SFF specifications are available at http://www.snia.org/sff/specifications
or ftp://ftp.seagate.com/sff

This specification was developed by the SFF Committee prior to it becoming the SFF TA (Technology Affiliate) TWG (Technical Working Group) of SNIA (Storage Networking Industry Association).

The information below should be used instead of the equivalent herein.

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If you are interested in participating in the activities of the SFF TWG, the membership application can be found at:
http://www.snia.org/sff/join

The complete list of SFF Specifications which have been completed or are currently being worked on can be found at:
http://www.snia.org/sff/specifications/SFF-8000.TXT

The operations which complement the SNIA's TWG Policies & Procedures to guide the SFF TWG can be found at:
http://www.snia.org/sff/specifications/SFF-8032.PDF

Suggestions for improvement of this specification will be welcome, they should be submitted to:
http://www.snia.org/feedback

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SFF Committee

SFF-8067 Specification for

40-pin SCA-2 Connector w/Bidirectional ESI

Rev 3.6 February 12, 2008

Secretariat: SFF Committee

Abstract: This specification defines the bidirectional capability to transfer ESI (Enclosure Services Interface) for the 40-pin SCA-2 (Single Connector Attach) connector for use in Fibre Channel applications.

This specification provides a common reference for systems manufacturers, system integrators, and suppliers. This is an internal working specification of the SFF Committee, an industry ad hoc group.

This specification is made available for public review, and written comments are solicited from readers. Comments received by the members will be considered for inclusion in future revisions of this specification.

Support: This specification is supported by the identified member companies of the SFF Committee.

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EXPRESSION OF SUPPORT BY MANUFACTURERS

The following member companies of the SFF Committee voted in favor of this industry specification.

Adaptec
DDK Fujikura
Dell
EMC
Emulex
ENDL
FCI
Fujitsu CPA
Hewlett Packard
Hitachi Cable
Hitachi GST
I/O Interconnect
Madison Cable
Ricoh
Robinson Nugent
Seagate
Sun Microsystems
Unisys
Volex

The following member companies of the SFF Committee voted to abstain on this industry specification.

Amphenol
Circuit Assembly
Comax
Finisar
Foxconn
Honda Connector
IBM
Infineon
Intel
LSI
Matsushita
Maxtor
Molex
Montrose/CDT
Pioneer NewMedia
Quantum
Toshiba America
Tyco
Vitesse Semiconductor
Yamagata Fujitsu

Foreword

The development work on this specification was done by the SFF Committee, an industry group. The membership of the committee since its formation in August 1990 has included a mix of companies which are leaders across the industry.

When 2 1/2" diameter disk drives were introduced, there was no commonality on external dimensions e.g. physical size, mounting locations, connector type, connector location, between vendors.

The first use of these disk drives was in specific applications such as laptop portable computers and system integrators worked individually with vendors to develop the packaging. The result was wide diversity, and incompatibility.

The problems faced by integrators, device suppliers, and component suppliers led to the formation of the SFF Committee as an industry ad hoc group to address the marketing and engineering considerations of the emerging new technology.

During the development of the form factor definitions, other activities were suggested because participants in the SFF Committee faced more problems than the physical form factors of disk drives. In November 1992, the charter was expanded to address any issues of general interest and concern to the storage industry. The SFF Committee became a forum for resolving industry issues that are either not addressed by the standards process or need an immediate solution.

Those companies which have agreed to support a specification are identified in the first pages of each SFF Specification. Industry consensus is not an essential requirement to publish an SFF Specification because it is recognized that in an emerging product area, there is room for more than one approach. By making the documentation on competing proposals available, an integrator can examine the alternatives available and select the product that is felt to be most suitable.

SFF Committee meetings are held during T10 weeks (see www.t10.org), and Specific Subject Working Groups are held at the convenience of the participants. Material presented at SFF Committee meetings becomes public domain, and there are no restrictions on the open mailing of material presented at committee meetings.

Most of the specifications developed by the SFF Committee have either been incorporated into standards or adopted as standards by EIA (Electronic Industries Association), ANSI (American National Standards Institute) and IEC (International Electrotechnical Commission).

If you are interested in participating or wish to follow the activities of the SFF Committee, the signup for membership and/or documentation can be found at:

www.sffcommittee.com/ie/join.html

The complete list of SFF Specifications which have been completed or are currently being worked on by the SFF Committee can be found at:

ftp://ftp.seagate.com/sff/SFF-8000.TXT

If you wish to know more about the SFF Committee, the principles which guide the activities can be found at:

ftp://ftp.seagate.com/sff/SFF-8032.TXT

Suggestions for improvement of this specification will be welcome. They should be sent to the SFF Committee, 14426 Black Walnut Ct, Saratoga, CA 95070.

1. Scope

The purpose of this SFF Specification is to define bidirectional transfer of ESI (Enclosure Services Interface) data over the 40-pin SCA-2 connector for Fibre Channel applications. A serialized protocol is used to transfer the data.

The SFF Committee was formed in August, 1990 to broaden the applications for storage devices, and is an ad hoc industry group of companies representing system integrators, peripheral suppliers, and component suppliers.

1.1 Description of Clauses

Clause 1 contains the Scope and Purpose.

Clause 2 contains Referenced and Related Standards and SFF Specifications.

Clause 3 contains the General Description.

Clause 4 contains the Glossary.

Clause 5 contains the Physical Positioning Requirements

Clause 6 contains the Signals

Clause 7 defines the Mapping of SCSI command to Enclosure Service Interface operation

Clause 8 specifies the Enclosure initiated ESI transfer (optional)

2. References

The SFF Committee activities support the requirements of the storage industry, and it is involved with several standards.

2.1 Industry Documents

The following interface standards are relevant to this Specification.

- ISO/IEC 14165-261, Fibre Channel - Link Services (FC-LS)(ANSI INCITS -xxx-2006)
- ISO/IEC 14165-252, Fibre Channel - Framing and Signaling - 2 -(FC-FS-2)(ANSI INCITS xxx-2006)
- ISO/IEC 14165-122, Fibre Channel - Arbitrated Loop - 2 (FC-AL-2) (ANSI INCITS 332-1999 and ANSI INCITS 332-1999/AM1-2003)
- ISO/IEC 14776-223, Fibre Channel Protocol - 3 (FCP-3)(ANSI INCITS 416-2006)
- ISO/IEC 14776-454, SCSI Primary Commands - 4 (SPC-4)(T10/1731-D)
- ISO/IEC 14776-372, SCSI Enclosure Services - 2 (SES-2) (T10/1559-D)

2.2 SFF Specifications

There are several projects active within the SFF Committee. The complete list of specifications which have been completed or are still being worked on are listed in the SFF-8000.TXT specification available at http://www.sffcommittee.com.

2.3 Sources

Those who join the SFF Committee as an Observer or Member receive electronic copies of the minutes and SFF specifications (http://www.sffcommittee.com/ie/join.html).

Copies of ANSI standards may be purchased from the InterNational Committee for Information Technology Standards (http://tinyurl.com/c4psg).

Copies of SFF, T10 (SCSI), T11 (Fibre Channel) and T13 (ATA) standards and standards

still in development are available on the HPE version of CD_Access (http://tinyurl.com/85fts).

2.4 Conventions

Certain terms used herein are the proper names of signals. These are printed in uppercase to avoid possible confusion with other uses of the same words; e.g., ATTENTION. Any lower-case uses of these words have the normal American- English meaning.

A number of conditions, commands, sequence parameters, events, English text, states or similar terms are printed with the first letter of each word in uppercase and the rest lower-case; e.g., In, Out, Request Status. Any lower- case uses of these words

The American convention of numbering is used i.e., the thousands and higher multiples are separated by a comma and a period is used as the decimal point. This is equivalent to the ISO/IEC convention of a space and comma.

American:	ISO:
0.6	0,6
1,000	1 000
1,323,462.9	1 323 462,9

2.5 Definitions

For the purpose of SFF Specifications, the following definitions apply:

Backplane: The components of the enclosure that mechanically support the SCA connector and create or route the required signals and power to the SCA connector from the enclosure. The backplane may be a true multi-device backplane, a paddle card inserted in a host computer, a paddle card attached to an appropriately designed cable, or any component with similar capabilities.

Device: The FC-AL peripheral that plugs into the backplane using the SCA connector. The device may be removable from the enclosure through an external port or may be permanently installed in the enclosure. The FC-AL peripheral may be any FC-AL device of any type that meets one of the standard form factors and establishes its connection to the backplane through an SCA-2 connector.

Optional: This term describes features which are not required by the SFF Specification. However, if any feature defined by the SFF Specification is implemented, it shall be done in the same way as defined by the Specification. Describing a feature as optional in the text is done to assist the reader. If there is a conflict between text and tables on a feature described as optional, the table shall be accepted as being correct.

Reserved: Where this term is used for defining the signal on a connector pin its actual function is set aside for future standardization. It is not available for vendor specific use. Where this term is used for bits, bytes, fields and code values; the bits, bytes, fields and code values are set aside for future standardization. The default value shall be zero. The originator is required to define a Reserved field or bit as zero, but the receiver should not check Reserved fields or bits for zero.

VU (Vendor Unique): This term is used to describe bits, bytes, fields, pins, signals, code values and features which are not described in this SFF Specification, and may be used in a way that varies between vendors.

VU Mode: A mode of execution by the device in which its use is not defined by this SFF Specification. The means by which a vendor invokes vendor unique operations within a device is defined by this SFF Specification.

3. General Description

This SFF Specification provides a mechanism for a Fibre Channel SCA-2 SCSI device as described in SFF-8045 to transfer information to and from an enclosure processor. The transfer may be initiated using the standard SCSI command set for the SCSI SES device type or at the request of the enclosure. The information is transmitted across the signal pins used to provide the loop identifier to the SCSI device. The protocol is designed to be implemented with simple direct access to the signals using the SCSI device's microprocessor. This specification describes both the physical layer signaling for the enclosure services information and the transport layer protocol for moving data through the device and formatting the data within a SCSI diagnostic page.

The protocol is able to determine whether the enclosure provides only the SEL_n signals as defined by SFF-8045, provides the SEL_n and Parallel ESI signals as optionally allowed by SFF-8045, or provides the SEL_n and Enclosure Services Interface as described by SFF-8067.

Basic communication protocols are defined to allow the presentation of basic enclosure services status by simple enclosures. More extensive communication protocols are defined to allow the transmission of the complete enclosure service interface data formats as described by the SCSI standards. The device will request enclosure information only when a SCSI command has requested the standard information or optionally at the request of the enclosure processor.

In all ways other than those items described here, SFF-8067 compliant devices are identical to SFF-8045 devices.

4. Table of Contents

FIGURES

TABLES

5. Revision History

The following reflects the revision history of this specification.

5.1 Revision 01/26/96

1)Initial draft of 8067
This proposed draft is extracted from the work of Jim Espy of CLARiiON and Radek Aster of Silicon Graphics. It was originally published as a formal proposal to the SFF committee as a specification entitled FC_AL STORAGE ENCLOSURE ENVIRONMENTAL SERVICES INTERFACE ENHANCEMENT, revision 1.1, dated 1/3/96.

5.2 Revision 02/02/96

1)Carified discovery process and added flow charts, Section 6.4.2.1
2)Carified -PARALLEL ESI signal pull-up value, Section 6.4.1.1

5.3 Revision 12/23/96

1)References to SFF-8065 deleted, since the project was cancelled.
Sections 3.0, 5.0, 6.2, and 6.3.
2)The references to SES replace the references for SPC where appropriate.
The revision level for SPC is updated. The changes appear in clause 2.1 (references) and clauses 7.1,
This also removes the editor's note in Section 7.1.
3)The list of pages is augmented to include those specified and reserved by SES. The changes appear in table 7.1 and clauses 7.1, 7.2, 7.3, and 7.4.
4)ESI is changed to "enclosure services" or SES where appropriate.
5)Page code checking is simplified. The changes appear in clauses 7.3, and 7.4.
6)One reason for forcing an ASC/ASCQ of ENCLOSURE SERVICES TRANSFER REFUSED is an invalid command to field to the enclosure processor. This is described in 7.3.
7)ASC/ASCQ values filled in in table 7.5, Section 7.5

5.4 Revision 01/02/97

1)Correct typo in 6.4.1.4 (from and to reversed in statement about direction of -DSK_RD)
2)Correct typo in 6.4.2.2 (-DRV_WR sb -DSK_WR)
3)Correct typo in 6.4.2.3 (-DRV_RD sb -DSK_RD)
4)Correct typo in 7.2 (SEND DIAGNOSTIC RESULTS sb RECEIVE DIAGNOSTIC RESULTS)
5)Correct table reference in 7.4 (table 7.3 sb table 7.4)
Correct page code in table 7.4 ('02'h sb '08'h)
Correct reference to byte in 7.4 (bit 7 is in byte 1, not byte 0)

5.5 Revision 01/22/97

1)Added SES to Section 2.1. References and corrected the revision level requirements.
2)Corrected improper use of word "port" in Section 6.1.2, replacing it with "access door".
3)Figure 6.2, provided TBD values.
4)The device model definition in Section 7.1 is clarified.
5)The SES sections of clause 7 are made explicitly informative, so that future revisions of SES can still operate compliantly with this specification. The mappings of the SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS commands are explicitly made normative, so that the enclosure services processor can count on a constant interface.

5.6 Revision 09/28/98

1)Added enclosure initiated ESI transfers.
2)Added a minimum -PARALLEL ESI negate time of 5ms.

5.7 Revision 11/19/98

1)Added an action specific byte enclosure request (see Table 8-1)
2)Added enclosure information action codes - Device ID, device temperature, and initiate loop initialization (see Tables 8-2, 8-7 thru 8-9)

5.8 Revision 3/2/99

1)Clarify the parameter length for the Enclosure request in text below Table 8-1.
2)Fix table byte numbering and transfer lengths, Table 8-3, 8-4, 8-5, and 8-8.
3)Defined value returned for the Port AL_PA and Port Position fields in Table 8-5 if the port does not have an AL_PA.
4)Expand Table 8-6 Loop Position Map Page and following text to include 2 maps.

5.9 Revision 6/18/99

1)Include signal name changes in Table 6-1 from SFF 8045
2)Changed the Port AL_PA entries in Table 8-5 to the 24-bit Port_Identifier. This includes the AL_PA.
3)Include the LIP type to send for Enclosure Initiated ESI (text after Table 8-7).
4)Added a minimum setup time on the enclosure asserting the START_1 and START_2 in 8.1 and Figure 8.1
5)Corrected Figure 6-3 note 1 from SEL_6 and SEL_7 to SEL_5 and SEL_6
6)Clarified "normal" manner in Figure 6-4 note 2.
7)Corrected Figure 8-1 note 3 from SEL_6 and SEL_7 to SEL_5 and SEL_6

5.10 Revision 7/21/99

1)Changed the bit order of the Device Control Code signals in Table 6-1 to match SFF 8045.
2)Added V symbol in Table 6-4
3)Changed parameter names (i.e., Vih to Iih), added V symbols, and corrected values in Table 6-5. 5.11 Dated 10/22/99

5.11 Revision 10/22/99

1) Added Table 8-10, Port Parameter page.
2) Added Action Code 06h in Table 8-2.
3) Corrected temperature range in text following Table 8-9

4) Changed the minimum -PARALLEL_ESI negate time from 5 msec to 20 msec in 6.4.2.

5.12 Revision 11/19/99

1) Added Table 8-11, Link Status page.
2) Added Action Code 07h in Table 8-2.
3) Added a flag bit in the Port Parameters page, Table 8-10, to indicate when the Link Status page has changed.
4) Delete references to Mode Select control of spin-down in **6.4.1.2.**

5.13 Revision 7/31/00

1) Changed the Enclosure Initiated ESI trigger from mated / unmated to mated to any other case, 8.1 & Figure 8-1
2) Added a spin-down control function and EIE page, table 8-12 and 8-13

5.14 Revision 3/20/01

1) Added REQ EDV, EDV STATE, PORT A, PORT B bits and missing parameter field name in Table 7-3
2) Corrected text below Table 8-1 to indicated the parameter length does not include the page header.
3) Added Table 8-14
4) Added Section 9
5) Global change in specification body from drive to device for consistency.

5.15 Revision 7/24/01

1) Added a time-out for device detected EDV transfers in 9.3.

5.16 Revision 1/27/05

1) Uodate 2.1 Industry Documents
2) Update TABLE 7-1 to indicate additional page codes assigned to SES
3) In 7.2 and 7.3 correct the SEND DIAGNOSTIC parameter length to Parameter Length
4) In TABLE 8-2 deleted the leading zeros. The ACTION CODES are 4 bits
5) In tables 8-3 thru 8-14 (excluding 8-7 and 8-12) corrected the ESI Page code in byte 0 to an 8 bit value.
6) In 8.3, corrected the name of the Enable SpinDn Ctrl bit.
7) Deleted the first sentence in 5 (duplicate of scope) and rename to Revision History to reflect the remaining content.
8) Change byte 1 name in TABLE 7.2 to Page Code Specific to match SPC.
9) Global, add 3 usecs for signal rise time to the times the device and enclosure wait for all rising edge signals.
10) Changed references to FC-PH to the newer FC-FS-2 and FC-LS standards.
11) Corrected error introduced in revision 3/20/01. In the text below Table 8-1 the parameter length does include the page header.

5.17 Revision Dated 4/20/05

1) TABLE 8-1 ENCLOSURE REQUEST - change the Action Code field to 8 bits.
2) TABLE 8-2 ACTION CODES - increase the assigned values to 2 digit hex values and added row for Vendor Specific

5.18 Revision Dated 2/12/08

1) TABLE 7-2 deleted, remaining tables in section 7 renumbered
2) FIGURE 7-1 deleted and added reference in 7.1 to SPC-3 for command formats.
3) TABLE 7-1 removed page code names and increase of page code range to 01-2Fh for ESI.
4) 7.2 increase of page code range to 01-2Fh.
5) Table contents moved to maintain section numbering.
6) Editorial changes.

6. Signals

6.1 Signal Conventions

Signal names are shown in all upper case letters. Signals can be asserted (active, true) in either a high (more positive voltage) or low (less positive voltage) state. A dash character (-) at the beginning or end of a signal name indicates it is asserted at the low level (active low). No dash or a plus character (+) at the beginning or end of a signal name indicates it is asserted high (active high). An asserted signal may be driven high or low by an active circuit, or it may be allowed to be pulled to the correct state by the bias circuitry. Details of the requirements are included in the signal definitions.

Unless noted otherwise, tables specify the voltage and/or current requirements at the device connector. Current flow into the device is positive and current flow out of the device is negative.

6.2 Signal Assignments

The signals that are not defined in this clause are defined by SFF-8045. The signal pinout is as shown in Table 6-1.

TABLE 6-1 FIBRE CHANNEL SCA-2 SIGNAL ASSIGNMENTS

40-pin SFF-8067 Connector Contact and Signal Name	Driven by Backplane/Device		40-pin SFF-8067 Connector Contact and Signal Name
1 -ENBL BYP CH1 (S)	D	B	(L) 12V CHARGE 21
2 12 VOLTS (S)	B	B	(L) GROUND (12V) 22
3 12 VOLTS (S)	B	B	(L) GROUND (12V) 23
4 12 VOLTS (S)	B	B	(S) +PORT 1_IN 24
* 5 -PARALLEL ESI (S)	D	B	(S) -PORT 1_IN 25
6 -DRIVE PRESENT (S)	D	B	(L) GROUND (12V) 26
7 READY LED OUT (S)	B/D	B	(S) +PORT 2_IN 27
8 POWER_CONTROL (S)	B	B	(S) -PORT 2_IN 28
9 START_1/MATED (S)	B	B	(L) GROUND (12V) 29
10 START_2/MATED (S)	B	D	(S) +PORT 1_OUT 30
11 -ENBL BYP CH2 (S)	D	D	(S) -PORT 1_OUT 31
*12 SEL_6 / -DSK_WR (S)	B/D	B	(L) GROUND (5V) 32
*13 SEL_5 / -DSK_RD (S)	B/D	D	(S) +PORT 2_OUT 33
*14 SEL_4 / -ENCL_ACK (S)	B	D	(S) -PORT 2_OUT 34
*15 SEL_3 / D(3) (S)	B/D	B	(L) GROUND (5V) 35
16 FAULT LED OUT (S)	B/D	B/D	(L) SEL_2 / D(2) 36*
17 DEV_CTRL_CODE_2 (S)	B	B/D	(L) SEL_1 / D(1) 37*
18 DEV_CTRL_CODE_1 (S)	B	B/D	(L) SEL_0 / D(0) 38*
19 5 VOLTS (S)	B	B	(L) DEV_CTRL_CODE_0 39
20 5 VOLTS (S)	B	B	(L) 5V CHARGE 40

Guide pins: Connected to GROUND (5V) on backplane and device.
* Signals whose definitions changed from SFF-8045 to SFF-8067.

6.3 Design Considerations

Except as specified in this specification, there are no additional design considerations to those described in SFF-8045.

6.4 SEL_n and Enclosure Service Interface operation

6.4.1 Signal Descriptions

6.4.1.1 -PARALLEL ESI

The -PARALLEL ESI signal is controlled by the SCSI device to request the enclosure to provide the SEL_n physical addressing signals, to request the enclosure to provide the -PARALLEL ESI signals defined by SFF-8045, and to request the execution of an ESI Block Read or an ESI Block Write operation as defined in this specification. The electronic characteristics of the -PARALLEL ESI signal are described in Table 6-2.

TABLE 6-2 OUTPUT CHARACTERISTICS OF -PARALLEL ESI

State	Current Drive Available	Output Voltage
HIGH	-100 uA < IOH < 100 uA	0 < VOH < 5.25V
LOW	IOL > 2 mA	0 < VOL < 0.5V

SFF-8067 devices are required to implement the -PARALLEL ESI signal.

SFF-8067 backplanes are required to implement the -PARALLEL ESI signal. A pull-up resistor of a minimum of 3 KOhm on the backplane is used to hold the signal in the negated state until it is driven by the device.

SFF-8067 devices installed in an SFF-8045 backplane will retrieve the optional P_ESI_n signals if the SCSI device asserts -PARALLEL ESI. This case will be differentiated from installation in a normal SFF-8067 backplane during the discovery phase of a transfer.

SFF-8045 devices installed in an SFF-8067 backplane will not perform the discovery process correctly. Null enclosure status will be transmitted in such a case.

Section 6.4.2 shows how -PARALLEL ESI is used in the Enclosure Service Interface sequencing.

6.4.1.2 START_x/MATED Controls

The method of starting the device's motor is established by the signals START_1 and START_2, as described in Table 6-3. The state of these signals can either be wired into the backplane socket or driven by logic on the backplane. In addition, the signals indicate to the device that the device has been mated to a backplane. The signals can also be optionally used by the backplane to indicate to the device that the device should prepare itself to be removed from the backplane or that the enclosure processor is initiating an ESI transfer.

Each device location should have these signals supplied independently to ensure proper operation. If the signals were bussed, a device with a power failure might clamp the signals in a condition that caused operational devices to behave incorrectly.

- If the GROUND state is implemented for START_1, bussing between devices is permissible.
- If the GROUND state is implemented for START_2, bussing between devices is permissible.
- If the OPEN state is implemented for START_1, this signal shall not be bussed between devices.
- If the OPEN state is implemented for START_2, this signal shall not be bussed between devices.
- If the enclosure contains logic that requests the device to power down, the START_1 and START_2 signals shall not be bussed between devices.

TABLE 6-3 DEFINITION OF MOTOR START / MATED CONTROLS

Case	START_2 / MATED	START_1 / MATED	Motor Spin Function
1	OPEN	OPEN	Un-Mated. Device is not mated. No spin-up will occur and precharge average current demands shall not be exceeded. Optional: prepare-for-removal indication to device from enclosure or initiate an ESI transfer request to device from enclosure.
2	OPEN	GROUND	Device is mated. After a mating deskew time has passed, the motor will spin up when the SCSI start command is received.
3	GROUND	OPEN	Device is mated. After a mating deskew time has passed, the motor will spin up after a delay in seconds of 12 times* the modulo 8 value of the numeric SEL_ID of the device.
4	GROUND	GROUND	Device is mated. After a mating deskew time has passed, the Motor spins up immediately after the completion of its reset and POST functions.

* This value may be reduced by device suppliers to reflect the worst case time duration of peak current drains at the 12V or 5V source (or both) during motor spin up. In no case should the delay exceed 12 seconds.

The mating deskew time is 250 msec. The device shall wait a minimum of 250 msecs after detecting one of the mated controls before setting its final values for the Motor Start/Mated controls and the selection ID values, since minor mechanical misalignments may cause the final mating to occur in any time order.

The backplane may optionally establish an open indication to both the START_1 and START_2 signals to indicate to the device that it should either prepare itself to have power removed or initiate an ESI request to the enclosure processor. The actual function is determined in the Discovery phase. The device detection of case 1, Un-Mated condition is optional.

If the function is prepare-for-removal, the device performs those behaviors necessary to prepare for the device to spin down and be removed. The device shall gracefully establish the bypass condition on both ports. The graceful bypass mechanism is still being defined, but basically requires that the device win arbitration, then assert the -ENBL BYP CH1 and -ENBL BYP CH2 signals. This eliminates the possibility that data may be corrupted while flowing on the loop.

A 10 KOhm pull up resistor to either 5 VOLTS or 3.3 VOLTS is provided on the disk device for each of the START_x/MATED signals to be sure that the control value is maintained in its "OPEN" state unless a ground is provided from the backplane.

The OPEN and GROUND states are established as described in Table 6-4.

TABLE 6-4 ELECTRONIC REQUIREMENTS FOR INPUT CONTROLS

State	Current	Voltage
OPEN	-20 uA < IIH < 20 uA	2.2V < VIH < 5.25V
GROUND	0 < IIL < -1 mA	-0.5V < VIL < 0.7V

6.4.1.3 SEL_n signals

The SEL_n signals are established by the backplane when the -PARALLEL ESI signal from the SCSI device is negated. The SEL_n signals shall be established at the SCSI device connector within 7 usecs (includes 3 usecs for rise time of the -PARALLEL_ESI signal, 1 usec for enclosure response and 3 usecs for the SEL_n signals rise time) of the negation of -PARALLEL ESI.

The backplane uses SEL_6 through SEL_0 ID lines to provide the binary value of the Loop Identifier to the device in that location. A SEL decode of 126 creates an AL_PA of 0 and is reserved for the fabric port, if any. A SEL decode of 127 is a flag for the device to use a soft address for the AL_PA. The SEL lines are used in a system to assign a physical location for each connection to a backplane, allowing the management of configuration and the simple identification of devices that need to be changed for maintenance reasons. The SEL lines specify the hard address for each device unless the system is required to override the values to manage duplicate SEL decodes.

The asserted (high) state establishes the binary 1 value.

- SEL_6 is the most significant binary bit, having the value of 2**6.
- SEL_0 is the least significant binary bit, having the value of 2**0.

The Loop Identifier is mapped according to tables in FC-AL to the proper AL_PA (AL Physical Address) for the SCSI device.

If a device were removed from the backplane and plugged into a different location in the backplane, the system normally uses the label information recorded on the device to recognize where this device should be mapped into its file management tables. This flexibility can be very desirable in data security applications or for configuration expansion. In some RAID configurations, the physical location in a string of disk devices can be extremely important and should remain consistent. It is recommended that physical location dependent systems use the capability to read the SEL ID value and the logical address to ensure proper configuration in the event of a maintenance or other error.

The ID Selection signals are tested by the device at power on to determine the proper Loop Identifier for a device. The signals may be tested at other times as required by the device. The ID Selection signal is expected to remain constant for a given device location, although some bits may be settable externally to differentiate the Loop Identifiers for different enclosures.

The high state is the asserted state and the low state is the negated state for the SEL_n signals, as described in Table 6-5. The driver on both the backplane and on the device shall be an open collector driver or other circuit without an active drive to the high state. The pull-up resistor shall be on the backplane and shall have a value appropriate to limit the required assertion drive to less than the specified Iol. The resistance should not be less than 3 KOhm.

The SEL_n signals are multiplexed to carry the ESI control signals, -DSK_WR, -DSK_RD, and -ENCL_ACK, and the ESI data signals, D(3), D(2), D(1), and D(0). The signals for each backplane slot must be driven individually and not bussed with those of another slot.

TABLE 6-5 SEL_n & ESI SIGNAL ELECTRICAL CHARACTERISTICS

Circuit/State	Voltage	Current
Driver/Asserted	0 < Vol < 0.5V	Iol < 1.6 mA into driver
Driver/Negated	2.0V < Voh < 5.25V	-20 uA < Ioh < 20 uA
Driver/Disabled	-0.5V < V < 5.25V	-20 uA < I < 20 uA
Receiver/Asserted	-0.5V < Vil < 0.7V	-20 uA < Iih < 20 uA
Receiver/Negated	2.2V < Vih < 5.25V	-20 uA < Iih < 20 uA
Receiver/Disabled	-0.5V < V < 5.25V	-20 uA < I < 20 uA

6.4.1.4 -DSK_WR, -DSK_RD, -ENCL_ACK, D(3), D(2), D(1), D(0)

The SEL_n signals change their properties when the SCSI device asserts the -PARALLEL ESI signal. When the -PARALLEL ESI signal is asserted, these signals operate as a bidirectional nibble (4-bit) wide communications interface under control of the device. Every transfer takes place in three phases. The discovery phase verifies that the enclosure and the device are both capable of SFF-8067 interactions. The command phase transfers a description of the operation to be performed by the enclosure services processor. The data transfer phase moves information provided by a SCSI command out to the enclosure services processor or moves information from the enclosure services processor into the SCSI device for transfer inbound on the SCSI interface. The electronic properties are as defined in Table 6-5.

Rules are additionally provided for those enclosures that meet a simplified subset of the SFF-8067 interface and for those enclosures that meet only SFF-8045 requirements.

The signal -DSK_WR is driven by the device to clock data outbound from the device to the enclosure during the command phase and an outbound data phase.

The signal -DSK_RD is driven by the SCSI device to clock data inbound from the enclosure to the device during an inbound data phase.

Both -DSK_WR and -DSK_RD take part in the discovery phase.

The signal -ENCL_ACK is driven by the enclosure services processor to indicate that outbound data is received and that inbound data is valid.

The signals D(3), D(2), D(1), and D(0) carry information to and from the processor. The conventions for transfer order are as described in Table 6-6 and Table 6-7.

TABLE 6-6 BIT AND BYTE ORDER IN ESI TRANSFERS

bit order in byte	7	6	5	4	3	2	1	0
transfer order on ESI interface	FIRST NIBBLE				SECOND NIBBLE			
bit order in ESI data	D(3)	D(2)	D(1)	D(0)	D(3)	D(2)	D(1)	D(0)
order in normal SCSI data string	7	6	5	4	3	2	1	0

TABLE 6-7 BYTE ORDERING IN ESI TRANSFERS

byte order on ESI interface	first	second	.....	n-1	n
byte order in SCSI or SFF-8067 specified string	0	1	.....	n-1	n

6.4.2 Data Transfer Protocol

An enclosure services information transfer is initiated either when a SCSI device receives a SCSI command of SEND DIAGNOSTIC or RECEIVE DIAGNOSTIC RESULTS specifying that a diagnostic page in the range defined in Table 7-1 as passed through to the ESI be transferred or when the SCSI device detects an Un-Mated on the START_1 and START_2 signals.

The device first asserts -PARALLEL_ESI , waiting a minimum of 4 usecs for SEL_ID to be removed from the SEL_n signals. This includes 1 usec for enclosure response and 3 usecs for SEL_n signal rise time. The device and enclosure then execute the Discovery phase, as described below. After successfully identifying the enclosure as supporting the SFF-8067 Enclosure Services protocol, the device performs a Command phase (using a fixed number of Write phase transfers) that provides the identification of the page to be transferred and the direction of the transfer. After the Command phase, the device performs a Read or Write phase to transfer the information block as defined by SCSI. When the Read or Write phase is complete, -PARALLEL_ESI is negated. The device shall wait a minimum of 7 usec before sensing the SEL_ID signals after -PARALLEL_ESI is negated. This includes 3 usecs for rise time of the -PARALLEL_ESI signal, 1 usec for enclosure response and 3 usecs for the SEL_n signals rise time.The -PARALLEL_ESI shall be negated a minimum of 20 msec before it is reasserted.

The negation of -PARALLEL_ESI is a message to the enclosure that whatever the state of the protocol, the entire transaction has been halted. A host block read command will generate Write and Read sequences per the example below:

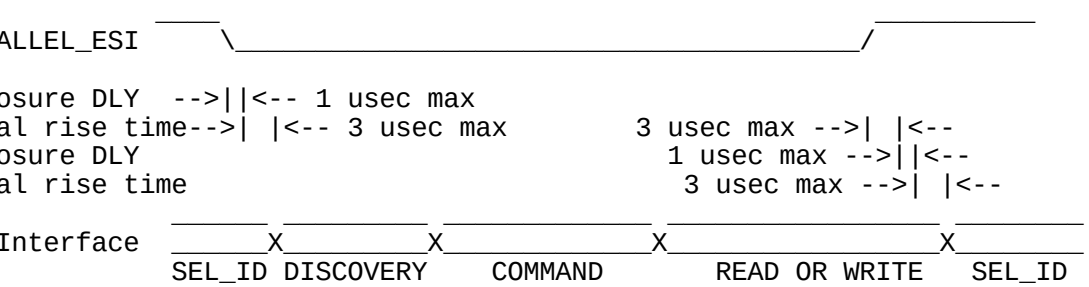


FIGURE 6-1 SUMMARY OF TRANSFER PHASES

6.4.2.1 Enclosure discovery phase

During the Discovery phase, the disk tests the enclosure interface for the following conditions:

a) Enclosure is an SFF-8067 enclosure.
b) Enclosure services circuit is available and not occupied by other SCSI devices.
c) SFF-8067 enclosure is operating correctly.
d) Enclosure is requesting a transfer.

Figure 6-2 provides a flowchart of the discovery process, together with the appropriate ASC/ASCQ. The text following the flow chart explains the discovery sequences. Timing charts are also provided.

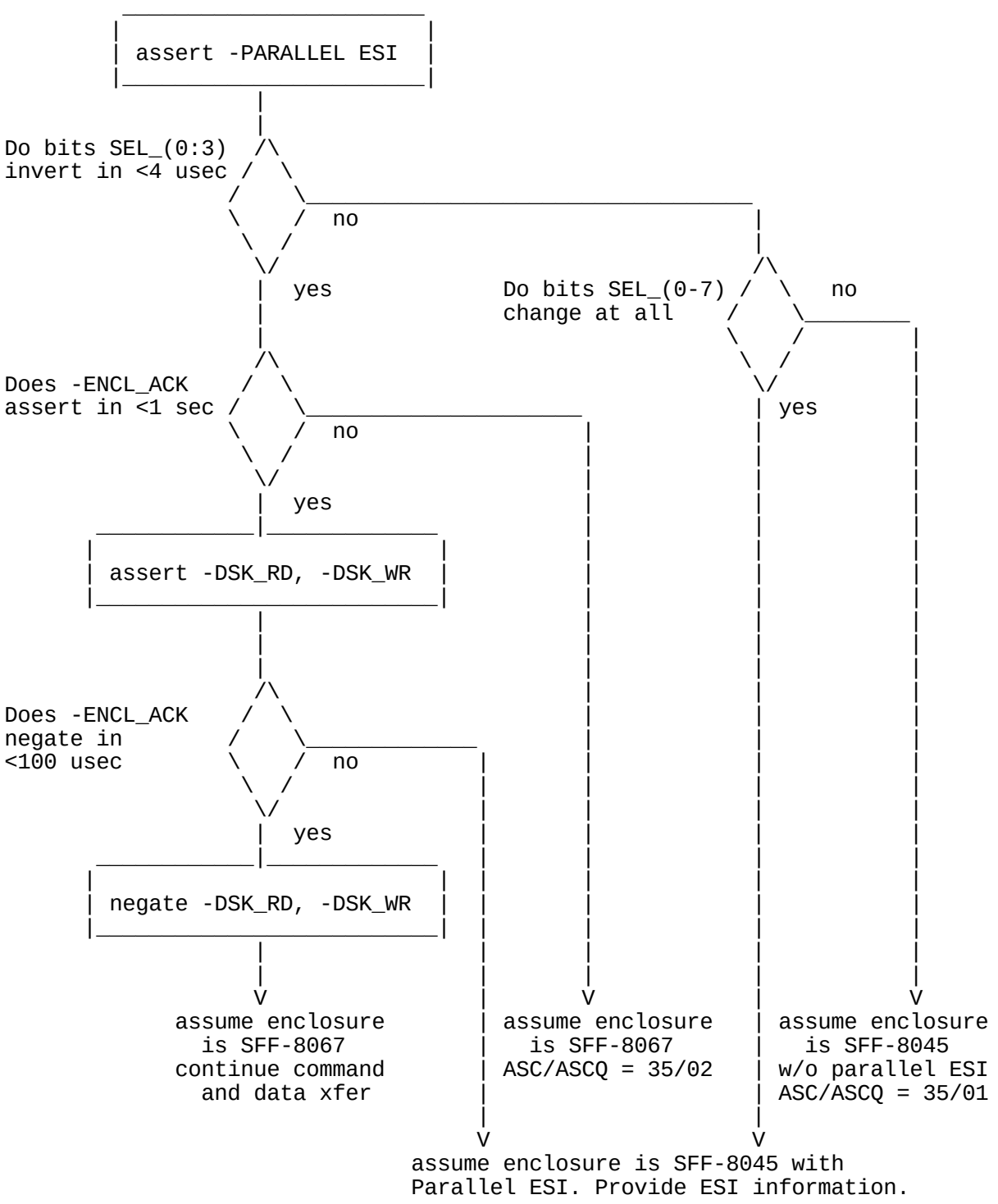


FIGURE 6-2 DISCOVERY FLOW CHART

An SFF-8067 SCSI device requests access to the enclosure's control circuitry by asserting -PARALLEL_ESI. The enclosure shall remove the SEL_ID value from SEL_n within 1 usec. SEL_4 shall take on the value corresponding to -ENCL_ACK, SEL_5 and SEL_6 shall be released so that the device can manage them as -DSK_RD and -DSK_WR respectively, and SEL_0, SEL_1, SEL_2, and SEL_3 shall be replaced by the enclosure with the complement of their values as a selection ID. This transition is detected by the SFF-8067 device, which immediately understands that the enclosure will probably accept further SFF-8067 communication procedures.

If the SEL_0 - SEL_3 value is not complemented within 4 usecs, the device considers that the enclosure is not compliant with SFF-8067 procedures. If any of the signals SEL_0 - SEL_6 value changes to a value other than the expected value from the enclosure, the device assumes that the enclosure is compliant with the parallel ESI function defined for SFF- 8045.

If the SEL_ID value does not change within 4 usecs, the device assumes that the enclosure is compliant with SFF-8045. If the SEL_ID value does not change, the SCSI device cannot determine through this interface whether the enclosure is providing parallel ESI information the same as the SEL_ID value or whether the enclosure does not support parallel ESI. This must be determined by testing a second device on the same enclosure or by knowledge of the expected enclosure bit values. See Section 7 for status conditions.

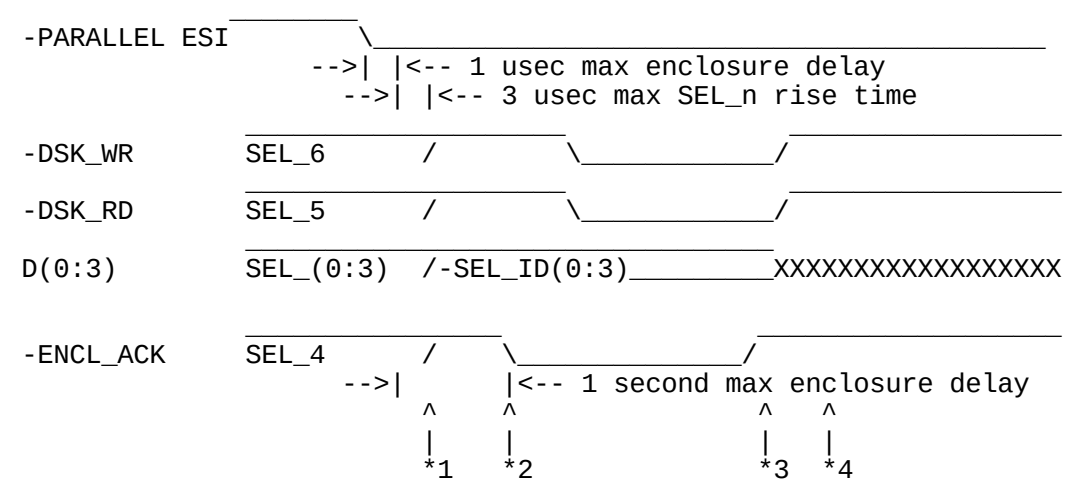
The enclosure uses the -PARALLEL_ESI indication from each participating device slot to select which device slots are requesting service. The enclosure switches its controls to whichever device slot it wants to communicate with first, then asserts the -ENCL_ACK signal to that device slot only. Another device slot will only receive the -ENCL_ACK signal after the enclosure has finished its work with the present device slot. If the SCSI device detects that the -ENCL_ACK signal did not return in less than one second, the device considers that the enclosure services circuitry is either unavailable or is not operational and negates -PARALLEL_ESI. See Section 7 for status conditions.

After the -ENCL_ACK is received by the device, the device asserts both DSK_RD and DSK_WR together. The enclosure shall negate ENCL_ACK within 100 usecs. If the enclosure does not negate ENCL_ACK, the device assumes that the enclosure is an SFF-8045 enclosure that provides parallel ESI information and that by chance the parallel ESI information contained the inverted SEL_(0:3) bits and asserted the -ENCL_ACK bit at the proper time. The device posts the information using the SFF-8045 format.

After the discovery phase has been successfully completed, the enclosure has been identified as an SFF-8067 enclosure, and the enclosure has indicated that it is available to the SCSI device with the assertion of -ENCL_ACK, the enclosure shall respond to any device request (-DSK_WR or -DSK_RD) within a single phase in less than 100 usecs. The failure of -DSK_WR or - DSK_RD to negate after the discovery process is detected as an SFF-8067 ENCLOSURE SERVICES TRANSFER REFUSED (timeout of the command phase transfer).

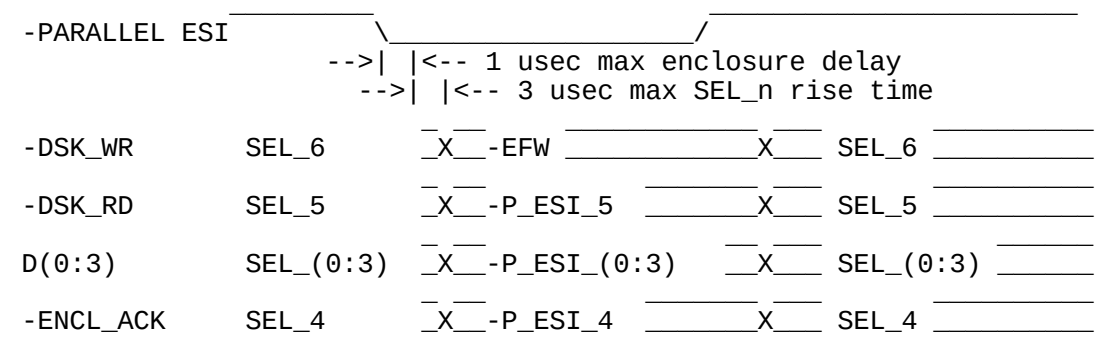
The enclosure shall respond to the first data transfer request following a command phase in less than 1 millisecond. The device shall implement appropriate timeouts with those minimum values to determine that the enclosure is operating normally. The specified CHECK CONDITION status shall be presented if the timeouts are exceeded.

The enclosure may implement timeouts to determine that the device is continuing an SFF-8067 communication normally. The timeout shall be a minimum of 100 milliseconds. After the timeout is exceeded with no actions performed by the SCSI device, the enclosure may ignore -PARALLEL ESI from that device until the signal is negated and once again asserted. The enclosure may post error conditions and may report those conditions to other devices.



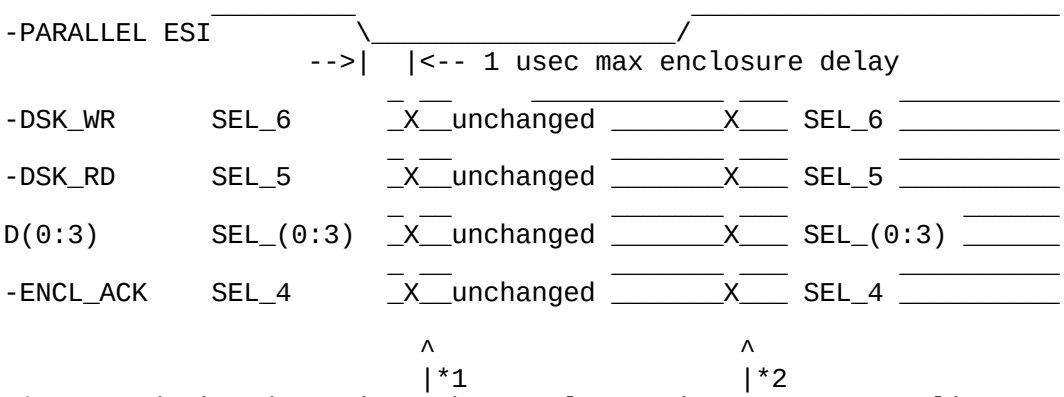
*1 SCSI device determines that enclosure is SFF-8067 compliant by noting that SEL_(0:3) bits have inverted and that SEL_5 and SEL_6 have the value that the device is presenting.
*2 Enclosure Services Processor indicates that it is ready to begin communication with the SCSI device.
*3 SCSI device recognizes availability of enclosure services and negates - DSK_RD and -DSK_WR.
*4 Failure of -DSK_RD and or -DSK_WR to negate is detected as SFF-8067 timeout

FIGURE 6-3 DISCOVERY PHASE (SFF-8067 ENCLOSURE)



*1 SCSI device determines that enclosure is SFF-8045 compliant and implement P_ESI by noting that SEL_ID bits have changed to a value other than the expected value.
*2 Enclosure returns to transmitting SEL_ID < 4 usecs after -PARALLEL ESI is negated. Device shall not initiate any SFF-8067 transfer actions, but shall report parallel ESI information in the Short Enclosure Status page (See SES-2).

FIGURE 6-4 DISCOVERY PHASE (SFF-8045 ENCLOSURE WITH PARALLEL ESI)



*1 SCSI device determines that enclosure is SFF-8045 compliant and either does not support P_ESI or has a P_ESI value the same as the SEL_ID value by noting that the SEL_ID bits have not changed. Device shall report a CHECK CONDITION status as specified.
*2 Enclosure returns to transmitting SEL_ID <4 usecs after -PARALLEL ESI is negated.

FIGURE 6-5 DISCOVERY PHASE (SFF-8045 ENCLOSURE WITHOUT PARALLEL ESI)

The interface is designed to be supported by a simple bit programmable bidirectional port on the SCSI device.

If an 8067 device is plugged into an 8045 backplane, it shall operate as an 8045 device. If an 8045 device is plugged into an 8067 backplane, there is no potential for damage but the device will not receive valid parallel ESI information from the enclosure, since the enclosure cannot determine whether to offer parallel ESI information or the required SFF-8067 information.

6.4.2.2 Write Phase and Command Phase transfer procedure

To perform a Write or Command Phase transfer, the device places the first nibble of data on D(0:3), and a minimum of 3 usec later, the device asserts -DSK_WR. When the enclosure sees -DSK_WR asserted, it reads D(0:3) and asserts -ENCL_ACK. When the device sees the asserted -ENCL_ACK, it negates -DSK_WR and is allowed to modify D(0:3) to the new value. If this is the last transfer before a Read phase is to be initiated, then D(0:3) shall be released. When the enclosure sees -DSK_WR negated, it negates -ENCL_ACK. The device can then proceed with more Write or Read sequences.

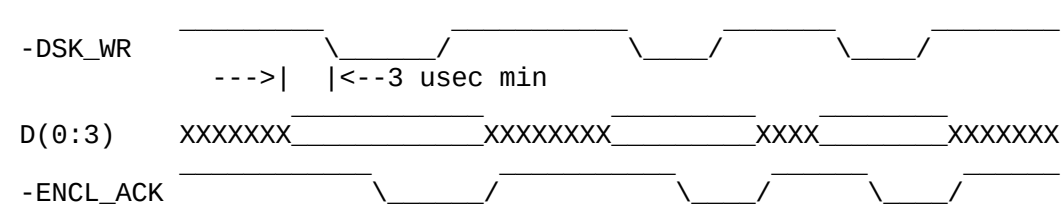


FIGURE 6-6 DATA TRANSFER PROCEDURE FOR WRITE AND COMMAND PHASES

Subsequent nibbles are provided according to the rules of byte ordering until all the required data has been transferred.

6.4.2.3 Read Phase transfer procedure

To perform a Read phase transfer, the device asserts -DSK_RD. When the enclosure sees -DSK_RD asserted, it places the first nibble of data onto D(0:3), and a minimum of 100 nanoseconds later, asserts -ENCL_ACK. When the device sees the asserted -ENCL_ACK, it shall wait a minimum of 3 usecs before it reads D(0:3) and negates -DSK_RD. When the enclosure sees the -DSK_RD negated, it negates -ENCL_ACK and begins to drive new data to D(0:3). The device can then proceed with more Read Phase transfers.

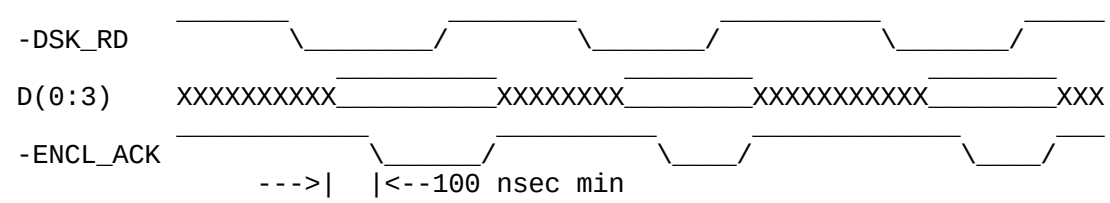


FIGURE 6-7 DATA TRANSFER PROCEDURE FOR READ PHASES

Subsequent nibbles are provided according to the rules of byte ordering until all the required data has been transferred.

7. Mapping of SCSI command to Enclosure Service Interface operation

This section provides an overview of the proper mapping between the enclosure services commands defined in SES-2 and the enclosure services interface defined by this specification. Section 7.1, describing the SCSI command definitions, is informative. Future revisions to the SES-n standard may modify the functions and formats communicated across the SCSI interface. The ESI interface functions defined in Sections 7.2 and the mechanisms relating the ESI and SCSI interfaces defined in Sections 7.3 and 7.4 are normative. Section 7.5 describing the ASC/ASCQs for such devices is informative.

7.1 Brief review of SCSI command set

The enclosure services device model is defined in SES. The device model allows commands accessing enclosure services information to be sent to any type of device. In addition, the model defines the capability of accessing the same information through a special enclosure services device type that can be run on a target and logical unit independent of any other SCSI device.

The commands used by all devices for the transmission of enclosure services information are the SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS commands. See SPC-4 for a definition of these commands. The SEND DIAGNOSTIC command transmits pages of information to the device for transfer to the enclosure across the interface defined by SFF-8067. The RECEIVE DIAGNOSTIC RESULTS command requests pages of information from the device, which the device must obtain from the enclosure across the interface defined by SFF-8067.

The CDB formats for the commands are defined in SPC-4.

SES-2 defines the page codes and content for the information transmitted to and from an enclosure. Table 7-1 defines page codes handled by the device and page codes passed to the enclosure.

TABLE 7-1 DIAGNOSTIC PAGE CODES DEFINED FOR ESI

Diagnostic Page Code	Description
00h	Handled by the device
01h-2Fh	Passed through to the enclosure with same page code
30h-FFh	Handled by the device

The general format of a diagnostic page is defined by SPC-2.

7.2 Definition of command bytes for enclosure (normative)

If a SCSI device receives one of the SCSI diagnostic commands with a page code value in the range defined in Table 7-1 as passed through to the ESI, it prepares the proper information for transmission to the enclosure in a command phase. The command phase is composed of 4 bytes, as defined in Table 7-2. The command phase is always clocked with -DSK_WR.

TABLE 7-2 ESI COMMAND PHASE INFORMATION

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code							
1	PORT B	PORT A	0 reserved		0	EDV STATE	REQ EDV	SEND
2	(MSB) Parameter Length							
3								(LSB)

The page code field specifies the diagnostic page that is to be transferred to or from the enclosure.

If the SEND bit is set to 1, the subsequent data transmission will be from the device to the enclosure as the result of a SCSI SEND DIAGNOSTIC command. The data transmission will be clocked with -DSK_WR from the SCSI device. If the SEND bit is set to 0, the subsequent data transmission will be from the enclosure to the device as the result of a SCSI RECEIVE DIAGNOSTIC RESULTS command. The data transmission will be clocked with -DSK_RD from the SCSI device.

The Parameter Length is 0 for a RECEIVE DIAGNOSTIC RESULTS command.

For a SEND DIAGNOSTIC command, the Parameter Length is the page length from the diagnostic page header incremented by 4, and reflects the total number of bytes that will be transferred to the enclosure unless the transfer is truncated by a shorter allocation length.

The PORT A or PORT B bit equal to one indicates that the SCSI command that initiated the ESI request with the enclosure was received on the device's port A or port B, respectively. For devices that do not support this function, both the PORT A and the PORT B bits are equal to zero.

The REQ EDV bit is used to request enabling of the ESI Data Validation (EDV) function. The REQ EDV bit is a one when the device is requesting to enable EDV. See Section 9. For all ESI commands other than request EDV, this bit is ignored.

The EDV STATE bit equal to one indicates that the device is using EDV as described in Section 9. For devices that do not support EDV or when EDV is not enabled, the EDV STATE bit is equal to zero.

7.3 Transmission of SEND DIAGNOSTIC pages to enclosure (normative)

When an SFF-8067 SCSI device receives a SEND DIAGNOSTIC command, it examines the CDB to determine the allocation length and to determine that the PF (Page Format) bit is set. If these conditions are met, it obtains at least 4 bytes of the parameters and examines the diagnostic page header. If the page code value is in the range defined in Table 7-1 as passed through to the ESI, the device prepares to communicate with the enclosure by executing a Discovery phase. SEND DIAGNOSTIC commands that do not involve enclosure activity are handled by the SCSI device according to the requirements of the SCSI SPC-3 standard.

If the Discovery phase determines that the enclosure is an SFF-8045 compliant enclosure, the device posts a CHECK CONDITION status to the SCSI initiator with sense information indicating an ASC/ASCQ of UNSUPPORTED ENCLOSURE FUNCTION. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

If the Discovery phase determines that the enclosure is an SFF-8067 compliant enclosure, but the enclosure does not assert -ENCL_ACK before the 1 second timeout period, the device posts a CHECK CONDITION status to the SCSI initiator with sense information indicating an ASC/ASCQ of ENCLOSURE SERVICES UNAVAILABLE. The SEND DIAGNOSTIC command can be tried again later or can be executed on another device in the same enclosure. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

If the Discovery phase determines that the enclosure is an SFF-8067 compliant enclosure and is responding correctly, the device begins transmission of the ESI Command phase.

The ESI Command transmits the page code extracted from the SCSI diagnostic page to the enclosure. The ESI command transmits the SEND bit with a 1 value to the enclosure. The ESI command transmits the Parameter Length, which is set to 4 more than the page length in the diagnostic page.

If the time between the assertion of -DSK_WR by the device and the assertion of -ENCL_ACK by the enclosure exceeds the device's timeout value (minimum timeout = 100 usec), the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE SERVICES TRANSFER REFUSED. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

The device then begins to execute the data transmission out to the enclosure. The entire diagnostic page is transferred to the enclosure unchanged, including the header (page code, reserved byte, and page length) and the ESI parameters.

If the time between the assertion of the first -DSK_WR and the first - ENCL_ACK of the data transfer exceeds the device's timeout value (minimum timeout = 1 millisecond), the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE SERVICES TRANSFER REFUSED. The device negates -PARALLEL ESI to terminate the communication with the enclosure. The enclosure services processor may refuse the transfer if the format of the command is invalid.

If the time between the assertion of -DSK_WR by the device and the assertion of -ENCL_ACK by the enclosure exceeds the device's timeout value (minimum timeout = 100 usec), the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE SERVICES TRANSFER REFUSED. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

When the transfer has been completed, the device provides GOOD status to the initiator.

Across the SCSI channel, the device requests either the number of bytes specified by the allocation length in the CDB or four more than the number of bytes specified in the diagnostic page header, whichever is smaller. The same number of bytes are transferred to the enclosure by the device.

The enclosure processes the parameters according to the requirements of the enclosure services model. Optional bits and fields may be ignored. Any information exceeding the page length actually required by the enclosure is received and ignored. Incorrect information is not used. If the parameter page is too short for the requirements of the enclosure or is truncated by an allocation length shorter than the diagnostic page length, the enclosure has the choice of acting on those values it considers valid or ignoring the entire page. Warning and error states, including those associated with invalid diagnostic page formats, may be created by the enclosure for future transmission in a RECEIVE DIAGNOSTIC RESULTS status page. Such states do not generate a SCSI status of CHECK CONDITION status to the SEND DIAGNOSTIC command.

7.4 Transmission of RECEIVE DIAGNOSTIC RESULTS from enclosure (normative)

When an SFF-8067 SCSI device receives a RECEIVE DIAGNOSTIC RESULTS command, it examines the CDB to determine the allocation length and the requested page code. If the page code is from 01 to 0Fh, inclusive, the device prepares to communicate with the enclosure by executing a Discovery phase.

If the Discovery phase determines that the enclosure is an SFF-8045 compliant enclosure that does not support Parallel ESI or cannot be determined to support Parallel ESI, the device returns CHECK CONDITION status to the SCSI initiator with sense information indicating an ASC/ASCQ of UNSUPPORTED ENCLOSURE FUNCTION. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

If the Discovery phase determines that the enclosure is an SFF-8067 compliant enclosure, but the enclosure does not assert -ENCL_ACK before the 1 second timeout period, the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE SERVICES UNAVAILABLE. The SEND DIAGNOSTIC command can be tried again later or can be executed on another device. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

If the Discovery phase determines that the enclosure is an SFF-8045 compliant enclosure that supports Parallel ESI, the device returns the Short Enclosure Status diagnostic page (page code 08h) described in Table 7-3, regardless of the requested page. GOOD status is presented and the SCSI command is completed. The device negates -PARALLEL ESI to terminate the communication with the enclosure. Bit 7 of byte 1 indicates that the enclosure has been determined to be an 8045 enclosure supporting Parallel ESI.

If the Discovery phase determines that the enclosure is an SFF-8067 compliant enclosure and responding correctly, the device begins transmission of the ESI Command phase.

TABLE 7-3 SPECIAL STATUS PAGE FORMAT FOR SFF-8045 PARALLEL ESI

Bit / Byte	7	6	5	4	3	2	1	0
0	Page Code = Status (08 hex)							
1	8045	EFW	P_ESI_5	P_ESI_4	P_ESI_3	P_ESI_2	P_ESI_1	P_ESI_0
2	Page Length (MSB) = 0							
3	Page Length (LSB) = 0							

The ESI Command transmits the page code specified by the SCSI CDB to the enclosure. The ESI command transmits the SEND bit with a 0 value to the enclosure. For the RECEIVE DIAGNOSTIC RESULTS command, the Parameter Length field shall be 0.

If the time between the assertion of -DSK_WR by the device and the assertion of -ENCL_ACK by the enclosure exceeds the device's timeout value (minimum timeout = 100 usec), the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE SERVICES TRANSFER REFUSED. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

The device then begins to execute the data transmission from the enclosure. The entire diagnostic page is transferred from the enclosure unchanged, including the header (page code, summary byte, and page length) and the enclosure service parameters. The device uses bytes 2 and 3 of the header to determine the total page length to be transferred. The device requests a number of bytes equal to the smaller of the total page length or the allocation length.

If the time between the assertion of the first -DSK_RD and the first - ENCL_ACK of the data transfer exceeds the device's timeout value (minimum timeout = 1 millisecond), the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE SERVICES TRANSFER REFUSED. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

If the time between the assertion of -DSK_RD by the device and the assertion of -ENCL_ACK by the enclosure exceeds the device's timeout value (minimum timeout = 100 usec), the device posts a CHECK CONDITION status to the SCSI initiator with an ASC/ASCQ of ENCLOSURE TRANSFER FAILED. The device negates -PARALLEL ESI to terminate the communication with the enclosure.

When the transfer has been completed, the device provides GOOD status to the initiator.

The SCSI device assumes no responsibility for providing correct parameters. If the Page Length is shorter than the Allocation Length, the SCSI device transfers only the number of bytes calculated for the total page length (Page Length + 4 bytes) from the enclosure and to the initiator. If the Page Length is longer than the Allocation Length, the SCSI device transfers only the number of bytes indicated by the Allocation Length from the enclosure and to the initiator. In that case, the Page Length in the page header is the value provided by the enclosure, which shall reflect the full page length that would be transferred if the Allocation Length were large enough. It is not an error if a RECEIVE DIAGNOSTIC RESULTS command is executed with an Allocation Length different than the Page Length + 4.

7.5 SES sense codes (informative)

TABLE 7-4 ASC/ASCQ DEFINED FOR ESI CONDITIONS

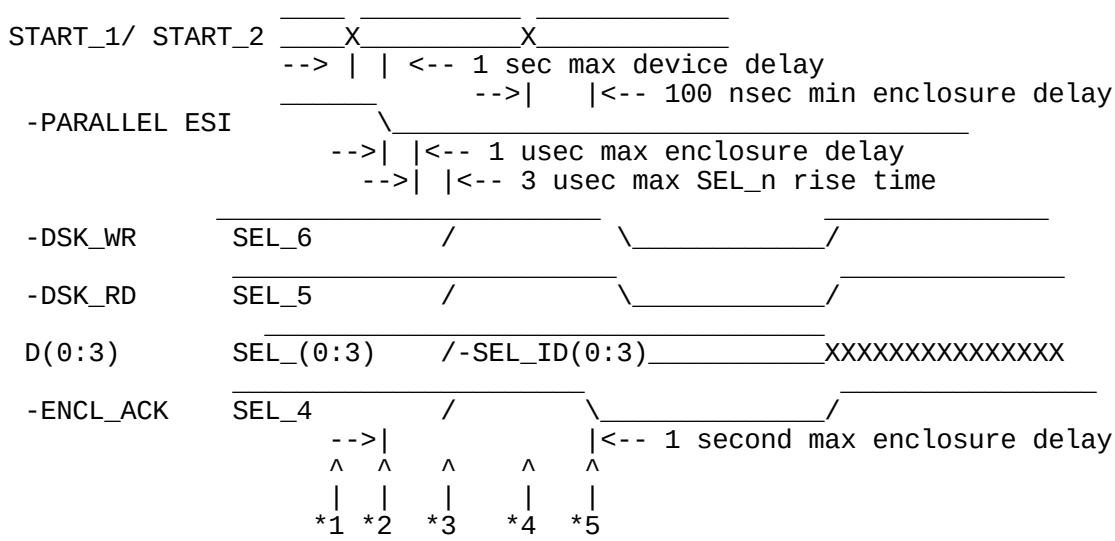
ASC/ASCQ	Definition
35h/00h	ENCLOSURE SERVICES FAILURE
35h/01h	UNSUPPORTED ENCLOSURE FUNCTION
35h/02h	ENCLOSURE SERVICES UNAVAILABLE
35h/03h	ENCLOSURE SERVICES TRANSFER REFUSED
35h/04h	ENCLOSURE SERVICES TRANSFER REFUSED

8. Enclosure initiated ESI transfer (optional)

Enclosure initiated ESI (EIE) provides a means for the enclosure to request information or action from a SCSI device that supports an 8067 ESI interface. The transfer of information is independent of the SCSI interface. The format of the information, however, is similar to the SES information transferred on the SCSI interface for ease of implementation.

8.1 EIE Discovery

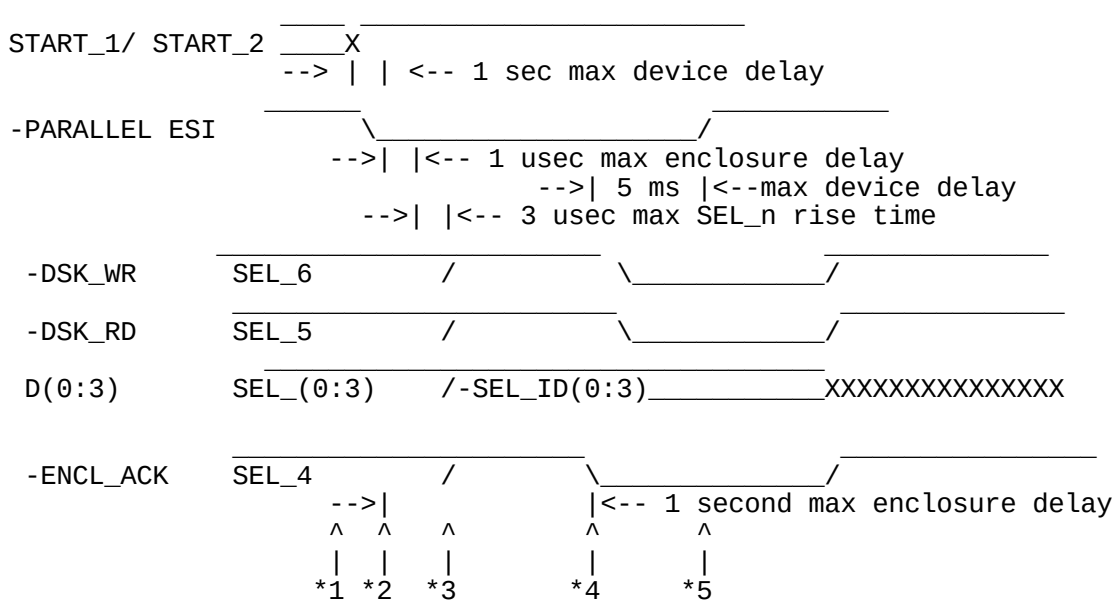
A discovery phase is defined to allow the enclosure to initiate an information request and allow the SCSI device to detect the request. If the SCSI device supports detection of the Un-Mated condition of the START_1 and START_2 signals, Case 1, and supports Enclosure Initiated ESI (EIE) transfers, it monitors the START_1 and START_2 signals. On detecting a transition from a valid mated condition, Case 2, 3, or 4, to a different case, the device asserts -PARALLEL ESI. To avoid a false spin-down due to a handshake timeout, initiating an EIE transfer by changing from a mated condition to the unmated condition is not recommended. If the enclosure is requesting a transfer with a case change, it returns the START_1 and START_2 signals to the original mated condition a minimum of 100 nanoseconds before asserting the -ENCL_ACK signal. The discovery phase continues as described in 6.4.2.1. Figure 8-1 illustrates a successful discovery of an EIE transfer request.



*1 Enclosure Services Processor changes START_1 and START_2 to indicate that it is requesting communication with the SCSI device.
*2 SCSI device asserts -PARALLEL ESI to indicate it is ready to begin communication with the Enclosure Services Processor.
*3 SCSI device determines that enclosure is SFF-8067 compliant by noting that SEL_(0:3) bits have inverted and that SEL_5 and SEL_6 have the value that the device is presenting.
*4 The Enclosure Services Processor returns START_1 and START_2 to Case 2,3, or 4.
*5 The Enclosure Services Processor asserts -ENCL_ACK and discovery continues as described in 6.4.2.1.

FIGURE 8-1 ENCLOSURE INITIATED ESI REQUEST

If discovery determines the enclosure does not support an 8067 capable interface or the enclosure has driven the START_1 and START_2 signals to an unmated condition and does not return the START_1 and START_2 signals to a valid mated condition, the device negates -PARALLEL_ESI and prepares for power removal as described in 6.4.1.2. Figure 8-2 shows a case where the enclosure does support 8067 ESI transfer but the enclosure is requesting the device to prepare for removal.



*1 Enclosure Services Processor negates START_1 and START_2 to indicate that it is requesting communication with the SCSI device.

*2 SCSI device asserts -PARALLEL ESI to indicate it is ready to begin communication with the Enclosure Services Processor.
*3 SCSI device determines that enclosure is SFF-8067 compliant by noting that SEL_(0:3) bits have inverted and that SEL_6 and SEL_7 have the value that the device is presenting.
*4 The Enclosure Services Processor asserts -ENCL_ACK to indicate it is ready to begin communication with the SCSI device.
*5 The SCSI device negates -PARALLEL ESI to end the ESI transfer and prepares for power removal as described in 6.4.1.2.

FIGURE 8-2 PREPARE FOR REMOVAL

8.2 EIE operations

Following successful discovery of an EIE transfer request, the SCSI device transfers an ESI command to the enclosure using the write and command phase procedure defined in 6.4.2.2. The contents of the command are defined in 8.3. The device follows the command with a read phase procedure as described in 6.4.2.3 to retrieve the transfer request information from the enclosure. The definition of the enclosure request is in 8.3.

If the enclosure is requesting information, the SCSI device sends an ESI command with Send = 1 to indicate to the enclosure it is ready to transfer the requested information. The command is followed by a write of the information requested by the enclosure. This information is defined in 8.3. Following the write, the device negates -Parallel ESI to end the operation. Figure 8-3 is a summary of these operations.

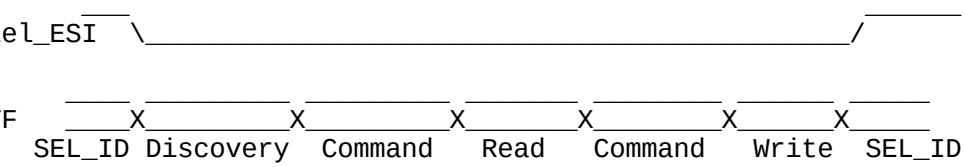


FIGURE 8-3 EIE OPERATION PHASES

If any errors or timeouts are detected during the EIE operation, the SCSI device aborts the operation and continues normal operation. Errors are not reported.

8.3 Enclosure requested information

If the enclosure services interface transfer is initiated by the enclosure, the SCSI device sends ESI Command Phase information as defined in Table 7-2 to the enclosure following successful discovery. The page code in the ESI command is 00h. This page code is reserved for SCSI diagnostic commands between the host and the SCSI device and will not appear in ESI transfers initiated by SCSI commands. The ESI command is a read operation, SEND=0, with parameter length of 6h.

The enclosure responds to the ESI command from the SCSI device with an ESI request as defined in Table 8-1. The information requested by the enclosure is identified by the action code. Table 8-2 defines the action codes.

TABLE 8-1 ENCLOSURE REQUEST

Bit / Byte	7	6	5	4	3	2	1	0
0	Page Code (00h)							
1	Action Code							
2	0	0	0	0	0	0	0	0
	Reserved							
3	Action Specific							
4	(MSB) Parameter Length							
5								(LSB)

The parameter length in the enclosure request is set by the enclosure to the number of bytes it is requesting including the four header bytes. The SCSI device sends the actual length of the requested information or the length identified in the request parameter length whichever is less. If the parameter length is equal to 0, The SCSI device ends the ESI transfer by negating Parallel_ESI.

TABLE 8-2 ACTION CODES

Action Code	Description
00h	Device Standard Inquiry Data
01h	Device Addresses
02h	Loop Position Map
03h	Initiate Loop Initialization
04h	Device Identification
05h	Device Temperature
06h	Port Parameters
07h	Link Status
08h	Spin-Down Control
09h	Request ESI Data Validation
0A to 7Fh	Reserved
80 to FFh	Vendor Specific

If the ESI request contains a valid Action Code and non-zero Parameter Length, the device responds with a write operation with the requested information. Table 8-3 defines the format of the EIE page. Tables 8-4 through 8-14 define the page contents for the identified action codes.

The Initiate Loop Initialization Action Code (03h) does not include a transfer of information to the enclosure. The Action Specific bits in the Enclosure Request define the operation to be performed. See Table 8-7.

For Vendor Specific Action Codes, the definition of the Action Specific bits is vendor specific. For the other Action Codes defined in Table 8_2, the Action Specific bits are 0 and ignored.

TABLE 8-3 ENCLOSURE INITIATED ESI PAGE FORMAT

Bit / Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code			
2	(MSB) Page Length (n-3)							
3								(LSB)
4	(MSB)							
.								
.	Data							
n								(LSB)

TABLE 8-4 DEVICE STANDARD INQUIRY DATA

Bit / Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (00h)			
2	(MSB) Page Length (24h)							
3								(LSB)
4	(MSB)							
.								
.	Inquiry Data							
39								(LSB)

Inquiry Data - The first 36 bytes of Standard Inquiry data. –See SPC-4. Note: the vendor specific, VS, bit in byte 6 is not valid.

TABLE 8-5 DEVICE ADDRESSES PAGE

Byte \ Bit	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (01h)			
2	(MSB) Page Length (24h)							
3								(LSB)
4	(MSB)							
.	Node Name							
11								(LSB)
12	Port A (01h)							
13	(MSB)							
.	Port A Port_Identifier							
15								(LSB)
16	Port A Position							
17	0	0	0	0	0	0	0	0
18	(MSB)							
.	Port A Name							
25								(LSB)
26	Port B (02h)							
27	(MSB)							
.	Port B Port_Identifier							
29								(LSB)
30	Port B Position							
31	0	0	0	0	0	0	0	0
32	(MSB)							
.	Port B Name							
39								(LSB)

- Node Name: A 64-bit Fibre Channel unique Name_Identifier assigned to the device.
- Port_Identifier: The FC 24-bit address assigned to the port. The lower byte is the current FC-AL AL_PA for this port. If the port does not have a Port_Identifer, a value of FF FF FFh is returned in the Port_Identifier field.
- Port Position: The offset value for this port's AL_PA in the FC-AL AL Loop Initialization Loop Position (LILP) Frame. If the port does not have an AL_PA, a value of FFh is returned in the Port Position field.
- Port Name: A 64-bit Fibre Channel unique Name_Identifier assigned to the Port.

TABLE 8-6 LOOP POSITION MAP PAGE

Byte \ Bit	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (02h)			
2	(MSB) Page Length (m-3)							
3								(LSB)
4	Offset Port A (n-4)							
5	(MSB)							
.								
.	Loop Map Port A							
n								(LSB)
n+1	Offset Port B (m-n+1)							
n+2	(MSB)							
.								
.	Loop Map Port B							
m								(LSB)

Offset: The offset field from the FC-AL LILP frame. The offset field indicates the number of bytes in the Loop Map. A value of 00h indicates the Loop Map is not available for the port.

Loop Map: Valid AL_PA entries from the payload of the FC-AL LILP frame. Only the valid AL_PA entries are transferred to minimize the transfer time on the ESI interface. The maximum Loop Map size is 127 bytes.

TABLE 8-7 INITIATE LIP ACTION SPECIFIC BITS

0	0	0	0	0	0	LIP Loop B	LIP Loop A

LIP Loop A/B Bits: When set to a 1, the device enters the Loop Initialization Process on either loop A, B, or both as indicated by these bits. The device originates a LIP(F7,AL_PS) if it has a valid AL_PA. The device originates a LIP(F7,F7) if it does not have a valid AL_PA.

TABLE 8-8 DEVICE IDENTIFICATION PAGE

Bit / Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (04h)			
2	(MSB) Page Length (n-3)							
3								(LSB)
4	(MSB)							
.								
.	Device ID Data							
n								(LSB)

Device ID Data: The device ID data is the contents of the SCSI Device Identification VPD page (83h). See SPC-4.

TABLE 8-9 DEVICE TEMPERATURE

Bit / Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (05h)			
2	(MSB) Page Length (06h)							
3								(LSB)
4	Temperature							
5								
.	Reserved							
9								

Temperature: The value of the device temperature sensor in degrees Celsius, offset by +20 degrees. The range expresses a temperature between -19 and +235 degrees Celsius. The value of 0 is reserved.

TABLE 8-10 PORT PARAMETERS

Bit / Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (06h)			
2	(MSB) Page Length (06h)							
3								(LSB)
4	Device Capabilities							
5	Reserved							LSP CHG
6	0	0	Port A Link Fail	Port A Bypass	0	Port A Link Rate		
7	Reserved							
8	0	0	Port B Link Fail	Port B Bypass	0	Port B Link Rate		
9	Reserved							

Device Capabilities - This is a bit significant field that indicates which Device Control Codes as defined in SFF 8045 are supported by the device. A one in a bit position indicates the corresponding Device Control Code is supported, e.g. a one in bits 7 and 6 indicates that Device Control Codes 7 and 6 are supported. This indicates the device supports Fibre Channel link rates of 1 and 2 GHz.

LSP CHG (Link Status Page Change) - A one in this field indicates the data in the Link Status Page has changed since the enclosure last read the Link Status Page. A zero indicates the Link Status Page data has not changed. When the enclosure reads the Link Status Page, this bit is cleared.

Port Link Fail - A one in this field indicates the device is currently detecting a Loop Failure condition as defined in FC-AL for the port.

Port Link Rate - This field is the value defined for the Fibre Channel link rate by the Device Control Code inputs in SFF 8045, i.e., 7 represents 1Ghz.

Port Bypass - A one in this field indicates the device is asserting the -ENBL BYP CH signal in the SCA connector for the port. A zero indicates the device is not requesting bypass.

TABLE 8-11 LINK STATUS PAGE

Byte	Bit 7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (07h)			
2	(MSB) Page Length (60h)							
3								(LSB)
4	(MSB)							
.	Link Failure Count, Port A							
7								(LSB)
8	(MSB)							
.	Loss of Sync Count, Port A							
11								(LSB)
12	(MSB)							
.	Loss of Signal Count, Port A							
15								(LSB)
16	(MSB)							
.	Primitive Sequence Protocol Error, Port A							
19								(LSB)
20	(MSB)							
.	Invalid Transmission Word Count, Port A							
23								(LSB)
24	(MSB)							
.	Invalid CRC Count, Port A							
27								(LSB)
28	(MSB)							
.	LIP F7 Initiated Count, Port A							
31								(LSB)
32	(MSB)							
.	LIP F7 Received Count, Port A							
35								(LSB)
36	(MSB)							
.	LIP F8 Initiated Count, Port A							
39								(LSB)
40	(MSB)							
.	LIP F8 Received Count, Port A							
43								(LSB)
44								
.	Reserved							
51								

52	(MSB)	
.	Link Failure Count, Port B	
55		(LSB)
56	(MSB)	
.	Loss of Sync Count, Port B	
59		(LSB)
60	(MSB)	
.	Loss of Signal Count, Port B	
63		(LSB)
64	(MSB)	
.	Primitive Sequence Protocol Error, Port B	
67		(LSB)
68	(MSB)	
.	Invalid Transmission Word Count, Port B	
71		(LSB)
72	(MSB)	
.	Invalid CRC Count, Port B	
75		(LSB)
76	(MSB)	
.	LIP F7 Initiated Count, Port B	
79		(LSB)
80	(MSB)	
.	LIP F7 Received Count, Port B	
83		(LSB)
84	(MSB)	
.	LIP F8 Initiated Count, Port B	
87		(LSB)
88	(MSB)	
.	LIP F8 Received Count, Port B	
91		(LSB)
92		
.	Reserved	
99		

Note: Implementation of the fields in this page is optional. A value of zero either indicates the field is not supported or no count has occurred.

When the device changes a value in this page, the device sets the LSP CHG bit in the Port Parameter Page. The enclosure may poll the Port Parameter Page to determine if it needs to read and process the Link Status Page. When the Link Status Page is read by the enclosure the LSP CHG bit is cleared.

The following fields are extracted from the FC-FS-2 defined Link Error Status Block, LESB:

Link Failure Count - Count of the number of Loss of Sync conditions that have occurred on the port which exceeded 100 mS in duration.

Loss of Sync Count - Count of the number of short (< 100 mS) Loss of Synchronization conditions that have occurred on the port.

Loss of Signal Count - Count of the number of Loss of Signal conditions on the port.

Primitive Sequence Protocol Error - Count of the number of FC-FS-2 defined Primitive Sequence Protocol Errors on the port. This field is not valid in loop mode.

Invalid Transmission Word Count - Count of the number of invalid transmission words/Running Disparity errors that have been detected on the port.

Invalid CRC Count - Count of the number of write data frames that have been received with invalid CRC’s on the port. These errors are only detected when this device is the target of the data transfer.

The following fields are unique to loop mode:

LIP F7 Initiated Count - Count of the number of loop initialization processes originated by the port with LIP –F7’s (Initialize LIP).

LIP F7 Received Count - Count of the number of loop initialization processes initiated on the port by receiving LIP-F7’s (Initialize LIP).

LIP F8 Initiated Count - Count of the number of loop initialization processes originated by the port with LIP –F8’s (Failure LIP).

LIP F8 Received Count - Count of the number of loop initialization processes initiated on the port by receiving LIP-F8’s (Failure LIP).

TABLE 8-12 SPIN-DOWN CONTROL ACTION SPECIFIC BITS

0	0	0	0	0	Read Status	Enable Spin Down	Enable SpinDn Ctrl

If the device supports the Spin-Down Control action code, it shall support the unmated spin-down option defined in SFF 8045.

Read Status - When this bit is a one, the device ignores the state of the Enable Spin Down and Enable SpinDn Ctrl bits in the request and returns the current state of these enables without changing their state. When this bit is a zero, the device updates the state of Enable Spin Down and Enable SpinDn Ctrl as directed by the corresponding bits in the request.

Enable Spin Down - When this bit and the Enable SpinDn Ctrl bit are ones, the device performs a spin-down if the Unmated Case is present on the motor control lines at the end of Enclosure Initiated ESI discovery. The Enable Spin Down bit is valid for a maximum of 3 seconds (a one shot). The enclosure sets this bit prior to invoking an Unmated Case to spin the device down. When this bit is a zero and the Enable SpinDn Ctrl bit is a one, the device does not spin-down on the detection of an Unmated Case on the motor control lines.

Enable SpinDn Ctrl - When this bit is a one, the device only performs a spin-down if the Enable Spin-Down bit is a one. Regardless of the state of this bit, the device performs the discovery process of Enclosure Initiated ESI and any associated transfer on detecting the Unmated Case. When this bit is a zero and the Unmated Case is present at the completion of Enclosure Initiated ESI discovery, the device performs a spin-down. Device implementations may default this bit to a one.

After processing a Spin-Down Control Enclosure Request, the device responds with the resulting status of the Spin-Down Control bits as formatted in Table 8-13.

TABLE 8-13 SPIN-DOWN CONTROL STATUS

Bit Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (08h)			
2	(MSB) Page Length (06h)							
3	(LSB)							
4	0	0	0	0	0	0	Enable Spin Down	Enable SpinDn Ctrl
5 . 9	Reserved							

TABLE 8-14 ESI Data Validation Accept

Bit / Byte	7	6	5	4	3	2	1	0
0	ESI Page (00h)							
1	0	0	0	0	Action Code (09h)			
2	(MSB) Page Length (02h)							
3								(LSB)
4	1	0	1	0 (A5h)	0	1	0	1
5	Reserved							

9. ESI Data Validation (optional)

ESI Data Validation (EDV) provides a mechanism to verify correct data is transferred over the ESI. This function is optional with support discovered by negotiation. When EDV is enabled, a checksum is calculated and appended to each ESI transfer phase, ESI command, data, and Enclosure request.

9.1 EDV Negotiation

The negotiation for EDV may either be originated by the device or by the enclosure. This covers the cases of ESI transfers originated by SES requests from the host and EIE requests. When EDV support is successfully negotiated, all subsequent transfers originated by the device or the enclosure use EDV. Although the negotiation to enable EDV may occur at anytime, it is recommended that knowledge of EDV being enabled be retained.

9.1.1 Device originated EDV

A device supporting EDV requests EDV be enabled when it receives from a host the first SCSI command initiating an ESI transfer request. The device requests EDV by originating an ESI transfer and sending an ESI command with a page code of 00h, SEND bit is 0 and the REQ EDV bit is set to a 1. See Section 7.2. After transferring the command the device enters a read phase.

An enclosure that supports EDV responds to the EDV request by sending the ESI Data Validation Accept as defined in TABLE 8-14. The device completes the request EDV transfer by negating -PARALLEL ESI and starts a new ESI transfer by reasserting -PARALLEL ESI to complete the transfer initiated by the command from the host. On this and subsequent transfers a checksum is appended to the ESI Command and data phases.

An enclosure that does not support EDV will either not respond to the request EDV ESI command or send data other than the accept response. The device completes the request EDV transfer by negating -PARALLEL ESI and starts a new ESI transfer by reasserting -PARALLEL ESI to complete the transfer initiated by the command from the host. EDV is not used on this or subsequent transfers.

9.1.2 Enclosure originated EDV

An enclosure supporting EDV and EIE may request EDV be enabled prior to origination of its first Enclosure Request. The enclosure requests EDV by originating an EIE transfer and sending an Enclosure Request with an Action Code of 9h.

A device that supports EDV responds to the Enclosure Request by sending the ESI Data Validation Accept as defined in TABLE 8-14.

9.1.3 Renegotiation of EDV

When the device aborts a transfer by negating -PARALLEL_ESI or when the enclosure aborts a transfer by failing to assert -ENCL_ACK within the timeout period, the device shall negotiate for EDV again except as described in the next paragraph. The renegotiation of EDV may occur immediately or may be postponed until another SCSI command requesting an ESI transfer is received from a host.

A transfer that fails because the checksum is invalid shall not cause the renegotiation of EDV. A transfer that fails on the last nibble of the checksum is an Enclosure Services Transfer Failure as described in Section 9.3; for all other nibbles, renegotiation of EDV is performed as described in Section 9.1.1.

9.2 Checksum

When EDV is enabled, information transferred on the ESI is verified by using a checksum. The information is summed 8-bits wide with end off carry out of the upper bit. This sum is subtracted from FFh. The resulting value is appended after the last nibble of information. The transfer length fields are not increased for the two added nibbles of checksum. Enabling EDV implies the presence of the checksum.

9.3 Error detection

When the device detects a sum error on data received from the enclosure as a result of a host request, the device returns a CHECK CONDITION status with ASC/ASCQ ENCLOSURE SERVICES FAILURE to the host.

When the enclosure detects a sum error on data received from the device as a result of a host request, the enclosure withholds -ENCL_ACK on the last nibble of the sum. The device times-out on -ENCL_ACK and returns a CHECK CONDITION status with ASC/ASCQ ENCLOSURE SERVICES FAILURE to the host.

For Enclosure Initiated ESI, the device does not report EDV errors to the host. Any recovery or reporting is the responsibility of the enclosure. For data transfers to the enclosure, the enclosure detects the error and the transfer is completed as normal on the interface. On transfers to the device, when the device detects an EDV checksum error it forces a time-out on the last nibble of the transfer. The device continues to assert -DSK_RD for a minimum of 20 msec or until the enclosure deasserts -ENCL_ACK after receiving -ENCL_ACK on the last nibble to fail the transfer. The enclosure discovers the transfer failed by detecting a time-out on -DSK_RD not deasserting.