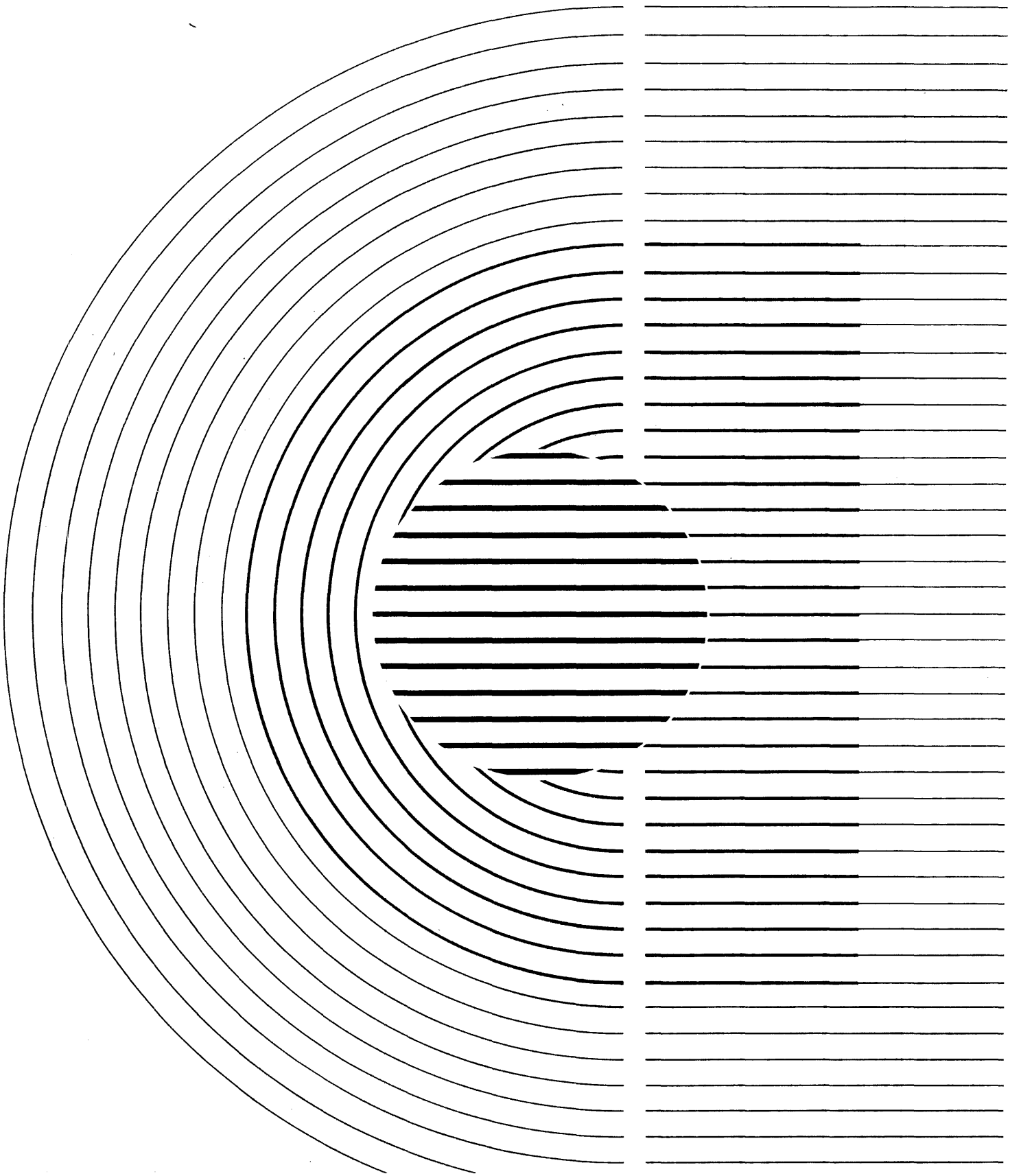
adaptec, inc.

ACB-4520A
User's Manual



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ACB-4520A User's Manual
5-¼" Winchester Disk Controller
SCSI to ESDI Controller

November 1986

Additional copies of this manual, or other Adaptec literature, may be obtained from:

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The ANSI X3.131-1986 Small Computer System Interface specification referenced herein can be obtained from: X3 Secretariat; Computer and Business Equipment Manufacturers Association, 311 First Street N.W., Suite 500, Washington, D.C. 20001.

Adaptec, Inc., 580 Cottonwood Drive, Milpitas, California 95035

404903-00 November, 1986

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1.0 INTRODUCTION

The ACB-4520A disk controller provides an intelligent interface from an ANSI X3.131-1986 Small Computer System Interface (SCSI) host interface to two ESDI-compatible disk drives.

1.1 SCOPE

This manual contains all the information necessary to quickly install and operate the ACB-4520A with an SCSI-compatible Host Adapter and up to two ESDI disk drives.

1.2 REFERENCE DOCUMENTS

o ANSI X3.131-1986 Small Computer System Interface Specification.

1.3 ACB-4520A FEATURES

- The ACB-4520A supportstwo ESDI hard- and/or soft-sectored drives.
- Through offset track formats and Adaptec's high-performance controller architecture, the ACB-4520A can achieve 1:1 interleave. This means one track of data can be read or written in one revolution of the disk. (See Sec. 4.1.5 for timing requirements to ensure 1:1 operation).
- The ACB-4520A supports a fully arbitratingSCSIsystem with upto seven other controllers and/or hostssharing the SCSI bus.
- The ACB-4520A provides maximum SCSI bus throughput by supporting bus disconnection and reconnection for explicit and implicit seeks.
- The ACB-4520A offers complete device independence by auto-configuring to any size formatted drive.
- The ACB-4520A may handle defects on a sector level by sparing sectors. This provides formatted disks with constant data capacity and defect free media may be maintained through use of the Reassign Blocks command.

- The ACB-4520A, utilizing an 8K dual-ported buffer, eliminates the need for sector interleaving. This allows an entire track of data to be read in a single revolution.

- The ACB-4520A supports reserve and release of the drive by a third party.

- The ACB-4520A provides increased reliability and data integrity through the ability to reassign blocks. The ACB-4520A will successfully complete the Reassign Blocks command, even in the case of power failure or a missing ID field.

- The ACB-4520A provides operating system flexibility by offering sector lengths of 256, 512 or 1024 bytes. The sector length desired may be programmed at format time.*

- The ACB-4520A minimizes SCSI Bus busy time to approximately two msec through quick disconnection on Format, Verify, Read and Write commands, and by not reconnecting to the SCSI bus until just before data transfer.

- The ACB-4520A increases performance, and provides ease of use by formatting the disk drive using the drive manufacturer's prerecorded defect list.

- The ACB-4520A utilizes the industry standard SCSI Common Command Set (Rev 4B). This simplifies driver development and provides industry wide compatibility.

*Some restrictions may apply to certain drives. Refer to the drive manufacturer's user's manual.

1.4 BOARD LAYOUT

The component layout of the ACB-4520A is shown in Figure 1-1.

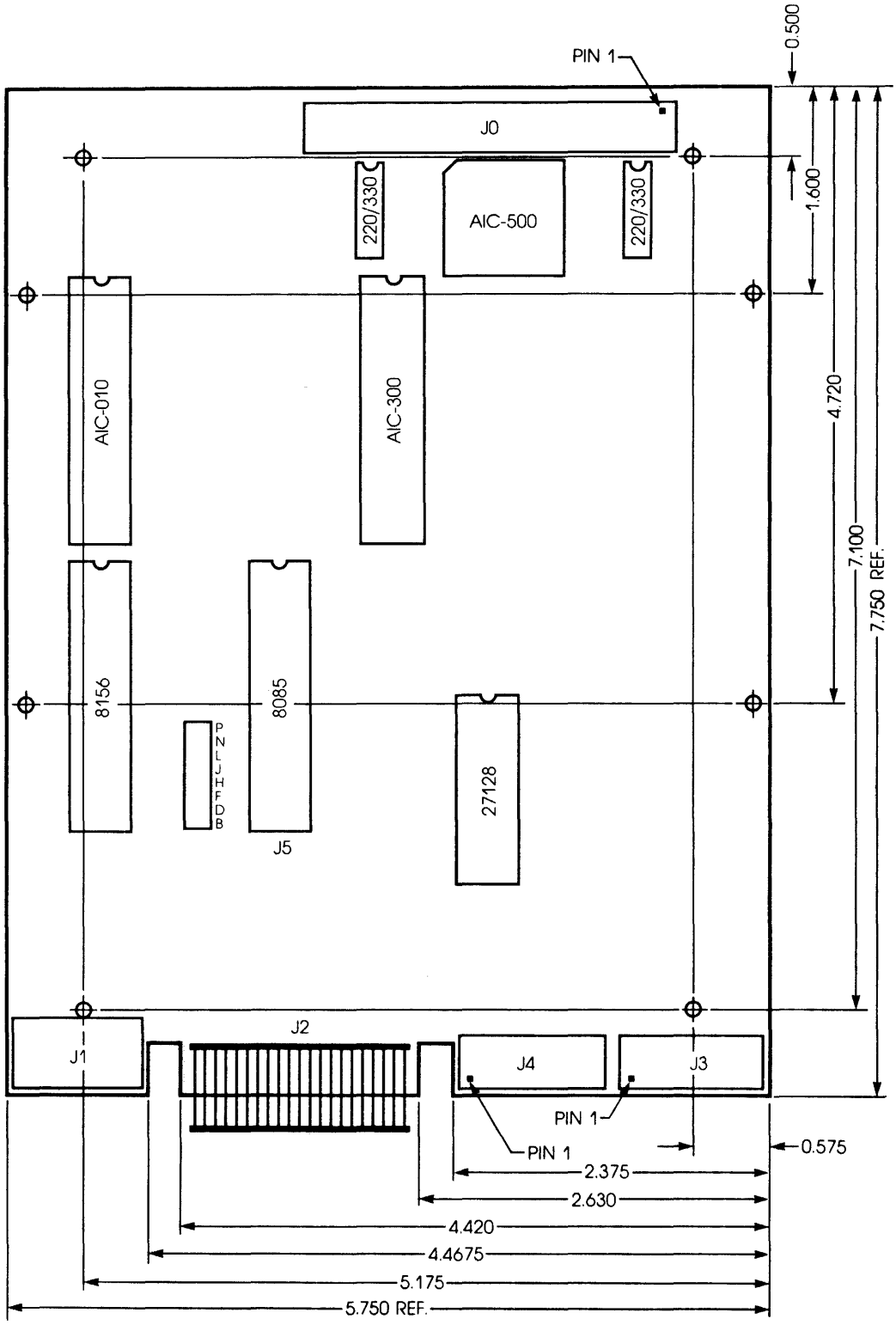


FIGURE 1-1. ACB-4520A BOARD LAYOUT

1.5 PRODUCT SPECIFICATION

1.5.1 PHYSICAL DIMENSIONS

Length: 7.75 inches
Width: 5.75 inches
Height: 0.8 inches

1.5.2 POWER REQUIREMENTS

Voltage (volts)	Tolerance (Units)	Current (max amps)	Ripple (volts, RMS)
+5 VDC	+/- 5%	1.5	.150

1.5.3 ENVIRONMENTAL REQUIREMENTS

	Operating	Storage
	o o o o	o o o o
Temperature (F/C):	32/0 to 131/55	-40/-40 to 167/75
Humidity:	10% to 95%	10% to 95%
Altitude (ft.):	Sea Level to 10,000	Sea Level to 20,000

Exhaust air flow may be required to keep the air on both sides of the board at or below the maximum operating temperature if adequate convective ventilation is not available.

1.6 QUALITY ASSURANCE

The ACB-4520A has been processed through Adaptec's extensive quality control procedure. All Adaptec custom ICs have been fully tested at temperature and voltage margins. All boards have been fabricated and assembled under close quality inspection. And, all boards have passed complete incircuit test procedures, have endured burn-in testing, and have been fully functionally tested. Adaptec should be notified immediately of any deviations from our high standard of quality.

2.0 THEORY OF OPERATION

The ACB-4520A provides a powerful mechanism for connecting up to two ESDI-compatible disk drives to a host computer via the SCSI bus. The SCSI bus provides a powerful general purpose device-independent connection usable by a wide range of computing systems.

The ACB-4520A provides all required formatting and data synchronizing functions for ESDI-compatible disk drives. The formatting function, data serializing/deserializing and ECC checking are provided by Adaptec's proprietary sequencer chip, the AIC-010.

The ACB-4520A provides up to 8K bytes of dual-ported buffering to allow high-performance data access, even if the attached host system can only accept data at relatively slow data rates. Adaptec's AIC-300 buffer controller provides full dual-porting for the buffer memory.

All low-speed control operations are managed by a powerful eight-bit microprocessor executing instructions from a 16K read-only control memory. The large control memory allows the implementation of several optional functions as well as a diagnostic self-test capability.

When the ACB-4520A is powered up, it automatically configures to the physical parameters of the attached drive(s), therefore, eliminating the need for configuration commands from the host system.

Figure 2-1 shows the ACB-4520A block diagram,and Figure 2-2 shows a flow chart of the ACB-4520A microcode structure.

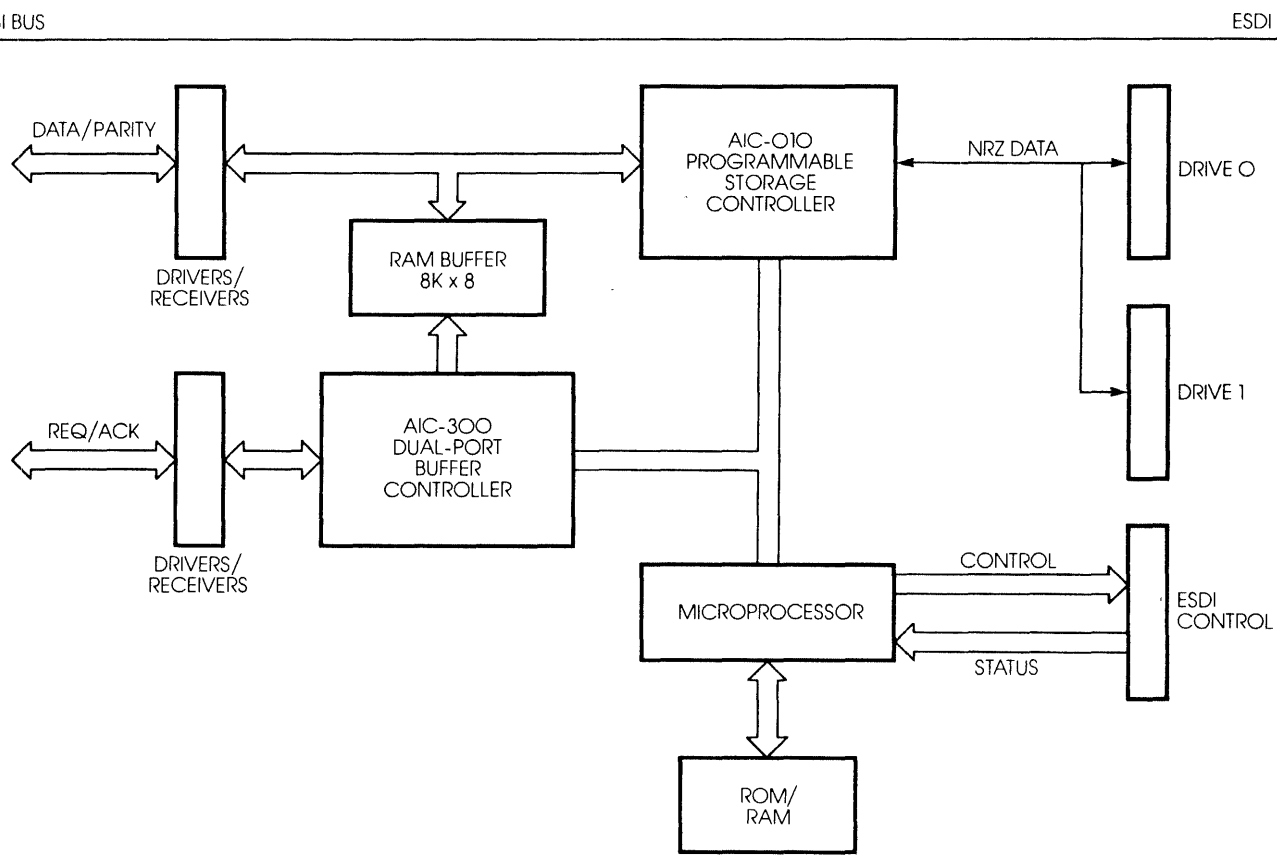


FIGURE 2-1. ACB-4520A BLOCK DIAGRAM

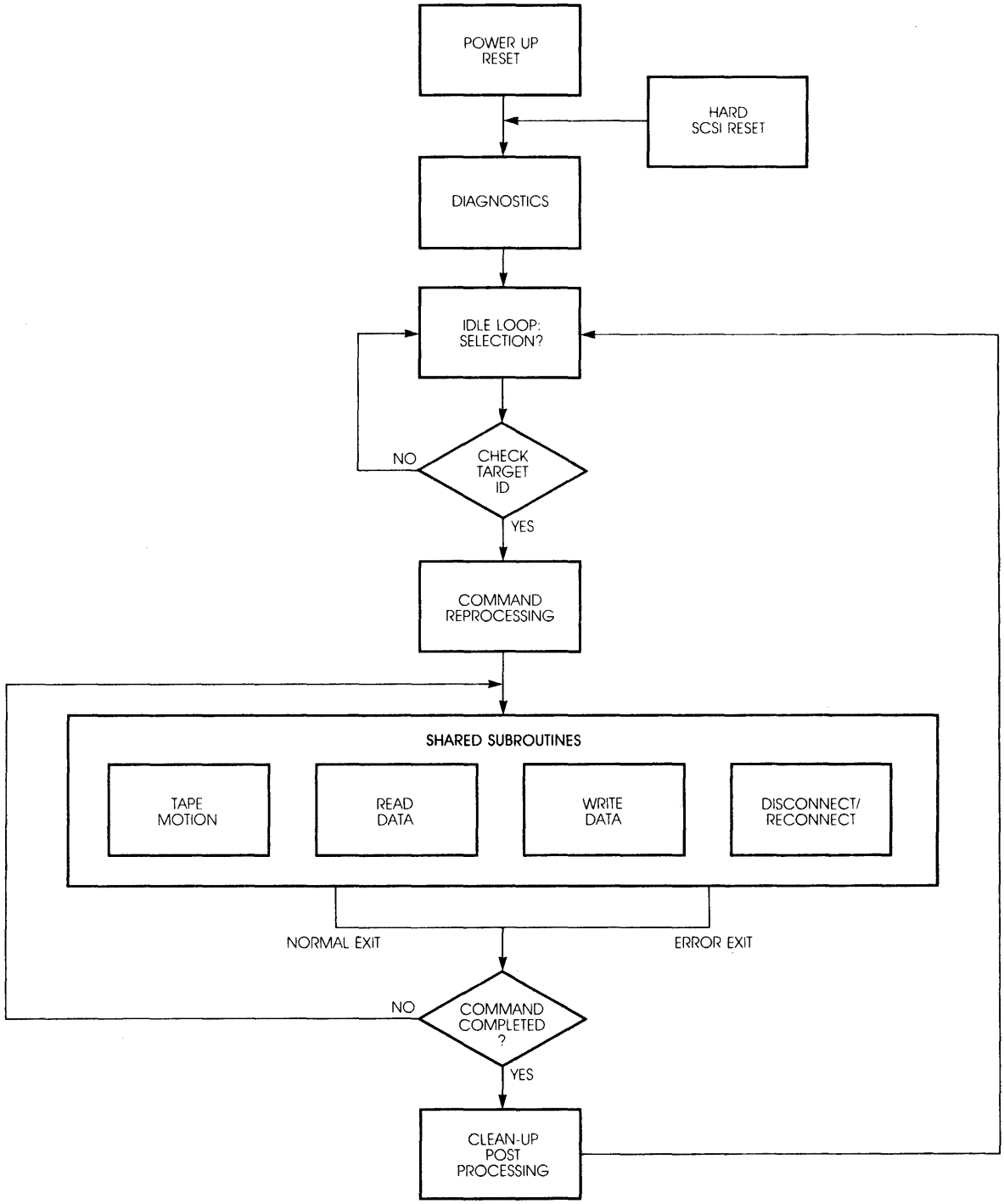


FIGURE 2-2. ACB-4520A MICROCODE STRUCTURE

2.1 SYSTEM CONFIGURATION

The ACB-4520Asupports systems with a wide range of complexity. Figure 2-3 shows three SCSI configurations supported by the ACB-4520A.

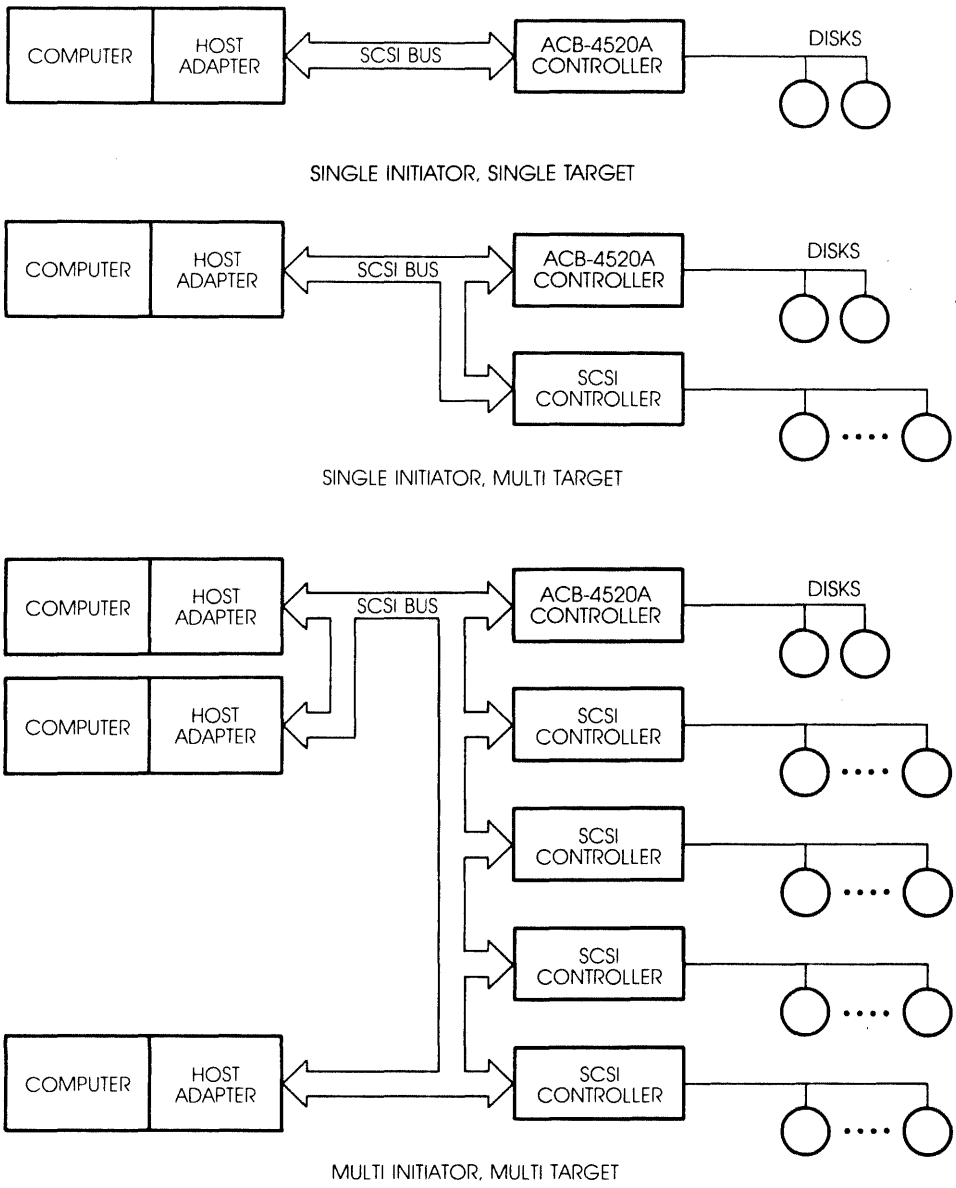


FIGURE 2-3. TYPICAL SCSI CONFIGURATIONS

3.0 INSTALLATION

The ACB-4520A is a self-contained circuit board. All logical and electronic functions required for its normal operation are contained on the circuit board. The ACB-4520A is simple to install, operate, and maintain.

3.1 UNPACKING

The ACB-4520A is shipped in a protective carton with shock absorbing material and static protecting material completely surrounding the card. The carton should be examined for external damage as it is opened. The cards were physically inspected when packed. Any mechanical damage to the cards should be reported to the shipper and to Adaptec as soon as possible.

CAUTION

All circuit boards containing VLSI circuitry have some sensitivity to electrostatic discharge. The ACB-4520A is no exception. Proper handling precautions, including personnel grounding and work surface grounding, should be taken to prevent circuit stress which can cause premature circuit failure.

3.2 PREPARATION OF INSTALLATION AREA

The ACB-4520A is generally designed into the host system or the peripheral disk system. Proper attention should be given to the location of the ACB-4520A so the necessary ventilation, installation clearances, and cabling paths are provided.

The power output is low enough that convective ventilation will be sufficient if the air and surrounding surfaces are at a temperature of 55 degrees Centigrade or less. If this requirement cannot be met by the system enclosure in its worst case environment, then the system enclosure must provide for appropriate ventilation and cooling.

Care should be taken to support the card mechanically. Any appropriate combination of the eight mounting holes provided can be used, depending on the forces to which the system will be subjected. No conductive material should come in contact with the ACB-4520A.

Installation clearances, for both the ACB-4520A and the selected power and signal cabling configuration, should be sufficient to optimize system cost, manufacturability, and maintainability.

The ACB-4520A emits a small amount of radio-frequency signals. Extremely sensitive components, such as high-bandwidth analog sensors, should be properly shielded from the ACB-4520A. Normal case construction is sufficient to shield the ACB-4520A as required by the FCC. If FCC compliance is required and the SCSI leaves the box in which the ACB-4520A is installed, the high-frequency signals generated by normal SCSI operation may require connector and cable shielding.

The ACB-4520A and all other partially shielded electronic devices are sensitive to high-power high-frequency electrical or magnetic sources. The ACB-4520A should be protected from such sources while it is operating. In particular, unshielded switching power supplies should be physically isolated from all electronic boards and their interconnecting cables. External noise sources, such as welding machines and radio transmitters, should be similarly isolated from electronic systems. Cable and connector shielding may be required in some environments.

An appropriate power source must be provided. Care should be taken to prevent ground loops and other power disturbances.

Proper programming support must be provided to generate the required command sequences. Additional program support must be provided to manage the SCSI protocols. Use of the advanced performance-oriented functions will require a more powerful SCSI host adapter that supports disconnect/reconnect and arbitration. Use of the advanced command functions requires expanded software support. Adaptec's host adapters will provide the required SCSI protocol services, but must receive the commands to be executed from appropriate system software. Many other SCSI systems are also available.

3.3 INSTALLATION

The following steps are required for installation of the ACB-4520A into a system properly designed to accept it. These steps are separate from any other testing and installation procedures required by other portions of the system, but can often be done in conjunction with those other installation steps.

1) Inspect the ACB-4520A for obvious physical damage before installing.

2) Install proper jumpers (see Section 3.4) to enable the desired ACB-4520A functions and to define the address of the ACB-4520A on the SCSI Bus.

3) Install the ACB-4520A with appropriate mounting hardware.

4) Make the required cable connections to the ACB-4520A. The cable connections are:

   J1 - Power cable
   J0 - SCSI cable
   J3, J4, - ESDI data cable (radial connections as required)
   J2 - ESDI control cable.

5) Install ESDI drives according to the manufacturer's directions. The drives must have appropriate drive select addresses and bus terminators set. The last ESDI drive on the control cable daisy chain must be terminated.

6) Power-on the system and perform any power-on test procedures required by the system.

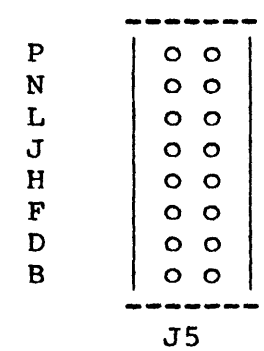
7) Format the attached drives. (See Section 3.7.)

NOTE:
IN A PRODUCTION ENVIRONMENT, THE DRIVES MAY BE OPTIONALLY FORMATTED BY A DEDICATED ACB-4520A MANUFACTURING WORK STATION BEFORE INSTALLATION. DUE TO THE INTELLIGENCE OF ESDI DRIVES, ALL PARAMETERS ARE STORED ON THE DRIVE BY THE FORMATTING PROCEDURE, FURTHER FORMATTING OR PARAMETER SPECIFICATION IS NOT REQUIRED AFTER INSTALLATION. THE ACB-4520A WILL AUTOCONFIGURE FROM THE DRIVE PARAMETERS AT POWER-ON TIME.

8) Perform appropriate system test and verification procedures. Errors related to drive operation, ACB-4520A operation, SCSI operation, and certain installation errors will be indicated through the normal SCSI error presentation mechanism.

3.4 CONFIGURING THE ACB-4520A

The ACB-4520A has a number of options that must be selected by the installation of hardware jumpers located at position J5 on the controller. The function of each jumper pair is shown.



J5

Diagnostics
Parity Enable
Reserved
Start Spindle
Adaptec 5500/4000 Compatibility
SCSI Address 2°2
SCSI Address 2°1
SCSI Address 2°0

3.4.1 DIAGNOSTIC MODE

The installation of the O-P jumper will cause the ACB-4520A to continuously repeat a diagnostic self-test. See Appendix B for details of this self-test.

3.4.2 PARITY ENABLE

The installation of the M-N jumper will cause the ACB-4520A to check for bus out (data into the ACB-4520A) parity errors. This jumper should only be installed if all SCSI devices communicating with the ACB-4520A generate SCSI data parity. The ACB-4520A will always generate parity on bus in data transfers.

3.4.3 START SPINDLE

Normally, the ACB-4520A will issue a START SPINDLE command at power-up. However, with jumper I-J installed the initiator must issue a START SPINDLE command before the drive will spin-up. This feature allows the initiator to control the power sequencing (and peak surge current) of the attached drives.

3.4.4 ADAPTEC ACB-5500/4000 COMPATIBILITY

When jumper G-H is installed, operation of the ACB-4520A will deviate from the Common Command Set specification in some areas. This jumper provides a software protocol which is fully compatible with the ACB-5500 and ACB-4000 families of hard disk controllers.

The following is a short description of the command set differences.

The REQUEST SENSE command will return only four bytes of sense data. With the G-H jumper removed, the REQUEST SENSE command will always return sense data in the extended sense format.

The FORMAT command will allow the specification of a data fill pattern other than 6Ch and a defect list may be provided by the host, but it will not be possible to use the manufacturer's supplied defect list.
The REASSIGN BLOCK command is not implemented for use with the G-H jumper installed.

The INQUIRY command will return a maximum of four data bytes.

The MODE SELECT and MODE SENSE commands will provide disk information only, retry handling will be specified through the SEND DIAGNOSTICS command.

The READ and WRITE BUFFER commands are implemented in a vendor-unique manner with different opcodes than the CCS specification.

For more detailed information on operation with the G-H jumper installed, see Appendix A and/or an ACB-4000A or ACB-5500 User's Manual.

3.4.5 SCSI BUS ADDRESS

The installation of jumpers A-B, C-D, and E-F set the SCSI bus address for the ACB-4520A. SCSI devices can have an address of zero to seven, but no two devices on the same bus can have the same address.

3.5 POWERING-ON THE ACB-4520A

Once the ACB-4520A is properly configured, the controller may be powered-on. When power is supplied to the system, the controller will enter a power-up mode and wait for a maximum of 18 seconds for the drive to become ready. During the 18-second power-on sequence, the controller performs a self test and begins checking for drives 0 and 1 to become ready. If the host sends a command requiring access to a drive before it has become ready, a DRIVE NOT READY (04_H) error will result. The controller will then check for a ready status on the next command requiring access to that drive.

If the drive does not come ready within 18 seconds after the controller is powered on, the controller will not perform automatic initialization if and when the drive becomes ready. To perform this function, the host must use the Reinitialize Drive option (60_H) of the Send Diagnostic Command.

When a command is received and the drive is ready but not initialized, the controller will read the drive's configuration data before executing the command. Once a drive is formatted, the host can determine the drive size (READ CAPACITY, 25_H, command) and self-configure without any driver software modification.

3.6 COMMUNICATING WITH THE ACB-4520A

The SCSI bus is a simple bus to interface. However, a quick reading of the SCSI spec may leave one lost due to its extreme attention to detail. Also, some SASI-like controllers exist on the market which allow some deviation from the ANSI/SCSI protocol. The important point to remember in designing a drive routine is that once the controller is started by the host, THE CONTROLLER CONTROLS THE SCSI BUS. The controller drives the data direction line (I/O), the phase lines (C/D and MSG) and initiates data transfers (REQ). The host driver should make no assumptions about the bus phases or byte counts. In addition, the controller can (and will) change phases between operations while going through intermediate phases. Thus, the phase lines (C/D and MSG) are only valid when the controller asserts REQ. Do not write your driver or allow your hardware to follow phases when REQ is not active or it may be 'fooled' by phase changes between REQ.

Also, some other controllers only support six-byte commands, thus some users have set up counters in their software to send a six-byte command. Since the ACB-4520A controller supports six- and 10-byte commands, the hardware/software should not count out the command bytes but rather should send command bytes as long as the controller requests them. Trust the controller; it 'knows' how many bytes it needs.

The sequence of operations for a single command used in the simplest of SCSI applications would be:

1) Select the controller onto the bus (wake it up). Be sure select remainsasserted until the controller responds Busy.

2) Send the ACB-4520A the appropriate command bytes until it changes phases (do not count bytes). If too many or too few bytes are REQuested, check for valid command op code and proper SCSI REQ/ACK timing. To ensure 1:1 interleave, the maximum REQ/ACK delay must be less than 280 nanoseconds.

3) If required, send/receive data until phase changes (do not count bytes; the controller will determine data direction).

4) Receive (REQ/ACK cycle) one status byte and save for evaluation (see Section 4.5).

5) Receive (REQ/ACK cycle) one message byte (see Section 4.2).

6) Check status byte. If Busy bit set, resend command; if Check bit set, send REQUEST SENSE (03h) command to get error.

A sample MODE SELECT command is shown below for a hard-sectored drive with two spare sectors per cylinder allocated for slipping defects. A Mode Select Command is not required preceding the Format Command when using the ACB-4520A. The Mode Select Command is only necessary if the host desires to modify any of the changeable Mode Select parameters.

Step 1: MODE SELECT COMMAND

Hex	Description
15	OP Code (15h) for MODE SELECT
00	Command for LUN 0
00	Reserved
00	Reserved
1C	Number of bytes appended (1Ch)
00	Reserved
	Extent Descriptor List
00	Reserved
00	Medium Type
00	Reserved
00	Block Descriptor length
	Direct Access Device Format Parameters
03	Mode Select Page Code
16	Page Length to follow
00	Reserved
00	Reserved
00	Reserved
02	Alternate Sectors per zone (LSB)
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Track Skew (sectors to skew per track)
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved
00	Reserved

After the Mode Select has been transferred to the controller and good completion status has been sent to the host, the drive may be formatted.

Step 2: FORMAT UNIT COMMAND

Interleave of 1:1
Three spare sectors per cylinder
Hard-Sectored Drive

FORMAT UNIT command

Hex	Description
04	Op code (04h for FORMAT UNIT command)
00	Lun 0 No defect data list, format with known defect information from primary and grown defect data lists maintained by drive and controller and do not accept a defect list from the host.
00	Reserved
00	High byte of interleave (must be 00)
01	Low byte of interleave
00	Reserved

The ACB-4520A provides true device independence by automatically formatting out all media defects by reading the manufacturer's defect map at format time. The user may specify, through the Mode Select command, the number of sectors per cylinder to be left available for future use in expectation of field grown defects. In the event of a grown defect, the Reassign Blocks Command uses a spare sector in the same cylinder, or on maximum cylinder - 1, to provide perfectly clean media. This intelligent defect handling scheme eliminates performance degradation due to media defects.

The ACB-4520A allows the user to select the desired interleave factor with the FORMAT UNIT command. The interleave can range from one to the number of sectors-per-track. The number represents the number of physical rotations of the disk which are necessary to read an entire track of data.

4.0 SCSI INTERFACE DESCRIPTION

This section briefly describes the SCSI protocol implemented by the Adaptec ACB-4520A controller. The SCSI protocols are described in detail in the ANSI X3.131-1986 Small Computer System Interface (SCSI) Specification, version 17.

4.1 GENERAL DESCRIPTION OF SCSI

This system interface provides an efficient method of communication between a maximum of eight computers and peripheral I/O devices. The eight-port daisy-chained bus defined by the SCSI specification supports the following features:

- Single or multiple host system
- Multiple peripheral devices and device types
- Multiple overlap of peripheral device operations
- Bus contention resolution through arbitration on a prioritized basis
- Asynchronous data transfer at up to 1.5 MBytes/sec.
- Host-to-host communication.

Communication on the bus is allowed between two bus ports at a time. A maximum of eight bus ports are allowed. Each port is attached to an SCSI device (e.g., controller or host adapter).

When two devices communicate with each other on the bus, one acts as an Initiator and the other acts as a Target. The Target (typically a controller) executes the operation. A device will usually have a fixed role as an Initiator or Target, but some devices may be able to assume either role. The ACB-4520A always assumes a Target role.

An Initiator, or attached host adapter, may address up to two logical units on an ACB-4520A. Each logical unit is a separate ESDI disk drive having the characteristics (i.e., capacity) with which it was formatted. The ACB-4520A manages them as independent units, keeping all necessary progress information for each device.

Access to the SCSI bus is handled through arbitration. The arbitrating SCSI device with the highest bus address is given priority. The Initiator selects a Target. The Target then manages all further communications, requesting commands from the Initiator, transferring the required data, and transmitting ending status. A Target may reselect an Initiator to complete a disconnected operation.

Data transfers on the bus are asynchronous and follow a defined REQUEST/ACKNOWLEDGE protocol. One eight-bit byte of information may be transferred with each handshake.

4.1.1 BUS SIGNALS

The SCSI bus consists of nine control signals and nine data signals. These are described below:

4.1.1.1 BUSY (BSY)

BSY is an "or-tied" signal which indicates that the bus is in use.

4.1.1.2 SELECT (SEL)

SEL is an "or-tied" signal used by an Initiator to select a Target or by a Target to reselect an Initiator.

4.1.1.3 CONTROL/DATA (C/D)

C/D is a Target-driven signal to indicate whether CONTROL or DATA information is on the data bus. Assertion indicates CONTROL. Outbound control information is a command while inbound control information is status.

4.1.1.4 INPUT/OUTPUT (I/O)

I/O is a Target-driven signal which controls the direction of data movement on the data bus relative to an Initiator. Assertion indicates INPUT to the Initiator.

4.1.1.5 MESSAGE (MSG)

MSG is a Target-driven signal indicating the MESSAGE phase.

4.1.1.6 REQUEST (REQ)

REQ is a Target-driven signal indicating a request for a REQ/ACK data transfer handshake.

4.1.1.7 ACKNOWLEDGE (ACK)

ACK is an Initiator-driven signal, in response to a target REQ, indicating the transfer of a byte to or from the ACB-4520A.

4.1.1.8 ATTENTION (ATTN)

ATTN is an Initiator-driven signal indicating the ATTENTION condition. ATTN is a request from the Initiator to transmit a message to the ACB-4520A.

4.1.1.9 RESET (RST)

RST is an "or-tied" signal indicating the RESET condition. The ACB-4520A never initiates a RESET condition.

4.1.1.10 DATA BUS (DB 7-0, PARITY)

Eight data bit signals, plus a parity bit signal, comprise the DATA BUS. DB(7) is the most significant bit and has the highest priority during arbitration. Significance and priority decrease with decreasing bit number with the least significant being DB(0).

Each of the eight data signals DB(7) through DB(0) is uniquely assigned as a Target or Initiator bus address (i.e., DEVICE I.D.). The Device ID is set in an ACB-4520A by jumpers A1, A2, and A4.

Data parity, DB(P), is odd. The ACB-4520A always generates correct bus parity for inbound transfers. A jumper is installed to enable the ACB-4520A to check outbound parity for those systems that support parity. All Initiators must support parity if the ACB-4520A parity check is enabled.

4.1.2 BUS PHASES

The bus has eight distinct operational phases and cannot be in more than one phase simultaneously. Detailed phase information and timing specifications are contained in the ANSI X3T9.2 SCSI Specification.

- BUS FREE
- ARBITRATION
- SELECTION
- RESELECTION
- COMMAND
- DATA
- STATUS
- MESSAGE

INFORMATION TRANSFER PHASES

4.1.2.1 BUS FREE PHASE

The BUS FREE phase, indicating that the bus is available for use, is entered by the deassertion and passive release of all bus signals. Once the BUS FREE phase is detected, the active initiator must deassert and passively release all bus signals (within a BUS CLEAR DELAY) after deassertion of BSY.

Devices sense BUS FREE when SEL and BSY are not asserted (simultaneously within a DESKEW DELAY of 45 nsec) and the RESET condition is not active.

4.1.2.2 ARBITRATION PHASE

The ARBITRATION phase allows one SCSI device to gain control of the bus. Once a device that wants to arbitrate for the bus detects the BUS FREE phase, it waits a BUS FREE DELAY, 800 nsec, and then asserts BSY with its own I.D. bit on the Data Bus. (Data parity is not guaranteed valid during ARBITRATION.)

After an ARBITRATION DELAY, the device examines the data bus. If a higher priority I.D. is on the bus or a select from another device is present, the device clears itself from arbitration by releasing the BSY and I.D. signals. If the device determines that its own I.D. is the highest priority, it leaves BSY asserted and asserts SELECT. ARBITRATION is then complete.

4.1.2.3 SELECTION PHASE

During the SELECTION phase, the I/O signal is deasserted so that this phase can be distinguished from the RESELECTION phase. The ACB-4520 operates in both arbitrating and nonarbitrating systems. In nonarbitrating systems, there may be only one Initiator. It may raise select with the Target I.D. asserted whenever the BUS FREE Phase is present.

In arbitrating systems, the SELECTION phase is entered with both BSY and SEL asserted; the Initiator then waits a minimum of a Bus Clear Delay plus a Bus Settle Delay before driving the DATA bus with the Target I.D. and its own I.D. After two DESKEW DELAYS, the Initiator then releases BSY. If only one Initiator is installed, and no disconnection is supported, the Initiator need not provide its own I.D.

On detecting the condition that Select and its own I.D. are asserted, and BSY and I/O are not asserted, the selected Target examines the DATA bus for the Initiator I.D. and responds by asserting BSY.

After a minimum of two DESKEW DELAYS, 90 nsec (following the detection of BSY from the Target), the Initiator deasserts SEL and may change the DATA signals.

The Initiator may "timeout" the SELECTION phase by deasserting the I.D. bits on the bus. If, after a TIMEOUT DELAY (250 msec) BSY has not been asserted, one of the selection timeout procedures specified in the ANSI X3.131-1986 SCSI specification will be followed. The ACB-4520A drives BSY within 250 microseconds of detecting SEL and its own I.D. If parity checking is enabled, Bus Out parity must be valid during the selection phase.

4.1.2.4 RESELECTION PHASE

If an Initiator supports reconnection, the ACB-4520A can release the SCSI bus for other activities while the disk devices are performing mechanical motions. The Initiator informs the ACB-4520 that it can support reconnection by transmitting the proper bits in the Identify MESSAGE OUT right after the Selection phase. The ACB-4520A will then disconnect at the proper times by presenting a Disconnect message to the Initiator. To minimize bus busy time, the Disconnect message will be preceded by a Save Data Pointer message only in the event of a partially completed data transfer at the time of disconnection. This reduces the SCSI bus busy time by only sending the essential messages.

After successfully gaining control of the SCSI by winning arbitration, the Target has both BSY and SEL asserted. It then informs the Initiator that it desires reconnection by asserting the I/O signal. The ACB-4520A then drops BSY. The reselected Initiator then asserts BSY. When the ACB-4520A sees the Initiator's BSY, it raises BSY and drops SEL, causing the Initiator to drop BSY, ending in the same state as it would be for a normal selection. The ACB-4520A then informs the Initiator which device is being reconnected with an Identify MESSAGE IN. The Initiator then restores all the necessary state information to continue the original operation.

4.1.2.5 INFORMATION TRANSFER PHASES

The COMMAND, DATA, STATUS and MESSAGE phases are all used to transfer data or control information through the SCSI bus.

The C/D, I/O and MSG signals are used to differentiate the various INFORMATION TRANSFER phases. Note that these signals are not meaningful until REQ has been asserted. See Table 4-1.

TABLE 4-1. INFORMATION TRANSFER PHASES

SIGNAL			PHASE NAME	DIRECTION OF INFORMATION XFER
MSG	C/D	I/O		
0	0	0	DATA OUT	(INIT to ACB-4520A)
0	0	1	DATA IN	(ACB-4520A to INIT)
0	1	0	COMMAND	(INIT to ACB-4520A)
0	1	1	STATUS	(ACB-4520A to INIT)
1	0	0	Reserved	
1	0	1	Reserved	
1	1	0	MSG OUT	(INIT to ACB-4520A)
1	1	1	MSG IN	(ACB-4520A to INIT)

NOTES: 0 = SIGNAL DEASSERTION
1 = SIGNAL ASSERTION
INIT = INITIATOR
ACB-4520A = TARGET

The INFORMATION TRANSFER phases use the REQ/ACK handshake to control data transfer. Each REQ/ACK allows the transfer of one byte of data. The handshake starts with the Target asserting the REQ signal. The Initiator responds by asserting the ACK signal, indicating a byte transfer. The Target then deasserts the REQ signal and the Initiator responds by deasserting the ACK signal.

With I/O signal asserted, data will be input to the Initiator from the ACB-4520A. The ACB-4520A ensures that valid data is available on the bus (at the Initiator port) before the assertion of REQ at the Initiator port. The data remains valid until the assertion of ACK by the Initiator. The Initiator must ensure that data has been read from the bus before asserting ACK. The ACB-4520A compensates for cable skew and the skew of its own drivers. The ACB-4520A always guarantees good parity on inbound data transfers.

With the I/O signal not asserted, data will be output from the Initiator to the ACB-4520A. The Initiator must ensure valid data on the bus (at the Target port) before the assertion of ACK on the bus. The Initiator should compensate for cable skew and skew of its own drivers. Valid data must remain on the bus until the ACB-4520A deasserts REQ. The ACB-4520A will optionally check parity on the outbound data transfers.

During each INFORMATION TRANSFER phase, the BSY line remains asserted, the SEL line remains deasserted, and the ACB-4520A will continuously envelop the REQ/ACK handshake(s) with the C/D, I/O and MSG signals in such a manner that these control signals are valid for at least a BUS SETTLE DELAY before the REQ of the first handshake and remain valid until the deassertion of ACK at the end of the last handshake.

4.1.2.5.1 COMMAND PHASE

The COMMAND phase is used by the ACB-4520A to obtain Command Descriptor Blocks from the Initiator.

The ACB-4520A asserts the C/D signal and deasserts the I/O and MSG signals during the REQ/ACK handshake(s) of this phase.

4.1.2.5.2 DATA PHASES (DATA IN/DATA OUT)

The DATA phase includes both the DATA IN phase and DATA OUT phase.

The DATA IN phase is used by the ACB-4520A to input device data or state information to the Initiator. The ACB-4520A asserts the I/O signal and deasserts the C/D and MSG signals during the REQ/ACK handshake(s) of this phase.

The DATA OUT phase is used by the ACB-4520A to obtain write data and control parameters from the Initiator. The ACB-4520A deasserts the C/D, I/O and MSG signals during the REQ/ACK handshake(s) of this phase.

4.1.2.5.3 STATUS PHASE

The STATUS phase is used by the ACB-4520A to send status information to the Initiator. Controller status contains information relating to the completion of the last command executed. Section 4.5 details the status information implemented in the ACB-4520A.

The Target asserts C/D and I/O and it deasserts the MSG signal during the REQ/ACK handshake(s) of this phase.

4.1.2.5.4 MESSAGE PHASES (MESSAGE IN/MESSAGE OUT)

The MESSAGE phase includes both MESSAGE IN and MESSAGE OUT phases. Section 4.2.2 details the messages information implemented in the ACB-4520A.

The MESSAGE IN phase is used by the ACB-4520A to present a message to the Initiator. The ACB-4520A asserts C/D, I/O and MSG during the REQ/ACK handshake(s) of this phase.

The MESSAGE OUT phase is used by the ACB-4520A to obtain a message from the Initiator. The ACB-4520A invokes this phase only in response to the ATTENTION condition from the Initiator. In response to the ATTENTION condition, the ACB-4520A asserts C/D and MSG and deasserts the I/O signal during the REQ/ACK handshake(s) of this phase. The Target handshakes byte(s) in this phase until the ATTN signal goes false.

4.1.2.6 SIGNAL RESTRICTIONS BETWEEN PHASES

When the BUS is between phases, the following restrictions apply to the bus signals:

- The BSY, SEL, REQ and ACK signals may not change.
- The C/D, I/O, MSG and DATA signals may change.
- The ATTN and RST signals may change as defined under the descriptions for the ATTENTION and RESET conditions.

4.1.3 BUS CONDITIONS

The bus has two asynchronous conditions: The ATTENTION condition and the RESET condition. These conditions cause certain BUS DEVICE actions and can alter the bus phase sequence.

4.1.3.1 ATTENTION CONDITION

ATTENTION allows the Initiator to signal the ACB-4520A of a waiting message. The ACB-4520A may access the message by invoking a MESSAGE OUT phase.

The Initiator creates the ATTENTION condition by asserting ATTN at any time except during the ARBITRATION and BUS FREE phase. The ACB-4520A responds when ready with the MESSAGE OUT phase. The Initiator keeps ATTN asserted if more than one byte is to be transferred.

The Initiator can only deassert the ATTN signal during the RESET condition, during a BUS FREE phase, or while the REQ signal is asserted and before the ACK signal is asserted during the last REQ/ACK handshake of a MESSAGE OUT phase.

While the ATTN is asserted, the Initiator must continue to respond to the Target command or data transfers since the Target may not process the ATTN immediately.

4.1.3.2 RESET CONDITION

The RESET condition, created by the assertion of RST, is used to immediately clear all devices from the bus and to reset these devices and their associated equipment. A Reset Condition will force the ACB-4520A to clear all uncompleted commands and return to default conditions.

RESET can occur at any time and takes precedence over all other phases and conditions. Any device (whether active or not) can invoke the RESET condition. On RESET, all devices immediately (within a BUS CLEAR DELAY, 800 nsec) deassert and passively release all bus signals except RST itself.

The RESET condition stays on for at least one RESET HOLD TIME, 25 usec. During the RESET condition, no bus signal except RST can be assumed valid.

Regardless of the prior bus phase, the bus resets to a BUS FREE phase following a RESET condition.

4.1.4 PHASE SEQUENCING

Phases are used on the bus in a prescribed sequence. In all systems, the RESET condition can interrupt any phase and is always followed by the BUS FREE phase. (Any other phase can also be followed by the BUS FREE phase.)

The normal progression is from BUS FREE to ARBITRATION, from ARBITRATION to SELECTION or RESELECTION and from SELECTION or RESELECTION to one or more of the INFORMATION TRANSFER phases (COMMAND, DATA, STATUS or MESSAGE).

There are few architectural restrictions on the sequencing between INFORMATION TRANSFER phases although the ACB-4520A does have a clearly defined sequence of transfers which it manages.

4.1.5 TIMING

Timing requirements are defined in the ANSI X3T9.2 SCSI Specification. Unless otherwise indicated, the delay time measurements for each device are calculated from signal conditions existing at the device port. Delays in the bus cable need not be considered for these measurements.

- ARBITRATION DELAY: 2.2 microseconds

  The minimum time that an SCSI device should wait from asserting BSY for arbitration until the data bus can be examined to see if arbitration has been won. There is no maximum time.

- BUS CLEAR DELAY: 800 nanoseconds (maximum)

  The maximum time allowed for a device to stop driving all bus signals after the release of BSY when going to BUS FREE.

- BUS FREE DELAY: 800 nanoseconds

  The minimum time allowed to an SCSI device from detection of the BUS FREE phase to its assertion of BSY and its I.D. during arbitration.

- BUS SETTLE DELAY 400 nanoseconds (minimum)

- DESKEW DELAY: 45 nanoseconds (minimum)

- RESET HOLD TIME: 25 microseconds (minimum)

  The minimum time during which RST is asserted. No maximum.

- SELECT TIMEOUT DELAY: 250 milliseconds

  The delay allowed for a BSY response from a TARGET before time out during SELECTION.

- REQ/ACK TIMING .280 nanoseconds

  To ensure 1:1 interleave operation, the maximum REQ/ACK delay must be less than 280 nanoseconds.

4.1.6 ELECTRICAL INTERFACE

All signals are low true and use open collector drivers terminated with 220 ohms to +5 volts (nominal) and 330 ohms to ground at each end of the cable.

Each signal driven by the controller has the following output characteristics:

True (Signal Assertion) = 0.0 to 0.4 VDC @ 48 mA (max/)
False (Signal Nonassertion) = 2.5 to 5.25 VDC.

Adaptec controllers use a 7438 open collector driver to meet this specification.

Each signal from the host to "the controller must have the following characteristics:

True (Signal Assertion) = 0.0 to 0.8 VDC @ .4mA (max.)
False (Signal Nonassertion) = 2.0 to 5.25 VDC.

A 74LS14 receiver with hysteresis meets this specification.

Figure 4-1 shows an example of proper bus termination.

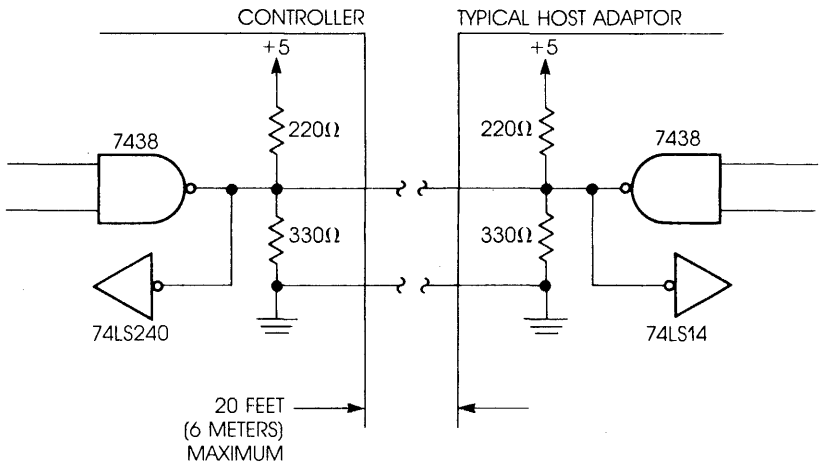


FIGURE 4-1. HOST ADAPTER BUS TERMINATION

4.1.7 CONNECTION DIAGRAM

A 50-pin connector is provided at position J4 for connecting to the SCSI bus. The SCSI single-ended nonshielded connection is used. All signals are asserted at the low level. All odd pins are grounded. A maximum cable length of 20 feet (6 meters) is allowed. Figure 4-2 shows the SCSI connection pins.

Ground	1	2	- Data Bit 0 (DBO)
		4	" 1
		6	" 2
		8	" 3
		10	" 4
		12	" 5
		14	" 6
		16	- Data Bit 7 (DB7)
		18	- Data Bit P (DBP)
		20	Ground
		22	Ground
	23	24	Ground
	25	26	No connection
	27	28	Ground
		30	Ground
		32	- Attention
		34	Ground
		36	- Busy
		38	- Acknowledge
		40	- Reset
		42	- Message
		44	- Select
		46	- Control/Data
		48	- Request
	49	50	- Input/Output

FIGURE 4-2. SCSI BUS PIN ASSIGNMENTS

4.2 MESSAGE SPECIFICATION

The message system allows communication between an Initiator and an ACB-4520A for purposes of physical path management. This section defines the messages supported by the ACB-4520A.

4.2.1 MESSAGE SYSTEM

The ACB-4520A supports a considerable number of messages to perform such special functions as disconnect/reconnect. Certain Initiators, including the Adaptec host adapters, fully support those messages, but certain others do not. The Initiator indicates that it can support more than the COMMAND COMPLETE message by creating the ATTENTION condition prior to the bus state of SEL asserted and BSY deasserted in the SELECTION phase.

If the ACB-4520A sees this ATTENTION condition, it will request a message byte from Initiator by executing a MESSAGE OUT information transfer. The outcoming IDENTIFY message indicates the drive to be selected and also indicates whether the disconnect/reconnect functions are supported by the Initiator.

The first message out may also be a BUS DEVICE RESET message.

Table 4-2 shows the messages supported by the ACB-4520A.

TABLE 4-2. MESSAGE CODES SUPPORTED BY THE ACB-4520A

HEX CODE	DESCRIPTION	DIRECTION	
00	Command Complete	In	
02	Save Data Pointer	In	
03	Restore Pointers	In	
04	Disconnect	In	
05	Initiator Detected Error		Out
06	Abort		Out
07	Message Reject	In	Out
08	No Operation		Out
0C	Bus Device Reset		Out
80 to FF	Identify	In	Out

4.2.2.1 SINGLE-BYTE MESSAGES

Command Complete (00h)

This message is sent by the ACB-4520A to indicate to the Initiator that the execution of a command or series of linked commands has terminated and that valid status has been sent to the Initiator. After sending this message, the ACB-4520A drops BSY and goes to the BUS FREE phase.

Save Data Pointer (02h)

This message is sent by the ACB-4520A to direct the Initiator to save a copy of the present active command execution state, including data address pointers and other information, for the currently connected disk drive. See the SCSI specification for a definition of pointers.

Restore Pointers (03h)

This code is sent from the ACB-4520A to direct the Initiator to restore the most recently saved pointers for the identified LUN to the active state. Pointers to the COMMAND, DATA, and STATUS locations for the LUN will be restored to the active pointers. COMMAND and STATUS pointers will be restored to their value at the beginning of the present command. The DATA pointer shall be restored to the value at the beginning of the command or at the value saved when the last SAVE DATA POINTER message was executed.

Disconnect (04h)

This message is sent by the ACB-4520A to inform an Initiator that the present physical path is going to be broken (the Target will disconnect by releasing BSY), but that a later reconnect will be required in order to complete the current operation. By not sending this message or the COMMAND COMPLETE message before going to BUS FREE phase (other than as a result of reset), the Target indicates that an error condition has occurred on the current command. This message does not save the DATA POINTER.

Initiator Detected Error (05h)

This message is from the Initiator to inform the ACB-4520A that an Initiator-detected retryable error has occurred since the last time the state of the DATA POINTER was saved. Commonly, this is for a data parity error. The ACB-4520A will post error status with an error code of 2D.

Abort (06h)

The message is sent from the Initiator to direct the ACB-4520A to:

- Clear any operation for the specified LUN from the selecting Initiator. Only an operation for the selecting Initiator is affected. If no logical unit has been selected by the IDENTIFY message, then only the operation in process on the bus will be cleared bythe Target.

- Cause the bus to go to the BUS FREE phase.

No status or ending message shall be sent for the operation. It is not an error to issue this message to an LUN that is not currently performing an operation for the Initiator.

Message Reject (07h)

This code is sent from the Initiator or ACB-4520A if the message received was inappropriate or not implemented. The Initiator will assert the ATTN signal prior to its release of ACK for the REQ/ACK handshake of the message that will be rejected. When the ACB-4520A sends this message, it will change to MESSAGE IN phase and send this MESSAGE prior to requesting additional message bytes.

No Operation (08h)

This message is sent from an Initiator in response to the ACB-4520's request for a message when the Initiator does not currently have any other valid message to send.

Bus Device Reset (0Ch)

This message can be sent from an Initiator to direct the ACB-4520A to reset all current I/O operations on that BUS DEVICE. This message forces the ACB-4520A to an initial state with no operations pending for any Initiator. Upon recognizing this message, the ACB-4520A goes to the BUS FREE phase.

Identify (80_H to C3h)

This code is sent by either the Initiator or ACB-4520A to establish the physical path connection between the Initiator and the ACB-4520A for a particular disk device (or Logical Unit).

Bit 7 is always set to identify this message.

Bit 6 is set by the Initiator to indicate it is capable of accommodating disconnection and reconnection.

Bits 5, 4, 3, and 2 are reserved and must be zero.

Bits 1, and 0 specify a logical unit number (disk drive address) address in the ACB-4520A.

4.3 FUNCTIONAL DESCRIPTION OF SCSI COMMANDS

By defining a fixed block structure using a simple, logical address scheme, the I/O interface can support device independence. The same code can be used to support both the ACB-5580 SMD Disk Controller and the ACB-5500 ST506 Disk Controller, in addition to the ACB-4520A ESDI Disk Controller. Also, by including the logical block address as a component of the command structure, implicit operations (such as SEEK and Retry) can be performed by the basic READ and WRITE commands.

This interface, despite its simplicity, is capable of providing the high level of performance required in a multihost/multitask environment. Functional examples of SCSI command and data interactions are detailed below.

4.3.1 SINGLE COMMAND EXAMPLE

A typical operation for the ACB-4520A is a READ of disk data.

The Initiator has an active state and a set of stored states (representing active disconnected devices). The Initiator sets up the active state for the operation requested by the host system, arbitrates for the SCSI bus, and selects the ACB-4520A. The ACB-4520A then assumes control of the operation.

The ACB-4520A checks to see if ATTN is present, indicating that the Initiator desires to send an Identify message. The ACB-4520A obtains the Identify message and uses it to determine which logical unit (ESDI drive) is being addressed and if the ACB-4520A should disconnect from the SCSI bus at some point during command execution to reduce the bus BUSY time. The ACB-4520A then obtains the command descriptor block, six or 10 bytes of command information, and determines that a Read of certain logical blocks is desired by the Initiator. The ACB-4520A performs all the disk control and data transfer operations necessary to transmit the logical blocks to the Initiator. All seeks, retries, defect skipping, and error correction are performed to recover the logical blocks as quickly as possible and with no management from the Initiator.

After the read data has been transferred to the Initiator, the ACB-4520A presents ending status and a Command Complete message to inform the Initiator that the operation was completed successfully. The bus is then freed for further operations.

4.3.2 DISCONNECT/RECONNECT EXAMPLE

In the above READ example, the drive may require a time-consuming physical seek to reach the requested data. In order to improve system throughput, the ACB-4520A disconnects from the Initiator, freeing the SCSI bus to allow other Initiator requests to be sent to other controllers.

A typical disconnection is performed after the READ Command has been transferred and before data is transferred. The ACB-4520A indicates that the SCSI bus will be freed up by sending the Disconnect Message, but that the operation will continue later. If some data has been transferred before the ACB-4520A disconnects from the SCSI bus, the Disconnect message will be preceded by the Save Data Pointer message.

When the physical motion of the device is complete and the Read/Write head is no more than a couple of sectors before the desired sector, the ACB-4520A reselects the Initiator and passes an Identify message to the initiator. If there was a previous transfer of data for the same disconnected command, the Identify message will be followed by Restore Pointer Message. The Identify message provides the necessary information for the Initiator to reactivate the stored state information. The read operation then continues as previously described.

4.4 COMMAND STRUCTURE

4.4.1 COMMAND DESCRIPTOR BLOCK (CDB)

An I/O request to a device is made by passing a Command Description Block (CDB) to the Controller. The first byte of the CDB is the command group and operation code. The remaining bytes specify the Logical Unit Number (LUN), starting block address, control byte, and the number of blocks to transfer. Commands are categorized into two formats supported in Adaptec controllers:

- Group 0: 6-Byte commands
- Group 1: 10-Byte commands

Figures 4-3 and 4-4 show typical Group 0 and Group 1 command descriptor block formats.

BYTE	BIT 07	06	05	04	03	02	01	00
00	Group Code			Opcode				
01	Logical Unit Number			(MBS)	Logical Block Address			
02	Logical Block Address							
03	Logical Block Address							(LSB)
04	Number of Blocks							
05	Reserved (0)							

FIGURE 4-3. GROUP 0 COMMANDS (SIX-BYTE COMMANDS)

BYTE	BIT 07	06	05	04	03	02	01	00
00	Group Code			Opcode				
01	Logical Unit Number			Command Specific Bits				REL ADR
02	(MBS)	Logical Block Address						
03	Logical Block Address							
04	Logical Block Address							
05	Logical Block Address							(LSB)
06	Reserved							
07	Number of Blocks							
08	Number of Blocks							
09	Reserved (0)							

FIGURE 4-4. GROUP 1 COMMANDS (10-BYTE EXTENDED BLOCK ADDRESS)

4.4.2 GROUP CODE

The group code can be 0 to 7 indicating the SCSI command group. The ACB-4520A uses only 0 and 1 to indicate Group 0 (six-byte) and Group 1 (10-byte) Commands.

4.4.3 OPERATION CODE

The operation code indicates to the controller the command to be executed. The operation code allows for 32 commands (00 HEX to 1F HEX).

4.4.4 LOGICAL UNIT NUMBER

Logical Unit Numbers identify up to eight devices attached to a controller. The ACB-4520A accepts Logical Unit Numbers from 0 to 1, addressing two ESDI disk devices per controller. The Logical Unit Number is only examined and used by the ACB-4520A if the IDENTIFY message was not provided.

4.4.5 COMMAND SPECIFIC BITS

Byte 01, bits 01-04 specify options which depend upon the particular command.

4.4.6 LOGICAL BLOCK ADDRESS

Group 0 commands contain 21-bit starting block addresses while Group 1 supports 32-bit block addressing.

4.4.7 NUMBER OF BLOCKS

A variable number of blocks may be transferred under a single command. Group 0 commands may transfer up to 256 blocks, while Group 1 commands may transfer up to 65,535 blocks. A zero value for a Group 0 command implies a 256-block transfer. A zero value for a Group 1 command implies a zero length transfer.

4.4.8 CONTROL BYTE

The control byte is the last byte in a Class 00 or Class 01 command. The command byte is defined as follows:

Bits 7-0 Reserved; must be zero

4.5 COMPLETION STATUS BYTE

Status is always sent at the end of a command or set of linked commands. Intermediate status is sent at the completion of a linked command. Any abnormal condition encountered during command execution causes command termination and ending status.

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Reserved			Conflt	Busy	Equal	Check	Reserv

FIGURE 4-5. COMPLETION STATUS BYTE

Bits 0, 5, 6 & 7: Zero for ACB-4520A.

Bit 1: Check condition. Sense is available. See REQUEST SENSE command, Section 6.3.

Bit 2: Condition met. Set when any SEARCH is satisfied.

Bit 3: Busy. Device is busy or reserved. Busy status will be sent whenever the ACB-4520A is unable to accept a command from a Host. This condition occurs when a Host that does not allow reconnection requests an operation from a reserved or busy device. It also occurs if a dual-port device is reserved to the other controller.

Bit 4: Reservation Conflict. When set with bit 3, indicates drive access or reservation request in conflict with an existing reservation.

5.0 ESDI INTERFACE DESCRIPTION

5.1 INTRODUCTION

The ESDI Interface is an emerging standard for connecting high-performance 5-1/4" Winchester disk drives to disk controllers. The ESDI interface requires a high-performance controller capable of communicating with any attached ESDI drive across a serial interface.

5.2 INTERFACE SIGNALS

The ESDI interface consists of a control cable and one or more data cables. The control cable is multidropped from the ACB-4520A to all attached disk drives. The last drive on the daisy chain must have resistive terminators installed to terminate the control cables. The data cables are radially connected between the ACB-4520A and a single drive. To use the ACB-4520A with two drives, the maximum supported, one control cable and two data cables are required. Figure 5-1 shows the ACB-4520A cabled for this configuration.

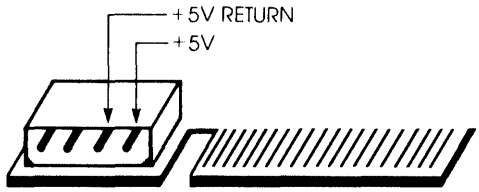


FIGURE 5-1. ACB-4520A POWER CONNECTOR J3

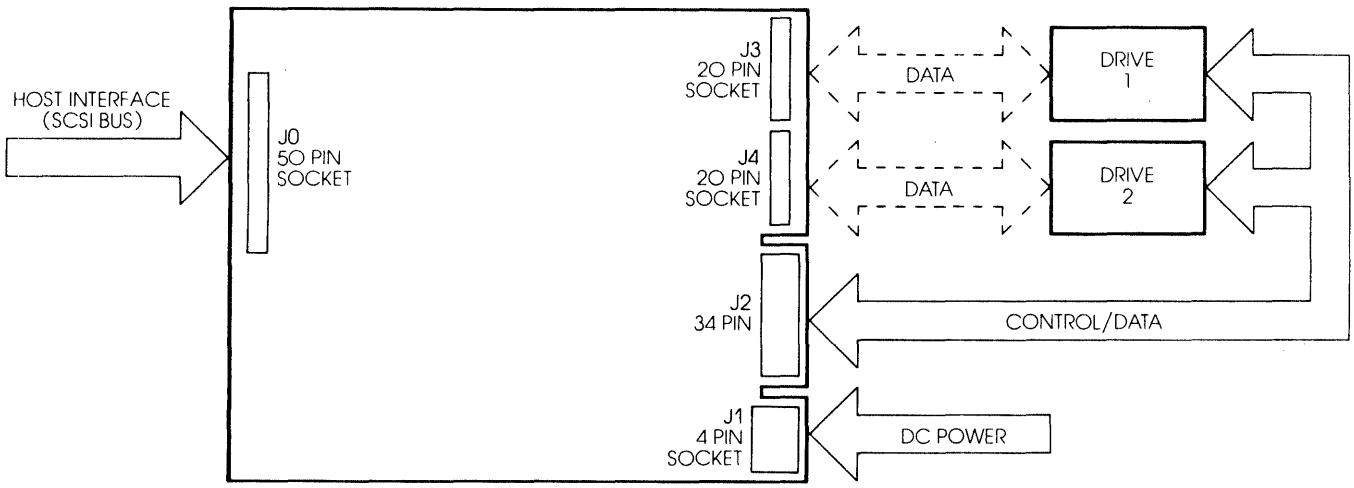


FIGURE 5-2. ACB-4520A CABLING

The daisy-chained control cable connects to the ACB-4520A through a 34-pin edge card connector J2. The suggested mating connector is 3M P/N 3402-000. The pin assignment for J2 is shown in Table 5-1.

TABLE 5-1. J2 CONNECTOR PIN ASSIGNMENT

GND RTN PIN	SIGNAL PIN	SIGNAL NAME
1	2	Head Select 2^3
3	4	Head Select 2^2
5	6	Write Gate
7	8	Config/-Status Data
9	10	Transfer ACK
11	12	Attention
13	14	Head Select 2^0
15	16	Sector/-Byte Clock/-address Mark Found
17	18	Head Select 2^1
19	20	Index
21	22	Ready
23	24	Transfer REQ
25	26	Drive Select 1
27	28	Drive Select 2
29	30	Drive Select 3
31	32	Read Gate
33	34	Command Data

The radial data cables connect to the ACB-4520A through 20-pin header connectors J3 and J4. Drive 0 must be connected to J0 and drive 1 must be connected to J1. The suggested mating connector is 3M P/N 3421-0000. The pin assignment for J0 and J1 is shown in Table 5-2.

TABLE 5-2. J3 AND J4 CONNECTOR PIN ASSIGNMENT

GND RTN PIN	SIGNAL PIN	SIGNAL NAME
	1	Drive Selected (Not used)
	2	Sector-Byte Clock-Address Mark Found (Not used)
	3	Command Complete
	4	Address Mark Enable
6	5	Reserved for Step Mode
	7	Write Clock (+)
	8	(-)
	9	Reserved for Step Mode (Grounded)
12	10	Read REF Clock (+)
	11	(-)
15	13	NRZ Write Data (+)
16	14	(-)
19	17	NRZ Read Data (+)
	18	(-)
	20	Index (Not used)

5.3 CONTROL SIGNAL DRIVERS AND RECEIVERS

The drivers have the following electrical specifications. Refer to Figure 5-3 for the recommended circuit.

TRUE/ACTIVE: 0.0 VDC to 0.4 VDC @ 1 = -48mA (Max.)

FALSE/DEACTIVE: 2.5 VDC to 5.25 VDC @ 1 = +250 uA (Open Collector)

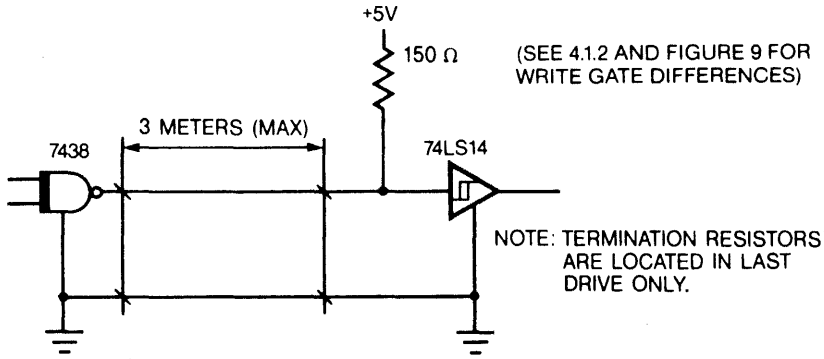


FIGURE 5-3. CONTROL SIGNALS, DRIVER/RECEIVER COMBINATION

5.4 DATA LINE DRIVERS AND RECEIVERS

The data drivers and receivers are differential in nature. The recommended circuit is shown in Figure 5-4.

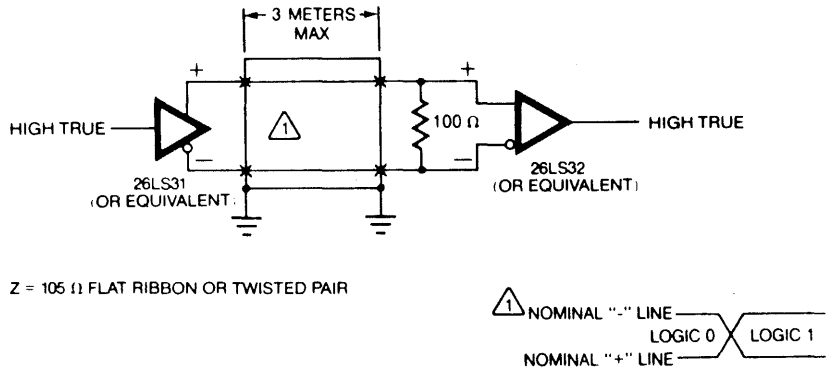


FIGURE 5-4. DATA LINE DRIVER/RECEIVER COMBINATION

5.5 FORMAT RULES (SOFT SECTOR)

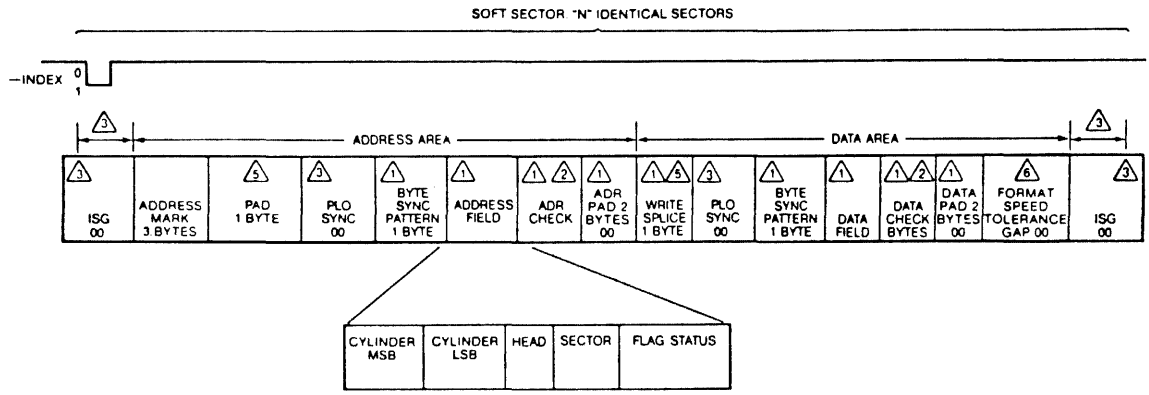
The purpose of a format is to organize a data track into smaller sequentially numbered blocks of data called sectors.

5.6 SOFT-SECTORED FORMAT

The format shown below in Figure 5-5 is similar to the format commonly used on hard-sectored disk drives and indicates minimum requirements.

This format is a soft-sectored type of sector which means that the beginning of each sector is defined by an Address Mark followed by a prewritten identification (ID) field which contains the physical sector address plus cylinder and head information. The ID field is then followed by a user supplied data field.

The definition at the functional areas shown in the soft-sectored format are identical to those described for the hard-sectored format. There is one additional field in this format and one field which is deleted. The additional field is the Address Mark field, and the field which is deleted is one byte of the the disk address. Instead of a five-byte physical address, the ACB-4520A uses a four-byte logical block address.



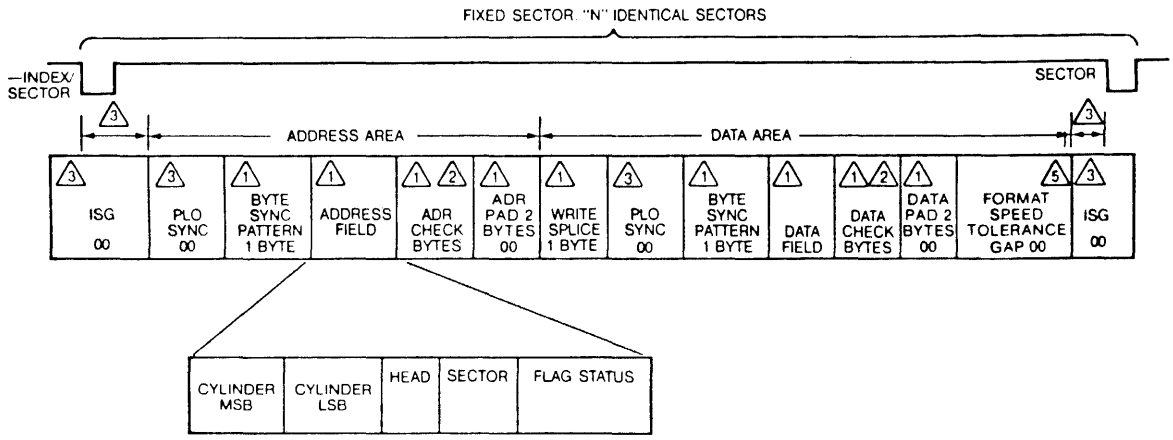
1. THESE AREAS ARE EXAMPLES ONLY AND MAY BE STRUCTURED TO SUIT INDIVIDUAL CUSTOMER REQUIREMENTS
2. THE NUMBER OF CHECK BYTES IS USER DEFINED
3. PLO SYNC FIELD AND ISG ARE AS REPORTED IN RESPONSE TO THE REQUEST CONFIGURATION COMMANDS
4. ALL BYTE NUMBERS INDICATED ARE MINIMUMS EXCEPT ADDRESS FIELD LENGTH
5. THIS AREA IS PART OF THE PLO SYNC FIELD TO ALLOW FOR READ GATE ACTIVATION DELAYS. CONTROLLER SHOULD TREAT THIS AS AN ADDITIONAL BYTE IN THE PLO SYNC FIELD
6. FORMAT SPEED TOLERANCE GAP IS REQUIRED IF REFERENCE CLOCK IS NOT TIED TO ROTATIONAL SPEED. THE APPLICABILITY OF THIS GAP IS DEFINED IN CONFIGURATION DATA

FIGURE 5-5. SOFT-SECTORED FORMAT

5.7 FORMAT RULES (FIXED SECTOR)

The record format on the disk is under control of the controller. The INDEX pulse and BYTE CLOCKS or INDEX and SECTOR pulses are available for use by the Controller to indicate the beginning of a track and allow the controller to define the beginning of a sector. A suggested format for fixed length data records is shown in Figure 5-6.

The format presented in Figure 5-6 consists of three functional areas; Intersector Gap, Address and Data. The data area is used to record the system's data files. The Address area is used to locate and verify the track and sector location on the Disk where the Data areas are to be recorded. This section refers to a SECTOR pulse which is generated internal to the controller from the SECTOR pulses available from the drive.



1. THESE AREAS ARE EXAMPLES ONLY AND MAY BE STRUCTURED TO SUIT INDIVIDUAL CUSTOMER REQUIREMENTS.
2. THE NUMBER OF CHECK BYTES IS USER DEFINED.
3. PLO SYNC FIELD AND ISG ARE AS REPORTED IN RESPONSE TO THE REQUEST CONFIGURATION COMMANDS.
4. ALL BYTE NUMBERS INDICATED ARE MINIMUMS EXCEPT ADDRESS FIELD LENGTH.
5. FORMAT SPEED TOLERANCE GAP IS REQUIRED IF REFERENCE CLOCK IS NOT TIED TO ROTATIONAL SPEED THE APPLICABILITY OF THIS GAP IS DEFINED IN THE CONFIGURATION DATA.

FIGURE 5-6. FIXED-SECTOR FORMAT

6.0 COMMAND DESCRIPTIONS

The following section describes the command set of the ACB-4520A. Adaptec has followed the ANSI X3T9.2 SCSI Specification. Additions are implemented only to support special Adaptec functions or to clarify certain commands with a very large number of possible implementations. Each command contains a list of possible conditions, the exception Sense Error Codes and the associated SCSI Sense Key. The possible error codes for each command lists the typical error conditions, but not all possible error conditions.

TABLE 6-1. COMMAND CODE SUMMARY

COMMAND CODE	COMMAND NAME	DATA/PARAMETER	SOURCE*
00(HEX)	Test Unit Ready	---	C
01	Rezero Unit	---	S
03	Request Sense	Sense Info In	C
04	Format Unit	Defect List Out	C
07	Reassign Blocks	Data Out	S
08	Read	Data In	C
0A	Write	Data Out	C
0B	Seek	---	S
0F	Translate	Info In	A
10	Set Threshold	Info Out	A
11	Read/Reset Usage Counter	Info In	A
12	Inquiry	Info In	C
15	Mode Select	Info Out	C

TABLE 6-1. COMMAND CODE SUMMARY
(Continued)

COMMAND CODE	COMMAND NAME	DATA/PARAMETER	SOURCE*
16	Reserve	---	C
17	Release	---	C
1A(HEX)	Mode Sense	Info In	C
1B	Start/Stop Unit	---	S
1C	Receive Diagnostic	Info In	SA
1D	Send Diagnostic	Info Out	C
25	Read Capacity	Info In	C
28	Read (Extended)	Data In	C
2A	Write (Extended)	Data Out	C
2B	Seek (Extended)	---	S
2E	Write and Verify	Data Out	SA
2F	Verify	---	SA
31	Search Data Equal	Data Out	SA
37	Read Defect Data	Data In	C
3B	Write Data Buffer	Data Out	C
3C	Read Data Buffer	Data In	C

* S = SCSI Standard Command
A = Adaptec Special Function
SA = SCSI Standard Command with Adaptec Subset.
C = Conforms to the Common Command implementation of the SCSI standard command.

6.1 TEST UNIT READY (00h)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	0	0
01	Logical Unit Number				Reserved (0)			
02	Reserved (0)							
03	Reserved (0)							
04	Reserved (0)							
05	Reserved (0)							

FIGURE 6-1. TEST UNIT READY COMMAND

This command returns zero status if the requested unit is powered-on and ready. If the drive is busy or reserved, appropriate status bits are set. If the drive is not operational, a check condition will be set in the status byte. In that case, Sense information will be preserved if a REQUEST SENSE command follows immediately. The Test Unit Ready command will not disconnect waiting for unit ready status.

Valid Errors:

Error	Error Code	Sense Key
Write Fault	03h	4
Drive Not Ready	04h	2
Bad Argument	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
ESDI Interface Error	4Ch	4

6.2 REZERO UNIT (01h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	0	1
01	Logical Unit Number			Reserved (0)				
02	Reserved (0)							
03	Reserved (0)							
04	Reserved (0)							
05	Reserved (0)							

FIGURE 6-2. REZERO UNIT COMMAND

This command moves the selected drive's actuator to track zero, then sends completion status. This may reset certain drive hardware failures.

Valid Errors:

Error	Error Code	Sense Key
No Seek Complete	02h	4
Drive Not Ready	04h	2
Bad Argument	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
ESDI Interface Error	4Ch	4

6.3 REQUEST SENSE (03h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	1	1
01	Logical Unit Number			Reserved (0)				
02	Reserved (0)							
03	Reserved (0)							
04	Allocation Length							
05	Reserved (0)							

FIGURE 6-3. REQUEST SENSE COMMAND

This command returns unit sense information.

The sense data will be valid for the CHECK status condition sent to the Host and will be saved by the controller until requested. Sense data will be cleared on receiving a subsequent command to the LUN related to the check condition from the Host that received the check condition. Other hosts will receive BUSY status to commands for a LUN with nonzero sense to report. Therefore, CHECK status should always be followed by a SENSE Command, or another command from the same initiator to clear sense information.

The ACB-4520A defaults to an extended sense data of 16h bytes. When the G-H jumper is installed, the sense data field is a maximum of four bytes.

The allocation length field indicates the maximum number of sense bytes that may be transmitted. An allocation length of zero defaults to request a 16h byte transfer. Any other length requests that number of bytes or fewer. The maximum number of bytes transmitted by the ACB-4520A is 22 (16h) for extended sense.

The REQUEST SENSE command is the most important mechanism for informing the host of abnormal states discovered by the ACB-4520A. Very few error conditions are presented as a result of REQUEST SENSE.

Valid Errors:

Error	Error Code	Sense Key
Bad Argument	24	5
SCSI Bus Out Parity Check	47	4
Reset Occurred	29	6
Mode Select Changed	2A	6
SCSI HA/Initiator Detected Error	48	4

BYTE	BIT 07	06	05	04	03	02	01	00
00	AdrVal	1	1	1	0	0	0	0
01	Reserved (0)							
02	Reserved (0)				Sense Key			
03	Logical Block Address (MSB)							
04	Logical Block Address							
05	Logical Block Address							
06	Logical Block Address (LSB)							
07	0	0	0	0	1	1	1	0
08	Reserved (0)							
09	Reserved (0)							
0A	Reserved (0)							
0B	Reserved (0)							
0C	Error Class				Error Code			
0D	Reserved (0)							
OE	Reserved (0)							
OF	Reserved (0)							
10	Reserved (0)							
11	Reserved (0)							
12	Device Status							
13	Device Status							
14	Device Vendor Unique Status							
15	Device Vendor Unique Status							

FIGURE 6-4. EXTENDED SENSE BYTE FORMAT.

The AdrVal (Address Valid) bit indicates that the Information Bytes contain a valid logical block address for which the error condition was recorded.

The error class indicates the general type of error detected. Class 0 errors are related to drive state, including ready, seek complete, write fault and similar errors. Class 1 errors are related to data recovery problems. Class 2 errors are related to invalid requests from the host system. Class 7 is the class defining SCSI extended sense information.

The error code defines precisely the failure that was detected. These codes are described in Tables 6-2, 6-3 and 6-4.

The logical block address is 32 bits long, and contains the address of the logical block for which the failure was detected. If the AdrVal bit is off, the logical block address is not meaningful. A few sense error codes store other information in the logical block address without turning on the AdrVal bit.

The Sense Key is the SCSI-standard decode classifying sense information for operating system interpretation. The Sense Keys are described in Table 6-5. Note that each error class and code is presented in byte 0Ch of the extended sense information to clarify and qualify the actual failure. The sense key for each error, presented in byte 2 of the extended sense information, is included in the error code table.

TABLE 6-2. CLASS 00 ERROR CODES IN SENSE BYTE (DRIVE ERRORS)

CODE	SENSE KEY	ERROR	MEANING
00	0	NO SENSE	No error occurred or error cleared before REQUEST SENSE command
01	4	NO INDEX/SECTOR	No index or sector signal found during rd, wr, or format
02	4	NO SEEK COMPLETE	Seek complete signal missing
03	4	WRITE FAULT	Drive detected failure which disallows writes
04	2	DRIVE NOT READY	Drive not ready
05	4	NOT SELECTED	Drive not selected
07	4	MULTIPLE SELECT	Multiple drives selected

TABLE 6-3. CLASS 01 ERROR CODES IN SENSE BYTE (TARGET ERRORS)

CODE	SENSE KEY	ERROR	MEANING
10	3	ID ECC ERROR	ID field could not be recovered by retry
11	3	UNCORRECTABLE DATA ERROR	Data field error could not be recovered by retry or correction
12	3	ID ADDRESS MARK NOT FOUND	Missing ID address mark
14	3	RECORD NOT FOUND	Logical block ID not on accessed tracks, but no ID CRC error
15	3	SEEK ERROR	Could not seek to track with correct ID
17	1	RECOVERABLE READ ERROR	Read error recovered with retries
18	1	RECOVERABLE READ ERROR	Mode Select command for details
19*	1	ERROR READING DEFECT LIST	Unrecovered read error reading the defect list
1A	5	PARAMETER OVERRUN	Overwrote buffer length on Write Buffer Command
1C**	1	DEFECT LIST NOT FOUND	Primary defect list not found

* When the G-H jumper is installed, this error indicates an ECC error detected during a verify operation.

** When the G-H jumper is installed, this error indicates a blown format.

TABLE 6-4. CLASS 02 ERROR CODES (SYSTEM-RELATED ERRORS)

CODE	SENSE KEY	ERROR	MEANING
20	5	ILLEGAL COMMAND	Command code is invalid or not implemented
21	5	ILLEGAL BLOCK ADDRESS	Block address outside address space by Logical Unit
24	5	BAD ARGUMENT IN CDB	Reserved bit not zero or invalid parameter
25	5	INVALID LOGICAL UNIT NUMBER	Logical Unit greater than one addressed
26	5	INVALID FIELD IN PARAMETER LIST	Reserved bit not zero or invalid parameter
29	6	RESET OCCURRED	Power on reset or bus reset occurred
2A	6	MODE SELECT CHANGED	Mode Select Data Changed by another host
2C	6	THRESHOLD LIMIT EXCEEDED	Counter threshold limit exceeded
31	3	FORMAT FAILED	Format error or blown format
32	1	NO SPARE SECTOR	Spare available only on the maximum cylinder minus one
32	3	NO SPARE SECTOR	No defect spare location available on the same cyl.
42	4	POWER ON FAILURE	Self Test Failed
45	4	SELECT/RESELECT FAILED	SCSI Timeout or select/ reselect
47*	4	SCSI BUS OUT PARITY CHECK	Parity check on outbound data transfer.
48**	4	SCSI HA/INITIATOR DETECTED ERROR	A message '05'h (Initiator Detected Error) was received from the host
49	5	ILLEGAL MESSAGE	An illegal message was received by the ACB-4520A
4C	4	ESDI INTERFACE	Unable to communicate with the ESDI drive.

* 2E with G-H jumper on
**2D with G-H jumper on

TABLE 6-5. SENSE KEYS

SENSE KEY	DESCRIPTION
0h	NO SENSE. Indicates that there is no specific sense key information to be reported. This would be the case for a successful command or where sense information was previously recovered or reset.
1h	RECOVERED ERROR. Indicates that the last command completed successfully with some recovery action performed by the ACB-4520A.
2h	NOT READY. Indicates that the Logical Unit addressed cannot be accessed. Operator intervention may be required to correct this condition.
3h	MEDIUM ERROR. Indicates that the command terminated with a nonrecovered error condition which was probably caused by a flaw in the medium or an error in the recorded data.
4h	HARDWARE ERROR. Indicates that the Target detected a nonrecoverable hardware failure (for example, controller failure, device failure, parity error, etc.) while performing the command or during a self test.
5h	ILLEGAL REQUEST. Indicates that there was an illegal parameter in the Command Descriptor or in the additional parameters supplied as data for some commands (Format Unit, Search Data, etc.)
6h	UNIT ATTENTION. Indicates that the removable medium may have been changed or the Target has been reset (by BUS DEVICE RESET message or a power on Reset Condition) since the last command was issued to the Logical Unit. This Sense Key is reported the first time that any command is issued after the condition is detected. The requested command will not be performed. The UNIT ATTENTION Sense Key will be reported to all Indicators which subsequently issue a command to the Logical Unit. This Sense Key is cleared for the next command from the same Indicator.

TABLE 6-5. SENSE KEYS
(Continued)

SENSE KEY	DESCRIPTION
7h	DATA PROTECT. Indicates that a command which reads or writes the medium was attempted on a block that is protected from this operation. The read or write operation is not performed.
8h-Ah	RESERVED. Not implemented by ACB-4520A.
Bh	ABORTED COMMAND. Indicates the ACB-4520A aborted the command.
Ch	EQUAL. Indicates a Search Data command has satisfied an equal comparison.
Dh	RESERVED. Not implemented by the ACB-4520A.
Eh	MISCOMPARE. Indicates that the source data did not match the data read from the medium.
Fh	RESERVED. Not implemented by the ACB-4520A.

6.4 FORMAT UNIT (04h)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	0	0	0	0	0	1	0	0
01	Logical Unit Number			Data	Cmplt	Defect list format		
02	Reserved (00)							
03	Reserved (00)							
04	Interleave							
05	Reserved (00)							

FIGURE 6-5. FORMAT UNIT COMMAND

The ACB-4520A will write from index to index all ID and DATA fields when the format unit command is issued. Data fields are completely written with $6C_H$ data pattern.

Byte 01 is used to indicate the type of defect list or lists to be used when formatting the ESDI disk drive. Format options are listed in Table 6-6.

When formatting with a user supplied defect list, bit 2 of byte 1 must be set to 1 while bits 0 and 1 do not matter. This indicates the defect data list is in the bytes from index format.

TABLE 6-6. FORMAT OPTIONS

FMT DATA 4	COMPLIST 3	DEFECT LIST 2	1	FMT 0	
0	0	0	0	0	**Format with all current defect lists.** This format option uses the manufacturer-supplied defect list, the grown defect list (the list of reassigned defects) and the list of defects which the user had previously provided (user-supplied defect data for previous formats). The ACB-4520A will not transfer a new defect list from the host to the controller using this option.
1	0	0	0	0	**Format with all current defect lists with user options.** This option is followed by four bytes of data in which byte 01 specifies the user option. If byte 01 is equal to B0h or 00h, all current defect lists will be used. If byte 01 is F0h, all current defect lists except the manufacturer's defect list are used. If byte 01 is equal to A0h or E0h, the format process will continue even if an unrecoverable error occurs while accessing the grown defect list, the current user-supplied defect list and/or the manufacturer-supplied defect list. In the event a read error occurs, check status will be returned to the host upon completion of the format, and the Sense Key, Recovered Error will be set.
1	1	0	0	0	**Format with the manufacturer-supplied defect list only.** This option is followed by four bytes of data in which byte 01 specifies the user option. If data byte 01 specifies option F0h, the drive will be formatted without using any defect lists. If data byte 01 specifies option B0h or 00h, the manufacturer's defect list only will be used. WARNING: THIS FORMAT OPTION ERASES ALL DEFECT LISTS EXCEPT THE MANUFACTURER-SUPPLIED DEFECT LIST.

TABLE 6-6. FORMAT OPTIONS
(Continued)

FMT DATA 4	COMPLIST 3	DEFECT LIST 2	1	FMT 0	
1	0	1	0	0	**Format with all current defect lists and user-provided defects.** This option is followed by four bytes of data in which byte 01 specifies the user option and bytes 02 and 03 specify the length of the user-provided defect list (in bytes from index format), and if data byte 01 specifies A0h or E0h, the format process will continue even if an unrecoverable defect list read error occurs.
1	1	1	0	0	**Format with the manufacturer-supplied defect list and the user-provided defect list.** This option is followed by four bytes of data in which byte 01 specifies the user option and bytes 02 and 03 specify the length of the user-provided defect list (in bytes from index format). If data byte 01 specifies option F0h, the drive will be formatted without using the manufacturer-supplied defect list. If data byte 01 specifies option B0h or 00h, all current lists will be used.

Sector interleaving may be required because of performance limitations in the host. The sector interleave number is equivalent to the number of disk revolutions required to read or write a full track of data.

The ID fields will be interleaved as specified in byte 04 of the CDB. An interleave number of one results in sequential ID fields being written on the disk. Any interleave number between one and the number of sectors-per-track results in interleaved formatting. A zero in this field will cause the default interleave factor of one to be used. Byte 3 must always be zero. The value in byte 4 must not exceed the number of sectors-per-track minus one. An error code of 24h (Bad Argument) will be returned if either of these rules is violated. Interleaving is recommended to improve performance on very slow SCSI hosts which perform data transfers greater than 8K bytes.

If data errors are noted by the controller while reading the defect list, all formatting is stopped and a Bad Argument (24h) is returned to the host.

Valid Errors:

Error	Error Code	Sense Key
No Sense	00h	0
No Index/Sector Signal	01h	4
No Seek Complete	02h	4
Write Fault	03h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
No Track 0 Found	06h	4
Multiple Drives Selected	07h	4
Error Reading Defect List	19h	1
Error Reading Defect List (failure halted format)*	19h	3
Defect List not Found	1Ch	1
Defect List not Found (failure halted format)*	1Ch	3
Bad Argument	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
Format Failed	31h	3
No Spare Available for Defect	32h	3
SCSI Bus Out Parity Check	48h	4
SCSI Initiator Detected Error	47h	4
ESDI Interface Error	4Ch	4

* To continue formatting, another format option, which will continue on error, must be specified in byte 01 of the four-byte header field.

6.4.1 DEFECT HANDLING

The ACB-4520A maps out all media defects through use of previously recorded defect maps. The user has the option of formatting the disk with the manufacturer's defect list only or the manufacturer's defect list, plus a list of any field-grown defects and/or any user-supplied defects. (For first time operation, a list of field-grown defects will not be available.)

The ACB-4520A handles disk defects on a sector level. Instead of assigning alternate tracks, at the cost of performance and capacity, the ACB-4520A deletes only the sector which contains a disk defect. If the disk defect is in a location which may allow it to affect two contiguous sectors, the ACB-4520A will map out both sectors.

To reduce the impact on performance due to sector sparing, it is recommended to allocate spare sectors at format time. The default number of spare sectors is two per cylinder if there are less than eight heads and three per cylinder if there are eight heads or more.

By allocating spare sectors on each cylinder of the drive, defect handling will not affect the total disk capacity, or SCSI peripheral performance since defects may be slipped into the spare sector locations on each cylinder. An example of the sector level defect skipping is illustrated in Figure 6-6.

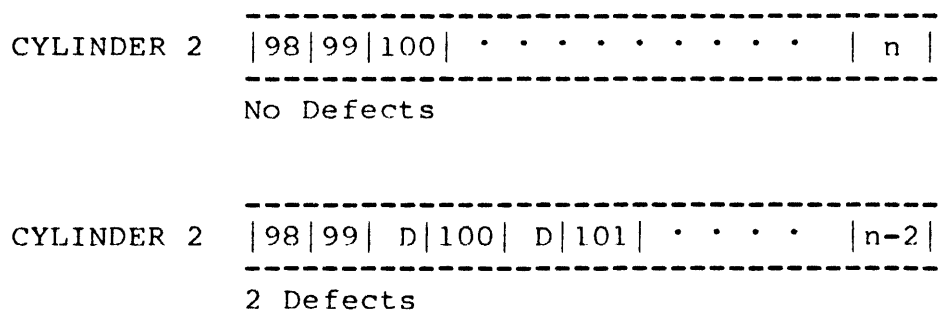


FIGURE 6-6. SECTOR LEVEL DEFECT SKIPPING

To facilitate system applications where a consistent number of sectors are required per cylinder and to allow reassigning of sectors when required by field-grown defects, the ACB-4520A allows a specified number of sectors-per-cylinder to be spared during formatting. The number of spare sectors allocated to each cylinder may vary from 0 to one less than the total number of sectors-per-track. Any value within this range may be specified in the MODE SELECT format information. For every spare sector allocated, one less sector will be available on each cylinder. To assure an adequate number of sectors for reassigning blocks within a cylinder, a number of spare sectors greater than the expected number of defects per cylinder should be chosen. The default number of spare sectors is two for drives with eight heads or less, and three for drives with greater than eight heads.

To assure the greatest achievable performance, the ACB-4520A will keep all sectors in logical order, even during defect handling.

The only exception is the Reassign Block Command. A spare sector at the end of the cylinder will be used to replace the reassigned block.

6.4.2 FORMAT UNIT DATA

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Reserved (00)							
01	EPS	P	Rsrvd	S	Reserved (00)			
02	(MSB) Defect list length							
03	Defect list length (LSB)							

FIGURE 6-7. FORMAT UNIT DEFECT LIST HEADER

The ACB-4520A formats all attached disk drives using the defect information available from the drives. It is therefore unnecessary for the host to provide a defect list to the ACB-4520A controller. Based on the Format Unit option provided and byte 01 of the Format Unit Defect List Header, the user may specify which defect lists to use, and/or provide a defect list if the user so desires.

TABLE 6-7. FORMAT UNIT DATA OPTIONS

The Defect list options provided through byte 01 of the Defect List Header are as follows:

BIT 7 6 5 4	
1 1 1 1	Do not use the manufacturer-supplied defect list in formatting and stop if an error occurs.
1 1 1 0	Do not use the manufacturer-supplied defect list in formatting and complete the format before reporting an error, if an error occurs.
1 0 1 0	Use the manufacturer-supplied defect list in formatting and complete the formatting process before reporting an error, if an error occurs.
1 0 1 1 or 0 0 0 0	Use the manufacturer-supplied defect list and the grown defect list, if specified in the CDB, and stop the format if an error occurs.

6.5 REASSIGN BLOCKS (07h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	0	1	0	1
01	Logical Unit Number			Reserved (00)				
02	Reserved (00)							
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							

FIGURE 6-8. REASSIGN BLOCKS COMMAND

The REASSIGN BLOCKS command requests the ACB-4520A to reassign the defective logical blocks to an area on the logical unit reserved for this purpose.

The initiator transfers a defect list (with any number of defect descriptors) containing the logical block addresses to be reassigned. The ACB-4520A will reassign the physical medium used for each logical block address in the list.

The physical medium used for the logical block address which is reassigned, will be on the same cylinder as the defective sector, or on the maximum cylinder minus one.

After executing a Reassign Block Command, a subsequent Format Unit Command using the "grown" defect list will restore continuity to the data fields on each track of the drive. By reformatting the drive after a Reassign Blocks which must move the data to a different cylinder, the performance degradation due to defect management is reduced.

All Data contained in the logical blocks specified, as well as any other block, will be preserved just as it exists at the time of the REASSIGN BLOCKS command. The ACB-4520A controller will execute the REASSIGN BLOCKS command even in the event of power failure during execution or an unreadable sector ID field. This feature ensures the highest attainable level of data integrity of the ACB-4520A and attached ESDI drives. It should be noted, when a block with an uncorrectable read error is reassigned, the reassigned block will contain the data as it is recovered, but will be written with good ECC.

The effect of specifying a logical block to be reassigned, which previously has been reassigned, is to reassign the block again. Thus, over the life of the medium, a logical block can be assigned to multiple physical addresses (until no more spare locations remain on the cylinder or on the maximum cylinder). The REASSIGN BLOCKS defect list contains a four-byte header followed by the defect descriptors. The length of each defect descriptor is four bytes.

The defect list length specifies the total length in bytes of the defect descriptors that follow. The defect list length is equal to four times the number of defect descriptors.

BYTE	Defect List Header
00	Reserved (00)
01	Reserved (00)
02	Defect List Length (MSB)
03	Defect List Length (LSB)
	Defect Descriptor(s)
00	Defect Logical Block Address (MSB)
01	Defect Logical Block Address
02	Defect Logical Block Address
03	Defect Logical Block Address (LSB)

FIGURE 6-9. REASSIGN BLOCKS DATA

The defect descriptor specifies a four-byte logical block address that contains the defect. The defect descriptors must be sorted into ascending order.

Valid Errors:

Error	Error Code	Sense Key
No Sense	00h	0
No Index/Sector Signal	01h	4
No Seek Complete	02h	4
Write Fault	03h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
No Track 0 Found	06h	4
Multiple Drives Selected	07h	4
Error Accessing Defect List	19h	1
Illegal block address	21h	5
Bad argument	24h	5
Illegal logical unit number	25h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
Invalid Field in Parameter List	26h	5
No Spare Sector Available*	32h	1
No Spare Sector Available (catastrophic failure)*	32h	3
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator detected error	48h	4
ESDI Interface error	4Ch	4

* No spare sector available with a Sense Key of 1 indicates the ACB-4520A had no spare sectors available on the same cylinder, but was able to Reassign the Block to the maximum cylinder minus one.

When the Sense Key of 3 is set, there were no spare sectors on either the same cylinder, or the maximum cylinder minus one. Therefore the Reassign Blocks command was not completed.

6.6 READ (08h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	1	0	0	0
01	Logical Unit Number			(MSB) Logical Block Address				
02	Logical Block Address							
03	Logical Block Address							(LSB)
04	Number of Blocks							
05	Reserved (0)							

FIGURE 6-10. READ COMMAND

This command transfers from the ACB-4520A the specified number of blocks starting at the specified logical starting block address of the selected ESDI drive. In conformance with the SCSI specification, a 'number of blocks' field equal to zero will transfer 256 blocks.

The control unit will verify a valid seek address and proceed to seek to the specified starting logical block address. If disconnection is allowed, the ACB-4520A will disconnect during seek actuator motion and will reconnect just prior to when the device is ready to transfer data. When the seek is complete the controller then reads the data field into the buffer, checks ECC and begins first data transfer to the Initiator.

Subsequent blocks of data are transferred into the buffer in a similar manner until the block count is decremented to zero. On a data ECC error, the block is re-read up to four times to establish a solid error syndrome. Correction will occur at the time when the error syndrome is the same for two consecutive tries. Correction is done directly into the data buffer, transparent to the host.

Blocks containing uncorrectable data errors may be transferred to the host depending on the error recovery options specified. A REQUEST SENSE will return the appropriate sense condition depending on the error recovery options specified.

Valid Errors:

Error	Error Code	Sense Key
No Sense	00h	0
No Index/Sector Signal	01h	4
No Seek Complete	02h	4
Write Fault	03h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
No Track 0 Found	06h	4
Multiple Drives Selected	07h	4
I.D. CRC Error	10h	3
Uncorrectable Data Error	11h	3
I.D. AM Not Found	12h	3
Record Not Found	14h	3
Seek Error	15h	3
Recoverable Read Error	18h	1
Illegal Block Address	21h	5
Volume Overflow	23h	5
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
Format Failed	31h	3
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator Detected Error	48h	4
ESDI Interface Error	4Ch	4

This set of errors is collectively referred to as Read Operation Errors.

6.7 WRITE (0Ah)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	1	0	1	0
01	Logical Unit Number			(MSB) Logical Block Address				
02	Logical Block Address							
03	Logical Block Address (LSB)							
04	Number of Blocks							
05	Reserved (0)							

FIGURE 6-11. WRITE COMMAND

This command transfers to the selected ESDI drive on the ACB-4520A the required number of blocks starting at the specified logical block address. The controller seeks to the specified logical starting block. If disconnection is allowed, the ACB-4520A will disconnect during seek actuator motion and will reconnect when the device is again ready to transfer data. When the seek is complete, the controller transfers the first block into its buffer and writes the buffered data and its associated ECC into the first logical sector. Since the controller is reconnecting just prior to the addressed sector, a slow host adapter may experience data underrun if the disk sectors are not formatted with proper interleave.

Subsequent blocks of data are transferred until the block count is decremented to zero. Head switching and defect skipping is performed transparent to the user. In conformance with the SCSI specification, a 'number of blocks' field equal to zero will transfer 256 blocks.

Valid Errors:

Error	Error Code	Sense Key
No Sense	00h	0
No Index/Sector Signal	01h	4
No Seek Complete	02h	4
Write Fault	03h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
No Track 0 Found	06h	4
Multiple Drives Selected	07h	4
I.D. CRC Error	10h	3
I.D. AM Not Found	12h	3
Record Not Found	14h	3
Seek Error	15h	3
Illegal Block Address	21h	5
Volume Overflow	23h	5
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
Format Failed	31h	3
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator Detected Error	48h	4
ESDI Interface Error	4Ch	4

This set of errors is collectively referred to as Write Operation Errors.

6.8 SEEK (0Bh)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	1	0	1	1
01	Logical Unit Number	(MSB)	Logical Block Address					
02	Logical Block Address							
03	Logical Block Address							
04	Reserved (00)							
05	Reserved (00)							

FIGURE 6-12. SEEK COMMAND

This command causes the selected drive to seek to the specified starting address. If head movement is required, the ACB-4520A returns completion status immediately after the seek command is issued and head motion starts, allowing it to free the bus and accept further commands. Any command received which specifies a drive with a seek in progress will immediately complete with a command completion status of busy (bit 3 set).

The drives actuator is moved to the expected track position but no ID field verification is attempted.

The ACB-4520A uses an implied seek on READ, WRITE and SEARCH commands eliminating the need for SEEK commands before each operation.

Valid Errors:

Error	Error Code	Sense Key
No Seek Complete	02h	4
Drive not Ready	04h	2
Illegal Block Address	21h	5
Bad Argument in CDB	24h	5
Invalid Logical Unit Number	25h	5
Reset Occured	29h	6
Mode Select Changed	2Ah	6
Initiator Detected Error	2Dh	4
Format Failed	31h	3
SCSI Bus out Parity Error	47h	4
ESDI Interface Error	4Ch	4

6.9 TRANSLATE (0Fh)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	1	1	1	1
01	Logical Unit Number			(MSB) Logical Block Address				
02	Logical Block Address							
03	Logical Block Address							(LSB)
04	Reserved (0)							
05	Reserved (0)							

FIGURE 6-13. TRANSLATE COMMAND

This command performs a logical address to physical address translation and returns the physical location of the requested block address in a cylinder, head, bytes from index format. This data may then be used to build a defect list for the FORMAT command.

To translate logical blocks, the ACB-4520A physically seeks the designated block and reads its ID field. If there is a data error in the ID field, an error status will be returned. It is then necessary to TRANSLATE the blocks before and after the targeted block to determine the location of the target block. The presence of formatted (skipped) defects, or interleave, will require a more complicated algorithm for determination of the error location.

Eight bytes are returned in the format of defect descriptors required by the FORMAT UNIT command (Figure 6-14).

BYTE	BIT 07	06	05	04	03	02	01	00
00	(MSB)	Cylinder Number						
01	Cylinder Number							
02	Cylinder Number							(LSB)
03	Head Number							
04	(MSB)	Bytes From Index						
05	Bytes From Index							
06	Bytes From Index							
07	Bytes From Index							(LSB)

FIGURE 6-14. TRANSLATE DATA

Valid Errors:

Errors	Error Code	Sense Key
No Sense	00h	0
No Index/Sector Signal	01h	4
No Seek Complete	02h	4
Write Fault	03h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
No Track 0 Found	06h	4
Multiple Drives Selected	07h	4
I.D. CRC Error	10h	3
I.D. AM Not Found	12h	3
Record Not Found	14h	3
Seek Error	15h	3
Illegal Block Address	21h	5
Bad Argument	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
Format Failed	31h	3
SCSI Bus Out Parity Error	47h	4
SCSI HA/Initiator Detected Error	48h	4
ESDI Interface Error	4Ch	4

6.10 SET THRESHOLD (10h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	0	0	0	0	0
01	Logical Unit Number				Reserved (0)			
02	Reserved							
03	Reserved							
04	Threshold Value							
05	Reserved (0)							

FIGURE 6-15. SET THRESHOLD COMMAND

The ACB-4520A optionally provides an error logging capability for those errors that are normally retried without any notification to the host system. The ACB-4520A counts blocks transferred, seek errors, corrected data errors and uncorrected data errors. The error logging mode and the frequency of error presentation is established by the SET THRESHOLD command, while the actual error information is presented by the READ/RESET USAGE COUNTERS command. The default state is error logging, but not reported. Power on reset establishes the default state.

A threshold value of 0 specifies that no error reporting will take place. A value between 1 and 255 will request that error reporting takes place. When the number of errors of any single type exceeds the threshold, the command that finds that error is completed normally. All subsequent commands will be terminated immediately with Check Condition. Sense status will indicate 2Ch, Error Count Overflow. When a READ/RESET USAGE COUNTER command is executed, the usage and error counters are off loaded and normal operation continues. The same threshold value remains in effect.

Valid Errors:

Errors	Error Code	Sense Key
Drive Not Ready	04h	2
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
SCSI Bus Out Parity Error	47h	4
Initiator Detected Error	48h	4

6.11 READ/RESET USAGE COUNTER (11h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	1	0	0	0	0
01	Logical Unit Number			Reserved (0)				
02	Reserved (00)							
03	Reserved (00)							
04	Bytes Allocated (09)							
05	Reserved (00)							

FIGURE 6-16. READ/RESET USAGE COUNTER COMMAND

The READ/RESET USAGE COUNTERS command recovers the information stored by the ACB-4520A for the particular disk device. The information is valuable to observe the statistical performance of the device and to point to devices which may need service before their performance degrades system operation.

All seeks and sectors read are counted in three-byte counters. Seek errors, correctable data errors, and uncorrectable data errors are counted in one byte counters.

When one of the error counters exceeds the threshold (set by the SET THRESHOLD command 10h), all subsequent commands for that device will terminate immediately with Check Condition status and an error code of 2Ch, Error Counter Overflow. This will continue until execution of the READ/RESET USAGE COUNTER command, which recovers the nine bytes of counter information and resets the counters.

BYTE	BIT 07	06	05	04	03	02	01	00
00	(MSB)	Sectors Read Count						
01	Sectors Read Count							
02	Sectors Read Count							(LSB)
03	(MSB)	Seek Usage Count						
04	Seek Usage Count							(LSB)
05	Seek Usage Count							
06	Uncorrectable Data Check Count							
07	Correctable Data Check Count							
08	Seek Check Count							

FIGURE 6-17. READ/RESET USAGE COUNTER PARAMETERS

The Sectors Read Count is a complete count of all logical blocks read to any host from the specified drive. This provides usage information against which error counts can be calibrated.

The Seek Usage Count is a complete count of all occurrences of an initial seek by the drive. Cylinder switching is not counted.

The Uncorrectable Data Check Count counts all occurrences of an uncorrectable data check on the specified device. Each Uncorrectable data check was also posted as an 11h error code.

The Correctable Data Check Count counts all occurrences of the successful recovery of a logical block that was unsuccessfully read at first. The Correctable Data Check Counter is incremented only when ECC is applied, not when the error is recoverable by rereading the sector. This information is available only through error logging, since these errors are recovered without notifying the host unless a Mode Select error recovery mode has been invoked.

The Seek Check Count counts all occurrences of a seek error whether or not recovery was successful. This information is available only from error logging, since seek errors are normally recovered without notifying the host.

Valid Errors:

Errors	Error Code	Sense Key
Drive Not Ready	04h	2
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
SCSI Bus Out Parity Error	47h	4
Initiator Detected Error	48h	4

6.12 INQUIRY (12h)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	1	0	0	1	0
01	Logical Unit Number			Reserved (00)				
02	Reserved (00)							
03	Reserved (00)							
04	Allocation Length (24h)							
05	Reserved (00)							

FIGURE 6-18. INQUIRY COMMAND

The INQUIRY command requests parameters describing the ACB-4520A and attached devices to be sent to the initiator.

The allocation length field specifies the number of bytes that the initiator has allocated for returning INQUIRY data. The ACB-4520A will return the allocation length number of data bytes or 36 bytes, whichever is less. Zero is a valid allocation length and indicates no data shall be transferred.

BYTE	BIT 07 06 05 04 03 02 01 00
00	Direct Access Device Type (00)
01	Reserved (00)
02	ANSI standard (01)
03	CCS implemented (01)
04	Additional Length (24h)
05	Reserved (00)
06	Reserved (00)
07	Reserved (00)
08	41h "A"
09	44h "D"
0A	41h "A"
0B	50h "P"
0C	54h "T"
0D	45h "E"
0E	43h "C"
0F	20h " "
10	41h "A"
11	43h "C"
12	42h "B"
13	2Dh "-"
14	34h "4"
15	35h "5"
16	32h "2"
17	30h "0"
18	20h " "
19	20h " "

1A	20h	" "
1B	20h	" "
1C	20h	" "
1D	20h	" "
1E	20h	" "
1F	20h	" "
20	(MSB)	Firmware Revision Level
21		Firmware Revision Level
22		Firmware Revision Level
23		Firmware Revision Level (LSB)

FIGURE 6-19. INQUIRY PARAMETERS

Byte 00 of the parameter list is zero, indicating the attached device is a direct access disk device with read and write capabilities.

Byte 02 is 01, indicating that the ACB-4520A meets the SCSI specifications, version 17B. Byte 03 is 01, indicating compliance with the SCSI Common Command Set.

Byte 04 of the INQUIRY data specifies the additional length, in bytes of INQUIRY data. The value in this field is equal to 1Bh; the number of bytes to follow.

Bytes 08 through 1Fh are ASCII characters identifying the Adaptec product being used. For this product the ASCII values spell out "Adaptec - ACB-4520A....."

Bytes 20h through 23h indicate the ACB-4520A's hardware and firmware revision level in ASCII.

Valid Errors:	Error Code	Sense Key
Bad Argument	24h	5
Reset Occured	29h	6
Mode Select Changed	2Ah	6
Format Failed	31h	3
SCSI Bus out Parity Check	47h	4
Initiator Detected Error	48h	4

6.13 MODE SELECT (15h)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	0	0	0	1	0	1	0	1
01	Logical Unit Number			PF	Reserved			SP
02	Reserved (0)							
03	Reserved (0)							
04	Number of Bytes							
05	Reserved (0)							

FIGURE 6-20. MODE SELECT COMMAND

The Mode Select command provides a means for the initiator to specify peripheral device parameters and ACB-4520A error handling options, as defined by the SCSI specification and the Common Command set.

The Mode Select parameters are architechurally divided by the SCSI document into a header (bytes 00-03), a block descriptor (bytes 04-0B), and additional parameters defined by the following Common Command Set pages;

01h Error Recovery Parameters
03h Direct Access Device Format Parameters
04h Rigid Disk Drive Geometery Parameters
20h Adaptec Unique Disconnect/Reconnect Parameters

More than one page may be sent in a Mode Select command.

Bit 4 of byte 01 is the page format (PF) bit. This bit is ignored by the ACB-4520A and may either be set or reset.

Bit 0 of byte 01 specifies whether the additional parameters defined in the pages are to be saved on the disk. If the parameters are savable and bit 0 is set to one, the parameters will be saved on the disk. In the event of a power-up or SCSI bus reset, the parameters will remain valid. If the parameters are not saveable, or if they are saveable and bit 0 is set to zero, the parameters will not be saved. At power-up or bus reset, any changes to those parameters will no longer be valid. Pages 03 and 04 are exceptions. These parameters are always saved regardless of the value specified in bit 0, and they are saved during the next successfully completed FORMAT command.

Bits 0, and 7 are not supported if the G-H jumpers is installed, and must be reset.

Byte 04 of the command specifies the number of information bytes to be passed with the command. The value must include the header (4 bytes) and the length of block descriptor and all additional page(s), if defined. When the G-H jumper is installed, indicating operation with noncurrent SCSI software, the ACB-4520A will post an Invalid Argument error unless this equals 22 (16h) or 24 (18h) bytes.

The parameter byte definition for the ACB-4520A follows.

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Reserved (00)							
01	Default Medium (00)							
02	Reserved (00)							
03	Length of Extent Descriptor List = 08 or 00							
04	Density Code = (00)							
05	Reserved (00)							
06	Reserved (00)							
07	Reserved (00)							
08	Reserved (00)							
09	(MSB) Block Size							
0A	Block Size							
0B	Block Size							(LSB)

FIGURE 6-21. EXTENT DESCRIPTOR LIST

Byte 01, the medium type, must be set to zero.

Byte 03, specifies the length of the extent descriptor list. The legal values for byte 03 are 00 or 08. A value of 00 in this field will skip the extent descriptor list bytes 04 through 0B and go directly to a Mode Select page, if one is provided.

Byte 04, the Density Code, uses the default value of 00H, since the density parameters are not available to the operating system.

Bytes 09 through 0B specify the data block size. The ACB-4520A supports block sizes of 256 bytes, 512 bytes and 1024 bytes. A value of 00 in bytes 09 through 0B will be accepted and the current block size will remain unchanged. If the drive is hard-sectored, the specified block size must either reflect the switch setting on the drive or be set to zero. If the drive is soft-sectored and the specified block size is different from the current block size, the ACB-4520A will automatically reset the format parameters (page 03) and drive geometry parameters (page 04) to their default values. These parameters may be set to desired values by sending Pages 03 and/or 04 after the extent descriptor list.

NOTE: If the block size is changed either by a Mode Select command or by changing the switch settings on the drive, the current format of the drive will become invalid. Access to the drive will not be allowed until it is reformatted.

If the block size or any parameter in the following pages is different from the current value(s), the ACB-4520A will return a Check Condition status in response to the first command from any host, other than the host issuing the command. The ACB-4520A will return a Mode Select Changed (2Ah) error code.

The following pages may be in any order, and each includes a self identifying length.

ERROR RECOVERY PARAMETERS (Page Code = 01h)

Mode Select data bytes associated with page one specify the error recovery parameters.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Error Recovery Parameters = 01							
01	Length in bytes = 01							
02	Reserved (0)		Error Recovery Options					

FIGURE 6-22. MODE SELECT ERROR RECOVERY PARAMETERS

Byte 00 specifies the page code number. Byte 01 specifies the length, in bytes, of the specific page starting at byte 02. For this page, the value in byte 01 must equal one. Any other value will return an Invalid Parameter (26h) error code.

Byte 02, bits 0-5, specify the error recovery procedure that the ACB-4520A will follow when encountering a data check error on a READ or VERIFY command. Bits 6 and 7 must be zero. The following table describes all the available options for error recovery as specified in bytes 02, bits 0 through 5.

TABLE 6-8. ERROR RECOVERY OPTIONS

bit 5	4	3	2	1	0	Recovery Method Title
1	0	0	0	0	0	Retries and correction are attempted and recovered data is transferred corrected.
1	0	0	0	0	1	Retries only are attempted and recovered data transfered corrected.
1	0	0	1	0	0	Retries and correction are attempted, recovered data is transfered corrected and data error is reported.
1	0	0	1	0	1	Retries only are attempted, recovered data transfered corrected and data error is reported.
1	0	0	1	1	0	Retries and corrections are attempted, recovered data is transferred corrected, data error is reported and transfer stopped.

TABLE 6-8. ERROR RECOVERY OPTIONS (Continued)

bit 5	4	3	2	1	0	Recovery Method Title
1	0	0	1	1	1	Retries only are attempted, recovered data transferred corrected,data error is reported and transfer stopped.
1	1	0	0	0	0	Transfer raw data.

Retries and Correction are Attempted and Recovered Data is Transferred Corrected. Data transfer stops only if the ACB-4520A's recovery scheme fails. If the data transfer stops, the ACB-4520A returns a check status with an unrecoverable read error (11h) error code. No errors will be posted if recovery is successful. This option is the ACB-4520A's default error recovery procedure.

Retries are Attempted and recovered Data is transfered corrected: Same as above except that no correction is applied.

Retries and Correction are attempted, Recovered data is transfered corrected and data error is reported: Data transfer stops only if the ACB-4520A's recovery scheme fails. If the data transfer stops, the ACB-4520A returns a check status with a unrecoverable read error (11h) error code. The ACB-4520A returns a check status with a recoverable read error (17h or 18h) code for the last block for which error recovery was sucessful.

Retries are attempted, recovered data is transferred corrected and data error is reported: Same as above except that no correction is applied. The ACB-4520A returns a check status with a recoverable read error (17h) code and the last block address for which the error recovery was successful.

Retries and correction are attempted, recovered data is transferred corrected, data error is reported and transfer stopped: Data transfer stops after the first read error is detected. The ACB-4520A returns a check status with a recoverable read error (17h or 18h) code and the block address for which the error recovery was successful.

Retries are attempted, recovered data is transferred corrected, data error is reported and transfer stopped: Same as above except that no correction is applied. The ACB-4520A returns a check status with a recoverable read error (17h) code and the block address for which the error recovery was successful.

Raw data transfer: No retries or corrections are attempted. The transfer length is entirely exhausted.

Note: This page is not saveable. At power-up or SCSI bus reset any change to the ACB-4520A's error recovery will no longer be valid.

DIRECT ACCESS DEVICE FORMAT PARAMETERS (Page Code 03Ah)

Mode Select data bytes associated with page three specify the direct access device format parameters.

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Page code = (03)							
01	Page Length = (16H)							
02	(MSB)	Number of Tracks per Zone *						
03	Number of Tracks per Zone *							(LSB)
04	(MSB)	Number of Alternate Sectors per Zone						
05	Number of Alternate Sectors per Zone							(LSB)
06	Reserved (00)							
07	Reserved (00)							
08	Reserved (00)							
09	Reserved (00)							
0A	Reserved (00)							
0B	Sectors per Track *							
0C	(MSB)	Bytes per Sector *						
0D	Bytes per Sector *							(LSB)
0E	(MSB)	Interleave *						
0F	Interleave *							(LSB)
10	Reserved (00)							
11	Track Skew Factor							
12	Reserved (00)							
13	Cylinder Skew Factor							

* - Parameters not changeable by MODE SELECT; field must be set to zero

FIGURE 6-23. DIRECT ACCESS DEVICE FORMAT PARAMETERS

14	SS*	HS*	RMB*	Reserved (00)			
15	Reserved (00)						
16	Reserved (00)						
17	Reserved (00)						

* - Parameters not changeable by MODE SELECT; field must be set to zero

FIGURE 6-23. (Continued)

Byte 00 specifies the page code number. Byte 01 specifies the length, in bytes, of the specific page starting at byte 02. For this page, the value in byte 01 must equal 16 (hex). Any other value will return an Invalid Parameter (26h) error code.

The value in bytes 02 and 03 specify the number of tracks in a zone. This value is used in conjuction with the Number of Alternate Sectors per Zone field to compute how many spare sectors the ACB-4520A will allocate for the drive. This value is not alterable through page code three and the field must be set to zero. However, the number of tracks per zone is equal to the number of usable data surfaces and can be altered indirectly through the page code four field that defines the number of data heads (byte 05).

The value in bytes 04 and 05 indicate the number of spare sectors per zone. For the ACB-4520A, the number of alternate sectors per cylinder is equal to the number of spares per zone. The controller places these spare sectors at the end of each cylinder.

If the number of spares per cylinder is greater than or equal to the number of sectors per track, then the number of spares per cylinder is truncated to the value of the number of sectors per track minus one. The default value for the number of spares sectors per zone is three.

Byte 0B(h) specifies the number of data sectors per track. This value is not changable by MODE SELECT. Any value other than zero in this field returns an Illegal Parameter error (26h) code. The ACB-4520A returns this value in the MODE SENSE command.

Bytes 0Ch and 0Dh specify the physical number of bytes in each sector as set by the drive manufacturer or by the drive sector switches. This value is not changable by MODE SELECT. Any value other than zero in this field returns an Illegal Parameter error (26h) code. The ACB-4520A returns this value in the MODE SENSE command.

Bytes 0Eh and 0Fh specify the interleave set for the drive. This value is not changable by MODE SELECT. Any value in this field will be ignored by the ACB-4520A. The host specifies this value in the FORMAT command. The ACB-4520A returns this value in the MODE SELECT command.

Byte 11h specifies the number of sectors the ACB-4520A will skew the format pattern from index on track boundaries. When the drive is formatted with 1:1 interleave, this feature allows data to be read or written across track boundaries without losing a revolution. Values from 0 to the number of sectors per track are valid. The default value for this field is two for 256 byte block size and one for 512 or 1024 byte block size.

Byte 13h specifies the number of sectors the ACB-4520A will skew the format pattern from index on cylinder boundaries. When the drive is formatted with 1:1 interleave, this allows data to be read or written across cylinder boundaries without losing a revolution. Values from zero to the number of sectors per track are valid. If a zero value is supplied, the ACB-4520A will disconnect across cylinder boundaries (if disconnection is allowed) during READ and WRITE operations. The default value for this field is zero (disconnect on cylinder boundaries).

Byte 14h specifies the Drive Type Field. Bit 7, if set, informs the controller that the drive attached to the designated Logical Unit Number is a soft-sectored drive. Setting bit 6 informs the controller the attached drive is hard-sectored. Bit 5, if set, informs the controller the attached drive is removable. Fixed drives require this bit to be reset. This value is not changeable by MODE SELECT. Any value other than zero in this field returns an Illegal Parameter error (26h) code. The ACB-4520A returns this value in the MODE SENSE command.

Note: This page is always saved, regardless of the setting of bit 0 in byte 01 of the Command Descriptor Block. However, the parameters are not saved on disk at the completion of the MODE SELECT command. They are saved at the successful completion of the next FORMAT command. If a power-on or SCSI bus reset occurs between the time of the completion of the MODE SELECT command and the start of the FORMAT command, the changed parameters will no longer be valid. Subsequent MODE SELECT commands before the next FORMAT may also modify these parameters.

DIRECT ACCESS DEVICE PHYSICAL PARAMETERS (PAGE CODE 04)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Page code = (04)							
01	Page Length = (04H)							
02	(MSB)		Number of Cylinders					
03	Number of Cylinders							
04	Number of Cylinders							(LSB)
05	Number of Heads							

FIGURE 6-24. PHYSICAL DISK PARAMETERS INFORMATION

Byte 00 specifies the page code number. Byte 01 specifies the length, in bytes, of the specific page starting at byte 02. For this page, the value in byte 01 must equal four. Any other value will return an Invalid Parameter (26h) error code.

Bytes 02, 03 an 04 specify the number of data cylinders on the drive. The ACB-4520A does not use alternate cylinders for defect management, so these may be included as data cylinders. The minimum number of cylinders is one, the maximum is 2048. The ACB-4520A reserves the last two physical cylinders of the drive for defect management and information storage. The controller will not allow a host to access these cylinders.

Byte 05 provides the number of usable data surfaces. The minimum is one, the maximum is 16.

Note: This page is always saved, regardless of the setting of bit 0 in byte 01 of the Command Descriptor Block. However, the parameters are not saved on disk at the completion of the MODE SELECT command. They are saved at the successful completion of the next FORMAT command. If a power-on or SCSI bus reset occurs between the time of the completion of the MODE SELECT command and the start of the FORMAT command, the changed parameters will no longer be valid. Subsequent MODE SELECT commands before the next FORMAT may also modify these parameters.

ADAPTEC UNIQUE DISCONNECT/RECONNECT PARAMETERS (PAGE CODE 20h)

The MODE SELECT data bytes associated with page code 20h specify the special Adaptec disconnection/reconnection parameters.

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Page code = (20)							
01	Page Length = (02H)							
02	Reconnect Time							
03	Buffer Pre-fill on Write Operation							

FIGURE 6-25. MODE SELECT ADAPTEC UNIQUE PAGE 20h

Byte 00 specifies the page code number. Byte 01 specifies the length, in bytes, of the specific page starting at byte 02. For this page, the value in byte 01 must equal four. Any other value will return an Invalid Parameter (26h) error code.

Byte 02 indicates the time, in 100 microsecond increments, that the host requires to complete the reconnection phase. This value allows the ACB-4520A to start reconnecting to the host when the drive's head is positioned several sectors before the target sector. When the reconnection to the host is complete, the drive's head is positioned directly in front of the target sector, thereby maximizing bus free time. This value cannot be greater than the time it takes for one revolution. If this parameter is set to zero, the ACB-4520A will reconnect immediately after the seek is complete. The default value of this field is zero.

Byte 03 indicates the amount of data the ACB-4520A will pre-fill the buffer on write operations prior to disconnecting from the host on the initial seek. The value is in 256 byte increments. The maximum value is 20h (8192 bytes). This parameter allows the ACB-4520A to start data transfer to the drive immediately upon detecting the target sector and gives the host extra time to restore data pointers and continue to send data.

This page is saveable. If bit 0 of byte 01 in the Command Descriptor Block is set to one, the parameters are saved on the disk. If a power-up or SCSI bus reset occurs, the values will remain valid. If this bit is reset, then the values will not be remain valid upon reinitialization of the ACB-4520A.

6.14 RESERVE (16h)

BYTE	BIT 7	6	5	4	3	2	1	0
00	Operation Code							
01	LogicalUnitNumber			3rdPty	3rdPartyDevice ID			Rsrvd
02	Reservation identification							
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							

FIGURE 6-26. RESERVE COMMAND

The RESERVE command is used to reserve an entire logical unit for the use of the reserving initiator. When the third party reservation bit is set, the logical unit may be reserved for another specified SCSI device. This command, along with the RELEASE command, provides the ACB-4520A the ability to resolve contention problems in a multiple-initiator environment.

The RESERVE command reserves the entire logical unit for the exclusive use of the initiator until released by a RELEASE command from the same initiator, by a power on RESET condition or by a BUS DEVICE RESET message from any initiator. A logical unit reservation will not be granted if the logical unit is reserved by another initiator. When an attempted reservation is made from a different host, the ACB-4520A will respond with a RESERVATION CONFLICT status. When an initiator issues a RESERVE command to a logical unit which the same initiator has already reserved and the reservation has not been cancelled, the net effect is unchanged with the reservation still in effect.

The third-party reservation option for the RESERVE command allows an initiator to reserve a logical unit for another SCSI device. If the third-party bit is zero, then the third-party reservation option is not requested. If the third-party bit is one, the RESERVE command reserves the logical unit specified in the third-party device ID field. The ACB-4520A will preserve the reservation until released by the same host, released by a BUS DEVICE RESET message or an SCSI bus power on reset.

The ACB-4520A does not support extent level reservations. If bit zero of byte one is set requesting an extent level reservation, the RESERVE command will be rejected with check status and the ILLEGAL REQUEST sense key set.

Valid Errors:

Error	Error Code	Sense Key
Bad Argument in CDB	24	5
Reset Occurred	29	6
Mode Select Changed	2A	6

6.15 RELEASE (17h)

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Operation Code							
01	LogicalUnitNumber			3rdPty	3rdPartyDevice ID			Rsrvd
02	Reservation identification							
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							

FIGURE 6-27. RELEASE COMMAND

The RELEASE command is used to release previously reserved logical units. The ACB-4520A will release a previously reserved logical unit, when the RELEASE command is received from the reserving initiator.

When the third-party bit is zero, the third-party release option is not requested. If the third-party bit is one, the ACB-4520A will release the specified logical unit if the reservation was made using the third-party reservation option by the same initiator for the same SCSI device as specified by the third-party device ID field.

The ACB-4520A does not support extent level reservations. If bit zero of byte one is set requesting an extent level reservation, the RELEASE command will be rejected with check status and the ILLEGAL REQUEST sense key set.

Valid Errors:

Error	Error Code	Sense Key
Bad Argument in CDB	24	5
Reset Occurred	29	6
Mode Select Changed	2A	6

6.16 MODE SENSE (1Ah)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	0	1	1	0	1	0
01	Logical Unit Number			Reserved (0)				
02	Page Control		Page Code (01, 03, 04, 20, or 3F)					
03	Reserved (0)							
04	Number of Bytes							
05	Reserved (0)							

FIGURE 6-28. MODE SENSE COMMAND

This command is used to interrogate the ACB-4520A device parameter table to determine the specific characteristics of the intelligent SCSI peripheral currently attached, or to return previously sent Mode Select data to the host.

Byte 02 of the command allows the user to specify which parameters to return.

The Page Control Field, bits 6 and 7 of byte 02, define the type of values to be returned. These are:

BIT 7 6	MEANING
0 0	**Report Current Values.** The values reported reflected those changes from previously completed MODE SELECT commands since power on. If no previous MODE SELECT command was issued, these values reflect the saved values or default values. Fields and bits not supported by the controller will set to zero.
0 1	**Report Changeable Values.** Fields and bits of the parameters requested that the controller allows to be changed are set to one. Those fields and bits not allowed to be changed are set to zero.
1 0	**Report Default Values.** The controller will report the default values for the parameters requested. Fields and bits not supported will be set to zero.
1 1	**Report Saved Values.** The values reported reflect those that have been saved on disk. Fields and bits not supported will be set to zero. If the parameters requested are not saveable, then the default values will be returned.

The Page Code, bits 0 through 5 of byte 02, determines which set of parameters to be returned. The page codes supported are those specified by the MODE SELECT command. They byte format of each page is identical to the format specified for the Mode Select Command. In addition, the value of 3Fh may be supplied for the Page Code. This will return all the supported pages. If a Page Code is requested that is not supported, the controller will return with an Invalid Argument (24h) error code.

Byte 04 of the command specifies the number of data bytes allowed to be returned by the command. Requesting less than the number of data bytes defined is not an error condition, and only the number requested will be returned.

The returned information will be the four-byte Parameter List, the Extent Descriptor List and the page(s) requested. These lists take the exact format of the data in the MODE SELECT command, except that the first byte will be the expected number of data bytes to be returned.

Valid Errors:

Error	Error Code	Sense Key
All Class 00 Error Codes		
Bad Argument in CDB	24	5
Invalid Logical Unit Number	25	5
Cartridge Changed	28	6
Reset Occurred	29	6
Mode Select Changed	2A	6
SCSI Bus Out Parity Check	47	4
SCSI HA/Initiator Detected Error	48	4

6.17 START/STOP UNIT (1Bh)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	0	0	0	1	1	0	1	1
01	Logical Unit Number			Reserved (0)				
02	Reserved (00)							
03	Reserved (00)							
04	Reserved (00)							St/Stp
05	Reserved (00)							

FIGURE 6-29. START/STOP UNIT COMMAND

This command allows the host to perform power-on and power-down routines incorporating the ACB-4520A.

If the drive supports MOTOR SPIN ON/OFF function, the controller will start and stop the drive motor when executing this command. Otherwise, no operation is performed.

Bit 0, Byte 04 is used to indicate if the command is START or STOP. This bit equal to one indicates a START command.

Valid Errors:

Error	Error Code	Sense Key
Drive Not Ready	04h	2
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator Detached Error	48h	4

6.18 SEND DIAGNOSTIC (1Dh)

BYTE \ BIT	7	6	5	4	3	2	1	0
00	0	0	0	1	1	1	0	1
01	Logical Unit Number			Reserved		Self Test		Reserved
02	Reserved (00)							
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							

FIGURE 6-30. SEND DIAGNOSTIC COMMAND

This command sends data to the Controller to specify the execution of diagnostic functions tests for Controller and peripheral units.

If the Self-Test bit (bit 2 byte 1) is set, the ACB-4520A will complete its default self test. For the self test, the data length will be zero and no data shall be transferred. If the self test successfully passes, the command will be terminated with a good status.

For a description of the self-test, see Appendix B.

Valid Errors:

Error	Error Code	Sense Key
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
Self Diagnostics Failed	42h	4
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator Detected Error	48h	4

6.19 READ CAPACITY (25h)

BYTE	BIT 7	6	5	4	3	2	1	0
00	0	0	1	0	0	1	0	1
01	Logical Unit Number			Reserved (00)				
02	(MSB) Logical Block Address							
03	Logical Block Address							
04	Logical Block Address							
05	Logical Block Address (LSB)							
06	Reserved (00)							
07	Reserved (0)							
08	Full or Partial Media Indicator							
09	Reserved (0)							

FIGURE 6-30. READ CAPACITY COMMAND

If the Partial Media Indicator (PMI) is 00, this command will return the address of the last block on the unit. It is not necessary to specify a starting block address in this command mode. If the PMI is 01, this command will return the address of the last block in the cylinder which contains the specified block address.

This feature is useful for determining drive capacities and determining the starting block number for cylinder level formatting

Figure 6-32 shows the format of the capacity data returned.

BYTE	BIT 7	6	5	4	3	2	1	0
00	(MSB)		Capacity Block Address					
01			Capacity Block Address					
02			Capacity Block Address					
03			Capacity Block Address					(LSB)
04	(MSB)			Block Size				
05				Block Size				
06				Block Size				
07				Block Size				(LSB)

FIGURE 6-32. READ CAPACITY PARAMETERS

The last block address of either the drive or cylinder is contained in the Capacity Block Address bytes. The block size for the particular format is contained in the Block Size bytes.

Valid Errors:

Error	Error Code	Sense Key
No Sense	00h	0
No Index/Sector Signal	01h	4
No Seek Complete	02h	4
Write Fault	03h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
No Track 0 Found	06h	4
Multiple Drives Selected	07h	4
ID ECC Error	10h	3
ID AM Not Found	12h	3
Record Not Found	14h	3
Seek Error	15h	3
Bad Argument in CDB	24h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator Detached Error	48h	4
ESDI Interface Error	4Ch	4

6.20 READ (EXTENDED) (28h)

BYTE	BIT 7	6	5	4	3	2	1	0
00	0	0	1	0	1	0	0	0
01	Logical Unit Number			Reserved (0)				
02	(MSB)	Logical Block Address						
03	Logical Block Address							
04	Logical Block Address							
05	Logical Block Address							(LSB)
06	Reserved (00)							
07	Number of Blocks							
08	Number of Blocks							
09	Reserved (00)							

FIGURE 6-33. READ COMMAND

This command is an extended address command which is otherwise identical to the Class 00 READ (08h) command.

The larger Logical Block Address and Number of Blocks fields are provided for accessing very large devices.

Valid Errors:

Read Operation Errors (see Section 6.6)

6.21 WRITE (EXTENDED) (2Ah)

BYTE	BIT 7	6	5	4	3	2	1	0
00	0	0	1	0	1	0	1	0
01	Logical Unit Number			Reserved (0)				
02	(MSB) Logical Block Address							
03	Logical Block Address							
04	Logical Block Address							
05	Logical Block Address							(LSB)
06	Reserved (00)							
07	Number of Blocks							
08	Number of Blocks							
09	Reserved (00)							

FIGURE 6-34. WRITE COMMAND

This command is an extended address command otherwise identical to the Class 00 WRITE (OAh) command. The Logical Block Address and Number of Blocks fields have been expanded for larger devices.

Valid Errors:

Write Operate Errors (see Section 6.7)

6.22 SEEK (EXTENDED) (2Bh)

BYTE	BIT 7	6	5	4	3	2	1	0
00	0	0	1	0	1	0	1	1
01	Logical Unit Number			Reserved (00)				
02	(MSB) Logical Block Address							
03	Logical Block Address							
04	Logical Block Address							
05	Logical Block Address							
06	Reserved (00)							
07	Reserved (00)							
08	Reserved (00)							
09	Reserved (00)							

FIGURE 6-35. SEEK (EXTENDED) COMMAND

This command is an extended address command which is otherwise identical to the Class 00 SEEK (0Bh) command. The Logical Block Address field has been expanded for larger devices.

Valid Errors:

Seek Operation Errors (see Section 6.8)

6.23 WRITE AND VERIFY (2Eh)

BYTE	BIT 7	6	5	4	3	2	1	0
00	0	0	1	0	1	1	1	0
01	Logical Unit Number			Reserved (0)				
02	(MSB)			Logical Block Address				
03				Logical Block Address				
04				Logical Block Address				
05				Logical Block Address				(LSB)
06				Reserved (00)				
07				Number of Blocks				
08				Number of Blocks				
09				Reserved (00)				

FIGURE 6-36. WRITE AND VERIFY COMMAND

This command is similar to the traditional "read after write" function. It is an extended address command which operates like a WRITE command over the specified number of blocks and then verifies the data written on a block-by-block basis. The verify function transfers no data to the host and only checks the ECC to be correct.

Since no data is transferred to the host during verify, correctable data checks will be treated in the same manner as uncorrectable data checks.

Valid Error:

Read Operation Errors	
Write Operation Errors	
*ECC Error During Verify	19h

*If the G-H jumper is installed.

6.24 VERIFY (2Fh)

BYTE	BIT 7	6	5	4	3	2	1	0
00	0	0	1	0	1	1	1	1
01	Logical Unit Number				Reserved (0)			
02	(MSB)			Logical Block Address				
03				Logical Block Address				
04				Logical Block Address				
05				Logical Block Address				(LSB)
06				Reserved (0)				
07				Number of Blocks				
08				Number of Blocks				
09				Reserved (0)				

FIGURE 6-37. VERIFY COMMAND

This command is similar to the previous WRITE AND VERIFY except that it verifies the ECC of an already existing set of data blocks. It is up to the Host to provide data for rewriting and correcting if an ECC error is detected.

Valid Errors:

Read Operation Errors	
*ECC Error During Verify	19h

*If the G-H jumper is installed.

6.25 SEARCH DATA EQUAL (31h)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	0	0	1	1	0	0	0	1
01	Logical Unit Number			Invert	Reserved (0)			
02	(MSB) Logical Block Address							
03	Logical Block Address							
04	Logical Block Address							
05	Logical Block Address (LSB)							
06	Reserved (00)							
07	Number of Blocks							
08	Number of Blocks							
09	Reserved (00)							

FIGURE 6-38. SEARCH DATA EQUAL COMMAND

This powerful extended address command provides for a search-and-compare-on-equal of any data on the disk. A starting block address and number of blocks to search are specified and a search argument is passed from the Host which includes a byte displacement (not supported) and the data to compare.

This command allows the host to perform a high-speed data verify. Unlike the VERIFY Command which only checks for ECC errors, the search data equal will compare a chosen data pattern against data contained in selected blocks "on the fly." This feature provides an excellent method of verifying disk integrity after format by searching not equal for a "6C" or other unique fill character.

The Invert bit (Byte 01, Bit 04) inverts the sense of the search comparison operation. With Invert on, a SEARCH DATA NOT EQUAL will cause the controller to stop on a sector not equal to the search data and report search satisfied with a status byte of equal (04 status). Otherwise, the search will be terminated by a search length equal to the number of blocks specified in the data bytes or the number of blocks specified in the command block. When terminated by the search block count, a no sense status will be reported.

When the invert bit is reset, the controller will stop on a sector equal to the search data and report a search satisfied with a status of equal (04 status). Otherwise, the search will be terminated by the number of blocks specified by the command block or the command data block. A Request Sense Command can then be issued to determine the block address of the matching record.

A Request Sense following a successful Search Data command will:

1) Set the Address Valid bit to one.

2) Report the address of the block containing the first matching record in the Information Bytes.

The Request Sense command following an unsuccessful Search Data command will:

1) Report an error code of No Sense (00h), provided no errors occurred.

2) Set the Valid bit to zero.

Figure 6-39 shows the SEARCH DATA EQUAL argument.

BYTE	BIT 07	06	05	04	03	02	01	00
00	(MSB)			Record Size				
01				Record Size				
02				Record Size				
03				Record Size				(LSB)
04	(MSB)			First Record Offset				
05				First Record Offset				
06				First Record Offset				
07				First Record Offset				(LSB)
08	(MSB)			Number of Records				
09				Number of Records				
10				Number of Records				
11				Number of Records				(LSB)
12	(MSB)			Search Argument Length				
13				Search Argument Length				(LSB)
14	(MSB)			Search Field Displacement				
15				Search Field Displacement				
16				Search Field Displacement				
17				Search Field Displacement				(LSB)
18	(MSB)			Pattern Length				
19				Pattern Length				(LSB)
20				Data Pattern				
.								
.								
.								
M+19				Data Pattern				

FIGURE 6-39. SEARCH DATA EQUAL ARGUMENT

A definition of the required data in the SEARCH argument is shown in Table 6-8.

TABLE 6-9. SEARCH DATA EQUAL ARGUMENT

BYTES	PARAMETER
00 TO 03	Record Size (Bytes) This must equal the formatted block size.
04 to 07	First Record Offset (Bytes) For the ACB-4520A this must be zero.
08 to 11	Number of Records For ADAPTEC controllers this must be less than or equal to the number of blocks specified in the command and greater than zero. The search will terminate upon a match or when the smaller of these values is encountered.
12 to 13	Search Argument length (Bytes) The number of bytes in the following search argument. Must equal the pattern length + 6.
14 to 17	Search Field Displacement The displacement from the beginning of the record to the first byte to be compared. Must be zero.
18 to 19	Pattern Length (M Bytes) The number of bytes in the following data pattern to be compared with a like size field in each record. The pattern length must equal the blocksize.
20 to M+19	Data Pattern The block of data to be compared.

Valid Errors:

Error	Error Code
All Read Operation Errors	

6.26 READ DEFECT DATA (37h)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Operation Code							
01	LUN			Reserved (0)				
02	Reserved (0)			P	G	Defect List Format		
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							
06	Reserved (00)							
07	Allocation Length (MSB)							
08	Allocation Length (LSB)							
09	Reserved (00)							

FIGURE 6-40. READ DEFECT DATA COMMAND

This command causes the ACB-4520A to transfer the medium defect data to the initiator.

The meaning of bits 0 through 2 of byte 2 is similar to the bit definition of bits 0 through 2 of byte 1 of the FORMAT UNIT command. Bit two must be set to one and bits zero and one must be reset since the ACB-4520A uses the bytes from index format exclusively.

The P bit set to one causes the ACB-4520A to return the primary defect list (otherwise known as the manufacturer-supplied defect list).

The G bit set to one causes the ACB-4520A to return list of grown defects.

With bits P and G both set to one, the ACB-4520A will return the manufacturer-supplied defect list and the grown defect list. When both the manufacturer-supplied and the grown defect list are requested by the host, a four-byte header with bit four of byte 01 set and the manufacturer-supplied defect list length in bytes two and three, followed by the manufacturer-supplied defect list will be returned first. Following the four byte header and the defect list will be another four byte header with bit 3 of byte one set and the grown defect list length specified in bytes two and three of this second header field. The READ DEFECT DATA Command will then terminate after returning the grown defect

list.

The allocation length specifies the number of bytes that the initiator has allocated for returned READ DEFECT DATA. An allocation length of zero indicates that no READ DEFECT DATA shall be transferred. Any other value will cause the ACB-4520A to return the number of defect bytes requested. If the number of bytes requested is less than the number of bytes required to return the defect data, the defect data list will be terminated upon sending the requested number of bytes. If the number of bytes requested is greater than the length of the defect list, the transfer will be terminated when all the READ DEFECT DATA has been tansferred.

The READ DEFECT DATA contains a four-byte header, followed by zero or more defect descriptors.

BYTE	BIT 07	06	05	04	03	02	01	00
00	Reserved							
01	Reserved			P		G	Defect List Format	
02	Defect List Length (MSB)							
03	Defect List Length (LSB)							

FIGURE 6-41. READ DEFECT DATA BYTES

Valid Errors:

Error	Error Code	Sense Key
No Index/Sector	01h	4
No Seek Complete	02h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
Multiple Select	07h	4
Error Reading Defect List	19h	1
Defect List Not Found	1Ch	1
Illegal Command	20h	5
Bad Argument in CDB	24h	5
Invalid Logical Unit Number	25h	5
Invalid Field in Parameter List	26h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
User Threshold Limit Exceeded	2Ch	6
Select/Reselect Failed	45h	4
SCSI Bus Out Parity Check	47h	4
SCSI AA/Initiator Detected Error	48h	4
Illegal Message	49h	5
ESDI Interface Error	4Ch	5

6.27 WRITE DATA BUFFER (3Bh)

BYTE \ BIT	07	06	05	04	03	02	01	00
00	0	0	1	1	1	1	0	0
01	LUN			Reserved (00)				
02	Reserved (00)							
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							
06	Reserved (00)							
07	Allocation Length							
08	Allocation Length							
09	Reserved (00)							

FIGURE 6-42. WRITE DATA BUFFER COMMAND

The Write Data Buffer Command may be used in conjunction with the Read data Buffer Command as a diagnostic function for testing the ACB-4520A's 8K bytes of data buffer memory and the SCSI bus integrity.

The allocation length specifies the maximum number of bytes the initiator has allocated for bytes of data to be written. The allocation length includes a four-byte header followed by the WRITE DATA BUFFER data.

An allocation length less than the available length is not an error condition. The data transfer will be terminated when allocation length or the 8K byte available length has been transferred from the host, whichever is shorter. An allocation length of zero will transfer zero data bytes without an error condition.

BYTE	BIT 07	06	05	04	03	02	01	00
00	Reserved (00)							
01	Reserved (00)							
02	Reserved (00)							
03	Reserved (00)							

FIGURE 6-43. WRITE DATA BUFFER DATA.

Valid Errors:

Error	Error Code	Sense Key
Drive Not Ready	04h	2
Drive Not Selected	05h	4
Multiple Select	07h	4
Illegal Command	20h	5
Bad Argument in CDB	24h	5
Invalid Logical Unit Number	25h	5
Invalid Field in Parameter List	26h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
User Threshold Limit Exceeded	2Ch	6
Select/Reselect Failed	45h	4
SCSI Bus Out Parity Check	47h	4
SCSI HA/Initiator Detected Error	48h	4
Illegal Message	49h	5
ESDI Interface Error	4Ch	5

6.28 READ DATA BUFFER (3Ch)

BYTE	BIT 07	06	05	04	03	02	01	00
00	0	0	1	1	1	0	1	1
01	LUN			Reserved (00)				
02	Reserved (00)							
03	Reserved (00)							
04	Reserved (00)							
05	Reserved (00)							
06	Reserved (00)							
07	Allocation Length							
08	Allocation Length							
09	Reserved (00)							

FIGURE 6-44. READ DATA BUFFER COMMAND

The Read Data Buffer Command may be used in conjunction with the Write data Buffer Command as a diagnostic function for testing the ACB-4520A's 8K bytes of data buffer memory and the SCSI bus integrity.

The allocation length specifies the maximum number of bytes the initiator has allocated for returned data. The allocation length includes a four byte header followed by the READ DATA BUFFER data.

An allocation length less than the available length is not an error condition. The data transfer will be terminated when allocation length or the 8K byte available length has been transferred to the host, whichever is shorter. An allocation length of zero will transfer zero data bytes without an error condition.

Bytes two and three provide the available buffer length. For the ACB-4520A, these bytes are 20h, and 00h respectively to indicate an 8K byte buffer.

BYTE	BIT 07	06	05	04	03	02	01	00
00	Reserved (00)							
01	Reserved (00)							
02	Available Length (20h)							
03	Available Length (00h)							

FIGURE 6-45. READ DATA BUFFER DATA

Valid Errors:

Error	Error Code	Sense Key
No Index/Sector	01h	4
No Seek Complete	02h	4
Drive Not Ready	04h	2
Drive Not Selected	05h	4
Multiple Select	07h	4
Error Reading Defect List	19h	1
Defect List Not Found	1Ch	1
Illegal Command	20h	5
Bad Argument in CDB	24h	5
Invalid Logical Unit Number	25h	5
Invalid Field in Parameter List	26h	5
Reset Occurred	29h	6
Mode Select Changed	2Ah	6
User Threshold Limit Exceeded	2Ch	6
Select/Reselect Failed	45h	4
SCSI Bus Out Parity Check	47h	4
SCSI AA/Initiator Detected Error	48h	4
Illegal Message	49h	5
ESDI Interface Error	4Ch	5

APPENDIX A. ESDI SIGNAL TIMING

A.1 DATA SIGNAL DESCRIPTIONS

Data and clock signals are transferred over differential pairs. These signals are provided at J2/P2 connectors on all drives. There are four differential pairs: NRZ WRITE DATA, NRZ READ DATA, WRITE CLOCK and READ/REFERENCE CLOCK.

A.1.1 DATA INPUT SIGNALS

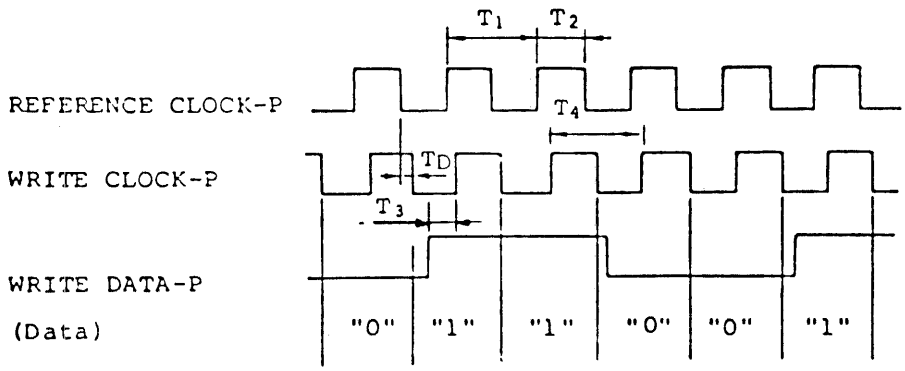
A.1.1.1 NRZ WRITE DATA

The controller places NRZ data on this differential pair that transmits it to the drive for recording on the disk. The data is generated in the controller in an NRZ format and sent out to the drive, synchronized with WRITE CLOCK pulses. Drive circuits convert it from NRZ format and write it on the disk in RLL 2,7 format.

A.1.1.2 WRITE CLOCK

The controller must transmit this timing pulse at the bit data rate for synchronization of WRITE DATA. The signal is derived from the REFERENCE CLOCK and it's timing is controlled by the controller. The controller must initiate it's transmission at least 250 ns before activating WRITE GATE.

Figure A-1 shows REFERENCE CLOCK and WRITE CLOCK signals.



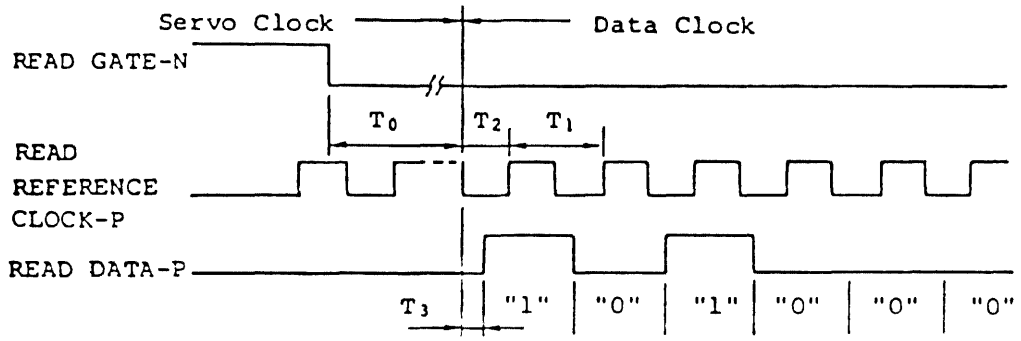
T_1 = 102.8 ns ± 8 ns
T_2 = $T_1/2$
T_3 = $T_4/2$ ± 20 ns
T_D = $2T_1$
T_4 = 102.8 ± 8 ns

FIGURE A-1. WRITE DATA AND CLOCK TIMING

A.2 DATA OUTPUT SIGNALS

A.2.1 NRZ READ DATA

The drive places NRZ data on this differential pair for transmission to the controller. The data written on the disk is RLL 2,7 format and decoded into NRZ format through the Variable Frequency Oscillator (VFO) and Data Separator circuits and clocked by the READ CLOCK signal for transmission. Data transfer is initiated after the VFO circuit is stabilized, so the controller must ignore the data for four bytes after activating READ GATE.



T_0 = 4 bytes
T_1 = 102.8 ns ± 10 ns
T_2 = T_1 ± 10 ns
T_3 = 0 ± 15 ns

FIGURE A-2. READ DATA AND CLOCK TIMING

A.2.2 READ/REFERENCE CLOCK

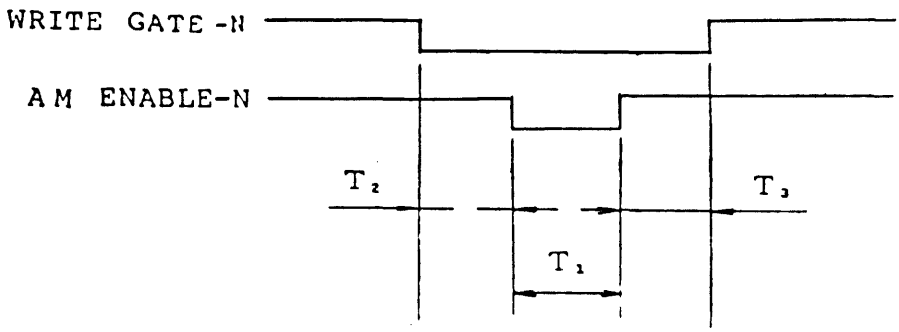
The drive transmits this timing pulse continuously for the controller to discriminate read data. When READ GATE is active, this signal is supplied by the Variable Frequency Oscillator (VFO) circuit synchronized with read data. When READ GATE is inactive, it is a servo clock or REFERENCE CLOCK. The transition from servo clock to data clock is completed in four bytes after READ GATE goes low.

Figure A-2 above shows the timing.

A.2.3 ADDRESS MARK ENABLE-N

This optional signal, when active with WRITE GATE, causes an Address Mark to be written. ADDRESS MARK ENABLE shall be active for 24 bit times.

ADDRESS MARK ENABLE, when active without WRITE GATE or READ GATE, causes a search for Address Marks.



T_1 = 24 Bit times
$T_2 = T_3$ = 100ns min

FIGURE A-3. WRITE ADDRESS MARK TIMING

APPENDIX B. SELF DIAGNOSTICS

B.1 SELF DIAGNOSTICS

NOTE:
THESE SELF-DIAGNOSTICS ARE FOR TROUBLESHOOTING ON A SYSTEM LEVEL ONLY. THEY ARE NOT INTENDED FOR REPAIR OF THE BOARD.

The ACB-4520A Controller has built-in diagnostics. These are performed at power-on time when the O-P jumper is installed. DO NOT connect the cables. If the board is functioning properly the LED will flash continuously with duration of 0.5 - 1.0 seconds per flash. If there is a problem with the controller, the LED will stay on for six seconds, flash once for one second (notating the start of diagnostics), and then flash in 0.5 second bursts. This will then be repeated as long as the O-P jumper is installed. The number of 0.5 second bursts is the error code. These error codes are detailed in Table B-1.

TABLE B-1. ACB-4520A SERIES CONTROLLER SELF-DIAGNOSTICS

ERROR CODE (NUMBER OF 0.5 SECOND BURSTS)	PROBABLE PROBLEM AREA
NONE	8085 SUBSYSTEM
1	8156 RAM
2	FIRMWARE
3	AIC-010 AND RELATED LOGIC
4	AIC-010 AND RELATED LOGIC
5	AIC-300 AND RELATED LOGIC
6	AIC-010 BUS
CONTINUOUS BURSTS OF 1 SEC, 1 SEC, 1/2 SEC (WITHOUT SIX-SECOND FLASH AND ONE-SECOND FLASH)	CONTROLLER PASSES SELF-DIAGNOSTICS

When a known good drive is correctly connected to the controller, it will seek and read. Error codes are invalid in this mode.

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