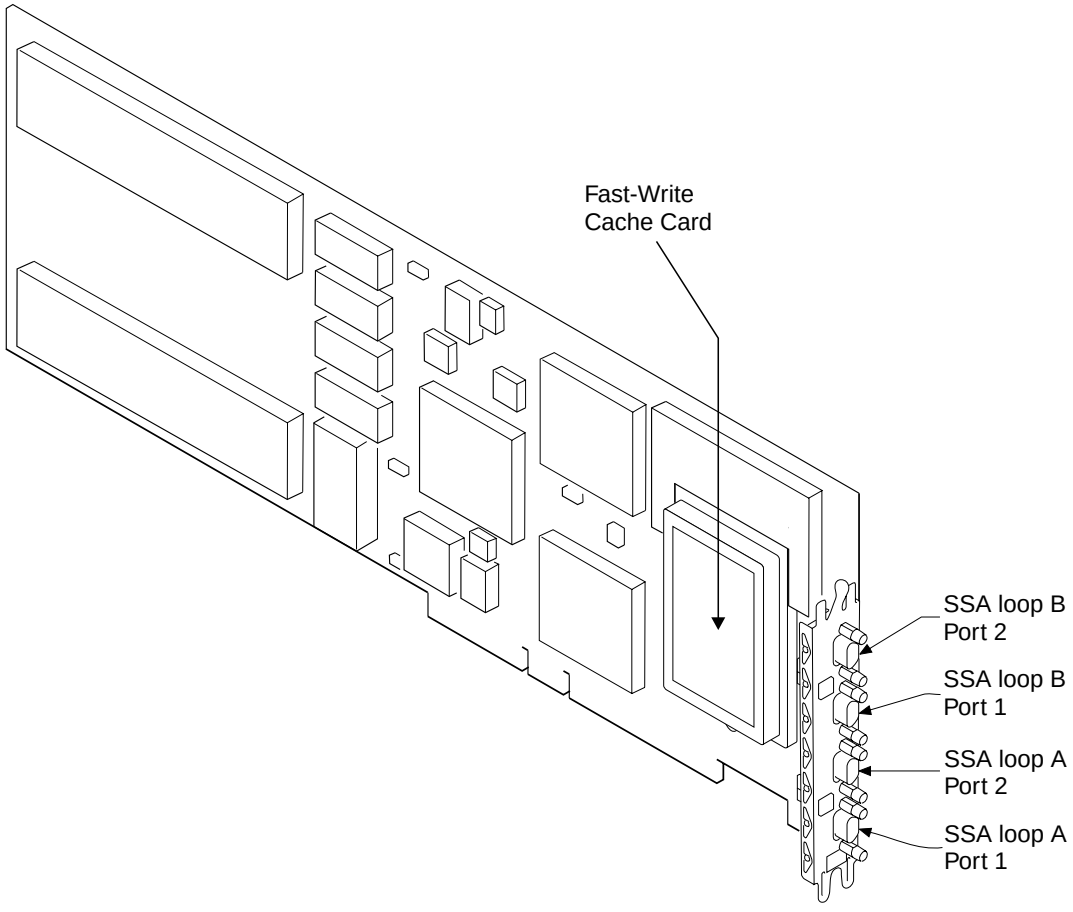


Figure 21. Micro Channel SSA Multi-Initiator/RAID EL Adapter Card Layout

Indicators

A light is provided for each SSA loop interface to assist in service for the SSA network. When one port of a SSA loop interface is not operational, the light for that SSA loop interface flashes continuously at approximately once every 2 seconds.

In addition there is a light mounted internally on the card rather than at the side with the connectors that flickers when there is activity on the adapter, that is, when it is processing I/O requests. If it is not flickering it means that either the system is not requesting any I/O operations or that the adapter has failed. This light may not be clearly visible on all systems.

Power Requirements

Voltage

5.0 +5%, −4.5%

Current
3.0 A maximum

Power 15 W maximum

Ripple 100 mV peak-to-peak maximum, dc to 50 KHz

Environment

Operating

Temperature
10 to 40°C

Humidity
8 to 80 %, noncondensing

Altitude
0 to 7,000 feet

Cooling
Natural convection

EMC FCC class A and CISPR 22 when packaged in a system unit

Nonoperating

Temperature
−40 to 60°C

Humidity
5 to 80 %, noncondensing

Altitude
−1,000 to 40,000 feet

SSA Cables

The external cables comply with the electrical characteristics defined in the *Serial Storage Architecture - 1995 Physical* document. Cable of 28 AWG gauge is used for lengths up to 20 meters. For a length of 25 meters, a 26 AWG gauge cable is used.

Fibre-Optic Extender

A fibre-optic extender is available to connect an industry-standard fiber optic cable within an SSA loop when that loop is used with a 7133 SSA Disk Subsystem. With a fibre-optic extender attached at each node, the distance between them can be up to 2.4 km. The maximum sustainable data-transfer rate in a single direction on an SSA link is approximately 18 MB/s. Extending the link with a fiber optic cable results in no degradation of this data-transfer rate for lengths up to 200 meters, and a gradual reduction in the achievable data-transfer rate beyond this distance. This data-transfer rate reduction generally has no effect on SSA subsystem performance for most applications.

Chapter 5. Array and Fast Write Filters

The SSA 4-Port RAID Adapter and Micro Channel SSA Multi-Initiator/RAID EL Adapter provide RAID functions by means of a filter between the device driver and the disk drive. The filter is implemented in microcode that runs in the adapter. The filter presents the image of a single disk drive to the device driver, and uses one or more members to implement this image. IPN transactions are provided to configure the image. The members are disk drives that are attached to this adapter. All, some, or none of the disk drives attached to an adapter can be members of the filter. On an SSA 4-Port RAID Adapter, the member disk drives of an array can be in either loop; on a Micro Channel SSA Multi-Initiator/RAID EL Adapter, all the member disk drives of an array must be in the same loop. There can be up to 16 members in an image. This chapter describes the number of members allowed, and the mapping from the image to the members, for the filter that is supplied in the adapter.

If the members of an array have different sizes, only the capacity of the smallest member is used for each member.

The adapters can support up to 32 arrays.

Disk Drives not in Arrays

The adapters support the use of attached disk drives without any filter. Data is transferred directly from the system interface to the SSA link without passing through a buffer.

The adapter overhead for nonarray operations is typically less than 125 µs and the microprocessor utilization is less than 330 µs. The adapter can execute up to 3000 short read/write operations per second, depending on the attached devices.

RAID-5

The RAID-5 filter combines N+1 members of equal capacity, C. A few kilobytes K are reserved for use by the filter; the rest are used for data and parity storage. In general, the first S blocks (a strip) of the image are mapped to the first S blocks of one member, and the second S blocks to the first S blocks of the next member, and so on across N members. The exclusive-OR of these strips (parity) is written on the first S blocks of

another member of the N+1 array. In the SSA 4-Port RAID Adapter, the parity of the first strips is held on member 1, the first data strip is on member 2, the second data strip is on member 3, and so on to the Nth data strip which is on member N+1. The parity of the next N strips is on member 1, The (N+1)th data strip is on member 2, the (N+2)th data strip is on member 3, and so on.

This pattern is repeated for the first 4xN data strips. For the next 4xN data strips, the parity is on the second member and the data strips start on the third member. This rotation of the parity member continues every 4xN data strips.

Read operations from the host are mapped into read operations to the members holding the required data. For short operations, this is usually one member; for longer transfers, all members might be used.

Write operations are handled in one of two ways:

- If aligned NxS blocks are to be written, data is written to N members, and the parity calculated and written to the remaining member.
- For other write operations, the old data is read from one member and the corresponding old parity from another. Then the new parity is calculated by exclusive-OR of old data, new data, and old parity, and the new data and new parity are written to the appropriate members. That is, a single host write operation becomes a read operation and a write operation to each of two members.

Writing using the first of these methods gives better performance because it requires fewer disk accesses.

A write operation is reported complete when the new data is written to the data disk. The new parity may be written to disk later. To protect against power failure before this is done, a note of the outstanding parity update is made in the nonvolatile memory.

Data transfer for RAID-5 operations takes place through the data buffer; data in the data buffer is used as a read cache to satisfy later read operations. This is particularly useful for RAID-5, because even write operations to a RAID-5 array result in read operations to physical disk drive members.

The microprocessor utilization for RAID-5 operations is less than 1 ms for a mixture of 30% write and 70% read, so that the adapter can perform up to 1000 RAID-5 operations per second.

The number of members N+1 must be in the range 3 to 16. The size (S) of each strip is 64KB. If the member capacity C-K is not a multiple of S, then the excess space is not used; the capacity of the image is

```
((C-K) mod S)xSxN
```

A resource-dependent-value attribute (PageAlignedSplits) is defined for RAID-5 that permits data to be written out of order even when the FF_Split bit is off. This can be set at configuration time.

If a write operation, whose data lies wholly within an aligned 4K page, is interrupted and does not complete, the resulting data recorded (as retrieved by a subsequent read operation) is one of:

- All the old data
- All the new data
- A single transition from new data to old data at some sector boundary within the data.

(An *aligned 4K page* is the first 4KB section of the logical array address space (starting at address 0) and each subsequent contiguous 4KB section of its address space.)

An operation that straddles more than one aligned 4K page is regarded as having been broken into aligned-4K-page operations and each is treated independently by the above rules. There is no guarantee of the order of the 4K pages to which the data is written.

When the PageAlignedSplits attribute is on, write operations take place in any order. The FF_Split value of the writes to each member matches that on the write transaction to the array; so, if split is turned off, data is guaranteed to be written in ascending LBA order on each member. When the PageAlignedSplits attribute is off and FF_Split is off, writes take place in ascending LBA order for the array.

Hot spares

Arrays can be configured with hot-spare disk drives. If an array has a hot spare disk drive available when a member fails, the hot spare is automatically used to replace the failed member. On an SSA 4-Port RAID Adapter, a single hot spare can be used to replace any failed disk drive that is a member of any array; on a Micro Channel SSA Multi-Initiator/RAID EL Adapter, a hot spare is required on each SSA loop in which there are array members.

When a disk drive fails and is missing from an SSA loop, it is replaced by a hot spare when a write transaction is received or, if the array has no incorrect data, when a read transaction is received.

It is recommended that hot spares are available. A write operation to an array that has a member missing causes that array to enter the degraded state. Unless the array is operating in the read-only-while-exposed mode, if an array is in the degraded state and if a write operation to the parity disk has not been completed and if there is a loss of power, data for the unwritten blocks cannot be recreated when the missing disk is replaced.

Fast Write

The fast write filter adds fast-write caching capability for individual disk drives and arrays. A write operation to a fast write filter results initially in the data being written to both the nonvolatile fast write cache and the volatile data buffer on the adapter; after which, status is sent to indicate that the operation is complete. At some later time, the data is written to the underlying disk drive or array; after which, the data in the

nonvolatile fast write cache is discarded. If a second write operation is addressed to the same location, the later one might replace the earlier in the buffer before it has been written to the underlying component. If multiple writes are done to adjacent locations, they may be combined into a single write to the disk. The service time is much shorter because completion is signalled as soon as the data is in the buffer.

If power fails before the data is written to disk, the data is preserved in the fast write cache. When power is restored the adapter, it writes the data to disk. If the adapter fails, any data not yet written to disk is preserved in the fast write cache, which can be removed and fitted to the replacement adapter card. When this new adapter is powered up, it writes the data to disk.

The fast write cache size is 4 MB. An LRC is generated for each page in the cache for integrity checking after a loss of power.

Any array or individually-accessed disk can be configured for fast write. For these arrays or disks all transactions from the host are sent to the fast write filter. The execution of the transactions is as follows:

Write Operations

- If the length of data is less than a defined value (which can be set by the user), the data is saved in the cache and completion is signaled before data is written to disk. Also, the user can specify the range of logical block addresses that are to be candidates for saving in the cache.
- If the length of data is greater than a defined value (which can be set by the user), the transaction is passed to the array or individually-accessed disk and data is written to disk before completion is signaled.

Read Operations

- If all the requested data is held in the cache, the fast write filter sends it from the volatile data buffer to the host without involving the RAID or disk services.
- If none of the requested data is held in the cache, the read transaction is forwarded to the RAID filter or disk service for execution.
- If part of the requested data is held in the cache, this data is destaged to the disks before the read transaction is forwarded to the RAID filter or disk service for execution.

Data is destaged from the nonvolatile data buffer to the disks at the following times:

- When the resource is closed.
- When a FN_ISAL_Flush transaction is executed for the resource.
- When the cache contains a set percentage of its maximum capacity. Data is not destaged immediately to benefit from the possibility of merging writes to disks.
- When data has been in the cache for a set duration (a few minutes).
- When a contiguous block of data has been saved in the cache. The amount of contiguous data for the RAID filter is a stripe (Nxstrip).

Array States

An array can be in one of the following states:

Online-Good
The array is online and it can be read and written. All the array members are present. All parity data (except that affected by recently completed write operations) is synchronized. No data or parity rebuilding is outstanding. The array is fully protected against the loss of one member.

Online-Exposed
One member is missing from the array. When the array is read, data can be reconstructed for the missing member. The first write operation causes the array to enter the Online-Degraded state, unless there is no hot spare available that can be used to replace the missing member.

In the Online-Exposed state, the missing member can be reintroduced or replaced. Then, after any necessary rebuilding, the array is returned to the Online-Good state.

Online-Degraded
One member is missing and a write operation has been received for the array. Read and write operations to the array are supported. However, if power is lost before all the parity data has been written, it might not be possible to recreate all the data for the missing member.

The missing member is permanently excluded from the array.

Online-Rebuilding
The array is online and it can be read and written. The full complement of array members are present but data and parity are being rebuilt on one of the members.

Offline
More than one member of the array is missing or has failed. Read and write operations are not supported.

The movement between states is illustrated in Figure 22 on page 52.

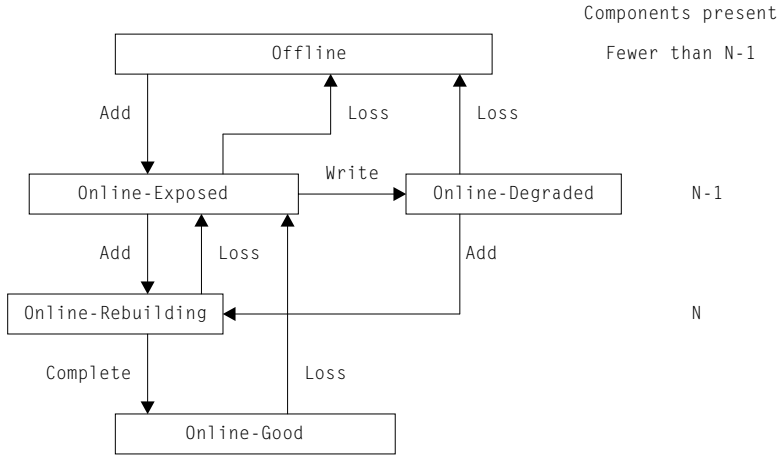


Figure 22. Array State Transitions

Array Configuration

An array-configuration utility is provided to create, delete, and change an array. Essential array information is maintained in the reserved area of the member disks of each array. This includes:

- Array serial number
- Member serial number
- Resource dependent values
- Bit maps (for bad parity)
- Out-of-sync flag

All the essential information is on the disks. The bit maps may be supplemented by information in the NVRAM. The information is stored in such a way that:

- If any disk is removed, it is still possible to operate the array
- If more than one disk is removed, it is possible to identify the serial number of the array but, possibly, no more.
- If any update to the information is interrupted or fails for any reason, it is still possible to determine the state of the array.

Multi-way RAID

On Micro Channel SSA 4-Port RAID adapters and Micro Channel SSA Multi-Initiator RAID/EL adapters with code prior to level 50, arrays are only available to a single host system. The micro Channel SSA Multi-Initiator RAID/EL adapter with code at level 50 or later allows 2 host systems to share the arrays. These hosts may also shared devices that are not configured in arrays.

Each system can execute to shared arrays all the functions currently provided for unshared arrays plus additional locking and fencing functions to allow systems to control access to the arrays.

No single failure of any component in the system should cause an array to be inaccessible to all healthy systems.

Member disks of an array must all be on the same SSA loop. All adapters on the same loop as a Micro Channel SSA Multi-Initiator/EL adapter with code at level 50 or later where any disk is configured for RAID, must have a SSA upper level protocol = FCh and a Query_protocol list = 02h. This identifies either a PCI or Micro Channel Multi-Initiator/EL adapter that supports RAID from two adapters. Up to two adapters can control the arrays that exist on two SSA loops between both adapters.

The two adapters act as peers for operations to arrays that have been configured from disks on the SSA loops. Each can read and write directly to the disks, but need to request locks to the other adapter to ensure their operations do not conflict. Some operations do not require a lock from the partner adapter before execution, for example a read if the partner has not locked the area of LBAs. All write operations require a lock with the partner adapter. A synchronising agent controls the transfer and acknowledgement of locks. A write operation involves requesting a lock for the required strips from the partner adapter. The partner grants the lock and remembers the strip that may now contain out of date parity information in its NVRAM. If the first adapter fails before the write completes, the partner has the information in its NVRAM of strips with out of date parity and is able to regenerate the parity after the adapter failure.

By exchanging locks during operations and by keeping synchronising information on each array, whenever one of the partner adapter fails, the other can continue to operate and there is no impact to any of the arrays

If there is only one adapter in the network, the array filters continue to request locks through the synchronising agent which immediately grants all lock requests on behalf of the absent adapter.

Fast Write Cache is supported provided there is only one adapter in the SSA loop.

Chapter 6. IPN Transactions

Introduction

The SSA 4-Port RAID Adapter provides a registry service, a disk service, and an array-configuration service, and an adapter service. Transactions are transmitted across the Micro Channel to these services in a Gateway Transaction Control Block (GTCB). The format of the GTCB is defined in “Gateway Transaction Control Block (GTCB)” on page 9.

Services are at the heart of the IPN architecture. They form the server side of the client-server model. All communication to and from a service uses IPN transactions. Each server can be said to exist on a node and have its own unique service number. The combination of the node and service number form the network address of the service.

Generally services are used to gain access to a resource, whose size and importance can vary greatly.

Every service has a service language that describes the way that the communication to that service must be performed. IPN Storage Access Language (ISAL) is the language used by the disk service. IPN Array Configuration Language (IACL) is the language used by the array-configuration service.

When a service is installed into an IPN kernel the type of the service must be declared. This effectively declares what type of language the service understands. The service type is a one-byte code and can be one of the following:

TP_ISAL
A disk or other resource that acts like one (see “Disk Service” on page 89)

TP_Registry
A local information server (see “Registry Service” on page 59)

TP_CfgAgent
An array configurator (see “Array-Configuration Service” on page 151).

TP_AdapterService
An adapter service (see “Adapter Service” on page 132).

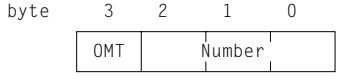
TP_ErrorLogger
A service in the device driver that receives error logs.

Device Addressing

Logical disks are identified by a resource ID. The host uses this resource ID to open the resource. During the process of opening the resource, a handle is returned for the resource. The host uses this handle when sending transactions to the resource.

Resource ID

The resource ID is an identifier that is passed to the resource manager to identify which logical disk the caller is referring to. The resource ID has the following structure:
Byte 3 is the owning-module-type field. This is a number that identifies the logical owner



of the resource. An SSA disk might be logically owned by the host disk driver; or, if it is part of a disk array, it might be owned by the RAID-5 manager. The following values are used:

```
OMT = 1 - Not Owned by anyone
      2 - Device Driver Physical Adapters
      3 - Device Driver Physical Targets                        (pdisks)
      4 - Device Driver manually configured logical disks       (hdisks)
      5 - Device Driver automatically configured logical disks (hdisks)
     'K'- RAID-5
     'W'- Disowned
     'Y'- Hot spare disk
```

The lower 24 bits of the resource ID is a number that is used to identify which resource is being used. This number is set automatically by the resource manager; asking the registry for a temporary resource ID (using the FN_REGY_GetTempResrcID transaction) provides a unique 24-bit number for this field.

ISAL Reserved Area

ISAL disk resources maintain a reserved area of 512 byte blocks. The number of blocks available is reported in the FN_ISALMgr_Characteristics transaction. The SSA Disk ISAL manager internally has 32 blocks mirrored of which 30 are available to the user. The blocks are normally mirrored on a disk so that 64 sectors are required. The normal ISAL interface (FN_ISAL_Read/Write) is used to read and write this area. A flag

specifies that the I/O should be directed to the reserved area. There are a number of restrictions that apply to data in this area which are:

- I/O operations can only be one block in length.
- The first 16 bytes of all blocks are reserved, so each block must have the following format:
  The signature is a unique 8-byte field that is used to identify the sector as containing

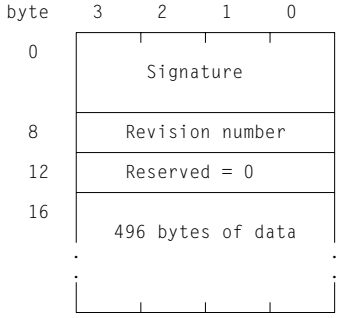


Figure 23. ISAL Reserved Area Sector Format

valid reserved area data (all the 32 sectors share the same signature). The signature field is an ASCII string 'ISALSIGN'. The revision number is used when reading the reserved data. The resource manager should read both mirrored copies and return the sector that contains the highest revision number (normally both are the same).

When writing a sector in the reserved area, the call sets up the first 16 bytes according to the rules here, and it is recommended that the new revision number is higher than the old value.

For the SSA 4-Port RAID Adapter, the reserved area starts 128 sectors from the end of the disk. The first sector of the reserved data (sector 0) is reserved as the device label record. Sectors 2 to 31 appear as ISAL reserved blocks 0 to 29.

Label Record

The label record is where the owning-module type (OMT) is recorded. If the OMT is OM_DriverManualDisk (used only in PC systems), the disk-number field is valid and is used. The label record is kept in the ISAL reserved area but is not accessible by a Read or Write operation. It is only written when an OMT other than OM_DriverAutomaticDisk is set.

Registry Service

The function of the registry service is to maintain a database of IPN information. Each node runs a copy of the registry service. The registry service has a fixed service number (0000 0001h).

The registry service keeps a list of all of the services running on its node, and also a list of all the other nodes that can be accessed through a gateway from its node. Using these two lists, it is possible to walk the whole IPN network and discover what services are available.

In addition, the registry service performs a number of asynchronous notification services, such as error logging. The error logging process registers itself with all the registries. When a module detects an error, it reports this to its local registry service. The registry service sees that the error is sent to the error logger. This approach avoids the error logger having to register itself with every module that is capable of logging an error.

The registry service supports the following application transactions:

Table 10. Registry Transactions

Transaction	Minor_function
FN_REGY_SystemVersionInfo	10
FN_REGY_GatewayNodeList	11
FN_REGY_Servicelist	13
FN_REGY_ConnectForNodeChange	14
FN_REGY_DiscForNodeChange	15
FN_REGY_NodeChangeToRegistry	16
FN_REGY_NodeChangeFromRegistry	17
FN_REGY_ConnectForErrorLogging	18
FN_REGY_DiscForErrorLogging	19
FN_REGY_LogErrorTo Registry	20
FN_REGY_LogErrorFromRegistry	21
FN_REGY_ConnectForResrcChange	22
FN_REGY_DiscForResrcChange	23
FN_REGY_ResrcChangeToRegistry	24
FN_REGY_ResrcChangeFromRegistry	25
FN_REGY_ResrcList	26
FN_REGY_GetTempResrcID	27
FN_REGY_ConnectForHealthCheck	28
FN_REGY_DiscForHealthCheck	29
FN_REGY_HealthCheckToRegistry	30
FN_REGY_HealthCheckFromRegistry	31
FN_REGY_SerialNumberSearch	32
FN_REGY_TestResrcsReady	33
FN_REGY_SetClusterNumber	34
FN_REGY_TestOneResrcReady	35
FN_REGY_SyncHCheckToRegy	36
FN_REGY_SyncHCheckFromRegy	37

FN_REGY_SystemVersionInfo

This transaction can be sent to a registry service to obtain its code level.

Minor_function
10

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to the buffer allocated to receive the following data:

Byte	3	2	1	0
0	Version			

Version
This field contains a 32-bit unsigned integer that identifies the current level of the registry code.

Result The following result fields can be returned:
AS_Success

FN_REGY_GatewayNodeList

This transaction returns the numbers of all the IPN nodes that might be known to the system. Further investigation is required to determine if a node is currently attached. The adapter registry services return a list of all nodes that could be connected for this configuration.

Minor_function
11

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
This is a pointer to a buffer which will receive the following data:

Byte	3	2	1	0
0	Node			
4	Node			
.				
n	Node			

Node This field contains the number of an IPN node that might be attached.

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count This field contains the number of entries in the received data DDR.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_ServiceList

This transaction returns the numbers of the Services that are running on the same node as the registry service.

Minor_function
13

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0			Type

Type This identifies the type of services that should be reported. “Service / Transaction Directives” on page 216 gives the full list of types supported; these include:
TP_ISAL
Disk service (or something that acts like one)
TP_Registry
Local information server
TP_CfgAgent
Array-configuration service
TP_AdapterService
Adapter service

Transmit_DDR
Null

Receive_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Service			
4	Service			
.				
n	Service			

Service
This identifies the services of the requested type on this node.

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count This field contains the number of entries in the received data DDR.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_ConnectForNodeChange

This transaction registers the caller as being interested in node-change asynchronous alerts.

Minor_function
14

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	Reserved= 0			Synchro

Node This identifies the IPN node to which node-change asynchronous alerts should be reported.

Service
This identifies the service of the IPN node to which node-change asynchronous alerts should be reported.

Synchro
When the synchro field is SR_Synchro, the registry service sends node-change asynchronous alerts for all nodes known to the registry service before this transaction completes. When the synchro field is SR_NoSynchro, node-change asynchronous alerts are only sent for nodes that register after the transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_TableFull

FN_REGY_DiscForNodeChange

This transaction registers the caller as being no longer interested in node-change asynchronous alerts.

Minor_function
15

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	Reserved = 0			Synchro

Node This identifies the IPN node to which node-change asynchronous alerts had been reported.

Service
This identifies the service of the IPN node to which node-change asynchronous alerts had been reported.

Synchro
When the synchro field is SR_Synchro, a node-change async with event type EV_NodeDead is reported for each known node. When the synchro field is SR_NoSynchro, no node-change asynchronous alerts are sent as a result of this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_NotInTable

FN_REGY_NodeChangeToRegistry

This transaction tells the registry service that the status of a node has changed. This is an internal transaction within the adapter.

Minor_function
16

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Event			
8	Reserved = 0			

Node This identifies the IPN node whose status has changed.

Event This identifies the event, which can be:
EV_NodeDead
Node has stopped working
EV_Rebooted
Node has completed its IPL

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_NodeChangeFromRegistry

This async transaction is passed on to all the modules that have connected for node-change asynchronous alerts.

To ensure that deadlock does not occur in the registry service, the receiver of this transaction should complete this transaction before issuing another transaction to the registry service.

Minor_function
17

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Event			
8	Reserved = 0			Synchro

Node This identifies the IPN node whose status has changed.

Event This identifies the event, which can be:
EV_NodeDead
Node has stopped working
EV_Rebooted
Node has completed its IPL

Synchro
The synchro field is SR_Synchro if the transaction is sent as a result of a FN_REGY_ConnectForNodeChange or FN_REGY_DiscForNodeChange transaction in which the synchro field was SR_Synchro. Otherwise, the synchro field is SR_NoSynchro.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_ConnectForErrorLogging

This transaction tells the registry service the node and service number of the error logger.

Minor_function
18

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			

Node This identifies the IPN node to which error logs should be sent.

Service
This identifies the service of the IPN node to which error logs should be sent.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_TableFull

FN_REGY_DiscForErrorLogging

This transaction tells the registry service that the error logger is no longer interested in receiving error logging records.

Minor_function
19

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			

Node This identifies the IPN node to which error logs had previously been sent.

Service
This identifies the service of the IPN node to which error logs had previously been sent.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_NotInTable

FN_REGY_LogErrorToRegistry

This transaction requests the registry service to send an error logging record to the error logger.

Minor_function
20

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0 through n	Error Data			

Error Data
See “FN_REGY_LogErrorFromRegistry” for the definition of error data.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_LogErrorFromRegistry

This transaction requests the error logger to log the error data supplied.

To ensure that deadlock does not occur in the registry service, the receiver of this transaction should complete this transaction before issuing another transaction to the registry service.

Minor_function
21

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Sense Format	Template	Type
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Port 1 SSA loop A	Port 2 SSA loop A	Port 1 SSA loop B	Port 2 SSA loop B
24	Count			
28 through n	Sense Data			

Type This defines the type of the sender of the error data:

TY_Disk
Disk

TY_Adapter
Adapter

Template
This defines the error template that should be used for logging the error data.

Sense Format
This defines the format of the sense-data filed when the type is TY_Adapter, as follows:

0 SD_Code:

Error code in bytes 28 through 30

1 SD_CodeAsn:

Error code in bytes 28 through 30, reserved in byte 31, array serial number in bytes 32 through 46

2 SD_CodeAsnCsn:

Error code in bytes 28 through 30, reserved in byte 31, array serial number in bytes 32 through 46, component serial number in bytes 48 through 62.

3

Byte **Content**

28 through 30
Error code = 000000h

31 Reserved

32 Network

0 NI_NetworkA

1 NI_NetworkB

33 Loop

0 LP_Unknown

1 LP_Loop

2 LP_String

34 Legal

0 LG_Unknown

1 LG_Legal

2 LG_Illegal

35 Master

0 MN_Unknown

1 MN_Master

2 MN_NonMaster

36 through 39
Node count (that is, the number of nodes, including this one, on this SSA network or 0xFFFFFFFF, if unknown)

40 through 43
Initiator count (that is, the number of initiators, including this one, on this SSA network or 0xFFFFFFFF, if unknown)

4

28 through 30
Error code

31 Reserved

32 through 46
Resource serial number

48 through 62
Logical Block Address

Serial Number
This 15-byte ASCII character field contains the serial number of the sender.

When the type field is TY_Adapter, the format of the serial number is the ASCII card serial number (as reported in the POS register) in bytes 4 through 11 and ASCII blanks in bytes 12 through 18.

When the type field is TY_Disk, the format of the serial number is as defined in “FN_ISALMgr_Inquiry” on page 91.

Port n This is the SSA address of the node in error on this port of the adapter card, or FFh if the disk in error is not connected to this port. If the type is TY_Adapter, this field is FFh.

Count This is the number of sense data bytes that follow this field.

Sense Data
If the type is TY_Disk, this is the SCSI sense data from the disk.

Note: The sense data received from the SSA-SCSI attachment to the disk is in big-endian format and this is returned in the parameter_DDR data without any byte swapping.

If the type is TY_Adapter, this is adapter status data. This includes the adapter error code in bytes 30 through 28 (byte 28 is the most significant byte). The rest of the sense data (up to byte 59) may include the serial number of the failing array and that of a component disk drive (where appropriate).

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_ConnectForResrcChange

This transaction informs the registry service that the client is interested in resource-change asynchronous alerts for resources of the specified owning module type (OMT).

Minor_function
22

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	Reserved = 0		Synchro	Owning Module Type

Node This identifies the IPN node to which resource-change asynchronous alerts should be sent.

Service
This identifies the service of the IPN node to which resource-change asynchronous alerts should be sent.

Owning Module Type
This identifies the type of resource for which resource-change asynchronous alerts should be sent.

Synchro
When the synchro field is SR_Synchro, the registry service sends, before this transaction completes, a FN_REGY_ResrcChangeFromRegistry transaction for all resources of the specified owning module type currently registered.

When the synchro field is SR_NoSynchro, only resource state changes registered after this transaction has completed are reported by a FN_REGY_ResrcChangeFromRegistry transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_TableFull

FN_REGY_DiscForResrcChange

This transaction informs the registry service that the client is no longer interested in resource-change asynchronous alerts for resources of the specified owning module type.

Minor_function
23

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	Reserved = 0		Synchro	Owning Module Type

Node This identifies the IPN node to which resource-change asynchronous alerts had previously been sent.

Service
This identifies the service of the IPN node to which resource-change asynchronous alerts had previously been sent.

Owning Module Type
This identifies the type of resource for which resource-change asynchronous alerts had previously been sent.

Synchro
When the synchro field is SR_Synchro, a FN_REGY_ResrcChangeFromRegistry transaction is sent before the completion of this transaction for each resource of the specified owning module type known by the registry service.

When the synchro field is SR_NoSynchro, no transactions are sent as a result of this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_NotInTable

FN_REGY_ResrcChangeToRegistry

This transaction informs the registry service about a resource change.

Minor_function
24

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Undefined			
4	Service			
8	ResourceID			
12	Reserved = 0			Change Code

Service
This identifies the service of the resource change.

ResourceID
This identifies the resource that has changed.

Change Code
The resource can be in one of the following states:

Unknown:
It is not possible to communicate with this resource and, if its presence had previously been known and it had been opened, the handle has been closed.

RS_Offline:
The presence of the resource has been detected and a handle is still assigned, but communication to the resource is not now possible. When in this state, the only valid transactions that can be sent to this handle are FN_ISAL_Close, FN_ISALMgrCharacteristics, and FN_ISALMgrStatistics. A result field AE_Offline is returned to all other transactions.

RS_Online:
The presence of the resource is known and is operational. It may or may not have been opened and a handle assigned. Even though it is operational it may not be fully functional, and some transactions may not be fully executed due to the degraded condition of the resource.

The change-code field identifies the reason for the resource change:

CC_Add:
The resource, which was previously unknown, is now in the RS_Offline state.

CC_SetOnline:
The resource, which was previously in the RS_Offline state, is now in the RS_Online state. Communication with this resource, which had a handle assigned, is now possible again.

CC_Add+CC_SetOnline:
The resource, which was previously unknown, is now in the RS_Online state. Communication is now possible.

CC_SetOffline:
The resource, which was previously in the RS_Online state, is now in the RS_Offline state. Communication to the resource is no longer possible but the handle is still assigned.

CC_Remove:
The resource, which was previously in the RS_Offline state,

is now unknown. Communication to the resource is not possible and the handle has been closed.

CC_SetOffline+CC_Remove:
The resource, which was previously in the RS_Online state, is now unknown. Communication to the resource is not possible and a handle is not assigned.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

FN_REGY_ResrcChangeFromRegistry

This transaction informs the previously-identified service of a resource change.

To ensure that deadlock does not occur in the registry service, the receiver of this transaction should complete this transaction before issuing another transaction to the registry service.

Minor_function
25

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	ResourceID			
12	Reserved = 0		Synchro	Change Code

Node This identifies the IPN node of the resource change.

Service
This identifies the service of the resource change.

ResourceID
This identifies the resource that has changed.

Change Code

This code identifies the reason for the resource change. The states of the resource are defined in “FN_REGY_ResrcChangeToRegistry” on page 74.

CC_Add:
The resource, which was previously unknown, is now in the RS_Offline state.

CC_SetOnline:
The resource, which was previously in the RS_Offline state, is now in the RS_Online state. Communication to this resource, which had a handle assigned, is now possible again.

CC_Add+CC_SetOnline:
The resource, which was previously unknown, is now in the RS_Online state. Communication is now possible.

CC_SetOffline -
The resource, which was previously in the RS_Online state, is now in the RS_Offline state. Communication to the resource is no longer possible but the handle is still assigned.

CC_Remove:
The resource, which was previously in the RS_Offline state, is now unknown. Communication to the resource is not possible and the handle has been closed.

CC_SetOffline+CC_Remove:
The resource, which was previously in the RS_Online state, is now unknown. Communication to the resource is not possible and a handle is not assigned.

Synchro

The synchro field is SR_Synchro when the transaction is sent as a result of the synchro field in a FN_REGY_ConnectForResrcChange or FN_REGY_DiscForResrcChange transaction being SR_Synchro.

If the transaction is sent as a result of the synchro field being SR_Synchro in a FN_REGY_ConnectForResrcChange transaction, the change-code field is:

- CC_Add, if the resource is in the RS_Offline state
- A combination of CC_Add and CC_SetOnline, if the resource is in the RS_Online state.

If the transaction is sent as a result of the synchro field in a FN_REGY_DiscForResrcChange transaction being SR_Synchro, the change-code field is:

- CC_Remove, if the resource is in the RS_Offline state
- A combination of CC_Remove and CC_SetOffline, if the resource is in the RS_Online state.

The synchro field is SR_NoSynchro when the resource change transaction is not a result of the synchro field in a FN_REGY_ConnectForResrcChange or FN_REGY_DiscForResrcChange transaction being RS_Synchro.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_RetryWhenMemory

FN_REGY_ResrcList

This transaction returns a list of resource IDs that have been added to the registry service for a particular owning module type (OMT).

Minor_function
26

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Skip		Reserved = 0	Owning Module Type

Skip This defines the number of resource-list entries that should be skipped before the first resource returned in the Receive_DDR data.

Owning Module Type

This identifies the owning module type of resources that should be reported. The owning module types are:

OM_DriverPhysicalDisk
This is for a physical SSA-SCSI disk. It is used by the host to identify disks that can perform commands, such as HardwareInquiry and Open in Service Mode, that cannot be sent to a logical disk. All physical disks have one of these entries in the registry as well as having one of the following logical disk entries. Errors are logged against resource IDs of this owning module type.

OM_NotOwned
This indicates that the disk is not owned by a resource manager or by a driver. This type of disk cannot be used by a driver or resource manager and is therefore a spare disk until the owning module type is changed.

OM_DriverAdapter
Resource IDs with this OMT refer to other adapter cards. This is used to implement adapter to adapter communications needed for HACMP.

OM_DriverManualDisk
This indicates a disk that has been assigned a permanent resource ID with a configuration tool. Personal systems generally require this, but RS/6000 systems do not.

OM_DriverAutomaticDisk
This is the other type of driver-owned logical disk. This indicates that the adapter, rather than an operator, has automatically assigned a number to a disk. All new disks are initialized with this value.

OM_FastWriteFilter
The fast write caching filter owns the disk.

OM_Raid5Filter
The RAID-5 filter owns the disk.

OM_ListAll
Report resource for all owning module types.

Transmit_DDR
Null

Receive_DDR
This is a pointer to a buffer which will receive the following data:

Byte	3	2	1	0
0	ResourceID			
4	Service Number			
8	Reserved = 0			State
12	ResourceID			
16	Service Number			
20	Reserved = 0			State
24	ResourceID			
28	Service Number			
32	Reserved = 0			State
.				
.	.			
n-8	ResourceID			
n-4	Service Number			
n	Reserved = 0			State

ResourceID
These are the resource IDs of the resources with the requested owning-module type. They are sorted in ascending order.

Service Number
This identifies the service for each resource ID of the requested type on this node.

State This can be:

RS_Offline:
The presence of the resource has been detected and a handle is still assigned, but communication to the resource is not now possible. When in this state, the only valid transaction that can be sent to this handle are FN_ISAL_Close, FN_ISALMgrCharacteristics, and FN_ISALMgrStatistics. A result field of AE_Offline is returned to all other transactions.

RS_Online:
The presence of the resource is known and is operational. It may or may not have been opened and a handle assigned. Even though it is operational it may not be fully functional, and some transactions may not be fully executed due to the degraded condition of the resource.

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count The number of entries in the received data DDR.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_GetTempResrcID

This transaction returns a temporary resource ID that can be used by a resource manager that needs to invent a resource ID name. The resulting 32-bit field has a 24-bit number unique among all resource IDs except those of type OM_DriverManualDisk. The upper 8 bits (the owning module type) is set to zero and the caller must fill in his owning module type before the resource ID can be used.

Minor_function
27

Parameter_DDR
None

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer which will receive the following data:

Byte	3	2	1	0
0	Resource ID			

Resource ID
The resulting prototype resource ID.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_ConnectForHealthCheck

This transaction sent to the local registry service by any client that needs to be informed when a health check should be performed.

Minor_function
28

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			

Node This identifies the IPN node.

Service
This identifies the service of the IPN node that is able to perform health checks.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_TableFull

FN_REGY_DiscForHealthCheck

This transaction is sent to the local registry service by any client that no longer needs to be informed of when health checks should occur.

Minor_function
29

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			

Node This identifies the IPN node.

Service
This identifies the service of the IPN node that is no longer able to perform health checks.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_NotInTable

FN_REGY_HealthCheckToRegistry

This transaction is sent to the registry service by a client when a health check needs to be performed.

Minor_function
30

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_HealthCheckFromRegistry

This transaction is sent by the registry service to all the local services that are registered as being able to perform health checks. It indicates these tests should occur now. The service sends error log data to the registry service which, for detected error conditions that cause a degraded operation or require a service action, forwards it to the error logger.

To ensure that deadlock does not occur in the registry service, the receiver of this transaction should complete this transaction before issuing another transaction to the registry service.

Minor_function
31

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_REGY_SerialNumberSearch

This transaction returns the resource ID and service number of the resource identified by the serial number supplied.

Minor_function
32

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0 through 11	Serial Number			
12	Owning Module Type	Serial Number		

Serial Number
This identifies the resource for which the resource ID is requested.

Owning Module Type
This identifies the type of resource, with the requested serial number, that should be reported. If this field is zero, the resourceID of the resource of any owning module type (OMT), except OM_DriverPhysicalDisk, is reported.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	ResourceID			
4	Service Number			
8	Reserved = 0			State

ResourceID
This is the resource ID of the resource identified by the serial number and owning module type.

Service Number
This is the service number of the manager that controls the resource.

State The current state of the resource can be one of the following (described in “FN_REGY_ResrcChangeToRegistry” on page 74):
RS_Online

RS_Offline

Result The following result fields can be returned:
AS_Success

AE_Failure

Illegal Request (range)

AE_NotInTable

FN_REGY_TestResrcsReady

This transaction returns an AS_Success result when all the known resources are ready to receive transactions. This may involve a delay while, for example, the spindle motor of a disk drive is started. If all the resources are not ready within the time period defined in the parameter_DDR, the AS_Failure result field is returned. The registry service sends FN_ISALMgr_TestResrcsReady transactions to all services that are registered to inquire if all their resources are ready.

Minor_function
33

Parameter_DDR
This is a pointer to a the following data:

Byte	3	2	1	0
0	Time			

Time This defines the maximum duration in seconds before a result field must be returned.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
None

Result The following result fields can be returned:
AS_Success

AE_Failure

Illegal Request (range)

FN_REGY_SetClusterNumber

This transaction identifies the cluster number of the system to the registry service. The cluster number can be in the range 0 through 2048. The adapter assumes cluster number 0 from power on until it has been set by this transaction.

Minor_function
34

Parameter_DDR
This is a pointer to a the following data:

Byte	3	2	1	0
0	Cluster Number			

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
None

Result The following result field can be returned:
AS_Success

FN_REGY_TestOneResrcReady

This transaction enquires of the registry the state of a resource identified by a serial number. The resource might not be in a state that permits it to be declared to the registry service.

Minor_function
35

Parameter_DDR
This is a pointer to a the following data:

Byte	3	2	1	0
0 through 11	Serial Number			
12	Reserved = 0	Serial Number		

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
None

Result The following result field can be returned:

AS_Success
The resource is known by the registry service and by a resource manager and can be used. If the resource is an array, it is not exposed, but it might be degraded or rebuilding.

AE_NotReady
The resource is known by a resource manager but it is not ready for use and has not been declared to the registry service. The resource might be a disk drive that is starting. This result is only returned if the resource is expected to become usable later.

AE_Offline
The resource is known by a resource manager but cannot be used because the array is in the offline state. An array is in this state when more than one of its components is not available.

AE_AvoidWrite
The resource is known by the registry service and a resource manager and can be used. However, write operations to the resource should be delayed because a write operation would cause an array to change from the exposed to the degraded state.

AE_NotInTable
The resource is not known by any resource manager.

Illegal Request (range)

Note: If the transaction is rejected with result AE_UnknownFunction, this should be treated as AE_NotInTable.

FN_REGY_SyncHCheckToRegy

In response to a FN_REGY_SyncHCheckToRegy transaction, the registry service issues a FN_REGY_SyncHCheckFromRegy transaction to all the connected services. If they all return AS_Success or AE_UnknownFunction, the registry service returns AS_Success. Otherwise, the registry service returns the most serious sense data it has received by means of the Status_DDR with an AE_Failure result field.

Minor_function
36

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Length			
4 through n	Sense Data			

The sense DDR consists of a 4-byte length field followed by sense information of variable length. The length of the sense data is a multiple of 4 and is less than, or equal to, 36.

Result The following result field can be returned:
AS_Success

Illegal Request (range)

AE_Failure

FN_REGY_SyncHCheckFromRegy

In response to a FN_REGY_HealthCheckFromRegy transaction, a service generates a FN_REGY_LogErrorToRegistry transaction shortly afterwards. However, in response to a FN_REGY_SyncHCheckFromRegy transaction, a service determines the most serious health-check complaint. The sense data that would usually be logged to the registry is returned in the Status_DDR data, and AE_Failure is returned in the result data. If there are no health-check complaints, the service returns AS_Success.

Any service that connects for health checks receives the new FN_REGY_SyncHCheckFromRegy transaction as well as the FN_REGY_HealthCheckFromRegy transaction.

Minor_function
37

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Length			
4 through n	Sense Data			

The sense DDR consists of a 4-byte length field followed by sense information of variable length. The length of the sense data is a multiple of 4 and is less than, or equal to, 36.

Only adapter errors can be returned by this means. The service receiving the FN_REGY_SyncHCheckFromRegy transaction is not permitted to perform lengthy processing (for example, that involving other transactions) before completing the transaction; such delay might cause deadlock within the adapter microcode.

Result The following result field can be returned:
AS_Success

Illegal Request (range)

AE_Failure

AE_UnkownFunction

Disk Service

The SSA 4-Port RAID Adapter disk service uses the IPN Storage Access Language (ISAL) to provide access to the disks in SSA subsystems. The language is similar to SCSI; however, only the functions required by clients are included.

ISAL has a single access mode that is set when the resource is opened. The ISAL transaction that opens a resource establishes a logical connection between the master and slave for that resource. This transaction is sent to the ISAL manager service which returns a handle for that manager that is used, in subsequent transactions, to access the resource just opened. All requests that are sent to the disk service are attempted. Error recovery is performed by the ISAL server and, if this fails, the sender is not required to retry the failed request. There is no contingent allegiance mode. Error logs are reported to the error logger without the sender having to request error data. If a request fails, commands that are waiting are not rejected; they are attempted in turn.

ISAL Transactions

The ISAL transactions that the disk service handles are listed in the following table.

In addressing resources, the handle number acts as a disk number (like a SCSI LUN). The transmit and receive parameters are used to point to I/O data buffers. The function parameter is sent in the minor function code field of the transaction function word, and any other parameters are sent in the parameter field of the transaction.

A physical resource is one with owning module type OM_DriverPhysicalDisk. A logical resource is one with any other owning module type.

Table 11. ISAL Transactions

Transaction	Minor_function	Valid to Logical Resource	Valid to Physical Resource
FN_ISALMgr_Inquiry	40	Yes	Yes
FN_ISALMgr_HardwareInquiry	41	No	Yes
FN_ISALMgr_SetOwningModuleType	42	Yes	No
FN_ISALMgr_AssignManualResrcID	43	Yes	No
FN_ISALMgr_GetPhysicalResrcIDs	44	Yes	No
FN_ISALMgr_GetPhysSvcAndRIDs	64	Yes	No
FN_ISALMgr_TestResrcsReady	45	Yes	Yes
FN_ISALMgr_TestOneResrcReady	63	Yes	Yes
FN_ISALMgr_VPDInquiry	46	Yes (note 4)	Yes
FN_ISALMgr_Characteristics	47	Yes	Yes
FN_ISALMgr_Statistics	48	Yes	Yes
FN_ISALMgr_FlashIndicator	49	Yes	Yes
FN_ISAL_NetworkInquiry (note 5)	66	Yes	No
FN_ISALMgr_Preferences (note 6)	67	Yes	No
FN_ISALMgr_LockQuery	69	Yes	No
FN_ISALMgr_Open	50	Yes (note 1)	Yes (note 3)
FN_ISAL_Close	51	Yes	Yes
FN_ISAL_Read	52	Yes	Yes
FN_ISAL_Write	53	Yes	Yes (Note 2)
FN_ISAL_Format	54	No	Yes (Note 2)
FN_ISAL_Progress	55	No	Yes (Note 2)
FN_ISAL_Lock	56	Yes	Yes
FN_ISAL_Unlock	57	Yes	Yes
FN_ISAL_Test	58	Yes	Yes
FN_ISAL_Download	60	No	Yes
FN_ISAL_Fence (note 6)	62	Yes	Yes
FN_ISAL_SCSI	59	No	Yes
FN_ISAL_Flush (note 5)	68	Yes	Yes

Notes:

1. A logical resource cannot be opened in MD_Service or MD_SCSI mode.

2. Format, Progress and Write transactions are not allowed to a physical resource if the corresponding logical resource for that device is also open.
3. A physical resource cannot be opened in MD_Service mode if the corresponding logical resource for that device is currently open. A physical resource cannot be opened in MD_ISAL_HA mode.
4. The array manager does not support the FN_ISALMgr_VPDInquiry.
5. These transactions are not supported on the SSA 4-Port RAID Adapter.
6. Array manager does not support this transaction on the SSA 4-Port RAID Adapter.

FN_ISALMgr_Inquiry

This transaction is sent to the disk service requesting the serial number of the specified resource.

Minor_function
40

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Resource ID			

Resource ID
This identifies the resource

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0 through 11	Serial Number			
12	Reserved = 0	Serial Number		

Serial Number
This 15-byte ASCII field contains the serial number of the specified resource. It has the following format:

• **Non-RAID Disk:**

Byte	3	2	1	0
0 through 11	Product Identifier			
12	Reserved = 0	'D'	SSA-SCSI LUN	

Note: The ASCII character 'D' is reported in byte 14 of the Status_DDR data if the resource is an SSA disk drive. If the SSA device is of any other type, byte 14 is the hexadecimal digit in bits 3 through 0 of byte 0 of the SSA-SCSI Inquiry data for that device, reported as an ASCII character. For example, the Character '5' is reported for a CD-ROM drive.

Product Identifier
This ASCII field identifies the device attached to the SSA bus. This is the 6-byte IEEE SSA unique ID translated to a 12-character ASCII string.

SSA-SCSI LUN
This ASCII field identifies the SSA-SCSI logical unit number of the resource.

- **Array resource:**

Byte	3	2	1	0
0 through 11	Array Name			
12	Reserved = 0	Array Letter	Array Name	

Array Name
This 14-ASCII-character field identifies the array.

Array Letter
This ASCII character identifies the type of filter of the array resource. The letter 'K' is used for a RAID-5 array.

Result The following Result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

FN_ISALMgr_HardwareInquiry

This transaction is sent to the disk service to return details about the specified resource. It returns hardware specific information. Only SSA resource managers that control physical SSA devices support this transaction. The transaction is rejected with illegal-request result if the owning module type of the resource is other than OM_DriverPhysicalDisk.

Minor_function
41

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Resource ID			
4	Reserved = 0			Immed

Resource ID
This identifies the resource

Immed This field controls whether the result field is returned immediately or after error recovery. (If the disk drive motor is stopped, error recovery can take over a minute.) The field can have the following values:

HI_Immediate
If the motor is stopped, AS_Success is returned immediately with status of ST_Failed and fail code of HF_MotorFail. The adapter attempts error recovery to restart the motor after the result field is returned. HI_Immediate is assumed if the parameter data length is less than 8 bytes.

HI_NotImmediate
If the motor is stopped, full error recovery is performed before the result field is returned.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Port 1 SSA loop A	Port 2 SSA loop A	Port 1 SSA loop B	Port 2 SSA loop B
4	Reserved = 0		Fail Code	Status

Port n This is the SSA address of the node on this port of the adapter card. If the resource is not connected to this port then a value of FFh is returned. These fields are valid if the result field is AS_Success or AE_ReservationConflict.

Status This reports the state of the resource and is valid if the result field is AS_Success. It has the following definition:

ST_Good
Good.

ST_Failed
Failed. In this state, if the resource is a target on a SSA link, a Test Unit Ready SSA command is rejected with check-condition status. This could be due to a failure of POST2, a stopped motor, or any degraded mode condition.

ST_LossRedundancy
In this state, the resource has lost some redundancy, for

example, loss of redundant power or cooling. The ISAL manager determines this by sending a SSA-SCSI Inquiry command to the resource.

Fail Code
This provides more details if the status is ST_Failed:

HF_MotorFail
The motor is stopped

HF_Unknown
No more details of the failure are available.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

AE_ReservationConflict

AE_Offline

AE_OfflineTimeout

AE_Failure

FN_ISALMgr_SetOwningModuleType

This transaction is sent to the disk service to set the owning module type (OMT) for the specified resource. This causes the ID for the resource to change and the new OMT to be written in the label record of the ISAL reserved area. This transaction is not used to change the OMT to OM_DriverManualDisk. FN_ISAL_AssignManualResrcID is used for that purpose.

If the resource is in the open state when this transaction is received, AS_success is returned in the result field, the new resourceID is created, and the old resource goes to the RS_Offline state. The transaction is rejected with illegal-request result if the owning module type of the resource is OM_DriverPhysicalDisk.

Minor_function
42

Parameter_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	Old Resource ID			
4	Reserved = 0			Owning Module Type

Old Resource ID
This specifies the current resource for which the owning module type should be set.

Owning Module Type
This defines the type of disk service that controls the resource.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	New Resource ID			

New Resource ID
This specifies the resource's new ID

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

AE_MediumError

AE_HardwareError

AE_ReservationConflict

AE_FencedOut

AE_Offline

AE_TableFull

AE_FormatDegraded

AE_FormatInProgress

AE_Failure

AE_NonIsal

The resource manager responds to this transaction by removing the old resource ID from the registry, getting a new temporary resource ID (by using a FM_REGY_GetTempResrcID command), setting the new OMT into it, and adding this to the registry.

FN_ISALMgr_AssignManualResrcID

This transaction is sent to the disk service to change a resource ID and owning module type. The owning module type is changed to type OM_DriverManualDisk and this is written in the label record of the ISAL reserved area.

If the resource is in the open state when this transaction is received, AS_Success is returned in the result field, the new resourceID is created, and the old resource goes to the RS_Offline state. The transaction is rejected with illegal-request result if the owning module type of the resource is OM_DriverPhysicalDisk.

Minor_function
43

Parameter_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	Old Resource ID			
4	New Resource ID			

Old Resource ID
This specifies the current resource's ID

New Resource ID
This specifies the resource's new ID. This must have an OMT of OM_DriverManualDisk in the format Ox04HHNNNN where:

Field	Value
HH	00
NNNN	disk number (a value of 0000 is valid but should be avoided)

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AS_InvalidRID

Illegal Request (range)

AE_InvalidRID

AE_MediumError

AE_HardwareError

AE_ReservationConflict

AE_FencedOut

AE_Offline

AE_FormatDegraded

AE_FormatInProgress

AE_Failure

AE_NonIsal

The resource manager responds to this transaction by removing the old resource ID from the registry and adding the new one (using the FN_REGY_ResrcChangeToRegistry transaction for both actions). If the act of adding the new resource ID results in a return of AE_InvalidRID, this means that the new resource ID is already in use and an error is reported to the user.

FN_ISALMgr_GetPhysicalResrcIDs

This transaction is used to translate a logical resource ID into its physical components. This function returns a list of resource IDs that are of type OM_DriverPhysicalDisk. The transaction is rejected with illegal-request result if the owning module type of the resource is OM_DriverPhysicalDisk.

Minor_function
44

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Logical resource ID			

Logical resource ID
This identifies the logical resource ID that is to be translated.

Transmit_DDR
Null

Receive_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Physical resource ID			
4	Physical resource ID			
.				
n	Physical resource ID			

Physical resource ID
This is a list of physical resource IDs that make up the logical resource ID

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count The number of entries in the received data DDR.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

AE_Offline

FN_ISALMgr_GetPhysSvcAndRIDs

This transaction is used to translate the ID of a logical resource into the IDs of its physical components. This function returns a list of resource IDs that are of the type OM_DriverPhysicalDisk and the service number that owns this resource.

The transaction is rejected with Illegal Request if the owning module type of the resource is OM_DriverPhysicalDisk.

Minor_function
64

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Logical Resource ID			

Logical Resource ID
This identifies the logical resource ID that is to be translated.

Transmit_DDR
Null

Receive_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Service number			
4	Physical resource ID			
8	Service number			
12	Physical resource ID			
.	.			
n-4	Service number			
n	Physical resource ID			

Service number
This identifies the service that owns each resource in the list.

Physical resource ID
This is a list of physical resource IDs that make up the logical resource ID.

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count The number of entries in the received data DDR.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

AE_Offline

AE_UnknownFunction
(Not supported on the SSA 4-Port RAID Adapter.)

FN_ISALMgr_TestResrcsReady

This transaction is used to test that all the resources that are known to and controlled by the resource manager have started and are operational.

Minor_function
45

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:

AS_Success
All known resources are operational

AE_Failure
One or more resources controlled by this manager is not yet operational. This might be a disk drive that has not reached its operating speed.

FN_ISALMgr_TestOneResrcReady

The registry service sends this transaction to each resource manager to enquire about the state of a resource identified by a serial number. The resource might not be in a state that permits it to be declared to the registry service.

Minor_function
63

Parameter_DDR
This is a pointer to a the following data:

Byte	3	2	1	0
0 through 11	Serial Number			
12	Reserved = 0	Serial Number		

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
None

Result The following result field can be returned:

AS_Success
The resource is known by the registry service and by a resource manager and can be used. If the resource is an array, it is not exposed, but it might be degraded or rebuilding.

AE_NotReady
The resource is known by a resource manager but it is not ready for use and has not been declared to the registry service. The resource

might be a disk drive that is starting. This result is only returned if the resource is expected to become usable later.

AE_Offline
The resource is known by a resource manager but cannot be used because the array is in the offline state. An array is in this state when more than one of its components is not available.

AE_AvoidWrite
The resource is known by the registry service and a resource manager and can be used. However, write operations to the resource should be delayed because a write operation would cause an array to change from the exposed to the degraded state.

AE_NotInTable
The resource is not known by any resource manager.

Illegal Request (range)

Note: If the transaction is rejected with result AE_UnknownFunction, this should be treated as AE_NotInTable.

FN_ISALMgr_VPDInquiry

This transaction is sent to the disk service to obtain Vital Product Data of the resource identified by the resource ID field.

Minor_function
46

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	ResourceID			
4	Reserved = 0		Page Code	EVPD

ResourceID
This identifies the resource for this transaction.

EVPD The Enable Vital Product Data (EVPD) field controls whether the data returned is standard inquiry data or individual VPD pages. EVPD can be:

VP_NoEVPD
Standard VPD inquiry data is returned.

VP_EVPD
The VPD inquiry data of the page identified by the page-code field is returned.

Page Code
This identifies the page of vital VPD inquiry data to be returned. Page 00h identifies the pages that can be returned.

Transmit_DDR
Null

Receive_DDR
This is a pointer to a buffer that receives the Vital Product Data. This is the same data as that returned to the SSA-SCSI Inquiry command which is defined in the functional specification of the resource.

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count The number of bytes in the received data DDR.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

AE_HardwareError

AE_Offline

AE_FormatInProgress

AE_FormatDegraded

FN_ISALMgr_Characteristics

This transaction is sent to the disk service to obtain the blocksize and capacity of the resource identified by the resource ID field.

The size returned does not include the area of the disk that is reserved for use by the adapter.

Minor_function
47

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	ResourceID			

ResourceID
This identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Number of Blocks			
4	Bytes per Block			
8	Number of Reserved Blocks			

Number of blocks
This field identifies the number of blocks available for user data.

Bytes per Block
This field identifies the blocksize of the user data.

Number of Reserved Blocks
This field identifies the number of blocks in the ISAL reserved area that are available. This does not include the blocks that the manager may be using for its own use, for example, for a label record.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

AE_HardwareError

AE_ReservationConflict

AE_FormatInProgress

AE_FormatDegraded

FN_ISALMgr_Statistics

This transaction is sent to the disk service to obtain statistics on the transactions executed for this adapter by the resource identified by the resource ID field. The statistics are cumulative from power-on, or adapter reset, and wrap on an overflow.

Minor_function
48

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	ResourceID			

ResourceID
This field identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This field is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Number of Reads			
4	Number of Writes			
8	Number of Blocks Read			
12	Number of Blocks Written			

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InvalidRID

FN_ISALMgr_FlashIndicator

This transaction is sent to the disk service to flash a light on the resource identified by the resource ID field.

Minor_function
49

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	ResourceID			
4	Flash			

ResourceID
This field identifies the resource for this transaction.

Flash When the flash field is 0h, the light does not flash. When the flash field is nonzero, the light flashes continuously: one second on, one second off.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_Offline

AE_InvalidRID

AE_FencedOut

AE_HardwareError

AE_ReservationConflict

AE_FormatInProgress

AE_OfflineTimeout

AE_notSupported

FN_ISALMgr_NetworkInquiry

This transaction is sent to the disk service to determine on which network the resource is attached. This is required for HA adapters that require the member disks to be attached on the same loop.

Minor_function
66

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Resource ID			

Resource ID
This identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Network ID			

Network ID
This identifies the SSA loop or string on which the resource is attached. It can be one of the following:

NI_NetworkA
In an SSA loop or string attached to adapter SSA interface A

NI_NetworkB
In an SSA loop or string attached to adapter SSA interface B

NI_NullNetwork
No network applicable. This can be returned by a resource exported by RDSK.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_UnkownFunction
(Returned by the Micro Channel SSA 4–Port RAID adapter.
AE_InvalidID

AE_Offline

FN_ISALMgr_Preferences

This transaction is sent to the disk service to enquire about the referred mode of operation. This is particularly useful to the fast-write filter to optimize its destaging of data.

Minor_function
67

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Resource ID			

Resource ID
This identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR

This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Valid mask			
4	Word 0			
8	Word 1			
.	.			
116	Word 28			
120	Word 29			

Valid mask

Each bit set in this field indicates that the corresponding word contains valid information. If the resource manager has no preferences, it can return all the bits in this field to zero. Bit 31 is reserved.

Words 0 through 29

Each word has an assigned meaning:

0 Destage Quantization

Recommended amount of data that should be destaged for optimum performance. Useful for the fast-write filter.

1 Destage offset

Recommended offset of the start of destaged data for optimum performance. Useful for the fast-write filter.

2 Queue depth

Recommended depth of queue of transactions to keep the resource busy.

3 Geometry sector

This word can be used to recommend as different value for OS/2 for the Cylinder/Head/Sector geometry.

4 Write queue depth

Recommended depth of queue of write transactions for this resource. This is used by the fast-write filter to restrict the number of queued write transactions to one; this increases the possibility of transactions being coalesced into full-stride writes. Other filters do not set the valid bit for word 4; therefore, the device driver includes both write and read transactions queued either using the value of word 2 or its own algorithm.

5 through 29

Not currently assigned.

Result The following result fields can be returned:

AS_Success

Illegal Request (range)

AE_UnkownFunction
This function might be returned by resource managers on adapters that do not support the function or by managers that do not have any preferences.

AE_InvalidRID

FN_ISALMgr_LockQuery

This transaction is sent to the disk service to determine to which adapter or system a resource is locked.

This transaction is supported only on adapters that perform locking without issuing a Reserve transaction to the disk drive. This transaction is not supported on the SSA 4-Port Adapter, the Enhanced SSA 4-Port Adapter, or the SSA 4-Port RAID Adapter.

Minor_function
69

Parameter_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	Resource ID			

ResourceID
This identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Reserved = 0		Cluster Number	
4 through 11	AdapterID			

If the resource is not locked, the entire status data is zero. If it is locked, it is either locked to a cluster number or an adapter ID and that field is returned.

Result The following result fields can be returned:
AS_Success

AE_UnkownFunction
(returned by the SSA 4-Port RAID Adapter)
AE_Offline

Illegal Request (range)

AE_FormatInProgress

AE_FormatDegraded

AE_NonIsal

FN_ISALMgr_Open

This transaction is sent to the disk service to request that a resource is opened. It returns a handle to be used to address the requested resource.

Minor_function
50

Parameter_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	Resource ID			
4	Reserved = 00h	Sharing Mode	Access Type	Operation Mode

Resource ID
ID number of the resource requested to be opened.

Operation Mode

MD_ISAL
IPN Storage Access Language (ISAL)

MD_ISAL_HA

The IPN Storage Access Language (ISAL) is to be used as for the MD_ISAL_HA operation mode, but whenever access to the resources is lost (which may only be temporary) a FN_REGY_ResrcChangeToRegistry transaction is sent with change code CC_SetOffline and transactions to the resource are terminated with AE_Offline. In the HA manager, the client filter needs to be aware of any loss of a resource even if it is temporary.

In operation mode MD_ISAL, temporary access to a resource is not immediately reported as access may be restored after an interval following, for instance, an SSA network transient or network reset. The device driver should use MD_ISAL operation mode and array filters in an HA environment will use MD_ISAL_HA.

MD_ISAL_HA mode is not supported on the Micro Channel SSA 4–Port RAID adapter. It is also not supported for physical resource IDs.

If the SSA network is illegal when an attempt is made to open a resource in MD_ISAL_HA mode, the transaction is rejected with an AE_Failure result.

MD_SCSI
SCSI pass-through. When a resource is in SCSI pass-through mode transactions other than SCSI sent to the returned handle are rejected with illegal-request result. If this mode is requested, the Open transaction is rejected with illegal-request result if it is sent to any resource ID that is not of the owning module type OM_DriverPhysicalDisk.

MD_Service
Service Mode. If this mode is requested, the Open transaction is rejected with Illegal Request, if it is sent to any resource ID that is not of the owning-module type OM_Driver_PhysicalDisk.

Certain conditions do not allow the resource to be open in MD_Service mode:

AE_Logopen
The associated logical resource is currently open.

AE_SSAString
The resource is in an SSA string rather than an SSA loop, but it is not the last node in the string

AE_ReservationConflict
The associated logical resource is currently locked. (Not supported on the SSA 4-Port RAID Adapter.)

AE_FencedOut
The associated logical resource is currently fenced out. (Not supported on the SSA 4-Port RAID Adapter.)

When a resource is in service mode, the adjacent SSA ports to this node are wrapped and the check light on the selected resource is turned on.

Access Type

AT_All Read and Write transactions allowed

Sharing mode

SM_DenyNone
Multiple clients are allowed to open this disk service for this resource.

SM_DenyAll
Deny read and write access.

If another client issues an Open transaction to this disk service for this resource, it is rejected with an illegal-request result. This controls whether other clients can open the resource through this disk service; it does not imply that the resource is reserved to this client only; another client can access the resource through another disk service.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	Handle			

Handle This is the number that the client should use to address the resource.

Result The following result fields can be returned:
AS_Success

AE_AccessDenied

Illegal Request (range)

AE_InvalidRID

AE_LogOpen

AE_SSAString

AE_InServiceMode

AE_ReservationConflict

AE_FencedOut

AE_Offline

AE_InServiceMode

AE_ReservationConflict
(Only if opening in MD_Service mode)
AE_FencedOut
(Only if opening in MD_Service mode)
AE_OtherAdapterInServiceMode

FN_ISAL_Close

This transaction is sent to the disk service to close the resource identified by the handle field. If any transactions are active for the resource with this handle, the resource is not closed and the transaction terminates with an illegal-request result field.

If the resource being closed was in service mode, it is returned to normal mode before the close is completed. This may involve unwrapping SSA links of adjacent nodes.

If the resource being closed was locked before the ISAL_Close transaction, it remains locked at the end of the transaction.

If the resource can be closed and it is not open to other clients, any data or metadata that is held for any of its members is flushed to those members so that they are synchronized. That is, the service behaves as if it had received a FN_ISAL_Flush transaction immediately before the FN_ISAL_Close transaction. Any errors encountered during this flushing are ignored and the result field returned to the FN_ISAL_Close transaction is that which would have been returned if the flushing had not been attempted.

Minor_function
51

Parameter_DDR
The data descriptor is a pointer to the following data:

Byte	3	2	1	0
0	Handle			

The handle field identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ISAL_Read

This transaction is sent to the disk service to read the specified blocks from the resource identified by the handle field.

Minor_function
52

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Address			
8	Count			
12	Extended Flags	Reserved = 0	Flags	Priority

Handle This identifies the resource that is to be read

Address
This is the logical block address of the data to be read

Count This is the number of logical blocks to be read

Priority
Reserved

Flags

FF_Verify
Verify data. No data is transferred to the client. The manager validates that the data could be read if requested. For an array, data is read from the components, and might be reconstructed from the other components, but it is not transferred to the client.

This option is available primarily for service functions to physical disks or to verify that data in an array can be read. If it is issued to a fast-write resource, an attempt might be made to destage cached data first. It is not recommended that FF_Verify is used for fast-write resources because this might incur write operations to the disk which might not have been intended.

FF_ExtendedFlags
The extended-flags field is not zero.

FF_Split
Data is allowed to be received out of order

FF_ReadDisk
Data must be read from the device and not from a cache

FF_ISALReservedArea

This flag causes the data to be read from the area of the disk drive reserved for ISAL. This is a separately addressed

area of the resource starting at address zero. It follows the access type and sharing modes defined when the resource is opened.

The blocks that can be read are from address zero to the number of reserved blocks reported in FN_ISALMgr_Characteristics, minus one. The client may use these blocks as needed. The label record and fence sector are not visible through this interface.

Extended Flags This field has bit-significant values.

EF_Override
Read operations are allowed to the resource even when it is reserved to another host or fenced out from this host.

Transmit_DDR
Null

Receive_DDR
This is a pointer to the buffer that receives the read data. The length of this buffer must be equal to or greater than the total number of bytes in the logical blocks requested.

Status_DDR
This is a pointer to the following data that is returned if the result field is AE_Warning or AE_MediumError:

Byte	3	2	1	0
0	Reserved = 0			Hint Flags
4	Address			

Hint Flags

RF_ReassignWarn
This flag, when set, indicates that the logical block identified by the address field should be reassigned. The logical block address must be within the range of the blocks requested in the Read transaction. All blocks up to this address must have been sent to the client.

Address
This is the address of the logical block that should be reassigned when the result field contains either AE_Medium Error or AS_Warning and the hint-flag field is RF_ReassignWarn.

Result The following result fields can be returned:
AS_Success

AE_ReservationConflict

AS_Warning

AE_HardwareError

AE_NotReady

AE_MediumError

AE_AccessDenied

AE_InvalidSignature

Illegal Request (range)

AE_Offline

AE_FencedOut

AE_FormatInProgress

AE_FormatDegraded

AE_OfflineTimeout

FN_ISAL_Write

This transaction is sent to the disk service to write the specified blocks to the resource identified by the handle field. The transaction is rejected with illegal-request result if the owning module type of the resource is OM_DriverPhysicalDisk and the corresponding logical resource is currently open.

Minor_function
53

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Address			
8	Count			
12	Extended Flags	Reserved = 0	Flags	Priority

Handle This identifies the resource that is to be written

Address
This is the logical block address where the data is to be written

Count This is the number of logical blocks to be written

Priority
Reserved

Flags

FF_Verify
Verify that, after writing the data, it can be read back (with reconstruction if necessary, in the case of an array).

FF_ExtendedFlags
The extended-flags field is not zero.

FF_FastWrite
The transaction can be completed before the data is written to the disk.

FF_ReassignWrite
The logical block is reassigned to another physical sector before being written with the data supplied. The count must be 1 when this option is requested.

FF_Split
Data is allowed to be written on the disk out of order. For RAID-5 arrays, a resource-dependent-value attribute can be set, from the configurator, to allow splits on an aligned 4K page even when the FF_Split bit is off. (see “RAID-5” on page 47.)

FF_ISALReservedArea

The data is written to the area of the disk reserved for ISAL. This is a separately addressed area of the resource starting at address zero. It follows the access type and sharing modes defined in the open of the resource.

The blocks that can be written are from address zero to the number of reserved blocks reported in FN_ISALMgr_Characteristics, minus one. The client can use these blocks as needed. The label record and fence sector are not visible through this interface.

Extended Flags
This field has bit-significant values. Multiple flags can be set. No flags are specified.

Transmit_DDR
This is a pointer to the transmit buffer. The length of this buffer must be equal to or greater than the total number of bytes of the logical blocks requested.

Receive_DDR
Null

Status_DDR
This is a pointer to the following data, which is returned when the result field is AE_Warning or AE_MediumError:

Byte	3	2	1	0
0	Reserved = 0			Hint Flags
4	Address			

Hint Flags

RF_ReassignWarn
This flag, when set, indicates that the logical block identified by the address field should be reassigned. The logical block address must be within the range of the blocks specified in the Write transaction.

Address
This is the address of the logical block that should be reassigned when the result field contains either AE_Medium Error or AS_Warning and the hint flag field is RF_BlockWarn.

Result The following result fields can be returned:

AS_Success

AE_ReservationConflict

AS_Warning

AE_HardwareError

AE_NotReady

AE_MediumError

AE_AccessDenied

AE_InvalidSignature

Illegal Request (range)

AE_Offline

AE_FencedOut

AE_WriteProtect

AE_LogOpen

AE_FormatInProgress

AE_FormatDegraded

FN_ISAL_Format

This transaction is sent to the disk service to start formatting the entire disk in the resource identified by the handle field. AS_Success is returned if formatting can be started. The FN_ISAL_Progress transaction can be used to track the progress and completion of the format operation. The transaction is rejected with illegal-request result if the owning module type of the resource is other than OM_DriverPhysicalDisk or corresponding logical resource ID for this device is currently open.

Minor_function
54

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Blocksize			

Handle This identifies the resource for this transaction

Blocksize
This is the number of bytes in each logical block. This must be a value that is supported by the disk drive.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AE_ReservationConflict

AE_HardwareError

AE_NotReady

Illegal Request (range)

AE_Offline

AE_FencedOut

AE_LogOpen

AE_FormatInProgress

The progress of the format operation can be obtained by issuing a Progress transaction. If the format operation is aborted or cannot be completed (for example, if the disk drive is powered off before the operation completes) the disk drive enters degraded mode. A Format transaction must then be reissued and completed before the disk drive will allow reads and writes.

FN_ISAL_Progress

This transaction is sent to the disk service to determine the progress of a format operation to the resource identified by the handle field. The transaction is rejected with AE_IllegalRequest result if the owning module type of the resource is other than OM_DriverPhysicalDisk. On the SSA 4-Port RAID Adapter, it is rejected with AE_IllegalRequest if the corresponding logical resourceID for this device is currently open.

Minor_function
55

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			

Handle This identifies the resource for this transaction

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Percent			

The percent field contains the percentage of a format operation that has been completed, as an unsigned integer from 0 to 99. A value of −1 is returned if a format operation is not in progress.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_Offline

AE_HardwareError

AE_LogOpen

FN_ISAL_Lock

This transaction is sent to the disk service to reserve exclusively to this client the resource identified by the handle field.

When a resource is locked, the lock is maintained for the following conditions:

- A lock comes into effect when an FN_ISAL_Lock is received for a resource that is not currently locked and a path exists from the client (for example, the device driver) to the resource.
- A lock is removed when:
  - An FN_ISAL_Unlock is executed successfully from the locking client and the path to the resource exists
  - An FN_ISAL_Unlock with the UL_Forced flag on is executed successfully from any client and the path to the resource exists
  - The client either unlocks or closes the resource and the path to the resource is lost. If the resource is held open and locked, the lock is not removed when the path to the resource is lost, but the lock might not be effective.
- The firmware does not attempt to retain the lock if a resource is closed with a lock in place and the path intact and the path is subsequently lost.
- A lock is not effective if the path from the locking client to the resource is broken (regardless of what the client does following loss of the path). Another client can access the resource or place its own lock.
- If a path is reestablished and the lock has not been lost according to the rules above, it is the responsibility of the software immediately above the break in the path to reestablish the lock (assuming that the lock has not been broken by another client).
- The disk is formatted.

A path is lost, that is, communication to the resource is not possible, if the firmware issues a CC_Remove change code if it can. If the resource is held open, the firmware cannot issue a CC_Remove, but the path is still lost. A transient CC_Offline that is followed by a CC_SetOnline (caused, for example, by an SSA network reset) is not a loss of path.

On the SSA 4-Port RAID Adapter, locking of a disk is implemented by sending a Reserve command to the disk drive. This has the effect of locking both the physical resource and the associated logical resource. On the Micro Channel SSA Multi-Initiator/RAID EL Adapter, locking is implemented within the adapter and information is held on the disk for the adapter to which it is currently locked. The following transactions, which are permitted on the SSA 4-Port RAID Adapter, are not permitted on the Micro Channel SSA Multi-Initiator/RAID EL Adapter if they are addressed to a resource of type OM_DriverPhysicalDisk:

- FN_ISAL_Lock
- FN_ISAL_Unlock
- FN_ISAL_Fence
- FN_ISAL_Flush

When the associated logical resource is locked to another initiator, the following transactions, which are rejected on the SSA 4-Port RAID Adapter, are executed on the Micro Channel SSA Multi-Initiator/RAID EL Adapter when addressed to a resource of type OM_DriverPhysicalDisk:

- FN_ISALMgr_HardwareInquiry
- FN_ISALMgr_Characteristics
- FN_ISALMgr_FlashIndicator
- FN_ISAL_Progress

Unless the resource identified by the handle field is a disk drive, an array, or a fast-write resource, the transaction is rejected with an AE_NonIsal result field.

Minor_function
56

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Reserved = 0			Type

Handle This identifies the resource for this transaction

Type This defines the type of lock to be performed:

LT_Normal
Lock resource to the cluster number of the client, if available, or to the adapter ID if it is not.

LT_AdapID
Lock resource to the adapter ID of the client.

Note: On the SSA 4-Port RAID Adapter, the type field is not inspected and a FN_ISAL_Lock transaction causes the resource to be locked to the adapter.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AE_ReservationConflict

Illegal Request (range)

AE_Offline

AE_FencedOut

AE_HardwareError

AE_FormatInProgress

AE_FormatDegraded

AE_OfflineTimeout

FN_ISAL_Unlock

This transaction is sent to the disk service to terminate the previous reservation to this client of the resource identified by the handle field. This transaction has no effect on the list of systems fenced out from the resource, even if the flag field is UL_Forced.

This transaction is rejected with AE_IllegalRequest if it is addressed to a resource of type OM_DriverPhysicalDisk. This transaction has no effect on the list of systems fenced out for the resource even when the flag is UL_Forced.

Minor_function
57

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Reserved = 0			Flag

Handle This identifies the resource for this transaction.

Flag The following flags control whether the unlock should be unconditional or not:

UL_Normal
The unlock operation is unsuccessful if the resource is already locked to another client.

UL_Forced
The resource is unlocked even if it is locked to another client. This can be implemented by resetting the resource.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AE_ReservationConflict

Illegal Request (range)

AE_Offline

AE_FencedOut

AE_HardwareError

AE_FormatInProgress

AE_FormatDegraded

AE_OfflineTimeout

FN_ISAL_Test

This transaction is sent to the disk service to test the ability of the resource identified by the handle field to execute transactions. This might involve internal tests being performed by the resource.

Minor_function
58

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Reserved = 0			Diagnostic

Handle This identifies the resource for this transaction.

Diagnostic

TT_Test
No internal test is performed in the resource

TT_Diag
Internal tests are performed in the resource

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AE_NotReady

AE_ReservationConflict

AE_HardwareError

Illegal Request (range)

AE_Offline

AE_FormatDegraded

AE_FencedOut

AE_FormatInProgress

AE_OfflineTimeout

FN_ISAL_Download

This transaction is sent to the disk service to download code to the resource. If the resource ID is not for a resource of owning module type OM_DriverPhysicalDisk, the transaction is rejected with an illegal-request result.

Execution of transactions sent to this physical disk after this transaction are delayed until after the Download transaction has completed.

Minor_function
60

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Count			
8	Reserved = 0			Flag

Handle This identifies the resource for this transaction

Count This is the number of bytes of the download

Flag This controls if the downloaded code is saved in nonvolatile storage:

DL_Save
Downloaded code is saved in nonvolatile storage

DL_NoSave
Downloaded code is not saved and will be lost when power is removed from the resource.

Transmit_DDR
This is a pointer to the transmit buffer

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AE_NotReady

AE_ReservationConflict

AE_HardwareError

Illegal Request (range)

AE_Offline

AE_FencedOut

AE_FormatInProgress

FN_ISAL_Fence

This transaction removes or adds initiators to the list of those fenced for the resource identified by the handle field. The list of systems fenced for that resource at the end of the transaction is returned. Only a single RAID adapter can be attached to disk drives in an SSA loop, so this transaction has no use.

Fencing provides a means of preventing access by one or more hosts that are suspected of malfunctioning or should be excluded from access to the resource for other reasons. In a two-initiator network, one processor can exclude the other by using the Lock transaction. With more than two initiators, the Lock transaction cannot be used for this purpose, because it excludes all hosts but one.

When an initiator is fenced out for the resource, the following transactions are rejected with result field AE_FencedOut:

- All transactions that require the resource to be opened before execution, except FN_ISAL_Fence with FF_Force or FN_ISAL_Close.
- ISAL Manager transactions FN_ISALMgr_SetOwningModuleType, and FN_ISALMgr_AssignManualResourceID.

If the host attempts to fence itself out from the resource, the transaction is failed with an illegal-request result field.

When the resource is locked to another initiator, the FN_ISAL_Fence transaction is still executed.

The transaction is rejected with AE_IllegalRequest if it is addressed to a resource of type OM_Driver_PhysicalDisk.

Hosts are identified for fencing by their cluster number which is set in the adapter by a FN_REGY_SetClusterNumber transaction. The cluster number can be in the range 1 through 2048. The adapter defaults to cluster number 0 from when power is turned on to it until it receives the FN_REGY_SetClusterNumber transaction. The maximum number of cluster numbers that can be fenced in or fenced out is 96.

Unless the resource identified by the handle field is a disk drive, an array, or a fast-write resource, it is rejected by an AE_NonIsal result field.

Minor_function
62

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Reserved = 0	Force	Count	

Handle This identifies the resource for this transaction.

Force

FF_Normal
If the resource is fenced out from this initiator, the transaction is not executed and is terminated with AE_FencedOut result field.

FF_Force
The transaction is executed even when the resource is fenced out from this initiator. FF_Force can be used to forcibly change the list of initiators fenced out that have been set by an initiator that has failed. It will also cause any reservation for that resource to be released.

Count This is the number of bytes of data that are pointed to by the Transmit_DDR parameter. If the count field is zero, the list of initiators fenced for the resource is returned without any change.

Transmit_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Mask Count		Modifier	ListFormat
4	Reserved = 0	Change	Cluster Number (1)	
8	Reserved = 0	Change	Cluster Number (2)	
.				
4n	Reserved = 0	Change	Cluster Number (n)	
4n+4	Mask Cluster Number (1)		Reserved = 0	
4n+8	Mask Cluster Number (3)		Mask Cluster Number (2)	
4n+4+2m	Mask Cluster Number (m)		Mask Cluster Number (m-1)	

ListFormat

This defines whether the list of systems is to be interpreted as systems fenced out or systems fenced in from the resource. If the list-format parameter of the current list of fenced systems is not in the same format as required by this transaction, the list format is changed to the new format and the previous list is deleted.

FL_FenceOut

The system identified by the following cluster-number field is to be added or removed to the list of initiators fenced out for this resource.

FL_FenceIn

The system identified by the following cluster-number field is to be added or removed from the list of fenced initiators **not** fenced out for this resource.

Modifier

FM_Change

The systems identified by the cluster numbers supplied are to be added or removed from the list of fenced clusters.

FM_CompareAndSwap

A mask of cluster numbers is provided in the Transmit_DDR data. Clusters are only removed from or added to the list of fenced clusters when the list of mask cluster numbers matches the list of fenced cluster numbers at the start of the transaction. The cluster numbers in the list of mask cluster numbers must be in ascending order.

Mask Count

This is a count of the number of bytes of Transmit_DDR data used for mask cluster numbers.

Change

This controls if the cluster number is added or removed from the list:

FC_Add
The system identified by the following cluster number field is added to the list of fenced initiators for this resource.

FC_Remove
The system identified by the following cluster number field is removed from the list of fenced initiators for this resource.

Cluster Number
The cluster number identifies the system that is to be added or removed from the list of those fenced out. The cluster number can be in the range 1 through 128.

Receive_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Cluster Number (1)		ListFormat	
4	Cluster Number (3)		Cluster Number (2)	
8	Cluster Number (5)		Cluster Number (4)	
.				
2n-2	Cluster Number (n)		Cluster Number (n-1)	

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Count			

Count This identifies the number of bytes in the Receive_DDR area.

Result The following result fields can be returned:
AS_Success

AE_ReservationConflict

AE_FencedOut

AE_Offline

AE_ClusterNumberNotKnown

AE_HardwareError

AE_NotReady

Illegal Request (range)

AE_FormatDegraded

AE_FormatInProgress

AE_OfflineTimeout

AE_NonIsal

The list of systems fenced for the resource is held in a fence sector in the ISAL reserved area which is mirrored for availability.

When the transaction requires that a system cluster number is added to or removed from the list, the fence sector for that resource is read with a SSA_SCSI linked Read command. The data from the fence sector is changed and written back to both copies of the sector using SSA_SCSI linked Write commands. Linking the commands prevents another system accessing or changing the sectors while being changed from this adapter.

The adapter then issues a SSA-SCSI Mode Select command to the resource that causes a mode-parameters-change unit-attention condition in the resource for all other initiators. On receipt of this unit-attention condition, all the other initiators reinitialize the resource and determine whether they are now fenced out from it.

During the initialization process, the fence sector is read and the list analyzed to determine if that adapter is fenced out from the resource. If it is not fenced out, all transactions can be executed to the resource. If it is fenced out, all transactions sent to the handle are rejected with result field AE_FencedOut. However, after initialization, the system could have been fenced in by another system, without being informed by means of a unit-attention condition report because it was not sending commands to that resource. Therefore, when initialization has found this system is fenced out, from the resource, any future transactions to the handle cause first a Test Unit Ready command to be sent to the resource. If this receives check status for a mode-parameters-changed unit-attention condition, the resource is reinitialized and the transaction can be executed if the system is no longer fenced out. If it is still fenced out, or the Test Unit Ready transaction executed without error, the transaction is terminated with AE_FencedOut result field.

FN_ISAL_SCSI

This transaction is sent to the disk service to issue a raw SCSI command to the resource identified by the handle field. Unlike all other transactions, the only recovery performed by the adapter is for SSA link errors.

Only one SCSI transaction can be accepted at a time for a given resource. The resource must have been opened in SCSI pass-through mode for this transaction to be executed. If the resource ID is not for a resource of owning module type OM_DriverPhysicalDisk, the transaction is rejected with an illegal-request result.

SSA-SCSI linked commands should not be used. The link bit in the command descriptor block must be 0.

Minor_function
59

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Handle			
4	Reserved = 0			Identifier
8 through n	Command Descriptor Block			

Handle This identifies the resource for this transaction. The physical resource identified can contain several logical units (LUNs).

Identifier
This field identifies the SSA_SCSI logical unit number to which the resource manager should send the SCSI command. The format of this field is as defined for SSA_SCSI:
- If bit 7 is 1, the field identifies the target routine
- Bits 6 through 0 identify the logical-unit routine.

Command Descriptor Block
This is as defined for SCSI and can be 6, 10, or 12 bytes.

Transmit_DDR
This is null or a pointer to any data or parameters to be sent to the device.

Receive_DDR
This is null or a pointer to a buffer for any data received from the device.

The Transmit_DDR and Receive_DDR fields cannot both be non-zero. These are used by the resource manager to determine the direction of data transfer.

Status_DDR
This is a pointer to a buffer that receives the following data when the result field is AE_SCSIError:

Byte	3	2	1	0
0	Reserved = 0			SCSI Status

SCSI Status
This is the status byte as defined in SSA_SCSI that is returned by the resource. It is always non-zero. If zero status (good) is returned in the SCSI_status SSA message, the result field is AS_Success and no data is sent to the buffer pointed to by the Status_DDR field.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_SCSIError

AE_Offline

AE_FencedOut

AE_ReservationConflict

AE_NotSupported

FN_ISAL_Flush

This transaction requests the service to flush any data or metadata for the resource so that the components of the resource are synchronized. This allows the adapter to be changed or adapters and disks to be powered off without the risks of having to rebuild arrays or losing data because of the removal of power. When the components are synchronized, any NVRAM contents are not critical.

The transaction causes the service to write any data and metadata required to its components to get them synchronized. The service then issues an FN_ISAL_Flush to each of its components. Services that do not have anything to flush, for example, the base disk service, return AS_Success. When all the components have returned AS_Success to each FN_ISAL_Flush, AS_Success is returned to this transaction.

After the array or filter is synchronized, it might remain synchronized for an indeterminate period, for example, until the next FN_ISAL_Write is received, or while an FN_ISAL_Write is not yet complete.

On a Micro Channel SSA Multi-Initiator/RAID EL Adapter, this transaction is rejected with AE_IllegalRequest if it is addressed to a resource of type OM_DriverPhysicalDisk.

Minor_function
68

Parameter_DDR
This is a pointer to a the following data:

Byte	3	2	1	0
0	Handle			

Handle This identifies the resource for this transaction.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
None

Result The following result fields can be returned:
AS_Success

AE_Failure
(Flush of resource failed)
AE_FlushComponentFailure
(Flush of component failed)
AE_Offline

Illegal Request (range)

AE_FencedOut

AE_OfflineTimeout

AE_UnknownFunction

Adapter Service

The adapter service can be used for adapter-only transactions and for transactions to be issued to other adapters. The service number is fixed for the adapter service. The adapter service supports the following transactions:

Table 12. Adapter Transactions

Transaction	Minor_function
FN_ADAP_TransferFromHost	80
FN_ADAP_TargetTransfer	83
FN_ADAP_TransferToHost	81
FN_ADAP_ConnectForHostTransfer	84
FN_ADAP_DisconnectForHostTransfer	85
FN_ADAP_GetClusterNumber	86
FN_ADAP_AdapterHealthCheck	90
FN_ADAP_ListSSANodes	91
FN_ADAP_QueryNodes	93
FN_ADAP_GetAdapterUID	94
FN_ADAP_SetTime	95
FN_ADAP_SetMasterPriority	96
FN_ADAP_GetMasterPriority	97
FN_ADAP_GetSupportLevel	98

FN_ADAP_TransferFromHost

This transaction is sent to the adapter service to request that data is sent to one or more systems. When the cluster-number field is FFFFh, the data is sent to the adapter service on all other nodes connected using FN_ADAP_TargetTransfer transactions. When the cluster number is any other value, a single FN_ADAP_TargetTransfer transaction is sent to the adapter service on that cluster.

If the type is TT_VSC, the service returns successful completion to the FN_ADAP_TransferFromHost transaction when it has received a completion (successful or unsuccessful) to all the FN_ADAP_TargetTransfer transactions it has sent or timed out waiting for a completion. If the completion is unsuccessful, the device driver of the other system will also have been monitoring its adapter and will have detected an error. If the type is TT_DataTransfer and the Cluster Number is not FFFFh, the application result either indicates successful completion, or why no FN_ADAP_TargetTransfer transaction could be sent or the application result returned by that transaction. If the cluster number is FFFFh for a TT_DataTransfer transaction type, the service returns successful completion to the FN_ADAP_TransferFromHost transaction when it has received a completion (successful or unsuccessful) to all the FN_ADAP_TargetTransfer transactions it has sent or timed out waiting for a completion.

Minor_function
80

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Cluster Number		Reserved = 0	Type
4	Count			
8 through n	Parameter Data			

Cluster Number
This identifies the cluster to which data should be sent. If the value is FFFFh, data is sent to all clusters attached. The cluster number must be FFFFh if the type is TT_VSC.

If the cluster number specified has multiple adapters, the adapter service chooses to which adapter it sends the FN_ADAP_TargetTransfer transaction.

Type This can be the following:

TT_VSC
Volume-status-change (VSC) type requires that the data is transmitted to all attached clusters. This can be used to inform other systems of a change in status of a particular resource.

TT_DataTransfer
Data is to be transmitted to the specified cluster (or all clusters if the cluster number is FFFFh). This can be used to send data between systems (target mode).

TT_CNUM
This indicates that the data transmitted consists of the cluster number. This is transmitted to all other clusters when the cluster-number field is FFFFh.

Count This defines the number of bytes of data to be sent. The maximum

value is 512. The location of this data is pointed to by the transmit_DDR. The count field must be an even number.

Parameter Data
If the type is TT_VSC, parameter data is a 16–byte field that includes the 15-byte ASCII serial number of the resource to which the broadcast data refers. If the type is TT_DataTransfer, this field contains miscellaneous fields including a definition of the originating cluster.

Transmit_DDR
This is a pointer to the data in the buffer that is to be transmitted. The maximum Data_length is 512 bytes.

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_MissingCluster

AE_RoutingError

AE_RemoteTimeout

AE_TargetNot Available

AE_TargetReceiverFull

AE_TargetTransferTooLarge

AE_Failure

FN_ADAP_TargetTransfer

This transaction is sent to the adapter service on the node identified in the cluster-number field. If the cluster number is FFFFh, the transaction is sent to the adapter service on all nodes that are attached. The data transmitted is that identified in the earlier FN_ADAP_TransferFromHost transaction. The receiving service sends an FN_ADAP_TransferToHost transaction to the host service identified by a previous FN_ADAP_ConnectForHostTransfer transaction.

If the type is TT_VSC, the receiving service returns a successful-completion result to the FN_ADAP_TargetTransfer transaction when it has received a completion to the FN_ADAP_TransferToHost transactions it has sent (successful or unsuccessful) or if no

host node has connected for host transfers. If this receiving service is not able to complete the FN_ADAP_TransferToHost transaction successfully, the adapter continually presents an error status of SS_VSC. The host device driver must reset the adapter card to recover from this situation.

If the type is TT_DataTransfer, the result returned indicates the success or otherwise of executing the transaction.

Minor_function
83

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Cluster Number		Reserved = 0	Type
4	Count			
8 through n	Parameter Data			

Cluster Number
This identifies the cluster to which data should be sent. If the value is FFFFh, data is sent to all clusters attached. The cluster number must be FFFFh if the type is TT_VSC.

If the cluster number specified has multiple adapters, the adapter service chooses to which adapter it sends the FN_ADAP_TargetTransfer transaction.

Type This can be the following:

TT_VSC
Volume-status-change (VSC) type requires that the data is transmitted to all attached clusters

TT_DataTransfer
Data is to be transmitted to the specified cluster (or all clusters if the cluster number is FFFFh).

TT_CNUM
This indicates that the data transmitted consists of the cluster number. This is transmitted to all other clusters when the cluster-number field is FFFFh.

Count This defines the number of bytes of data to be sent. The maximum value is 512. The location of this data is pointed to by the transmit_DDR. The count field must be an even number.

Parameter Data
If the type is TT_VSC, parameter data is a 16-byte field that includes the 15-byte ASCII serial number of the resource to which the broadcast data refers. If the type is TT_DataTransfer, this field contains miscellaneous fields including a definition of the originating cluster.

Transmit_DDR
This is a pointer to the data that is to be transmitted. The maximum Data_length is 512 bytes.

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_Failure

AE_TargetNotAvailable

AE_TargetReceiverFull

AE_TargetTransferTooLarge

FN_ADAP_TransferToHost

This transaction is sent to the host service identified by a previous FN_ADAP_ConnectForHostTransfer transaction. The data transmitted is that identified in the earlier FN_ADAP_TargetTransfer transaction. If the type field is TT_VSC and, after a timeout period, no completion is received from the host service, good-completion result is returned to the FN_ADAP_TargetTransfer transaction and the adapter continually presents an error status of SS_VSC. The host device driver must reset the adapter card to recover from this situation.

Minor_function
81

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Cluster Number		Reserved = 0	Type
4	Count			
8 through n	Parameter Data			

Cluster Number
This identifies the cluster to which data should be sent. If the value is FFFFh, data is sent to all clusters attached. The cluster number must be FFFFh if the type is TT_VSC.

If the cluster number specified has multiple adapters, the adapter service chooses to which adapter it sends the FN_ADAP_TargetTransfer transaction.

Type This can be the following:

TT_VSC
Volume-status-change (VSC) type requires that the data is transmitted to all attached clusters

TT_DataTransfer
Data is to be transmitted to the specified cluster (or all clusters if the cluster number is FFFFh).

TT_CNUM
This indicates that the data transmitted consists of the cluster number. This is transmitted to all other clusters when the cluster-number field is FFFFh.

Count This defines the number of bytes of data to be sent. The maximum value is 512. The location of this data is pointed to by the transmit_DDR. The count field must be an even number.

Parameter Data
If the type is TT_VSC, parameter data is a 16-byte field that includes the 15-byte ASCII serial number of the resource to which the broadcast data refers. If the type is TT_DataTransfer, this field contains miscellaneous fields including a definition of the originating cluster.

Transmit_DDR
This is a pointer to the data that is to be transmitted.

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_Failure

AE_TargetNot Available

AE_TargetReceiverFull

AE_TargetTransferTooLarge

FN_ADAP_ConnectForHostTransfer

This transaction informs the adapter service of the service number in the host node that is able to receive FN_ADAP_TransferToHost transactions. Only a single host node can be connected at a time for each type of target transfer data.

Minor_function
84

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	Timeout		Cluster Number	
12	Reserved = 0			Type

Node This is the IPN node that can receive the data.

Service
This is the service on that node that can receive the data for the specified type of target transfer.

Timeout
This is the time in seconds that the adapter service should use to timeout FN_ADAP_TransferToHost transactions that are sent to the host.

Cluster Number
This is the cluster number of the node.

Type This defines the type of target transfer transactions for which the host node is connecting. It can be:
TT_VSC
TT_DataTransfer
TT_CNUM

Note: If the type field is not included in the Parameter_DDR data (parameter length 12 bytes), the adapter assumes that the host node is connecting for TT_VSC type of transfers.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ADAP_DiscForHostTransfer

This transaction informs the adapter service of the service number in the host node that is no longer able to receive FN_ADAP_TransferToHost transactions of the type specified.

Minor_function
85

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Node			
4	Service			
8	Reserved = 0		Cluster Number	
12	Reserved = 0			Type

Node This is the IPN node that can no longer receive the data.

Service
This is the service on that node that can no longer receive the data for the specified type of target transfer.

Cluster Number
This is the cluster number of the node.

Type This defines the type of target transfer transactions for which the host node is connecting. It can be:
TT_VSC
TT_DataTransfer
TT_CNUM

Note: If the type field is not included in the Parameter_DDR data (parameter length 12 bytes), the adapter assumes that the host node is connecting for TT_VSC type of transfers.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ADAP_GetClusterNumber

This transaction is sent from an adapter service on one node to another node to obtain the cluster number of that node.

Minor_function
86

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
12	Reserved = 0		Cluster Number	

Cluster Number
This field contains the cluster number of the node that has been set by the FN_REGY_SetClusterNumber transaction. If this has not yet been set, a cluster number of 0 is returned (0 means undefined). The cluster number can be in the range 1 through 127.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ADAP_AdapterHealthCheck

This transaction is sent to the adapter to report any adapter errors. Only degraded type errors can be reported in the Status_DDR data.

If the adapter has knowledge of multiple degraded errors that could be reported, only the lowest adapter error code is reported.

Minor_function
90

Parameter_DDR
Null

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
12	Reserved = 0	Adapter Error Code		

Adapter Error Code
This field contains the adapter error code of 6 hexadecimal characters. These codes are the same as are reported in adapter sense data when logging an error to the error logger. Byte 0 is the most-significant byte of the error code.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ADAP_ListSSANodes

This transaction is sent to the adapter to report details of all nodes on the SSA network specified that have been configured. If a network change is in progress, the transaction is terminated with a result field AE_InConfig and no other information is returned.

The list of nodes is ordered according to network topology. The list starts with the node nearest port 1 and ends if it is a loop with the node closest to port 2. If the SSA network is a string, the list is ordered by the list of nodes starting from port 1 to the end of that part of the string followed by the list of nodes starting from port 2 to the end of that part of the string.

The nodes reported are those configured at the time of the last valid SSA configuration. This may not be exactly consistent with the adapters known to all services, for example, adapter service for target mode, at the time of the transaction. If an illegal SSA network is detected during a SSA configuration by the adapter, the configuration held in the adapter that is reported by this transaction is not updated from the valid configuration.

Minor_function
91

Parameter_DDR
This is a pointer to a buffer that contains the following data:

Byte	3	2	1	0
0	Reserved = 0	NetworkId		

NetworkID
This identifies the SSA interface on the adapter to which the SSA loop or string is attached. It can be one of the following:
NI_NetworkA

NI_NetworkB

Transmit_DDR

Null

Receive_DDR

This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0 through 4	Adapter ID or device SSA UID			
8	SSA Path 1			
12	SSA Path 2			
16	Total Other Ports	Port on Path 1	Port on Path 2	Remote NetworkID
20 through n	Repeat for each adapter			

AdapterID or Device SSA UID

This 8-byte binary number uniquely identifies the node. If the node is an adapter (identified by a remote networkID of NI_NetworkA or NI_NetworkB), it is the adapterID. This is the same as the SSA UID of the modules that control the SSA links with the least significant bit (bit 0) = 0; bytes 6 and 7 are 00h.

If the node is a device (identified by a Remote NetworkID of NI_Device), the 8-byte number is the device SSA UID of the node; bytes 6 and 7 are 00h.

SSA Path 1

This 4-byte field is the path component of the SSA address field from port 1 to the node. As switches are not supported, byte 11 is the only byte used for the SSA address field; bytes 8 through 10 are zero. Bit 7 of byte 11 is zero to indicate that there are no other bytes in the path component.

If this remote node is not attached to port 1 of the adapter, FFFFFFFFh is returned.

SSA Path 2

This 4-byte field is the path component of the SSA address field from port 2 to the node. As switches are not supported, byte 15 is the only byte used for the SSA address field; bytes 12 through 14 are zero. Bit 7 of byte 15 is zero to indicate that there are no other bytes in the path component.

If this remote node is not attached to port 2 of the adapter, FFFFFFFFh is returned.

Total Other Ports

This contains a value that is one less than the total number of ports implemented on the node. This is normally 1b as all nodes supported have two ports.

Port on Path 1
This identifies the number of the port on the remote node that is linked to port 1 of this adapter that is either:

PI_Port1
Port 1 of the SSA chip is being used

PI_Port2
Port 2 of the SSA chip is being used

If this remote node is not attached to port 1 of the adapter, FFh is returned.

Port on Path 2
This identifies the number of the port on the remote node that is linked to port 2 of this adapter that is either:

PI_Port1
Port 1 of the SSA chip is being used

PI_Port2
Port 2 of the SSA chip is being used

If this remote node is not attached to port 2 of the adapter, FFh is returned.

Remote NetworkID
This identifies the SSA chip on the remote node to which this SSA loop or string is attached when the remote node is an adapter or that the remote node contains a single SSA chip when the node is a device. It can be one of the following:

NI_NetworkA
Connected to SSA chip A on node

NI_NetworkB
Connected to SSA chip B on node

NI_Device
Single SSA chip on node

Status_DDR
This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Number of Entries			
4	Reserved = 0		LoopFlag	Reserved = 0
8	ChangeCount			

Number of Entries
This is the number of nodes configured on the SSA loop or string; identification and port information of each of these is returned in the

Receive_DDR data. It does not include the current adapter, so a value of zero is returned if the adapter is the only node on the SSA network.

LoopFlag
This indicates whether the SSA network is a loop, a string, or an invalid configuration:

SC_Loop
SSA loop configuration

SC_String
SSA string configuration

SC_IllegalString
Invalid SSA configuration (either a loop or a string)

ChangeCount
This indicates the number of times the configuration information has changed from power on. It can be used to determine if there have been any changes since the last transaction was used.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

AE_InConfig

FN_ADAP_QueryNodes

This transaction can be used to determine what devices and adapters are on an SSA network. This might be useful when the adapter determines that the network is illegal, and does not configure new devices or adapters. Other transactions report only details of a legal network or parts of an illegal network that existed before it became illegal.

If a network change is in progress, the transaction is terminated with a result field AE_InConfig and no other information is returned.

Minor_function
93

Parameter_DDR
This is a pointer to a buffer that contains the following data:

Byte	3	2	1	0
0	Reserved = 0	Query Adapter	Port	NetworkID
4	Path			

NetworkID
This identifies the SSA interface on the adapter to which the SSA loop or string is attached. It can be one of the following:

NI_NetworkA

NI_NetworkB

Port This identifies the port on the SSA interface from which the Query_node SSA message should be sent. It can be:

PI_Port1
Port 1 of the SSA interface to be used

PI_Port2
Port 2 of the SSA interface to be used

Query Adapter
When this field is 1, the status data refers to this adapter and not to the node identified by the path field. The path field is only used to identify the node when the query-adapter field is 0.

Path This 4-byte field is the path component of the SSA address field from the adapter to the device. Because there can be no switches, byte 7 is the only byte that is used for the SSA address field; bytes 4-6 are zero. Bit 7 of byte 7 is zero to indicate that there are no other bytes in the path component. If switches are supported in the future, the path component could contain up to four byte fields.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
This is a pointer to a buffer that receives the following data that is part of the Query_node_reply data that is returned by the target SSA node:

Byte	3	2	1	0
0	Valid Mask			
4	ChangeCode			
8	Version	ULP	Total Other Ports	Current Port
12	Reserved = 0			
16 through 20	Unique_ID			
24	Reserved = 0			Port mask
28	Reserved = 0			

Valid Mask
This identifies which bytes of the status field are valid. Bit 0 of byte 0 = 1b shows that byte 0 is valid; bit 7 of byte 3 = 1b shows that byte 31 is valid.

ChangeCode
This indicates how many times the configuration information has

changed since power-on time. ChangeCode can be used to determine whether any changes have occurred since this transaction was previously used.

Current Port
This identifies the number of the port on the destination node that is now being used. Current port can have one of the following values:

Pl_Port1
Port 1 of the SSA chip is being used

Pl_Port2
Port 2 of the SSA chip is being used

Total Other Ports
This contains a value that is one less than the total number of ports implemented. This will normally be 1b as devices supported all have two ports.

ULP The Upper Level protocol identifies the SSA upper-level protocol that the node supports. This can be:

80 SSA-IA/95SP (level supported by current disk drives)

FC The Micro Channel SSA Multi-Initiator/RAID EL Adapter

Version
This identifies the version of the SSA transport layer that is supported by the adapter that is sending the message to the node. It can be:

01h SSA-1A/95PH

The value to be used for extensions for 40 MB/s SSA support is to be determined.

Master Priority
Bits 6-4 define the priority of the node for becoming the master of the SSA web. A value of zero indicates that this node is not capable of becoming a master (that is, it is not an adapter).

Bit 7 is used in SSA Query_node_reply to indicate that the node has no space to add an entry for the adapter that sent the Query_node. This is 0b for this transaction because the Query_node sent has the disable-registration bit = 0; the node does not, therefore, add the sender of the Query_node to its adapter or configuration table.

Bits 0-3 are reserved = 0.

Unique_ID
This 8-byte binary number uniquely identifies the node. It consists of two reserved bytes in bytes 22-23 (containing zeroes) followed by a 6-byte IEEE Universal Address.

Port Mask
This field is a bit vector to indicate the port number of those ports operational on the target node. Bit 7 = 1b indicates that port 1 is

operational; Bit 6 = 1 indicates that port 2 is operational. It can therefore be determined whether the other port of a 2-port node is operational and has another node attached to it. This can be done by inspecting the other port number in the port-mask field from the port number on which the message was received as identified in the current-port field.

Result The following result fields can be returned:

AS_Success

Illegal Request (range)

AE_UnknownFunction

AE_InConfig

AE_QNTimedOut

FN_ADAP_GetAdapterUID

This transaction returns the SSA UID of the specified SSA interface on the adapter. The SSA UID of both SSA interfaces on the adapter are identical except for the least significant bit (bit 0).

Minor_function

94

Parameter_DDR

This is a pointer to a buffer that contains the following data:

Byte	3	2	1	0
0	Reserved = 0	NetworkId		

NetworkID

This identifies the SSA interface on the adapter for which the SSA UID is requested. It can be one of the following:

NI_NetworkA

NI_NetworkB

Transmit_DDR

Null

Receive_DDR

Null

Status_DDR

This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0 through 4	SSA UID			

SSA UID
This 8-byte binary number uniquely identifies the adapter that is using this SSA interface. Bytes 6 and 7 are 00h.

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ADAP_SetTime

This transaction is used to set a time value that is held in the adapter. It is used in the adapter to identify the value of the adapter internal timer at that time. The time value cannot be read by the host, but can be part of data that is saved during a dump to identify the times of the traces.

Minor_function
95

Parameter_DDR
This is a pointer to a buffer that contains the following data:

Byte	3	2	1	0
0	TimeInSeconds			

TimeInSeconds
This is the time, in seconds, since EPOCH.

TimeInMilliseconds
This is the time, in milliseconds, within the second that was identified in the TimeInSeconds field.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_ADAP_SetMasterPriority

This transaction is used to set the SSA adapter master priority. It is used during SSA configuration to determine which adapter is to become the SSA master. The SSA master is the adapter that has the highest UID for the adapter with the highest master priority.

Minor_function
96

Parameter_DDR
This is a pointer to a buffer that contains the following data:

Byte	3	2	1	0
0	Reserved = 0		Master Priority	NetworkID

NetworkID
This identifies the SSA interface on the adapter whose master priority is to be set. It can be one of the following:

NI_NetworkA

NI_NetworkB

Master Priority
This is used to set the master priority of the SSA interface specified. It can have values 0 through 7 decimal. The default value of master priority is 4. It is recommended that the master priority be set to a value of 5 for an adapter that is required to be the SSA master.

Transmit_DDR
Null

Receive_DDR
Null

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

AE_UnknownFunction

Illegal Request (range)

FN_ADAP_GetMasterPriority

This transaction is used to fetch the SSA master priority. It is used during SSA configuration to determine which adapter is to become the SSA master. The SSA master is the adapter that has the highest UID for the adapter with the highest master priority

Minor_function
97

Parameter_DDR
This is a pointer to a buffer that contains the following data:

Byte	3	2	1	0
0	Reserved = 0	NetworkId		

NetworkID

This identifies the SSA interface on the adapter whose master priority is to be fetched. It can be one of the following:

NI_NetworkA

NI_NetworkB

Transmit_DDR

Null

Receive_DDR

Null

Status_DDR

This is a pointer to a buffer that receives the following data:

Byte	3	2	1	0
0	Reserved = 0	Master Priority		

Master Priority

This is used to set the master priority of the SSA interface specified. It can have values 0 through 7 decimal. The default value of master priority is 4.

Result The following result fields can be returned:

AS_Success

Illegal Request (range)

FN_ADAP_GetSupportLevel

This transaction is sent from an adapter service on one node to obtain the support level of that adapter. This can be used in conjunction with the LL field in the VPD data and the device ID field to precisely identify the card and its firmware function.

Minor_function

Parameter_DDR

Null

Transmit_DDR

Null

Receive_DDR

Null

Status_DDR

This is a pointer to a buffer which will receive the following data:

Byte	3	2	1	0
0	Reserved = 0			Support Level

Support Level
This field contains the support level of the adapter and identifies the firmware on the card. the support levels are:

02 SSA Multi-Initiator/EL adapter

03 Reserved

Result The following result fields can be returned:
AS_Success

AE_UnknownFunction
not supported on adapters prior to SSA Multi-Initiator/EL adapter with code at level 50 or later

Array-Configuration Service

The array-configuration service uses the IPN array configuration language (IACL) to define the configuration of array filters to be used in the adapter. In these transactions, Parameter_DDR and Status_DDR are used, but Transmit_DDR and Receive_DDR are not.

The array-configuration service handles the following transactions:

Table 13. Array-Configuration Transactions

Transaction	Minor_function
FN_IACL_Register	102
FN_IACL_Unregister	103
FN_IACL_Command	101

FN_IACL_Register

This transaction is issued by a filter service to declare to the array-configuration service that the filter exists. This must be sent before any configuration transactions can be issued to the array-configuration service.

Minor Function
102

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Service			
4	Reserved = 0			Filter Type

Service
This is the service number of the registering filter

Filter Type
This is the filter type of the registering filter

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_IACL_Unregister

This transaction is issued by a filter service to declare to the array-configuration service that no more transactions should be sent to this filter.

Minor Function
103

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0			Filter Type

Filter Type
This is the filter type of the registered filter

Status_DDR
Null

Result The following result fields can be returned:
AS_Success

Illegal Request (range)

FN_IACL_Command

In this transaction, the real function is defined in the first word of the parameter DDR. The functions are defined on pages 154 through 195.

Minor Function
101

Parameter_DDR
This is a pointer to data that has the following format:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function	
4 through n	Command Parameters			

Function
This specifies the one of the following functions:

Code	Function
1	FC_IACLVersion
2	FC_ResrcCount
3	FC_ResrcList
4	FC_ResrcView
5	FC_CandidateCount
6	FC_CandidateList
7	FC_ResrcCreate
8	FC_ResrcDelete
9	FC_ResrcRename
10	FC_ComponentView
11	FC_ComponentExchange
12	FC_QueryMetaResrcParams
13	FC_ModifyResrcParams
14	FC_FlashIndicator
15	FC_VPDInquiry
16	FC_VPDHardwareInquiry
17	FC_CompExchCount
18	FC_CompExchCandList
19	FC_AdapterVPD
20	FC_SyncHealth
21	FC_Wrap
22	FC_Unwrap
23	FC_UnwrapAll
24	FC_Test
25	FC_Format
26	FC_Certify
27	FC_Read
28	FC_Write
29	FC_AdapterSN
30	FC_CacheFormat

Filter Type

This identifies the filter that is being configured, for both arrays and disks that are not in arrays. The valid filter types are:

- FT_DriverAutomaticDisk *
- FT_Raid5Filter
- FT_FastWriteFilter
- FT_PhysicalDisk *
- FT_NotOwned *
- FT_HotSpare *
- FT_BlankReserved *
- FT_Disowned *

The filter types marked with a * are not filters but represent resources that are either unowned by or are logically attached to the system device driver. These filter types are referred to as *pseudofilters*. The other filter types are referred to as *real filters*.

The filter type FT_DriverAutomaticDisk supports only the following commands:

- FC_IACLVersion
- FC_ResrcCount
- FC_ResrcList
- FC_ResrcView
- FC_ResrcCreate
- FC_ResrcDelete
- FC_CandidateCount
- FC_CandidateList

Status_DDR

All FN_IACL_Command transactions return Status_DDR data. The format of this data is:

Byte	3	2	1	0
0	Unused			
4	Length			
8 through n	Command Result			

The length field is the byte count of Status_DDR data that follows this field.

FC_IACLVersion

This function returns the version number of the IACL language. This allows the array-configuration service to validate that the IACL level supported by the adapter card (array-configuration service and the RAID Filters) is correct. It also allows the array-configuration service to determine which filter types are present on the adapter. The array-configuration service returns AE_NotInTable for filters not present.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 1	

Function

This is the function code, 1, for FC_IACLVersion

Filter Type

This is the filter type to which the function is directed.

Status_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length = 4			
8	Version			

Length This is 4, showing that 4 bytes of data follow this field

Version
This is a 32-bit unsigned integer that identifies the code level of the filter. A value of zero is returned if the filter is not present.

Result The following result fields can be returned:

AS_Success

AE_Failure

Illegal Request (range)

FC_ResrcCount

This function returns the number of resources that a particular filter has created by earlier FC_ResrcCreate functions.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 2	

Function
This is the function code, 2, for FC_ResrcCount

Filter Type
This is the filter type to which the function is directed

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length = 4			
8	Resource Count			

Length This is 4, showing that 4 bytes of data follow this field

Resource Count
This is a 32 bit unsigned integer that identifies the number of resources created for this filter.

Result The following result fields can be returned:
AS_Success

AE_Failure

Illegal Request (range)

FC_ResrcList

This function requests a list of resources for the specified filter and their status. The selection of resource names (serial numbers) that are required is identified in the parameter data.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 3	
4	First Resource Number (n)			
8	Requested Count (m)			

Function

This is the function code, 3, for FC_RescrList

Filter Type

This is the filter type to which the function is directed

First Resource Number (n)

This is the ordinal number of the first resource (starting with zero) that is reported in the Status_DDR data.

Requested Count (m)

This is the number of resources from the first resource number that are to be reported.

Status_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length			
8 through 19	Serial Number (n)			
20	Reserved = 0	Serial Number (n)		
24	Reserved = 0		Percent	Status
28 through 39	Serial Number (n+1)			
40	Reserved = 0	Serial Number (n+1)		
44	Reserved = 0		Percent	Status
.				
20m-12 through 20m-1	Serial Number (n+m)			
20m	Reserved = 0	Serial Number (n+m)		
20m+4	Reserved = 0		Percent	Status

Length The identifies the number of bytes that follow this field (320 maximum)

Serial Number
This 15-character ASCII string is the name of the array.

Status This can be one of the following:

FS_ResrcOffline
If this is a pseudofilter, this status indicates the resource is in the RS_Offline state defined on “FN_REGY_ResrcChangeToRegistry” on page 74. If it is a real filter, this status indicates that the array does not have enough components to function or it contains inconsistent components.

FS_ResrcOnline
This is returned only for a pseudofilter. It indicates the resource is in the RS_Online state defined in “FN_REGY_ResrcChangeToRegistry” on page 74.

FS_ResrcOnlineNonDeg
The array is not degraded and is fully operational.

FS_ResrcOnlineDeg
The array is degraded.

FS_ResrcOnlineRebuild
The missing component has been returned to a degraded array which is in the process of rebuilding.

FS_ResrcOnlineExposed
A component is missing from an array and no write operations have yet been required to that component.

FS_ResrcUnknown
This is the state that an array is in until N-1 members are visible for the first time.

FS_ResrcWrapped
The physical resource is wrapped

FS_RescrFormatting
The physical resource is being formatted: the percent field reports the amount currently formatted.

FS_ResrcCertifying
The physical resource is being certified: the percent field reports the amount currently certified.

FS_ResrcFormatFailed
Formatting the disk has failed; the percent field reports how much of the disk was formatted before the failure.

FS_ResrcCertifyFailed
Certifying the disk has failed; the percent field reports how much of the disk was certified before the failure.

FS_ResrcInUse
This is reported only for an NVRAM resource. It indicates that the defined resource is associated with a known array.

FS_ResrcDormant
This is reported only for an NVRAM resource. It indicates that the defined resource is not associated with any known array.

Percent
This is an integer in the range 0 through 99 indicating the percentage completion of an operation for the following fields:
FS_ResrcRebuild
FS_ResrcFormatting
FS_ResrcCertifying

Result The following result fields can be returned:
AS_Success

AE_Failure

Illegal Request (range)

FC_ResrcView

This function is used to examine one resource of a filter in more detail. The resource name is sent in the parameter_DDR data. Details of the resource characteristics and status are returned in the status_DDR data.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 4	
4 through 15	Serial Number			
16	Reserved = 0			

Function
This is the function code, 4, for FC_ResrcView

Filter Type
This is the filter type to which the function is directed

Serial Number
This 15-character ASCII string is the name of the resource.

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length = 44			
8	Component Count			
12	Resource Size			
16 through 47	Resource Dependent Values			
48	Reserved = 0		Percent	Status

Length This is the number of bytes of data, 44, that follow this field

Component Count
This is the number of components that are incorporated into the resource

Resource Size
This is the number of blocks available for user data

Resource Dependent Values
These resource parameters differ for each filter type. The structure for each filter type is reported by the FC_QueryMetaResrcParams function (see “FC_QueryMetaResrcParams” on page 171). All filters report the block size in bytes 19 through 16. Zeroes are returned in fields not defined.

Status This can be one of the following:

FS_ResrcOffline
If this is a pseudofilter, this status indicates the resource is in the RS_Offline state defined on “FN_REGY_ResrcChangeToRegistry” on page 74. If it is a real filter, this status indicates that the array does not have enough components to function or it contains inconsistent components.

FS_ResrcOnline
This is only returned for a pseudofilter. It indicates the resource is in the RS_Online state defined on “FN_REGY_ResrcChangeToRegistry” on page 74.

FS_ResrcOnlineNonDeg
The array is not degraded and is fully operational.

FS_ResrcOnlineDeg
The array is degraded.

FS_ResrcOnlineRebuild
The missing component has been returned to a degraded array which is in the process of rebuilding.

FS_ResrcOnlineExposed
A component is missing from a RAID-5 array and no writes have yet been required to that component.

FS_ResrcUnknown
This is the state that an array is in until N-1 members are visible for the first time.

FS_ResrcWrapped
The physical resource is wrapped

FS_RescrFormatting
The physical resource is being formatted: the percent field reports the amount currently formatted.

FS_ResrcCertifying
The physical resource is being certified: the percent field reports the amount currently certified.

FS_ResrcFormatFailed
Formatting the disk has failed; the percent field reports how much of the disk was formatted before the failure.

FS_ResrcCertifyFailed
Certifying the disk has failed; the percent field reports how much of the disk was certified before the failure.

FS_ResrcInUse
This is reported only for an NVRAM resource. It indicates that the defined resource is associated with a known array.

FS_ResrcDormant
This is reported only for an NVRAM resource. It indicates that the defined resource is not associated with any known array.

Percent
This is an integer in the range 0 through 99 indicating the percentage completion of an operation for the following fields:
FS_ResrcRebuild
FS_ResrcFormatting
FS_ResrcCertifying

Result The following result fields can be returned:
AS_Success

AE_Failure

AE_BadResrcSerialNumber

Illegal Request (range)

FC_CandidateCount

This function reports the total number of candidate components that are available for use in creating an array. Only those currently unused candidates that match exactly the specified type (resource dependent values) are included in the count.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 5	
4 through 35	Resource Dependent Values			

Function
This is the function code, 5, for the FC_CandidateCount function

Filter Type
This is the filter type to which the function is directed

Resource Dependent Values
This field differs for each filter type (see “FC_ResrcView” on page 158 for details)

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length = 4			
8	Candidate count			

Length This is the number of bytes of data that follow this field (4)

Candidate Count
This is the number of currently unused components, with characteristics matching the resource-dependent-value field, that could be used to create the array.

Result The following result fields can be returned:
AS_Success

AE_Failure

AE_BadParameterValues

AE_InvalidCandidateRequest

Illegal Request (range)

FC_CandidateList

This function reports the serial numbers of candidate components that are available for use in creating an array. (The total number of available components is returned by the FC_CandidateCount function.) The function specifies the ordinal number of the first component and number of candidates (maximum 16) for which data is to be reported. The length field reports the number of candidates for which data is returned.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 6	
4 through 35	Resource Dependent Values			
36	First Candidate (n)			
40	Requested Count (m)			

Function

This is the function code, 6, for FC_CandidateList

Filter Type

This is the filter type to which the function is directed

Resource Dependent Values

This field differs for each filter type (see “FC_ResrcView” on page 158 for details)

First Candidate (n)

This is the ordinal number of the first candidate (starting with zero) that could be used to create the array specified.

Requested count

This is the number of candidates (maximum 16), starting with the candidate specified in the first-candidate field, for which data is requested.

Status_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length			
8 through 19	Serial Number (n)			
20	Reserved = 0	Serial Number (n)		
24	Reserved = 0		Percent	Status
28 through 39	Serial Number (n+1)			
40	Reserved = 0	Serial Number (n+1)		
44	Reserved = 0		Percent	Status
.				
20m-12 through 20m-1	Serial Number (n+m)			
20m	Reserved = 0	Serial Number (n+m)		
20m+4	Reserved = 0		Percent	Status

Length This is the number of data bytes that follow this field (320 maximum)

Serial number
This 15-character ASCII string is the serial number of each component.

Status This can be one of the following:

FS_CandOnline
The component is in the RS_Online state (see “FN_REGY_ResrcChangeToRegistry” on page 74).

FS_CandOffline
The component is in the RS_Offline state (see “FN_REGY_ResrcChangeToRegistry” on page 74).

Percent
This field is zero.

Result The following result fields can be returned:
AS_Success

AE_Failure

AE_BadParameterValues

AE_InvalidCandidateRequest

Illegal Request (range)

FC_ResrcCreate

This function is used to create a new resource, composed from a group of components (maximum 16). The new resource will have the name or serial number provided in the resource-serial-number field. If the filter type is FT_DriverManualDisk or FT_DriverAutomaticDisk, the ComponentCount must be set to zero and there are no associated component serial numbers.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 7	
4 through 15	Resource Serial Number			
16	Reserved = 0	Resource Serial Number		
20 through 51	Resource Dependent Values			
52	Component Count (n)			
56 through 67	Serial Number (1)			
68	Reserved = 0	Serial Number (1)		
72 through 83	Serial Number (2)			
84	Reserved = 0	Serial Number (2)		
.				
40+16n through 51+16n	Serial Number (n)			
52+16n	Reserved = 0	Serial Number (n)		

Function

This is the function code, 7, for FC_ResrcCreate

Filter Type

This is the filter type to which the function is directed

Resource Serial Number

This 15-character ASCII string is the name or serial number of the resource that is created by this function.

Resource Dependent Values

This field differs for each filter type (see “FC_ResrcView” on page 158 for details)

Component Count

This is the number of components to be used to create the new resource.

Serial number

These 15-character ASCII strings are the serial numbers of the components to be used to create the new resource.

Status_DDR

No Status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Unused			
4	Length = 0			

Result The following result fields can be returned:

AS_Success

AE_BadResrcSerialNumber

AE_BadComponentCount

AE_BadComponentSerialNumber

AE_BadParameterValues

AE_Failure

AE_SetOMTFailed

AE_NvramError

AE_InvalidCreateRequest

Illegal Request (range)

FC_ResrcDelete

This function is used to delete an existing resource.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 8	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		

Function

This is the function code, 8, for FC_ResrcDelete

Filter Type
This is the filter type to which the function is directed

Serial Number
This 15-character ASCII string is the name of the resource that is to be deleted.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Unused			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_BadResrcSerialNumber

AE_Failure

AE_ConfirmRequired

Illegal Request (range)

FC_ResrcRename

This function is used to rename an existing resource.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 9	
4 through 15	Old Serial Number			
16	Reserved = 0	Old Serial Number		
20 through 31	New Serial Number			
32	Reserved = 0	New Serial Number		

Function
This is the function code, 9, for FC_ResrcRename

Filter Type
This is the filter type to which the function is directed

Old Serial Number
This 15-character ASCII string is the old name or serial number of the resource. .

New Serial Number
This 15-character ASCII string is the new name or serial number of the resource. .

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Unused			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_BadOldSerialNumber

AE_BadNewSerialNumber

AE_Failure

Illegal Request (range)

FC_ComponentView

This function is used to return the serial numbers of all the members of a resource. The number of the members is returned by the FC_ResrcView function. The request includes the ordinal number of the first member and the number of members to be reported (maximum 16). The returned length field describes the number of members reported.

It is not valid to address the FC_ComponentView function to a pseudofilter.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 10	
4 through 15	Resource Serial Number			
16	Reserved = 0	Resource Serial Number		
20	First Component (n)			
24	Requested Count (m)			

Function
This is the function code, 10, for FC_ComponentView

Filter Type
This is the filter type to which the function is directed

Resource Serial Number
This 15-character ASCII string is the name of the resource.

First Component
This is the ordinal number of the first member (starting at zero) to be reported.

Requested Count
This is the maximum number of members that should be reported starting from the identified first member.

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length			
8 through 19	Serial Number (n)			
20	Reserved = 0	Serial Number (n)		
24	Reserved = 0		Percent	Status
28 through 39	Serial Number (n+1)			
40	Reserved = 0	Serial Number (n+1)		
44	Reserved = 0		Percent	Status
.				
20m-12 through 20m-1	Serial Number (n+m)			
20m	Reserved = 0	Serial Number (n+m)		
20m+4	Reserved = 0		Percent	Status

Length This is the number of data bytes that follow this field (320 maximum)

Serial number
These 15-character ASCII strings are the serial numbers of each member.

Status This can be one of the following:

FS_CompPresent
This is returned if the resource is made out of other members that are all present.

FS_CompNotPresent
This is returned if the array is made out of other arrays and this member is missing.

FS_CompNotPresentDeconf
This can be returned in a RAID-5 array for a member that is deconfigured.

FS_CompNotPresentBlank
This member is a blank slot (that is, type FT_BlankReserved)

FS_CompPresentRebuild
This is a destination of a current rebuild operation.

FS_CompPresentRebuildme
This is a destination of a future rebuild operation.

Percent
These fields are zero.

Result The following result fields can be returned:
AS_Success

AE_Failure

AE_BadResrcSerialNumber

AE_FiltersOnly

Illegal Request (range)

FC_ComponentExchange

This function is used to replace a member of a resource with a new member, for example, to replace a faulty disk drive in a RAID-5 array. It is acceptable not to define a new replacement if one is not available; provide a null serial number instead (this should be unique if more than one null replacement is to be undertaken). Attempting to exchange a member of a degraded array is not permitted because it would cause deletion of the array; FC_ResrcDelete should be used instead.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 11	
4 through 15	Resource Serial Number			
16	Reserved = 0	Resource Serial Number		
20 through 31	Old Component Serial Number			
32	Reserved = 0	Old Component Serial Number		
36 through 47	New Component Serial Number			
48	Reserved = 0	New Component Serial Number		

Function
This is the function code, 11, for FC_ComponentExchange

Filter Type
Filter Type to which the function is directed

Resource Serial Number
This 15_character ASCII string is the name of the array.

Old Component Serial number
This 15-character ASCII string is the name of the old member.

New Component Serial Number
This 15-character ASCII string is the name of the new member.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Unused			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_BadResrcSerialNumber

AE_BadOldComponentSerialNumber

AE_BadNewComponentSerialNumber

AE_DegradedArray

AE_Failure

AE_ArrayIsBroken

AE_BadExchangeCandidate

AE_FiltersOnly

Illegal Request (range)

FC_QueryMetaResrcParams

This function returns a description of the resource parameters for the specified filter type. These are used in other functions, for example, FC_ResrcView.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 12	

Function
This is the function code, 12, for FC_QueryMetaResrcParams

Filter Type
This is the filter type to which the function is directed

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length			
8	Fields	Reserved = 0	Max Component	Min Component
12	Offset		Size	Type
16	MinValue			
20	MaxValue			
24	Default Value			
28	StepValue			
32	Control			
36 through n	Further definitions (copies of bytes 12 through 35 for each parameter)			

Length The number of data bytes that follow this field

Min Component
This is the minimum number of components for this filter type.

Max Component
This is the maximum number of components for this filter type.

Fields This is the number of parameters defined in the function. Each parameter is described in the same format as bytes 12 through 35 of the status data.

Type This is the type of parameter, which can include the following:
SDS_BLOCKSIZE
SDS_DISK_NUMBER
SDS_STRIPE_SIZE
SDS_STRETCH_SIZE
SDS_MODE_FLAGS
SDS_STRIDE_SIZE
SDS_HOT_SPARE_ENABLED
SDS_HOT_SPARE_EXACT_SIZE
SDS_REBUILD_PRIORITY
SDS_SPEC_READ
SDS_BAD_PTY_STRIDE
SDS_BAD_COMPONENT_STRIDE
SDS_BAD_STRIPE

Size This is the size in bits of the contents of the parameter

Offset This is the offset of this parameter from the start of the resource parameters. It must be byte aligned even though the parameter might not contain an integer number of bytes.

MinValue
This is the minimum value allowed for this parameter

MaxValue
This is the maximum value allowed for this parameter

Default value
This is the default value used for this parameter

StepValue
This is the increment allowed for this parameter

Control
This contains the following control information for the parameter:
SDSF_MB
Units are MB
SDSF_KB
Units are KB
SDSF_PERCENT
Units are %
SDSF_ON_OFF
Display On/Off rather than 0/1
SDSF_BYTES
Units are bytes
SDSF_READONLY
Cannot be changed
SDSF_UNIQUE
Entries must be different

Result The following result fields can be returned:
AS_Success

AE_Failure

Illegal Request (range)

FC_ModifyResrcParams

This function is used to modify resource parameters of a specified array.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 13	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20 through 51	New Resource Dependent Values			

Function
This is the function code, 13, for FC_ModifyResrcParams

Filter Type
This is the filter type to which the function is directed

Serial number
This is the serial number of the resource.

New Resource Dependent Values
This contains new data for the resource parameter for this filter. The data differs for each filter type (see “FC_QueryMetaResrcParams” on page 171 for details).

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Unused			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_BadParameterValues

AE_Failure

AE_NotInTable

AE_FiltersOnly

Illegal Request (range)

FC_FlashIndicator

This function is used to cause the light on all the components of the resource to flash or to stop it flashing.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 14	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Flash			

Function

This is the function code, 14, for FC_FlashIndicator

Filter Type

This is the filter type to which the function is directed

Serial Number

This is the serial number of the component whose light is to be set flashing or turned off.

Flash When this is zero, the light does not flash. When this is nonzero the light flashes on and off continuously. The duration of each flash is approximately one second.

Status_DDR

No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Unused			
4	Length = 0			

Result The following result fields can be returned:

AS_Success

AE_BadParameterValues

AE_Failure

AE_NotInTable

Illegal Request (range)

FC_VPDInquiry

This function returns the Vital Product Data (VPD) information from the resource. It is valid only for it to be sent to a resource type FT_DriverAutomaticDisk, FT_DriverManualDisk, FT_PhysicalDisk, or FT_NotOwned. It is not valid to sent it to an array filter.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 15	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Reserved = 0		Page Code	EVPD

Function

This is the function code, 15, for FC_VPDInquiry

Filter Type

Filter Type to which the function is directed

Serial Number

This is the serial number of the resource whose VPD is requested.

EVPD This field, Enable Vital Product Data (EVPD), controls whether the data returned is standard inquiry data or individual VPD pages. EVPD can be:

VP_NoEVPD

Standard VPD inquiry data is returned.

VP_EVPD

The VPD inquiry data of the page identified by the page-code field is returned.

Page Code

This identifies the page of vital VPD inquiry data to be returned. Page 00h identifies the pages that can be returned.

Status_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length			
8 through n	VPD Data			

Length This is the number of bytes that follow this field.

VPD Data
This is the same data as that returned to a SSA-SCSI Inquiry command to the resource. This data is defined in the *Technical Reference* for the resource.

Result The following result fields can be returned:
AS_Success

AE_BadParameterValues

AE_Failure

AE_NotInTable

Illegal Request (range)

FC_HardwareInquiry

This function returns hardware-specific information about the specified resource. It is valid only for resource types FT_DriverAutomaticDisk, FT_DriverManualDisk, FT_PhysicalDisk, and FT_NotOwned. It is not valid to send it to an array filter.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 16	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		

Function
This is the function code, 16, for FC_HardwareInquiry

Filter Type
Filter type to which the function is directed

Serial Number
This is the serial number of the resource for which information is requested.

Status_DDR
This is pointer to the buffer that receives the following data:

Byte	3	2	1	0
0	Port 1 SSA loop A	Port 2 SSA loop A	Port 1 SSA loop B	Port 2 SSA loop B
4	Reserved = 0			Status

Port n This is the SSA address of the node on this port of the adapter card.

If the resource is not connected to this port then a value of FFh is returned. This field is valid when the result field is AS_Success or AE_ReservationConflict.

Status This reports the state of the resource and is valid when the result field is AS_Success. It has the following definition:

ST_Good
Good

ST_Failed
Failed. In this state, if the resource is a target on an SSA link, a Test Unit Ready SSA command is rejected with check-condition status. This might be caused by a failure of power-on self-tests, a stopped motor, or any degraded mode condition.

ST_LossRedundancy
In this state, the resource has lost some redundancy, for example, loss of redundant power or cooling. The disk service determines this by sending a SSA-SCSI Inquiry command to the resource.

Result The following result fields can be returned:
AS_Success

AE_NotFilters

AE_Failure

AE_NotInTable

Illegal Request (range)

FC_CompExchCount

This function returns the number of components that are available to be exchanged into a given array.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 17	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Reserved = 0			Exchange Type

Function
This is the function code, 17, for FC_CompExchCount

Filter Type
This is the filter type to which the function is directed

Serial Number
This 15-character ASCII string is the name of the array for which a component exchange is required.

Exchange Type
This can be one of the following:

FT_NotOwned
The count field in the status data refers to the number of components that could be exchanged.

FT_HotSpare
The count field in the status data refers to the number of hot-spare components available to this filter.

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length of following data = 4			
8	Count of available exchange components			

Result The following result fields can be returned:
AS_Success

AE_BadResrcSerialNumber

Illegal Request (range)

AE_Failure

AE_FiltersOnly

AE_NotInTable

FC_CompExchCandList

This function reports the serial numbers of all the exchange components that are available to be exchanged into a specified array. The function specifies the ordinal number of the first candidate and the number of candidates for which serial numbers are requested.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 18	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	First Candidate			
24	Requested Count			
28	Reserved = 0			Exchange Type

Function
This is the function code, 18, for FC_CompExchCandList

Filter Type
This is the filter type to which the function is directed

Serial number
This 15-character ASCII string is the name of the array for which a component exchange is required.

First Candidate
This is the ordinal number of the first component (starting with zero) to be reported.

Requested Count
This is the maximum number of members to be reported.

Exchange type
This can be one of the following:

FT_NotOwned
The identification of members that can be exchanged is returned in the status data

FT_HotSpare
The identification of members that can be hot spares for this filter is returned in the status data.

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Unused			
4	Length			
8 through 19	Serial Number (n)			
20	Reserved = 0	Serial Number (n)		
24	Reserved = 0		Percent	Status
28 through 39	Serial Number (n+1)			
40	Reserved = 0	Serial Number (n+1)		
44	Reserved = 0		Percent	Status
.				
20m-12 through 20m-1	Serial Number (n+m)			
20m	Reserved = 0	Serial Number (n+m)		
20m+4	Reserved = 0		Percent	Status

Length This is the number of data bytes that follow this field.

Serial number
This 15-character ASCII string is the serial number of each candidate.

Status This can be one of the following:

FS_CandOnline
The component is in the RS_Online state (see “FN_REGY_ResrcChangeToRegistry” on page 74).

FS_CandOffline
The component is in the RS_Offline state (see “FN_REGY_ResrcChangeToRegistry” on page 74).

Percent
This field is zero.

Result The following result fields can be returned:
AS_Success

AE_Failure

AE_BadResrcSerialNumber

AE_FiltersOnly

AE_NotInTable

Illegal Request (range)

FC_AdapterVPD

This function returns the adapter VPD information.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 19	

Function
This is the function code, 19, for FC_AdapterVPD

Filter Type
This is the filter type to which the function is directed. This must be FT_Adapter, which is not really a filter.

Status_DDR
This is a pointer to the buffer that receives the following data:

Byte	3	2	1	0
0	Reserved = 0			
4	Length			
8 through n	VPD data			

Length This is the number of data bytes that follow this in field.

VPD data
This is the adapter VPD data

Result The following result fields can be returned:
AS_Success

AE_NotInTable

Illegal Request (range)

FC_SyncHealth

This function returns the most significant health-check sense data of all services attached to the registry. In response to the FC_SyncHealth transaction, the array-configuration service issues a FN_REGY_SyncHealthCheckToRegy transaction to the registry service. If no sense data is to be returned, the result field is AS_Success. The result field is AE_Failure, if sense data is returned in the status data.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 20	

Function
This is the function code, 20, for FC_SyncHealth

Filter Type
This is the filter type to which the function is directed. This must be FT_Adapter, which is not really a filter.

Status_DDR
This is a pointer to the buffer that receives following data:

Byte	3	2	1	0
0	Reserved = 0			
4	Length			
8 through n	Sense data			

Length This is the number of data bytes that follow this in field.

Sense data
The sense data is the most significant error log data from attached services. “FN_REGY_LogErrorFromRegistry” on page 69 defines the sense data.

Result The following result fields can be returned:
AS_Success

AE_NotInTable

Illegal Request (range)

AE_Failure

FC_Wrap

This function opens the identified physical resource in service mode. This causes the SSA ports on the adjacent nodes to be wrapped. The handle returned to the array-configuration service, when the resource is opened in service mode, is not returned to the client but held by the array-configuration service pending a future FC_Unwrap or FC_UnwrapAll or until the adapter is rebooted.

The rules for resources that can be opened in service mode causing adjacent SSA ports to be wrapped are defined in “FN_ISALMgr_Open” on page 109.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 21	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		

Function
This is the function code, 21, for FC_Wrap

Filter Type
This is the filter type to which the function is directed. This must be FT_PhysicalDisk, which is not really a filter.

Serial Number
This is the serial number of the resource to be wrapped.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_NotInTable
Filter not FT_PhysicalDisk or serial number not found
AE_PhysWrapped
Device is currently wrapped
AE_PhysFormatting
Device is currently formatting
AE_PhysCertifying
Device is currently certifying
AE_AccessDenied

AE_Failure

AE_InvalidRID

AE_LogOpen

AE_SSAString

Illegal Request (range)

AE_InServiceMode

FC_Unwrap

This function closes the identified physical resource that had previously been in service mode. If the resource has not previously been opened in MD_Service mode (via the FC_Wrap IACL transaction), AE_NotOpen result field is returned.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 22	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		

Function
This is the function code, 22, for FC_Unwrap

Filter Type
This is the filter type to which the function is directed. This must be FT_PhysicalDisk, which is not really a filter.

Serial Number
This is the serial number of the resource to be unwrapped.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_NotInTable
Filter not FT_PhysicalDisk or serial number not found
AE_NotOpen
Resource not opened via FC_Wrap
Illegal Request (range)

AE_Failure

FC_UnwrapAll

This function closes any physical resource that had previously been in service mode.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 23	

Function
This is the function code, 23, for FC_UnwrapAll

Filter Type
This is the filter type to which the function is directed. This must be FT_PhysicalDisk, which is not really a filter.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_NotInTable
Filter not FT_PhysicalDisk or serial number not found
Illegal Request (range)

AE_Failure

FC_Test

This function causes internal checkouts to be executed in a physical resource. It is implemented by the array-configuration service issuing a FN_ISALMgr_Open and FN_ISAL_Test followed by an FN_ISAL_Close to the identified physical resource.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 24	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Reserved = 0			Type

Function
This is the function code, 24, for FC_Test

Filter Type
This is the filter type to which the function is directed. This must be FT_PhysicalDisk, which is not really a filter.

Serial Number
This is the serial number of the resource to be tested.

Type This must be TT_Test to request that internal checkout be performed in the resource.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:
AS_Success

AE_NotInTable
Filter not FT_PhysicalDisk or serial number not found
AE_PhysWrapped
Device is currently wrapped
AE_PhysFormatting
Device is currently formatting
AE_PhysCertifying
Device is currently certifying
AE_AccessDenied
(Copied from FN_ISALMgr_Open)
AE_InvalidRID
(Copied from FN_ISALMgr_Open)
AE_LogOpen
(Copied from FN_ISALMgr_Open or FN_ISAL_Test)
Illegal Request (range)

AE_ReservationConflict
(Copied from FN_ISAL_Test)
AE_HardwareError
(Copied from FN_ISAL_Test)
AE_NotReady
(Copied from FN_ISAL_Test)
AE_Offline
(Copied from FN_ISAL_Test)
AE_FencedOut
(Copied from FN_ISAL_Test)
AE_FormatDegraded
(Copied from FN_ISAL_Test)
AE_FormatinProgress
(Copied from FN_ISAL_Test)

FC_Format

This function causes formatting of the physical disk to start. AS_Success is returned if formatting does start. The array-configuration service issues a FN_ISALMgr_Open and FN_ISAL_Format to the physical disk. If formatting starts successfully, the array-configuration service constructs a record that tracks the serial number of the disk.

The array-configuration service periodically issues FN_ISAL_Progress to this disk to determine the progress of the formatting. If a FC_ResrcList or FC_ResrcView transaction is issued to a disk being formatted, the progress of the format from the last FN_ISAL_Progress transaction issued is returned in the SNS_Percent field.

When formatting completes successfully, the handle is closed and the record of the disk serial number is removed. If formatting fails, the handle is closed and a record kept for that disk so that FS_ResrcFormatFailed can be returned to a subsequent FC_ResrcList or FC_ResrcView transaction. This failure record persists until the adapter is re-booted or a wrap, format or certify is issued.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 25	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Blocksize			

Function

This is the function code, 25, for FC_Format

Filter Type

This is the filter type to which the function is directed. This must be FT_PhysicalDisk, which is not really a filter.

Serial Number

This is the serial number of the resource to be formatted.

Blocksize

This is the number of bytes in each block. This must be a value that is supported by the disk drive.

Status_DDR

No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:

AS_Success

AE_NotInTable
Filter not FT_PhysicalDisk or serial number not found
Illegal Request (range)

AE_PhysWrapped
Device is currently wrapped
AE_PhysFormatting
Device is currently formatting
AE_PhysCertifying
Device is currently certifying
AE_Failure

AE_AccessDenied
(Copied from FN_ISALMgr_Open)
AE_InvalidRID
(Copied from FN_ISALMgr_Open)
AE_LogOpen
(Copied from FN_ISALMgr_Open or FN_ISAL_Format)
AE_ReservationConflict
(Copied from FN_ISAL_Format)
AE_HardwareError
(Copied from FN_ISAL_Format)
AE_NotReady
(Copied from FN_ISAL_Format)
AE_Offline
(Copied from FN_ISAL_Format)
AE_FencedOut
(Copied from FN_ISAL_Format)
AE_LogOpen
(Copied from FN_ISAL_Format)
AE_FormatinProgress
(Copied from FN_ISAL_Format)

FC_Certify

This function starts the verification of every block on the physical disk. AS_Success is returned if this verification can be started successfully.

The array-configuration service issues a FN_ISALMgr_Open to the physical disk before returning the result field to the FC_Certify transaction. If the disk opens successfully, the array-configuration service constructs a record that tracks the serial number of the disk being certified and the progress of the certification.

The array-configuration service sends FN_ISAL_Reads with FF_Verify flag on to verify that all blocks on the disk can be read. If a FC_ResrcList or FC_ResrcView transaction is issued to a disk that is being certified, the progress of the certify is returned in the SNS_Percent field.

When certifying completes successfully, the handle is closed and the record of the disk serial number is removed. If certifying fails, the handle is closed and a record kept for that disk so that FS_ResrcCertifyFailed can be returned to a subsequent FC_ResrcList or FC_ResrcView transaction. This failure record persists until the adapter is re-booted or a wrap, format, or certify is issued.

Parameter_DDR

This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 26	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Blocksize			

Function

This is the function code, 26, for FC_Certify

Filter Type

This is the filter type to which the function is directed. This must be FT_PhysicalDisk, which is not really a filter.

Serial Number

This is the serial number of the resource to be certified.

Blocksize

This is the number of bytes in each block. This must be a value that is supported by the disk drive.

Status_DDR

No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:

AS_Success

AE_NotInTable

Filter not FT_PhysicalDisk or serial number not found

Illegal Request (range)

AE_PhysWrapped

Device is currently wrapped

AE_PhysFormatting

Device is currently formatting

AE_PhysCertifying

Device is currently certifying

AE_Failure
Unable to begin certifying
AE_AccessDenied
(Copied from FN_ISALMgr_Open)
AE_InvalidRID
(Copied from FN_ISALMgr_Open)
AE_LogOpen
(Copied from FN_ISALMgr_Open)

FC_Read

This function reads a single sector from the disk identified by the serial number field.

The array-configuration service issues an FN_ISALMgr_Open, FN_ISALMgrCharacteristics, FN_ISAL_Read, and FN_ISAL_Close to the resource before returning the result field for the FC_Read function.

Because this IACL function does not involve sending a handle to identify the resource, some applications, for example, service, might prefer to use this rather than FN_ISAL_Read when reading a sector from a disk.

The function can be addressed to a resource of any filter type, but that resource must not already be open by the device driver or by another filter.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 27	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Logical Block Address			
24	Reserved = 0		Flags	Priority

Function
This is the function code, 27, for FC_Read

Filter Type
This is the filter type to which the function is directed.

Serial Number
This is the serial number of the resource to be read.

Logical Block Address
This is the logical block address of the block to be read.

Flags This field controls the type of read to be executed. These are defined in detail in “FN_ISAL_Read” on page 112.

Priority
This field is reserved for future use.

Status_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			
8 through n	Data			

Length Number of bytes of data following in the status data. Only 512-byte blocksize is supported.

Data The data on the LBA requested.

Result The following result fields can be returned:
AS_Success

AE_NotInTable
Filter not FT_PhysicalDisk or serial number not found
Illegal Request (range)

AE_PhysWrapped
Device is currently wrapped
AE_PhysFormatting
Device is currently formatting
AE_PhysCertifying
Device is currently certifying
AE_Failure
Unable to begin reading
AE_AccessDenied
(Copied from FN_ISALMgr_Open)
AE_InvalidRID
(Copied from FN_ISALMgr_Open)
AE_LogOpen
(Copied from FN_ISALMgr_Open)
AE_ReservationConflict
(Copied from FN_ISAL_Read)
AE_HardwareError
(Copied from FN_ISAL_Read)
AE_NotReady
(Copied from FN_ISAL_Read)
AE_MediumError
(Copied from FN_ISAL_Read)
AE_InvalidSignature
(Copied from FN_ISAL_Read)
AE_Offline
(Copied from FN_ISAL_Read)
AE_FencedOut
(Copied from FN_ISAL_Read)
AE_FormatDegraded
(Copied from FN_ISAL_Read)

AE_FormatinProgress
(Copied from FN_ISAL_Read)
AS_Warning
(Copied from FN_ISAL_Read)

FC_Write

This function writes a single sector to the disk identified by the serial number field.

The array-configuration service issues an FN_ISALMgr_Open, FN_ISALMgrCharacteristics, FN_ISAL_Write, and FN_ISAL_Close to the resource before returning the result field for the FC_Write function.

Because this IACL function does not involve sending a handle to identify the resource, some applications, for example, service, might prefer to use this rather than FN_ISAL_Write when writing a sector to a disk.

The function can be addressed to a resource of any filter type, but that resource must not already be open by the device driver or by another filter.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 28	
4 through 15	Serial Number			
16	Reserved = 0	Serial Number		
20	Logical Block Address			
24	Reserved = 0		Flags	Priority
28 through n	Data			

Function
This is the function code, 28, for FC_Write

Filter Type
This is the filter type to which the function is directed.

Serial Number
This is the serial number of the resource to be written.

Logical Block Address
This is the logical block address of the block to be written.

Flags This field controls the type of write to be executed. These are defined in detail in “FN_ISAL_Write” on page 115.

Priority
This field is reserved for future use.

Data The data to be written. The number of bytes should be that of the blocksize of the disk. Only 512-byte blocksize is supported at this time.

Status_DDR

No status data is returned for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:

AS_Success

AE_NotInTable

Filter not FT_PhysicalDisk or serial number not found

Illegal Request (range)

AE_PhysWrapped

Device is currently wrapped

AE_PhysFormatting

Device is currently formatting

AE_PhysCertifying

Device is currently certifying

AE_Failure

Unable to begin writing

AE_AccessDenied

(Copied from FN_ISALMgr_Open)

AE_InvalidRID

(Copied from FN_ISALMgr_Open)

AE_LogOpen

(Copied from FN_ISALMgr_Open)

AE_ReservationConflict

(Copied from FN_ISAL_Write)

AE_HardwareError

(Copied from FN_ISAL_Write)

AE_NotReady

(Copied from FN_ISAL_Write)

AE_MediumError

(Copied from FN_ISAL_Write)

AE_InvalidSignature

(Copied from FN_ISAL_Write)

AE_Offline

(Copied from FN_ISAL_Write)

AE_FencedOut

(Copied from FN_ISAL_Write)

AE_FormatDegraded

(Copied from FN_ISAL_Write)

AE_FormatinProgress

(Copied from FN_ISAL_Write)

AE_WriteProtect
(Copied from FN_ISAL_Write)
AS_Warning
(Copied from FN_ISAL_Write)

FC_AdapterSN

This function returns the serial number of the adapter.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 29	

Function
This is the function code, 29, for FC_AdapterSN

Filter Type
This is the filter type to which the function is directed. This must be FT_Adapter, which is not really a filter.

Status_DDR
This is a pointer to the buffer that receives the following data:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 8			
8 through 12	AdapterID			

Length Number of bytes that follow in this field (8)

AdapterID
This 8-byte binary number uniquely identifies the adapter. It is the serial number of the adapter as reported in the VPD.

Result The following result fields can be returned:

AS_Success

AE_Failure

AE_UnknownFunction

FC_CacheFormat

This function zeroes all the data in the cache if the data has all been destaged to the disk drive. The function is provided for security purposes.

If the cache contains any data that has not been destaged to the disk drive, the transaction is rejected with AE_Failure. The function should only be sent to the fast write filter; it is rejected with AE_UnknownFunction by all other filters.

Parameter_DDR
This is a pointer to the following data:

Byte	3	2	1	0
0	Reserved = 0	Filter Type	Function = 30	

Function
This is the function code, 30, for FC_CacheFormat

Filter Type
This is the filter type to which the function is directed. This must be FT_FastWriteFilter.

Status_DDR
No status data is required for this function, but a Status_DDR that points to the following data is returned:

Byte	3	2	1	0
0	Reserved = 0			
4	Length = 0			

Result The following result fields can be returned:

AS_Success

AE_Failure
Cache contains data not yet destaged to disk

AE_UnknownFunction
Filter not FT_FastWriteFilter but a known filter. This is always returned by the SSA 4-Port RAID Adapter

AE_NotInTable
Unknown filter

Application Results

The following Application-result fields might be returned at the end of a transaction:

AS_Success
The transaction has been successfully completed.

AS_Warning
The transaction has been successfully completed, but the Status DDR contains warning information that either the unit might fail soon or a logical block should be reassigned.

AE_NotReady
The service is not ready to execute this transaction.

AE_MediumError
The transaction has terminated with a nonrecoverable error condition caused by a flaw in the disk surface or an error in the recovered data. The Status DDR contains the address of the logical block in error.

AE_HardwareError
A nonrecoverable hardware error was detected during this transaction.

AE_ReservationConflict
The transaction was not executed because the resource was reserved to another client.

AE_WriteProtect
The transaction was not executed because write operations are not permitted to the resource.

AE_Failure
The transaction could not be completed for a reason other than an error.

AE_AccessDenied
Access is denied because of the mode in the open operation for that resource.

Illegal Request (range)
There was an illegal field in the transaction. A range of result field codes are reserved for Illegal Request to provide more information on the field in error.

AE_Offline
The resource was in the RS_Offline state and the transaction to this handle could not be executed. The only valid transactions that can be addressed to a handle for a resource in the RS_Offline state are FN_ISAL_Close, FN_ISALMgr_Characteristics, and FM_ISALMgr_Statistics.

AE_SCSIError
Nonzero SSA-SCSI status was returned from the resource while opened in MD_SCSI mode.

AE_UnknownFunction
The function requested is not supported.

AE_LogOpen
This function cannot be executed while the corresponding logical resource is open. This could be an attempt to open the physical resource in MD_Service mode or to send certain transactions to the physical resource.

AE_SSAString
An attempt was made to open a physical resource in MD_Service mode while that resource was in an SSA string network rather than in a loop.

AE_FencedOut
The resource is currently fenced out from executing this transaction from this client.

AE_TableFull
Resource table is full.

AE_InvalidRID
Resource is currently not known by the recipient.

AE_NotInTable
Only returned to transactions originating from the registry.

AE_NotYetImplemented
Function is not yet implemented.

AE_RetryWhenMemory
Only returned to transactions originating from the registry.

AE_ClusterNumberNotKnown
Only returned in the FN_ISAL_Fence transaction.

AE_FormatDegraded
A format operation to the disk drive has unsuccessfully completed and the user data area is not accessible.

AE_FormatInProgress
The disk drive is currently executing a formatting operation.

AE_MissingCluster
The cluster number is not known to the system.

AE_RoutingError
Error in executing a TargetTransfer transaction to another node.

AE_RemoteTimeout
The remote host did not respond to a TransferToHost transaction within the timeout period.

AE_TargetNotAvailable
The remote node is not available to receive data from the sending cluster.

AE_TargetReceiverFull
The buffer in the remote host is not available to receive data.

AE_TargetTransferTooLarge
The buffer in the remote host is too small to receive the data specified.

AE_MediaReadOnly
Write operations are not permitted to this resource, for example, to a degraded array.

AE_ParityNotValid
Parity is not valid for an array.

AE_QNTimedOut
Returned only to FN_ADAP_QueryNodes to indicate that the node did not respond to the Query Node SMS that was sent.

AE_InConfig
The adapter was in the process of SSA reconfiguration when the transaction was received.

AE_InServiceMode
The transaction cannot be executed because the resource is in service mode.

AE_OfflineTimeout

AE_NotFound

AE_PhysWrapped

AE_PhysCertifying

AE_PhysFormatting

AE_NotOpen

AE_TransferFailed

AE_TabAborted

AE_NonIsal

AE_NotSupported

AE_OtherAdapterInServiceMode

The following Application_result fields might be returned during configuration or array transactions:

AE_BadSerialNumber

AE_BadOldSerialNumber

AE_BadNewSerialNumber

AE_BadComponentCount

AE_BadComponentSerialNumber

AE_BadResrcSerialNumber

AE_BadOldComponentSerialNumber

AE_BadNewComponentSerialNumber

AE_BadParameterValues

AE_ArrayIsBroken

AE_SetOMTFailed

AE_BadExchangeCandidate

AE_FiltersOnly

AE_NotFilters

AE_NvramError

AE_InvalidCandidateRequest

AE_InvalidCreateRequest

AE_ReadOnlyParameterValue

AE_ArrayIsBrokenOrDegraded

AE_AvoidWrite

AE_AvoidReadWrite

AE_NotLocal

AE_FlushCompFailure

AE_ConfirmRequired

Chapter 7. Error Recovery and Error Logging

This section defines the error recovery and error reporting that is performed by the adapter when adapter, SSA-link, or attached-device errors are detected.

Strategy

The following strategy is implemented for error recovery and error reporting:

Error Recovery

- All possible error recovery for the attached devices is performed by the adapter. The error recovery is based on async-alert conditions, SCSI status, or a decode of the SCSI Key/Code/Qualifier sense data. If an error log entry is to be made as a result of the error recovery procedure (ERP), the adapter sends the error data to the error logger with the ID of the failing physical resource and the ID of the error log template.
- SSA Link errors are recovered in accordance with the SSA link ERP specification included in the SSA-PH functional specification. If the ERP fails, the error data is logged against the resource ID of the adapter.

Error Logging

The adapter logs disk errors only against the failing physical device.

Errors are logged as a result of:

- Device errors reported by an I/O device
- Adapter-detected failures (These include errors in the adapter, arrays, SSA links, and SSA configuration.)
- Device-driver-detected failures
- Device driver healthcheck-detected errors

The following error data is logged:

- Error data logged against disk drives consists of the 32 bytes of SCSI sense data returned by the disk drive.
- Error data logged as a result of adapter-detected failures consists of up to 36 bytes of data. The first three bytes are an adapter error code. The remainder of the data depends on the error type.

- It is possible for a user to unconfigure a pdisk without losing access to the hdisk that is assigned to that pdisk. Under these circumstances, an attempt to log errors against the pdisk fails. If the error logger receives an error log for a pdisk that is unconfigured, it should log an error against the adapter.

Error Record Templates

Each error code is assigned to an error log template.

The following is a list of error templates with their ID numbers. The ID numbers are used in byte 1 of the FN_REGY_LogErrorFromRegisty transaction to identify the template. The device driver translates the error-log-template ID to the system error ID.

01h SSA_DISK_ERR4

02h DISK_ERR4

03h SSA_DISK_ERR2

04h DISK_ERR1

05h SSA_DISK_ERR3

06h SSA_LINK_ERROR

07h SSA_DETECTED_ERROR

08h SSA_DEVICE_ERROR

09h SSA_DEGRADED_ERROR

0Ah SSA_HDW_ERROR

0Bh SSA_HDW_RECOVERED

0Ch SSA_SOFTWARE_ERROR

0Dh SSA_LINK_OPEN

0Eh SSA_DISK_ERR1

0Fh SSA_LOGGING_ERROR

10h SSA_ARRAY_ERROR

11h SSA_SETUP_ERROR

12h SSA_REMOTE_ERROR

13h SSA_CACHE_ERROR

14h SSA_CONFIG_COMPLETE

Device Error Recovery

Any device attached to the adapter reports failures by means of asynchronous-alert conditions, SCSI status codes, and SCSI sense data. For each device type attached to the adapter, a table is maintained in the adapter that defines the error recovery procedure (ERP) to be used and the data to log for all failure conditions reported by means of SCSI sense data. The default ERP table is for the SSA disk drives supplied with the 7133 SSA Subsystem. These ERP tables are built from data provided by the attaching devices. The data provided by the devices is in the following format:

Description
A text description of the error condition. This is here for information only and is not included in the ERP tables in the adapter microcode.

SCSI K/C/Q
The SCSI sense data key, code, and qualifier fields.

ERP# The error recovery procedure to be used.

Log The error-logging strategy that is used by the error recovery procedure as follows:
0 = No log entry
1 = Log the sense data
2 = Log first sense data if the ERP fails
3 = Log last sense data if the ERP fails

Template
The error logging template that should be used to log this error.

Bad Sector Management

When a sector cannot be read from a disk, but that data can be reconstructed from the other components of an array, the bad sector is reassigned by a facility called *IDISK*.

IDISK notes all sectors that return an unrecoverable medium error. When a write operation is next directed to such a sector, IDISK reassigns that block before writing the new data. If the sector cannot be reassigned by the drive, IDISK performs a software reassignment to an area of the disk outside the customer data area. Future read and write operations to that logical block address use the new sector.

When a disk that is a member of a RAID-5 array reports that it has an unrecoverable data error on one of its sectors, the array rewrites that sector when it has to reconstruct the data for that sector. The rewriting action causes IDISK to reassign the bad sector before the data is rewritten.

SSA Link Error Recovery

The SSA link error recovery procedures are defined in the SSA functional specification. This section defines the error logging strategy that is applied when link errors are reported to the adapter by means of asynchronous alert codes.

When an asynchronous alert is received, the adapter that is the SSA master logs the error code in accordance with the adapter error logging data table below.

If the error recovery fails, all adapters on the network are left with an open loop. Under these circumstances, the adapters log an error code indicating that the serial link is in degraded mode.

For alerts of type 6, no error recovery is applied. However, if the asynchronous alert type is 06 and the subtype is 01 (redundant power failure), the adapter waits for a period to see if asynchronous alerts with the same type and subtype fields are reported from more than one device and then logs the appropriate error code as defined in the table below.

Adapter Error Logging Data

The following table defines the error codes and error-log templates used when adapter error recovery procedures are invoked. These are hexadecimal characters. Each of the errors in this table are logged against the adapter resource ID.

Table 14. Adapter Error Logging Data

Condition	Template	Error Code
No error (only returned for AdapterHealthCheck)	-	00 00 00
Async type = 00 - 01 (no log)	-	-
Async type = 02 Unknown message	SSA_SOFTWARE_ERROR	32 A0 02
Async type = 03 Invalid message	SSA_SOFTWARE_ERROR	32 A0 03
Async type = 04 Protocol error	SSA_SOFTWARE_ERROR	32 A0 04
Async type = 05 Environmental error (not reported)	SSA_DETECTED_ERROR	02 A0 05
Async type = 06, Subtype = 01. Where ERP finds only one async of this type and subtype	SSA_DETECTED_ERROR	02 A0 06
Async type = 06, Subtype = 01. Where ERP finds more than one device reporting this async type and subtype	SSA_DETECTED_ERROR	02 A1 06
Async type = 06 Subttype = 03. Port not operational and POSTs failed	SSA_DEVICE_ERROR	02 A2 06
Async type = 10 Permanent line fault P=port(0-3) HH=hop(00-99)	SSA_LINK_OPEN	22 0P HH
Async type = 11 No characters received P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 1P HH
Async type = 12 Remote port disabled P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 2P HH
Async type = 13 Link reset failed P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 3P HH
Async type = 14 Retry limit exceeded P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	02 4P HH
Async type = 15 Hardware error P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 5P HH

Table 14. Adapter Error Logging Data (continued)

Condition	Template	Error Code
Async type = 16 Frame reject P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 6P HH
Async type = 17 Invalid retry status P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 7P HH
Async type = 18 Time-out waiting for Disabled state P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 8P HH
Async type = 19 Time-out waiting for Ready state P=port(0-3) HH=hop(00-99)	SSA_LINK_ERROR	A2 9P HH
Invalid async. code	SSA_LINK_ERROR	32 FF FF
Single device reports loss of redundant power or cooling	SSA_DETECTED_ERROR	03 00 C0
Multiple devices report loss of redundant power or cooling	SSA_DETECTED_ERROR	03 01 C0
Invalid SCSI status received	SSA_DEVICE_ERROR	03 03 FF
Adapter Hardware Failure	SSA_HDW_ERROR	04 00 00
Adapter 1 MB DRAM module zero failure	SSA_DEGRADED_ERROR	04 00 01
Adapter 2 MB DRAM module zero failure	SSA_DEGRADED_ERROR	04 00 02
Adapter 4 MB DRAM module zero failure	SSA_DEGRADED_ERROR	04 00 04
Adapter 8 MB DRAM module zero failure	SSA_DEGRADED_ERROR	04 00 08
Adapter 16 MB DRAM module zero failure	SSA_DEGRADED_ERROR	04 00 16
Adapter 32 MB DRAM module zero failure	SSA_DEGRADED_ERROR	04 00 32
Adapter 1 MB DRAM module one failure	SSA_DEGRADED_ERROR	04 10 01
Adapter 2 MB DRAM module one failure	SSA_DEGRADED_ERROR	04 10 02
Adapter 4 MB DRAM module one failure	SSA_DEGRADED_ERROR	04 10 04
Adapter 8 MB DRAM module one failure	SSA_DEGRADED_ERROR	04 10 08
Adapter 16 MB DRAM module one failure	SSA_DEGRADED_ERROR	04 10 16
Adapter 32 MB DRAM module one failure	SSA_DEGRADED_ERROR	04 10 32
Adapter both DRAM failure	SSA_HDW_ERROR	04 20 00
Adapter Fast Write Cache card failure	SSA_DEGRADED_ERROR	04 25 00
Not enough DRAM for Fast Write Cache	SSA_DEGRADED_ERROR	04 25 10
Fast Write resource detected, but no Fast Write Cache card on adapter	SSA_DEGRADED_ERROR	04 25 15
Incorrect data on identified resource (LBAs not known)	SSA_CACHE_ERROR	04 25 20
Incorrect data on unidentified resource	SSA_CACHE_ERROR	04 25 21
Incorrect data on identified resource (LBAs known)	SSA_CACHE_ERROR	04 25 22
Bad version number of Fast Write Cache	SSA_CACHE_ERROR	04 25 23
Fast Write Cache not accessible for the resource	SSA_CACHE_ERROR	04 25 24
Fast Write Cache is not correct for the resource	SSA_CACHE_ERROR	04 25 25
The adapter does not provide support for a Fast Write Cache card	SSA_DEGRADED_ERROR	04 25 26
Dormant Fast Write cache entry exists	SSA_DEGRADED_ERROR	04 25 27

Table 14. Adapter Error Logging Data (continued)

Condition	Template	Error Code
Duplicate Fast Write disk serial number detected	SSA_DEGRADED_ERROR	04 25 28
SSA device is preventing the completion of link configuration, where P=port (0-3) and HH=decimal hop (00-99) of the failing device	SSA_DEVICE_ERROR	04 3P HH
Device with 'failed' status where P=port (0-3) and HH=decimal hop (00-99) of the failed device	SSA_DEVICE_ERROR	04 4P HH
Open SSA Link where P=port (0-3) and HH=decimal hop (00-99) of the first device that is not accessible on the shortest link	SSA_LINK_ERROR	24 5P HH
Array offline - more than one disk not available	SSA_DEGRADED_ERROR	04 60 00
Minimum disk resources not available for array filter	SSA_ARRAY_ERROR	04 70 00
Incorrect data area of array	SSA_ARRAY_ERROR	04 75 00
Illegal Link Configuration (SIC-SIC/>48 drives/>1 adapter)	SSA_DEGRADED_ERROR	04 80 00
Illegal Link Configuration detected by array filter	SSA_DEGRADED_ERROR	04 85 00
One array member disk is on a different loop	SSA_DEGRADED_ERROR	04 86 00
Multiple array member disks are on a different loop	SSA_DEGRADED_ERROR	04 87 00
Array not available - invalid strip table full	SSA_DEGRADED_ERROR	04 88 00
Array not available - multiple device failures	SSA_DEGRADED_ERROR	04 89 00
Disk failure during array build	SSA_DEGRADED_ERROR	04 89 50
Array filter degraded - one disk not available	SSA_ARRAY_ERROR	04 90 00
Array filter exposed - one disk not available	SSA_ARRAY_ERROR	04 91 00
No spares available for an array that is configures for spares	SSA_ARRAY_ERROR	04 95 00
Incorrect parity in array	SSA_ARRAY_ERROR	04 97 00
Different adapter on each loop	SSA_DEGRADED_ERROR	04 98 00
Error accessing remote device	SSA_REMOTE_ERROR	04 A0 00
Unable to configure device	SSA_DEVICE_ERROR	04 BP HH
Data scrubbing reconstructed a data block and reassigned it	SSA_ARRAY_ERROR	04 E0 00

SSA Disk Drive Error Recovery Table

The following are the error recovery procedures implemented in the adapter for SSA disk drives when connected to a SSA adapter. Each of the errors in this table is logged against the disk drive resource ID.

Table 15. SCSI Sense Key/Code/Qualifier recovery procedures

Description	SCSI K/C/Q	ERP#	Log	Template
No Additional Sense Information	0 00 00	1	0	-
No Index/Sector Signal	1 01 00	1	1	SSA_DISK_ERR2

Table 15. SCSI Sense Key/Code/Qualifier recovery procedures (continued)

Description	SCSI K/C/Q	ERP#	Log	Template
No Seek Complete	1 02 00	1	1	SSA_DISK_ERR2
Peripheral Device Write Fault	1 03 00	1	1	SSA_DISK_ERR2
Track Following Error	1 09 00	1	1	SSA_DISK_ERR2
Write Error Recovered With Auto Reallocation	1 0C 01	1	1	SSA_DISK_ERR3
Write Error - Recommend Reassignment	1 0C 03	2	1	SSA_DISK_ERR3
Record Not Found	1 14 01	1	1	SSA_DISK_ERR3
Record Not Found - Recommend Reassignment	1 14 05	2	1	SSA_DISK_ERR3
Record Not Found - Data Auto Reallocated	1 14 06	1	1	SSA_DISK_ERR3
Random Positioning Error	1 15 00	1	1	SSA_DISK_ERR2
Positioning Error Detected by Read of Medium	1 15 02	1	1	SSA_DISK_ERR2
Data Synchronization Mark Error	1 16 00	1	1	SSA_DISK_ERR3
Data Synchronization Mark Error - Data Rewritten	1 16 01	1	1	SSA_DISK_ERR3
Data Synchronization Mark Error - Recommend Rewrite	1 16 02	3	1	SSA_DISK_ERR3
Data Synchronization Mark Error - Data Auto-Reallocated	1 16 03	1	1	SSA_DISK_ERR3
Data Synchronization Mark Error - Recommend Reassignment	1 16 04	2	1	SSA_DISK_ERR3
Recovered Data With Retries	1 17 01	1	1	SSA_DISK_ERR3
Recovered Data with Positive Head Offset	1 17 02	1	1	SSA_DISK_ERR3
Recovered Data with Negative Head Offset	1 17 03	1	1	SSA_DISK_ERR3
Recovered Data using previous sector ID	1 17 05	2	1	SSA_DISK_ERR3
Recovered Data Without ECC - Data Auto-Reallocated	1 17 06	1	1	SSA_DISK_ERR3
Recovered Data Without ECC - Recommend Reassignment	1 17 07	2	1	SSA_DISK_ERR3
Recovered Data Without ECC - Recommend Rewrite	1 17 08	3	1	SSA_DISK_ERR3
Recovered Data Without ECC - Data Rewritten	1 17 09	1	1	SSA_DISK_ERR3
Recovered Data with Error Correction and Retries Applied	1 18 01	1	1	SSA_DISK_ERR3
Recovered Data - Data Auto-Reallocated	1 18 02	1	1	SSA_DISK_ERR3
Recovered Data - Recommend-Reassignment	1 18 05	2	1	SSA_DISK_ERR3
Recovered Data With ECC - Recommend Rewrite	1 18 06	3	1	SSA_DISK_ERR3
Recovered Data With ECC - Data Rewritten	1 18 07	1	1	SSA_DISK_ERR3
Primary Defect List Not Found	1 1C 01	12	1	SSA_DISK_ERR2
Grown Defect List Not Found	1 1C 02	12	1	SSA_DISK_ERR2
Partial Defect List Transferred	1 1F 00	12	1	SSA_DISK_ERR2

Table 15. SCSI Sense Key/Code/Qualifier recovery procedures (continued)

Description	SCSI K/C/Q	ERP#	Log	Template
Internal Target Failure	1 44 00	1	1	SSA_DISK_ERR2
Spindles Not Synchronized	1 5C 02	15	2	SSA_DISK_ERR4
Predictive Failure Analysis Threshold Reached on Recovered Error	1 5D 00	1	1	SSA_DISK_ERR4
Logical Unit Not Ready Cause Not Reportable	2 04 00	6	2	SSA_DISK_ERR4
Logical unit is in the process of becoming ready	2 04 01	7	2	SSA_DISK_ERR4
Logical Unit Not Ready, initialization command required	2 04 02	6	2	SSA_DISK_ERR4
Logical Unit Not Ready, Format in Progress	2 04 04	4	2	SSA_DISK_ERR4
Medium Format Corrupted Reassign Failed	2 31 00	8	1	SSA_DISK_ERR4
Format Command Failed	2 31 01	4	1	SSA_DISK_ERR4
Diagnostic Failure	2 40 80	8	2	SSA_DISK_ERR4
Diagnostic Failure	2 40 85	14	1	SSA_DISK_ERR4
Diagnostic Failure	2 40 B0	9	1	DISK_ERR4
Logical Unit Failed Self-Configuration	2 4C 00	8	2	SSA_DISK_ERR4
Write Error - Auto-Reallocation Failed	3 0C 02	5	1	DISK_ERR1
Write Error - Recommend Reassignment	3 0C 03	5	1	DISK_ERR1
Unrecovered Read Error	3 11 00	5	1	SSA_DISK_ERR2
Unrecovered Read Error - Auto Reallocation Failed	3 11 04	5	1	DISK_ERR1
Unrecovered Read Error - Recommend Reassignment	3 11 0B	5	1	DISK_ERR1
Recorded Entity Not Found	3 14 00	5	1	DISK_ERR1
Record Not Found	3 14 01	5	1	SSA_DISK_ERR2
Record Not Found - Recommend Reassignment	3 14 05	5	1	DISK_ERR1
Data Synchronization Mark Error	3 16 00	5	1	SSA_DISK_ERR2
Data Synchronization Mark Error - Recommend Reassignment	3 16 04	5	1	DISK_ERR1
Defect List Error in Primary List	3 19 02	4	1	SSA_DISK_ERR4
Defect List Error in Grown List	3 19 03	4	1	SSA_DISK_ERR4
Medium Format Corrupted Reassign Failed	3 31 00	4	1	SSA_DISK_ERR4
Format Failed	3 31 01	4	1	SSA_DISK_ERR4
Internal Target Failure	3 44 00	8	1	DISK_ERR1
No Index/Sector Signal	4 01 00	13	2	SSA_DISK_ERR4
No Seek Complete	4 02 00	13	2	SSA_DISK_ERR4
Peripheral Device Fault	4 03 00	13	2	SSA_DISK_ERR4
Track Following Error	4 09 00	13	2	SSA_DISK_ERR4
Unrecovered Read Error in Reserved Area	4 11 00	4	1	SSA_DISK_ERR4
Recorded Entity Not Found	4 14 00	13	2	SSA_DISK_ERR4

Table 15. SCSI Sense Key/Code/Qualifier recovery procedures (continued)

Description	SCSI K/C/Q	ERP#	Log	Template
Record Not Found - Reserved Area	4 14 01	4	1	SSA_DISK_ERR4
Random Positioning Error	4 15 00	13	2	SSA_DISK_ERR4
Positioning Error Detected by Read of Medium	4 15 02	13	2	SSA_DISK_ERR4
Data Synchronization Mark Error in Reserved Area	4 16 00	4	1	SSA_DISK_ERR4
Defect List Error in Primary List	4 19 02	4	1	SSA_DISK_ERR4
Defect List Error in Grown List	4 19 03	4	1	SSA_DISK_ERR4
Medium Format Corrupted Reassign Failed	4 31 00	5	1	SSA_DISK_ERR4
No Defect Spare Location Available	4 32 00	4	1	SSA_DISK_ERR4
Defect list update failure	4 32 01	4	1	SSA_DISK_ERR4
Diagnostic Failure	4 40 80	8	2	SSA_DISK_ERR4
Diagnostic Failure	4 40 85	14	1	SSA_DISK_ERR4
Diagnostic Failure	4 40 90	8	2	SSA_DISK_ERR4
Diagnostic Failure	4 40 A0	8	2	SSA_DISK_ERR4
Diagnostic Failure	4 40 B0	9	1	DISK_ERR4
Diagnostic Failure	4 40 C0	8	2	SSA_DISK_ERR4
Diagnostic Failure	4 40 D0	8	2	SSA_DISK_ERR4
Internal Target Failure	4 44 00	13	2	SSA_DISK_ERR4
Spindles Not Synchronized	4 5C 02	15	2	SSA_DISK_ERR4
Parameter List Length Error	5 1A 00	10	2	SSA_DISK_ERR1
Invalid Command Operation Code	5 20 00	10	2	SSA_DISK_ERR1
Logical Block Address out of Range	5 21 00	10	2	SSA_DISK_ERR1
Invalid Field in CDB	5 24 00	10	2	SSA_DISK_ERR1
Logical Unit Not Supported	5 25 00	10	2	SSA_DISK_ERR1
Invalid Field in Parameter List	5 26 00	10	2	SSA_DISK_ERR1
Not Ready To Ready Transition, (Medium may have changed)	6 28 00	9	0	-
Power On Reset, or Reset Message occurred	6 29 00	9	0	
Mode Parameters Changed	6 2A 01	9	0	-
Log Parameter Changed	6 2A 02	9	0	-
Commands Cleared by Another Initiator	6 2F 00	9	0	-
Microcode has been changed	6 3F 01	9	0	-
Spindles Synchronized	6 5C 01	13	0	-
Spindles Not Synchronized	6 5C 02	15	2	SSA_DISK_ERR4
Write Protected	7 27 00	4	2	SSA_DISK_ERR4
Internal Target Failure	B 44 00	13	2	SSA_DISK_ERR4
Invalid Message Error	B 49 00	10	2	SSA_DISK_ERR1
Overlapped Commands Attempted	B 4E 00	16	2	SSA_DISK_ERR1

Table 15. SCSI Sense Key/Code/Qualifier recovery procedures (continued)

Description	SCSI K/C/Q	ERP#	Log	Template
Miscompare During Verify Operation	E 1D 00	4	1	SSA_DISK_ERR4
Invalid KCQ	x xx xx	4	2	SSA_DISK_ERR4

Appendix A. Identifier Values

This section supplies the values of the identifiers referenced elsewhere in this document. All values are decimal, except where shown as hexadecimal.

Registry Transactions

Name	Value
FN_REGY_SystemVersionInfo	10
FN_REGY_GatewayNodeList	11
FN_REGY_DriverGatewayNodeList	12
FN_REGY_ServiceList	13
FN_REGY_ConnectForNodeChange	14
FN_REGY_DiscForNodeChange	15
FN_REGY_NodeChangeToRegistry	16
FN_REGY_NodeChangeFromRegistry	17
FN_REGY_ConnectForErrorLogging	18
FN_REGY_DiscForErrorLogging	19
FN_REGY_LogErrorToRegistry	20
FN_REGY_LogErrorFromRegistry	21
FN_REGY_ConnectForResrcChange	22
FN_REGY_DiscForResrcChange	23
FN_REGY_ResrcChangeToRegistry	24
FN_REGY_ResrcChangeFromRegistry	25
FN_REGY_ResrcList	26
FN_REGY_GetTempResrcID	27
FN_REGY_ConnectForHealthCheck	28
FN_REGY_DiscForHealthCheck	29
FN_REGY_HealthCheckToRegistry	30
FN_REGY_HealthCheckFromRegistry	31
FN_REGY_SerialNumberSearch	32
FN_REGY_TestResrcsReady	33
FN_REGY_SetClusterNumber	34
FN_REGY_TestOneResrcReady	35
FN_REGY_SyncHCheckToRegy	36
FN_REGY_SyncHCheckFromRegy	37
EV_Rebooting	1
EV_NodeDead	2
EV_Rebooted	3
EV_NodeUnreliable	4
RS_Offline	1
RS_Online	2
CC_Add	01h
CC_SetOnline	02h
CC_SetOffline	04h
CC_Remove	08h
TY_Disk	0
TY_Adapter	1
SR_NoSynchro	0
SR_Synchro	1

Name	Value
LP_Unknown	0
LP_Loop	1
LP_String	2
LG_Unknown	0
LG_Legal	1
LG_Illegal	2
MN_Unknown	0
MN_Master	1
MN_NonMaster	2
SD_Code	0
SD_CodeAsn	1
SD_CodeAsnCsn	2

ISAL Transactions

Name	Value
FN_ISALMgr_Inquiry	40
FN_ISALMgr_HardwareInquiry	41
FN_ISALMgr_SetOwningModuleType	42
FN_ISALMgr_AssignManualResrcID	43
FN_ISALMgr_GetPhysicalResrcIDs	44
FN_ISALMgr_TestResrcsReady	45
FN_ISALMgr_VPDInquiry	46
FN_ISALMgr_Characteristics	47
FN_ISALMgr_Statistics	48
FN_ISALMgr_FlashIndicator	49
FN_ISALMgr_Open	50
FN_ISAL_Close	51
FN_ISAL_Read	52
FN_ISAL_Write	53
FN_ISAL_Format	54
FN_ISAL_Progress	55
FN_ISAL_Lock	56
FN_ISAL_Unlock	57
FN_ISAL_Test	58
FN_ISAL_SCSI	59
FN_ISAL_Download	60
FN_ISALMgr_QueryFilterType	61
FN_ISAL_Fence	62
FN_ISALMgr_TestOneResrcReady	63
FN_ISALMgr_Get PhysSvcAndRIDs	64
FN_ISALMgr_ServiceMode	65
FN_ISALMgr_NetworkInquiry	66
FN_ISALMgr_Preferences	67
FN_ISAL_Flush	68
FN_ISALMgr_LockQuery	69
MD_ISAL	0
MD_SCSI	1
MD_Service	2
MD_ISAL_HA	3

Name	Value
AT_All	0
AT_ReadOnly	1
AT_WriteOnly	2
SM_DenyNone	0
SM_DenyAll	1
SM_DenyWrite	2
SM_DenyRead	3
SM_DenyNothing	4
FF_Verify	01h
FF_NoCache	02h
FF_PreFetch	04h
FF_Split	08h
FF_ReadDisk	10h
FF_FastWrite	20h
FF_ISALReservedArea	40h
FF_ReassignWrite	80h
EF_NoCache	01h
EF_RelocationArea	02h
RF_ReassignWarn	01h
RF_DriveWarn	02h
RF_RewriteWarn	04h
RF_BlockWarn	08h
UL_Normal	0
UL_Forced	1
LT_Normal	0
LT_AdapID	1
ST_Good	0
ST_Failed	1
ST_LossRedundancy	2
ST_FormatInProgress	3
VP_NoEVPD	0
VP_EVPD	1
TT_Test	0
TT_Diag	1

Name	Value
AE_HardwareError	−4
AE_ParityNotValid	−6
AE_MediaReadOnly	−7
AE_IllegalRequest	−100 to −150
AE_TableFull	−9
AE_InvalidRID	−10
AE_InvalidSignature	−11
AE_AccessDenied	−12
AE_NotReady	−13
AE_ReservationConflict	−14
AE_WriteProtect	−15
AE_NotInTable	−16
AE_Offline	−17
AE_MediumError	−18
AE_SCSIError	−20
AE_LogOpen	−21
AE_FencedOut	−22
AE_FormatDegraded	−23
AE_FormatInProgress	−24
AE_ClusterNumberUnknown	−25
AE_SSAString	−26
AE_AvoidReadMe	−27
AE_AvoidWrite	−28
AE_NotLocal	−29
AE_NotYetImplemented	−30
AE_RetryWhenMemory	−31
AE_NotFound	−32
AE_FlushCompFailure	−33
AE_InServiceMode	−34
AE_OfflineTimeout	−35
AE_BadSequenceNumber	−36
AE_BadTransferLRC	−37
AE_BadblockLRC	−38
AE_NotSupported	−40
AE_NonIsal	−41
AE_OtherAdapterInServiceMode	−42

Name	Value
AE_BadSerialNumber	−500+0
AE_BadOldSerialNumber	−500+1
AE_BadNewSerialNumber	−500+2
AE_BadComponentCount	−500+3
AE_BadComponentSerialNumber	−500+4
AE_BadResrcSerialNumber	−500+5
AE_BadOldComponentSerialNumber	−500+6
AE_BadNewComponentSerialNumber	−500+7
AE_BadParameterValues	−500+8
AE_ArrayIsBroken	−500+9
AE_SetOMTFailed	−500+10
AE_BadExchangeCandidate	−500+11
AE_FiltersOnly	−500+12
AE_NotFilters	−500+13
AE_NvramError	−500+14
AE_InvalidCandidateRequest	−500+15
AE_InvalidCreateRequest	−500+16
AE_ReadOnlyParameterValue	−500+17
AE_ArrayIsBrokenOrDegraded	−500+18
AE_Physwrapped	−500+19
AE_PhysCertifying	−500+20
AE_PhysFormatting	−500+21
AE_NotOpen	−500+22
AE_BadComponent	−500+23
AE_ConfirmRequired	−500+24
OM_NotOwned	1
OM_DriverAdapters	2
OM_DriverPhysical	3
OM_DriverManualDisk	4
OM_DriverAutomaticDisk	5
OM_FirstFilter	E
OM_Raid5Filter	K
OM_Disowned	W
OM_NvramEntry	X
OM_HotSpareDisk	Y
HF_Unknown	0
HF_MotorFail	1
HI_NotImmediate	0
HI_Immediate	1
DL_NoSave	0
DL_Save	1
FF_Normal	0
FF_Force	1
FL_FenceOut	1
FL_FenceIn	2
FC_Add	1
FC_Remove	2
FM_Change	0
FM_CompareAndSwap	1

Adapter Services

Name	Value
FN_ADAP_TransferFromHost	80
FN_ADAP_TargetTransfer	83
FN_ADAP_TransferToHost	81
FN_ADAP_ConnectForTransfer	84
FN_ADAP_DisconnectForTransfer	85
FN_ADAP_AdapterHealthCheck	90

Service / Transaction Directives

Name	Value
DC_StartTransaction	19
DT_Illegal	0
DT_VAddress	1
DT_VChain	2
DT_VScatGatV	3
DT_VScatGatP	4
DT_VTcb	5
DT_VMonitor	6
DT_PAddress	7
DT_PScatGatP	8
DT_Indirect	9
DT_Invalid	10
DT_Null	11
DT_Microchannel	12
DT_MicrochannelScatGat	13
DT_Cfe	14
DT_ADDScatGatP	15
DT_Xmd	16
DT_WindowOffset	17
DT_ADDBaseVP	18
DT_Buf	19
DT_VAddressScatGat	20
DT_VMicrochannel	21
MF_System	1
MF_Application	2
MF_Gateway	3
AS_Warning	1
AS_Success	0
AE_UnknownFunction	-1
AE_Busy	-2
AE_Failure	-3
AE_NotYetImplemented	-30
AE_RetryWhenMemory	-31
AE_NotFound	-32

Name	Value
OT_XferTCB	0
OT_Parms	1
OT_Fetch	2
OT_Store	3
OT_Status	4
OT_Done	5
OT_FastDone	6
FF_Exclusive	1
DC_SlaveInstallService	23
SN_Router	0
SN_Registry	1
SN_TimeServer	2
SN_ErrorLogger	3
SN_SSAGS	4
SN_SSADS	5
SN_CfgAgent	6
SN_AdapterService	7
SN_WAManager	12
TP_Unused	0
TP_Unknown	1
TP_Router	2
TP_ISAL	3
TP_FileSystem	4
TP_Database	5
TP_Resource	6
TP_Registry	7
TP_TimeServer	9
TP_ErrorLogger	10
TP_SSAGS	11
TP_SSADS	12
TP_Window	13
TP_BlowTorch	14
TP_CfgAgent	15
TP_AdapterService	16
TP_Debug	17
TP_Nvram	18

Node Numbers

Name	Value	
NN_Local	0	The local node
NN_Host	1	The host
NN_AdapterA	11	First Adapter on bus 1
NN_AdapterAEnd	18	Last Adapter on bus 1
NN_AdapterB	21	First Adapter on bus 2
NN_AdapterBEnd	28	Last Adapter on bus 2
NN_DaughterA	31	First Daughter on bus 1
NN_DaughterAEnd	38	Last Daughter on bus 1
NN_DaughterB	41	First Daughter on bus 2
NN_DaughterBEnd	48	Last Daughter on bus 2
NN_UserStart	49	First User mode node
NN_UserEnd	63	Last User mode node
NN_PeerStart	64	
NN_PeerEnd	95	

Configuration / Array Identifiers

Name	Value
FN_IACL_Command	101
FN_IACL_Register	102
FN_IACL_Unregister	103
FT_NotOwned	A
FT_DriverAutomaticDisk	B
FT_DriverManualDisk	C
FT_PhysicalDisk	D
FT_FastWriteFilter	E
FT_Raid5Filter	K
FT_PartitioningFilter	L
FT_Disowned	W
FT_HotSpareDisk	Y
FT_BlankReserved	Z
FT_Adapter	Z+1

Name	Value
FC_IACLVersion	1
FC_ResrcCount	2
FC_ResrcList	3
FC_ResrcView	4
FC_CandidateCount	5
FC_CandidateList	6
FC_ResrcCreate	7
FC_ResrcDelete	8
FC_ResrcRename	9
FC_ComponentView	10
FC_ComponentExchange	11
FC_QueryMetaResrcParams	12
FC_ModifyResrcParams	13
FC_FlashIndicator	14
FC_VPDInquiry	15
FC_HardwareInquiry	16
FC_ComponentExchCandCount	17
FC_ComponentExchCandList	18
FC_AdapterVPD	19
FC_SyncHealth	20
FC_Wrap	21
FC_Unwrap	22
FC_UnwrapAll	23
FC_Test	24
FC_Format	25
FC_Certify	26
FC_Read	27
FC_Write	28
FC_AdapterSN	29
FS_CandOnline	20
FS_CandOffline	21
FS_ResrcOffline	40
FS_ResrcOnline	41
FS_ResrcOnlineNonDeg	42
FS_ResrcOnlineDeg	43
FS_ResrcOnlineRebuild	44
FS_ResrcOnlineExposed	45
FS_ResrcFormatting	50
FS_ResrcFormatFailed	51
FS_ResrcCertifying	52
FS_ResrcCertifyFailed	53
FS_CompNotPresent	60
FS_CompNotPresentDeconf	61
FS_CompNotPresentBlank	62
FS_CompPresent	65
FS_CompPresentRebuild	66
FS_CompPresentRebuildMe	67
FS_ResrcInUse	68
FS_ResrcDormant	69
FS_ResrcInUse	70 InUse (X%used)
FS_ResrcDormant	71 Dormant (X%used)

Name	Value
FS_ResrcWrapped	80 Wrapped, in service mode
SDS_BLOCKSIZE	1
SDS_DISK_NUMBER	2
SDS_STRIPE_SIZE	3
SDS_STRETCH_SIZE	4
SDS_MODE_FLAGS	5
SDS_STRIDE_SIZE	6
SDS_HOT_SPARE_ENABLED	7
SDS_HOT_SPARE_EXACT_SIZE	8
SDS_REBUILD_PRIORITY	9
SDS_SPEC_READ	10
SDS_DATA_SCRUB_ENABLED	11
SDS_DATA_SCRUB_RATE	12
SDS_SIZE	13
SDS_CACHE_SIZE	14
SDS_INITIALIZE	15
SDS_DELAY	16
SDS_SPLIT_RESOLUTION	17
SDS_WRITE_IN_DEG	18
SDS_LAZY_PARITY_WRITE	19
SDS_PAGE_ALIGN_SPLIT	20
SDS_NETWORK_ID	21 Network ID
SDS_GEOM_SECT	22 Geometry hint
SDS_READ_CACHE_DISABLE	23 Read cache disabled
SDS_READ_AHEAD_ENABLE	24 Read ahead enabled
SDS_BAD_PTY_STRIDE	25
SDS_BAD_COMPONENT_STRIDE	26
SDS_BAD_STRIPE	27
SDS_MIN_LBA	28 Fastwrite min LBA of cached LBA range
SDS_MAX_LBA	29 Fastwrite max LBA of cached LBA range
SDS_MAX_WRITE_LENGTH	30 Fastwrite max length of writes cached
SDS_ALLOW_DELETE	31 Fastwrite allow data in cache to be deleted
SDS_MIRROR_ENABLE	32 Fastwrite snoop data into battery-backed SRAM
SDS_SKIP_WR_REBUILD	33 Skip Write Rebuild
SDS_SPLIT_CONFIRM	34 Split Confirm (RAID-1 only)
SDS_FAST_DECONFIGURE	35 Fast Deconfigure
SDS_CACHE_FSW	36 Set if full stride writes are to be cached
SDS_BLOCK_LRC	37 Block LRC protection

Name	Value
SDSF_MB	00000001h
SDSF_KB	00000002h
SDSF_PERCENT	00000004h
SDSF_ON_OFF	00000008h
SDSF_BYTES	00000010h
SDSF_SECONDS	00000020h
SDSF_MINUTES	00000040h
SDSF_HOURS	00000080h
SDSF_READONLY	80000000h
SDSF_UNIQUE	40000000h

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