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ACB-5500 User's Manual

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ACB-5500 User's Manual
5¼″ Winchester Disk Controller
SCSI to ST506

October, 1985

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1.Ø INTRODUCTION

The ACB-55ØØ disk controller provides an intelligent interface from an ANSI X3T9.2 SCSI host interface to four ST5Ø6 compatible disk drives.

1.1 SCOPE

This manual contains all of the information necessary to quickly install and operate the ACB-55ØØ with an SCSI compatible Host Adapter and up to four ST5Ø6 disk drives.

1.2 REFERENCE DOCUMENTS

- ANSI X3T9.2 Small Computer System Interface Specification

1.3 ACB-55ØØ FEATURES

- The ACB-55ØØ supports four ST5Ø6 hard- and soft-sectored drives.
- The ACB-55ØØ supports a fully arbitrating SCSI system with up to seven other controllers or hosts sharing the SCSI bus.
- The ACB-55ØØ provides maximum SCSI bus throughput by supporting bus disconnection and reconnection for explicit and implied seeks.
- The ACB-55ØØ offers complete device independence by auto configuring to any size formatted drive. By storing drive parameters on the drive at format time, the need for host initialization of the controller for various drive types is eliminated.
- The ACB-55ØØ may handle defects on a sector level by allowing the host to request that spare sectors be reserved on a cylinder basis. This provides formatted disks with constant data capacity and allows cylinder level formatting.
- The ACB-55ØØ, utilizing a 2K dual-ported buffer, eliminates the need for sector interleaving. This allows the host to read a track of data in a single revolution.
- The ACB-55ØØ allows the host to reserve an entire logical unit, or particular extents on a logical unit, limiting or prohibiting data access by other hosts on the SCSI bus.

- The ACB-5500 reduces selection overhead by allowing the host to link commands. Once a command is completed, the controller will immediately request and execute the next linked command.

- The ACB-5500 reduces system overhead by queuing commands to the controller from different hosts. As commands are completed, the next queued command will be executed.

- The ACB-5500 provides great operating system flexibility by offering sector lengths of 256, 512, or 1024 bytes. The sector length is programmed at format time.

- The ACB-5500 supports direct and relative addressing of logical blocks.

- The ACB-5500 guarantees excellent data integrity by utilizing a 32-bit error correction code on both the data and I.D. fields, SCSI bus parity checking and generation, and data buffer parity checking.

1.4 BLOCK LAYOUT

The component layout of the ACB-5500 is shown in Figure 1-1.

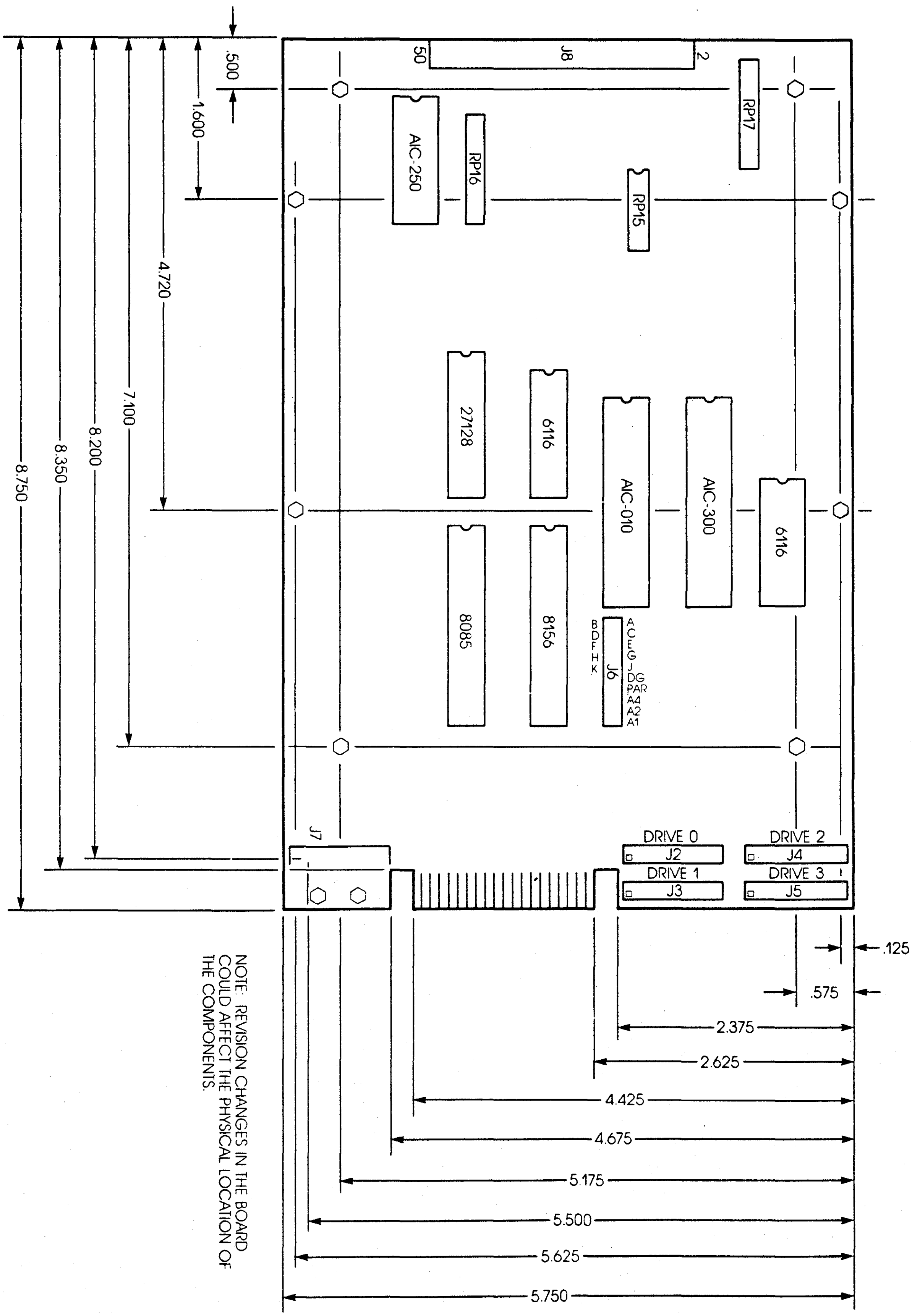

Figure 1-1 ACB-5500 Board Layout

1.5 PRODUCT SPECIFICATION

1.5.1 PHYSICAL DIMENSIONS

Length: 8.76 inches
Width: 5.75 inches
Height: .8 inches

1.5.2 POWER REQUIREMENTS

Voltage (volts)	Tolerance (Units)	Current (max amps)	Ripple (volts, RMS)
+5	4.75 to 5.25	1.5	.150
+12	+10.8 to +13	0.300	.150

1.5.3 ENVIRONMENTAL REQUIREMENTS

	Operating	Storage
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-5500 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. 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.Ø THEORY OF OPERATION

The ACB-55ØØ provides a powerful mechanism for connecting up to four ST5Ø6 compatible disk drives to a host computer via the Small Computer Systems Interface (SCSI). The SCSI provides a powerful general purpose device-independent connection usable by a wide range of computing systems.

The ACB-55ØØ provides all of the data separation circuitry required to convert 5 Mb/sec NRZ to MFM encoded data. Adaptec's AIC-25Ø encode/decode chip designed with a discrete VCO circuit control write precompensation, addresses mark detect and data separation functions.

The ACB-55ØØ provides all required formatting and data synchronizing functions for ST5Ø6 compatible disk drives. The formatting function, data serializing/deserializing and ECC checking are provided by Adaptec's proprietary sequencer chip, the AIC-Ø1Ø.

The ACB-55ØØ provides up to 2K bytes of dual-ported buffering to allow high performance data access even if the attached host system can only accept data at very low rates. Adaptec's AIC-3ØØ buffer controller provides full dual porting for the buffer memory.

The data transfer path is fully checked, using ECC and buffer parity checking to assure data integrity. Data integrity is not compromised by the unchecked control microprocessor.

All low-speed control operations are managed by a powerful 8-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-tst capability.

The formatting process stores device dependent parameter information on the attached disk drives. When the ACB-55ØØ is powered up, it automatically configures all internal tables from the stored parameters so that no drive configuration commands are required from the host system.

Figure 2-1 shows the ACB-55ØØ block diagram, and Figure 2-2 shows a flow chart of the ACB-55ØØ microcode structure.

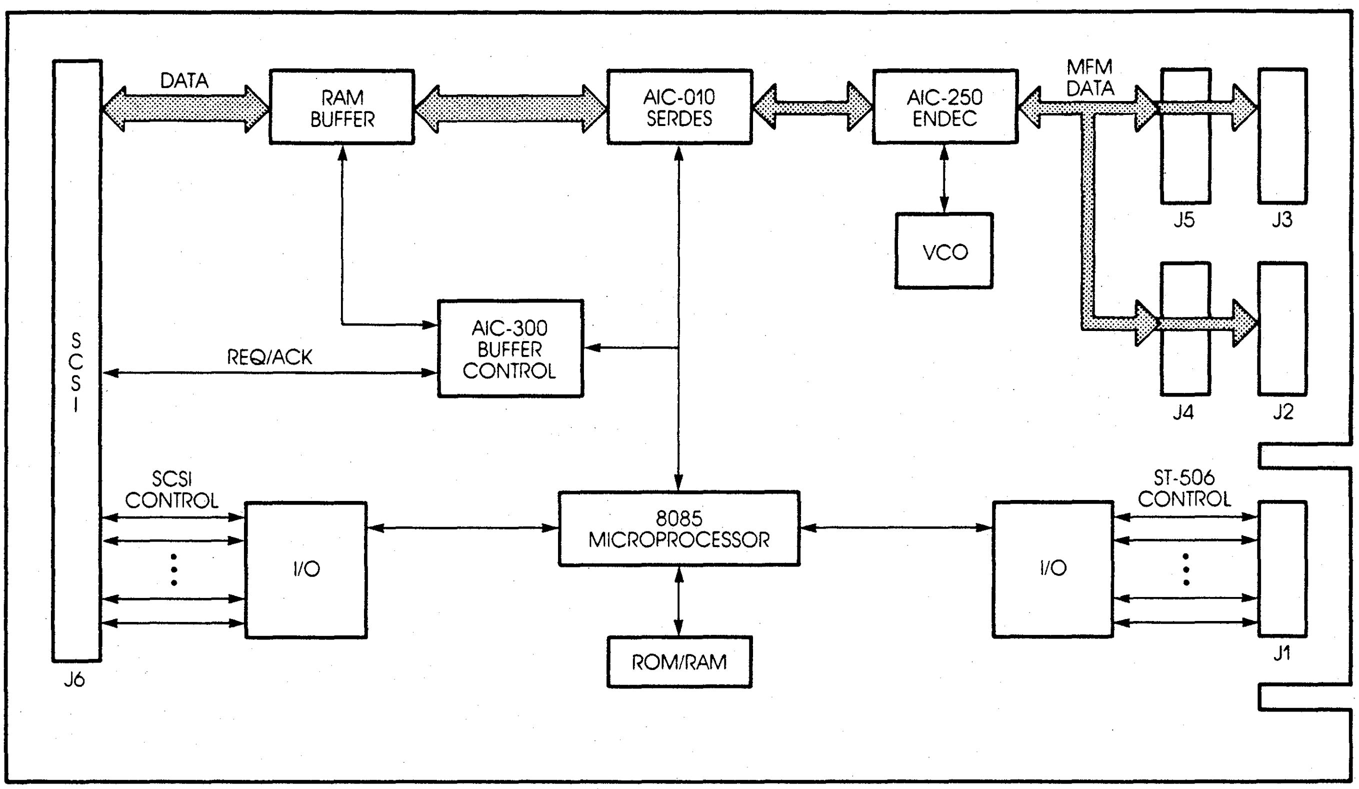

Figure 2-1. ACB-5500 Block Diagram

```
   Power Up ----> Power Up Diagnostics ----> IDLE, polling  <--|
    Reset    ^Hard    and Reset          |   host selection or |
              |                          |   seek complete     |
              |                          |         |           |
   SCSI Reset----> Get Off SCSI bus-----*          |           |
             Soft  If working, sets up       Host Selection    |
                   for command retry           Checking <----- |
                                                   |         | |
                                                   |         | |
                                             Command Pre-    | |
                                               Processing    | |
                                                   |         | |
        ------------------------------------------------     | |
Shared  /  |        |        |        |        |        |    | |
Sub-   |  SEEK     READ     WRITE   FORMAT   READ BUF. OTHERS| |
routines\  |        |        |        |        |        |    | |
        ------------------------------------------------     | |
                             |        |                      | |
                      Normal exit   Error exit               | |
                             |        |                      | |
                             |---------                      | |
                             |                               | |
                      Command linking ----------------------*  |
                             |                                 |
                             |                                 |
                         Clean up                              |
                             |                                 |
                             ----------------------------------*
```

Figure 2-2. ACB-5500 Microcode Structure

2.1 SYSTEM CONFIGURATION

The ACB-5500 supports systems with a wide range of complexity. Figure 2-3 shows three SCSI configurations supported by the ACB-5500.

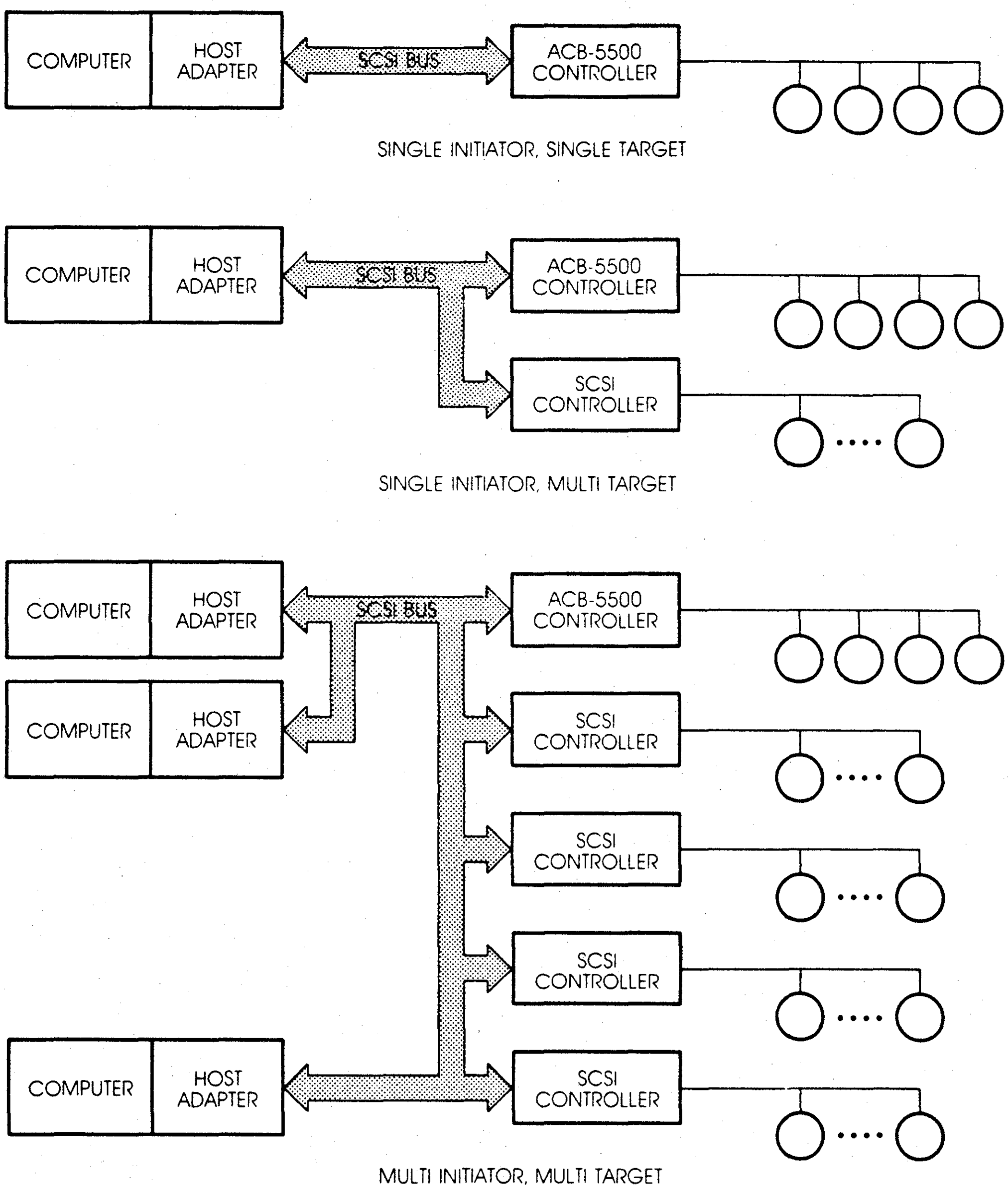

Figure 2-3. Typical SCSI Configurations

3.Ø INSTALLATION

The ACB-55ØØ is a self-contained circuit board. All logical and electronic functions required for its normal operation are contained on the circuit board. The ACB-55ØØ is simple to install, operate, and maintain.

3.1 UNPACKING

The ACB-55ØØ 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 electro-static discharge. The ACB-55ØØ 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-55ØØ is generally designed into the host system or the peripheral disk system. Proper attention should be given to the location of ACB-55ØØ so that the necessary ventilation, installation clearances, and cabling paths are provided.

The power output is low enough so 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 8 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-55ØØ.

Installation clearances, both for the ACB-5500 and the selected power and signal cabling configuration, should be sufficient to optimize system cost, manufacturability, and maintainability.

The ACB-5500 emits a small amount of radio-frequency signals. Extremely sensitive components, such as high band-width analog sensors, should be properly shielded from the ACB-5500. Normal case construction is sufficient to shield the ACB-5500 as required by the FCC. If FCC compliance is required and the SCSI leaves the box in which the ACB-5500 is installed, the high frequency signals generated by normal SCSI operation may require connector and cable shielding.

The ACB-5500 and all other partially shielded electronic devices are sensitive to high power high frequency electrical or magnetic sources. The ACB-5500 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. Any system supporting the ACB-4000 will also support the ACB-5500. Use of the advanced performance oriented functions will require a more powerful SCSI host adapter that supports disconnect/reconnect, command linking, 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-5500 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 ACB-5500 for obvious physical damage before installing.

2) Install proper jumpers (see Section 3.4) to enable the desired ACB-5500 functions and to define the address of the ACB-5500 on the SCSI Bus.

3) Install ACB-5500 with appropriate mounting hardware.

4) Make the required cable connections to the ACB-5500. The cable connections are:

J7 - Power cable
J8 - SCSI cable
J2, J3, J4, J5 - ST506 data cable (radial connections as required)
J1 - ST506 control cable.

5) Install ST506 drives according to the manufacturer's directions. The drives must have appropriate drive select address and bus terminators set. The last ST506 drive on the control cable daisy chain must be terminated.

5) 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-5500 manufacturing work station before installation. Since all parameters are stored on the drive by the formatting procedure, further formatting or parameter specification is not required after installation. The ACB-5500 will auto configure to the drive parameters at power-on time.

8) Perform appropriate system test and verification procedures. Errors related to drive operation, ACB-5500 operation, SCSI operation, and certain installation errors will be indicated through the normal SCSI error presentation mechanism.

3.4 CONFIGURING THE ACB-5500

The ACB-5500 has a number of options that must be selected by the installation of hardware jumpers located at position J6 on the controller. The function of each jumper pair is shown in Table 3-1. The jumper header is designed to accommodate jumpers with optimum reliability, the jumper pairs may be wire-wrapped together.

Table 3-1. Configuration Jumpers

A	o o	B	- SCSI Reset Option
C	o o	D	- Reserved
E	o o	F	- Hard Sectored LunØ
G	o o	H	- Hard Sectored Lun1
J	o o	K	- Reserved
	o o	Diag	- Diagnostic Mode
	o o	Par	- Parity Enable
	o o	A4	- SCSI Address 2^2
	o o	A2	- SCSI Address 2^1
	o o	A1	- SCSI Address 2^0

3.4.1 SCSI RESET OPTION

The installation of the A-B jumper will cause the ACB-55ØØ to initiate a "Hard" reset in response to an SCSI bus reset. Without this jumper installed, a "Soft" reset will result. The effect of both a "Hard" and "Soft" reset are detailed in Section 4.1.3.2.

3.4.2 HARD SECTORED/REMOVABLE DRIVES

The installation of the E-F or G-H jumpers will indicate to the ACB-55ØØ that a hard sectored drive is attached as logical Unit Ø or 1 respectively. The presence of a jumper will cause the ACB-55ØØ to use the sector pulse input from the drive. The jumpers must only be installed if a hard sectored drive is attached. Hard sectored drives must either be logical unit Ø or 1.

3.4.3 DIAGNOSTIC MODE

The installation of the DIAG jumper will cause the ACB-55ØØ to continuously repeat a diagnostic self test. Appendix A details this self test.

3.4.4 PARITY ENABLE

The installation of the PAR jumper will cause the ACB-5500 to check for bus out (data into the ACB-5500) parity errors. This jumper should only be installed if all SCSI devices communicating with the ACB-5500 generate SCSI data parity. The ACB-5500 will always generate parity on bus in data.

3.4.5 SCSI BUS ADDRESS

The installation of jumper A4, A2, and A1 set the SCSI bus address for the ACB-5500. SCSI devices can have an address of 0 to 7 but no two devices can have the same address.

3.5 POWERING-ON THE ACB-5500

Once the ACB-5500 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 drive 0, 1, 2, and 3 to become ready. If the host sends a command requiring access to a drive before it has become ready (and before 18 seconds have elapsed) the controller will accept the command and continue to check for a ready status. Once the drive comes ready, the controller will then execute the command; if 18 seconds elapse, and the drive does not come 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.

Once a drive comes ready, the controller will recalibrate the head to track 0. If the drive started at track 0, the controller will step the head off of track 0 to confirm that the drive can seek and that the track 0 signal was valid. With the drive's ability to seek confirmed, the controller then seeks back to track 0. The drive actuator (if it can be seen) appears to make a short 'blip.'

The controller then attempts to read from track 0, parameter information, which is written during formatting. If the drive is unformatted, or had been formatted by other than an Adaptec controller, the parameter information is not present. The controller then sets "blown format" to warn the user that the drive is unusable, the reset sequence is stopped and the controller is ready for a command. The drive must be formatted to allow a READ or WRITE access to disk data.

If the drive is correctly formatted, the controller will seek the drive to the last cylinder and read the largest block address present. The parameter information and largest block addresses are saved by the ACB-5500.

Once the last block address has been read, the controller will seek the drive back to track 0, stopping several times in 'zones' to read the devect counyt within each zone. This defect count is also saved in the controller to asllow it to better predict the location of a block on the disk for accurate seeking.

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. This device independence provides a major advantage for host systems using true SCSI controllers over the SASI-like units that send parameters at a reset and with commands.

3.6 COMMUNICATING WITH THE ACB-5500

The SCSI bus is a simple bus to interface. However, a quick reading of the SCSI spec may leave you 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 drive should make no assumptions about the bus phases or byte counts. In addition, the controllr can (and will) change phases betwen 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, other controllers only support some 6-byte commands, thus some users have set up counters in their software to send a 6-byte command. Since the ACB-5500 controller supports 6 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 remains asserted until the controller responds Busy.

2) Send the ACB-5500 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.

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

4) Receive (REQ/ACK cycle) 1 status byte and save for evaluation (See Section 4.5).

5) Receive (REQ/ACK cycle) 1 message byte (See Section 4.2).

6) Check status byte. If Busy bit set, resend command; if Check bit set, send REQUEST SENSE ($Ø3_H$) command to get error.

3.7 FORMATTING WITH THE ACB-55ØØ

A sample MODE SELECT command for a Seagate ST412-type drive is described below:

Step 1: MODE SELECT Command

Drive Type: Seagate ST412:
3Ø6 cylinders
4 heads
28 uS step rate
Reduced write current at cylinder 256
Write precompensation at cylinder 256

Hex	Description
	MODE SELECT Command
15	OP Code (15_H) for MODE SELECT
ØØ	Formatting LunØ
ØØ	Reserved
ØØ	Reserved
16	Number of data bytes appended (16_H)
ØØ	Reserved
	Extent Descriptor List
ØØ	Reserved
ØØ	Reserved
Ø8	Length of drive descriptor list
ØØ	Density code
ØØ	Reserved
ØØ	Reserved
ØØ	Reserved
ØØ	High byte of block size to be formatted (256 bytes)
Ø1	Middle byte of block size to be formatted
ØØ	Low byte of block size to be formatted
	Drive Parameter List
Ø1	Interface code (must be Ø1)
Ø1	High byte of cylinder count
Ø2	Hard sector drive or removable cartridge
32	Low byte of cylinder count
Ø4	Total number of heads
Ø1	High byte of reduced write current cylinder
ØØ	Low byte of reduced write current cylinder
Ø1	High byte of write precompensation cylinder
ØØ	Low byte of write precompensation cylinder
ØØ	Landing zone position (see STOP, $1B_H$, command)
Ø1	Head step rate (Ø2-12 us, Ø1=28us, ØØ=3Ms)

Note: Two additional bytes would be added for a hard-sectored or removable drive (See Section 6.14).

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

Interleave of 1:1
Fill data fields with $E5_H$
1 defect at head 2, cylinder 11, 256 bytes from index
2 space sectors per cylinder

FORMAT UNIT command

Hex	Description
Ø4	Op code ($Ø4_H$ for FORMAT UNIT command)
1E	LunØ and indicate fill character and defect descriptor appended
E5	Character to be filled in data fields
ØØ	High byte of interleave (must be ØØ)
Ø1	Low byte of interleave
ØØ	Reserved

FORMAT UNIT Data Block

ØØ	Format entire unit
Ø2	Allocate 2 spare sectors per cylinder
ØØ	High byte of length of defect list
Ø8	Low byte of length of defect list
ØØ	High byte of cylinder number of defect
ØØ	Middle byte of cylinder number of defect
ØB	Low byte of cylinder number of defect
Ø2	Head number of defect
ØØ	High byte of defect bytes from index
ØØ	Middle byte of defect bytes from index
Ø1	Middle byte of defect bytes from index
ØØ	Low byte of defect bytes from index

The same procedure can be used for formatting single cylinders. Section 6.4.2 contains details on changes required to the FORMAT UNIT command for cylinder level formatting.

The ACB-55ØØ allows you to select the desired interleave factor with the FORMAT UNIT command. The interleave can range from zero to the number of blocks per track, minus 1. The number represents the number of physical blocks between consecutive logical block numbers, thus an interleave of 1 means that the sectors are consecutive.

The use of an interleave factor 1 allows a maximum transfer rate but will only be effective with a host adapter and system capable of very high transfer rates. On the other hand, the use of interleaving can maximize the storage capacity of your drive.

Table 3-2 shows the number of formatted sectors per track for different block sizes and interleaves when using soft sectored drives.

Table 3-2. Interleaved Sectors/Track

SECTOR SIZE	INTERLEAVE	SECTORS/TRACK
256	1	32
256	>1	33
512	1	17
512	>1	18
1024	1	9
1024	>1	9

4.0 SCSI INTERFACE DESCRIPTION

This section briefly describes the SCSI protocol implemented by the Adaptec ACB-5500 controller. The SCSI protocols are described in detail in the ANSI X3T9.2 Small Computer System Interface Specification, version 14.

4.1 GENERAL DESCRIPTION OF SCSI

This system interface provides an efficient method of communication between a maximum of 8 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 (8) 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-5500 always assumes a Target role.

An Initiator, or attached host adapter, may address up to four logical units on an ACB-5500. Each logical unit is a separate ST 506 disk drive having the characteristics (i.e., capacity) with which it was formatted. The ACB-5500 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 9 control signals and 9 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-5500

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-5500.

4.1.1.9 RESET (RST)

RST is an "or-tied" signal indicating the RESET condition. The ACB-5500 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-5500 by jumpers A1, A2, and A4.

Data parity, DB(P), is odd. The ACB-5500 always generates correct bus parity for inbound transfers. A jumper is installed to enable the ACB-5500 to check outbound parity for those systems that support parity. All Initiators must support parity if the ACB-5500 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

(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-5500 operates in both arbitrating and non-arbitrating systems. In non-arbitrating 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 "time out" 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 X379.2 SCSI specification will be followed. The ACB-5500 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-5500 can release the SCSI bus for other activities while the disk devices are performing mechanical motions. The Initiator informs the ACB-5500 that it can support reconnection by transmitting the proper bits in the Identify MESSAGE OUT right after the Selection phase. The ACB-5500 will then disconnect at the proper times, first presenting a Save Pointers message and a Disconnect message to the Initiator. The Save Pointers message indicates to the Initiator that it must preserve all necessary information to later continue the operation when reconnect takes place.

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-5500 then drops BSY. The reselected Initiator then asserts BSY. When the ACB-5500 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-5500 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 MSG	C/D	I/O	PHASE NAME	DIRECTION OF INFORMATION XFER
0	0	0	DATA OUT	(INIT to ACB-5500)
0	0	1	DATA IN	(ACB-5500 to INIT)
0	1	0	COMMAND	(INIT to ACB-5500)
0	1	1	STATUS	(ACB-5500 to INIT)
1	0	0	Reserved	
1	0	1	Reserved	
1	1	0	MSG OUT	(INIT to ACB-5500)
1	1	1	MSG IN	(ACB-5500 to INIT)

NOTES: 0 = SIGNAL DEASSERTION
1 = SIGNAL ASSERTION
INIT = INITIATOR
ACB-5500 = 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-5500. The ACB-5500 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-5500 compensates for cable skew and the skew of its own drivers. The ACB-5500 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-5500. 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-5500 deasserts REQ. The ACB-5500 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-5500 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-5500 to obtain Command Descriptor Blocks from the Initiator.

The ACB-5500 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-5500 to input device data or state information to the Initiator. The ACB-5500 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-5500 to obtain write data and control parameters from the Initiator. The ACB-5500 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-5500 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-5500.

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-5500.

The MESSAGE IN phase is used by the ACB-5500 to present a message to the Initiator. The ACB-5500 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-5500 to obtain a message from the Initiator. The ACB-5500 invokes this phase only in response to the ATTENTION condition from the Initiator. In response to the ATTENTION condition, the ACB-5500 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:

- o The BSY, SEL, REQ and ACK signals may not change.
- o The C/D, I/O, MSG and DATA signals may change.
- o 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-5500 of a waiting message. The ACB-5500 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-5500 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.

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.

By setting jumpers A-B on the ACB-5500 jumper header (J6), the user can select either a hard reset mode or a soft reset mode.

When the jumper is installed, a hard reset mode is established. When in hard reset mode, a RESET condition will force the ACB-5500 to clear all uncompleted commands, to release all reservations including dual port reservations, and to return all other modes, including mode select, set limits, and diagnostic states to their power on default conditions. The next time a drive is selected from the Initiator, the drive and all its mode select parameters will be re-initialized.

When the jumper is not installed at position A-B, a soft reset mode is established. After clearing the SCSI bus information and waiting until the Reset Condition has ended, the ACB-5500 will attempt to complete any uncompleted commands which were fully identified. All SCSI device reservations and operating modes are preserved. The ANSI X3T9.2 SCSI specification defines the conditions under which commands are considered completely identified and completed.

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-5500 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.

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 Non-Assertion) = 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 Non-Assertion) = 2.0 to 5.25 VDC.

A 74LS14 receiver with hysteresis meets this specification.

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

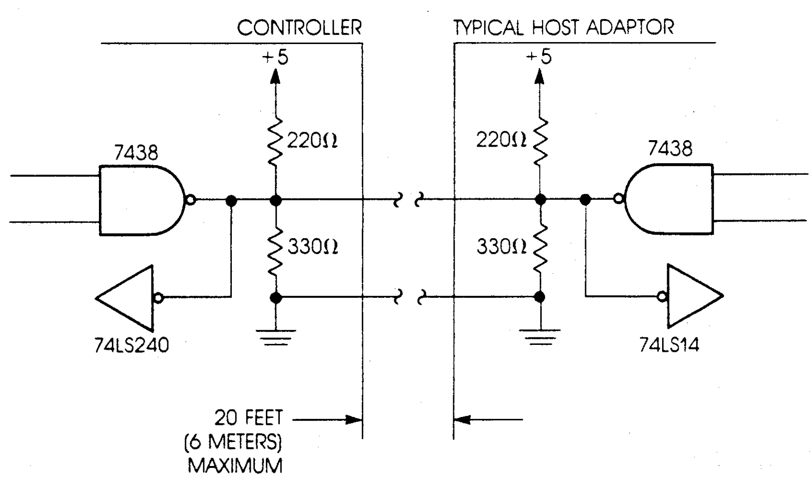

Figure 4-1. Host Adapter Bus Termination

4.1.7 CONNECTION DIAGRAM

A 50-pin latching connector is provided at position J8 for connecting to the SCSI bus. The SCSI single-ended non-shielded 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 Ø (DBO)
		4	" 1
		6	" 2
		8	" 3
		1Ø	" 4
		12	" 5
		14	" 6
		16	- Data Bit 7 (DB7)
		18	- Data Bit P (DBP)
		2Ø	Ground
	23	22	Ground
	25	24	Ground
	27	26	No connection
		28	Ground
		3Ø	Ground
		32	- Attention
		34	Ground
		36	- Busy
		38	- Acknowledge
		4Ø	- Reset
		42	- Message
		44	- Select
		46	- Control/Data
		48	- Request
	49	5Ø	- Input/Output

Figure 4-2. SCSI Bus Pin Assignments

4.2 MESSAGE SPECIFICATION

The message system allows communication between an Initiator and an ACB-55ØØ for purposes of physical path management. This section defines the messages supported by the ACB-55ØØ.

4.2.1 MESSAGE SYSTEM

The ACB-55ØØ supports a considerable number of messages to perform such special functions as disconnect/reconnect and command linking. 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-55ØØ 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.

4.2.2 SCSI MESSAGE DESCRIPTIONS

Table 4-2 shows the messages supported by the ACB-5500.

Table 4-2. Message Codes Supported by the ACB-5500

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
0A	Linked Command Complete	In	
0B	Linked Command Complete w/Flag	In	
0C	Bus Device Reset		Out
80 to FF	Identify	In	Out

4.2.2.1 SINGLE BYTE MESSAGES

Command Complete (00_H)

This message is sent by the ACB-5500 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-5500 drops BSY and goes to the BUS FREE phase.

Save Data Pointer (02_H)

This message is sent by the ACB-5500 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 ($Ø3_H$)

This code is sent from the ACB-55ØØ to direct the Initiator to restore the most recently saved pointers for the particular 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 ($Ø4_H$)

This message is sent by the ACB-55ØØ 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 ($Ø5_H$)

This message is from the Initiator to inform the ACB-55ØØ 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-55ØØ will post error status with an error code of 2D.

Abort ($Ø6_H$)

The message is sent from the Initiator to direct the ACB-55ØØ 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 by the 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 (07_H)

This code is sent from the Initiator or ACB-5500 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-5500 sends this message, it will change to MESSAGE IN phase and send this MESSAGE prior to requesting additional message bytes.

No Operation (08_H)

This message is sent from an Initiator in response to the ACB-5500's request for a message when the Initiator does not currently have any other valid message to send.

Linked Command Complete ($0A_H$)

This message is sent from the ACB-5500 to an Initiator to indicate that the execution of a linked command has been completed and that status has been sent. The Initiator is then allowed to set up the pointers for the initial state for the next linked command.

Linked Command Complete with Flag ($0B_H$)

This message is sent from the ACB-5500 to an Initiator to indicate that the execution of a linked command (with the FLAG set) has completed and that status has been sent. The Initiator is then allowed to set up the pointers for the initial state of the next linked command. Typically the FLAG would cause an interrupt in the Initiator.

Bus Device Reset ($0C_H$)

This message can be sent from an Initiator to direct the ACB-5500 to reset all current I/O operations on that BUS DEVICE. This message forces the ACB-5500 to an initial state with no operations pending for any Initiator. Upon recognizing this message, the ACB-5500 goes to the BUS FREE phase.

Identify (80_H to FF_H)

This code is sent by either the Initiator or ACB-5500 to establish the physical path connection between the Initiator and ACB-5500 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-5500.

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-5500 SMD Disk Controller and the ACB-5500 ST506 Disk Controller. In addition, 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 multi-host/multi-task environment. Functional examples of SCSI command and data interactions are detailed below.

4.3.1 SINGLE COMMAND EXAMPLE

A typical operation for the ACB-5500 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-5500. The ACB-5500 then assumes control of the operation.

The ACB-5500 checks to see if ATTN is present, indicating that the Initiator is hoping to send an Identify message. The ACB-5500 obtains the Identify message and uses it to determine which logical unit (SMD drive) is being addressed. The ACB-5500 then obtains the command descriptor block, 6 or 10 bytes of command information, and determines that a Read of certain logical blocks is desired by the Initiator. The ACB-5500 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-5500 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-5500 disconnects from the Initiator, freeing the SCSI bus to allow other Initiator requests to be sent to other controllers or other devices on the same controller during the time that would otherwise be unusable.

A typical disconnection is performed after the READ Command has been transferred and before data is transferred. The ACB-5500 indicates that the Initiator must store its active state information by sending a Store Pointers message, then sends a Disconnect message to indicate that the SCSI bus will be freed up, but that the operation will continue later.

When the physical motions of the device are complete, the ACB-5500 reselects the Initiator and passes an Identify message to it. The Identify message provides the necessary information for the Initiator to re-activate the stored state information. The read operation then continues as previously described.

4.3.3 LINKED COMMAND EXAMPLE

The Link function defines a relationship between commands which, when combined with the RELATIVE ADDRESS BIT, allows previous operations to modify subsequent commands. Linked operation makes high performance I/O functions possible by providing a relative addressing capability and allowing multiple command execution without invoking the host software and without requiring a new SELECTION phase.

As one example of a linked operation, the Initiator may want to restrict any Read operations to a certain set of tracks. This may be done by linking a SET LIMITS command to a READ command. After normal execution of the SET LIMITS command, the ACB-5500 presents a LINKED COMMAND COMPLETE message instead of a COMMAND COMPLETE message. The LINKED COMMAND COMPLETE indicates to the Initiator that it must now set up for the next command, a READ. The ACB-5500 requests the Command Descriptor Block, interprets the READ, and continues a normal READ command, but limited to the set of logical blocks specified by the SET LIMITS command.

The linked command structure can similarly be used by the SEARCH EQUAL command, followed by a disk READ of the data found.

4.3.4 COMMAND QUEUING EXAMPLE

In a multi-host environment, (say, file server) the data are shared among hosts. When one host is using drive A,access from the other hosts to the same drive will get busy status since the drive can only do one task at one time. The other hosts must continue to poll the status of drive A until the busy goes away.

The polling has three disadvantages:

A. Cause SCSI bus busy
B. Require host overhead
C. The response time is delayed by the host polling interval

This delay could be as long as several hundred milli-seconds. The ACB-5500 and ACB-5580 will queue the requests from the other hosts and disconnect from the SCSI bus. As soon as the first host request is done, one of the queued requests is performed by reconnecting to the host. This function will dramatically increase the performance of a multi-host environment.

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:

o Group 0: 6-Byte commands

o 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)						Flag	Link

Figure 4-3. Group 0 Commands (6-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)						Flag	Link

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-5500 uses only 0 and 1 to indicate Group 0 (6 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 8 devices attached to a controller. The ACB-5500 accepts Logical Unit Numbers from 0 to 3, addressing 4 SMD disk devices per controller. The Logical Unit Number is only examined and used by the ACB-5500 if the IDENTIFY message was not provided.

4.4.5 COMMAND SPECIFIC BITS

Byte Ø1, bits Ø1-Ø4 specify options which depend upon the particular command.

4.4.6 RELATIVE ADDRESS BIT

The RELATIVE ADDRESS BIT (Bit Ø of Byte Ø1) of the Group 1 commands is set to indicate that the block address portion of the CDB is a two's complement displacement. This displacement is to be added to the Block Address last accessed on the unit to form the Block Address for the present command. This feature is only available when linking commands. The feature requires that a previous command in the linked group have accessed a block of data on the device.

4.4.7 LOGICAL BLOCK ADDRESS

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

4.4.8 NUMBER OF BLOCKS

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

4.4.9 CONTROL BYTE

The control byte is the last byte in a Class ØØ or Class Ø1 command. The command byte is defined as follows:

Bits 7-2	Reserved; must be zero
Bit 1	FLAG--This bit indicates that an interrupt is requested for this command in a group of linked commands. This bit may only be set for LINKED commands.
Bit Ø	LINK--This bit indicates the existence of a LINKED command which will be automatically executed upon successful completion of the current command.

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-5500.

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-5500 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.Ø ST5Ø6 INTERFACE DESCRIPTION

5.1 INTRODUCTION

The ST5Ø6 Interface is an industry standard for connecting 5 1/4" Winchester disk drives to disk controllers. The ST5Ø6 interface is based on an interface developed by Seagate Technology for the ST5Ø6 and ST412 disk drives. This interface has since been implemented in a majority of 5 1/4" disk drives. The ST5Ø6 interface, as implemented by the ACB-55ØØ, is characterized by 5 Mb/s data and an MFM encoding scheme.

5.2 INTERFACE SIGNALS

The ST5Ø6 interface consists of a control cable and one or more data cables. The control cable is multi-dropped from the ACB-55ØØ 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-55ØØ and a single drive. To use the ACB-55ØØ with four drives, the maximum supported, one control cable and four data cables are required. Figure 5-1 shows the ACB-55ØØ cabled for this configuration.

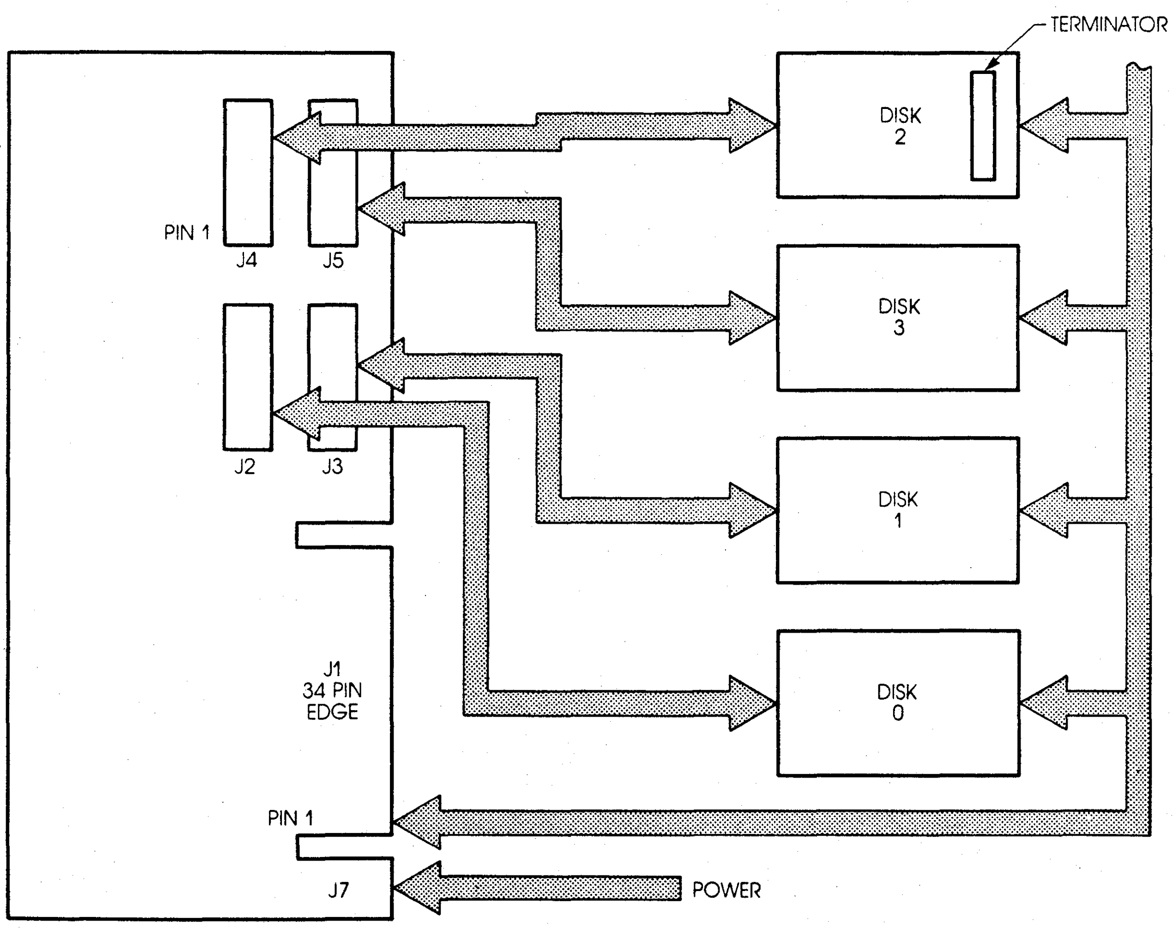

Figure 5-1. ACB-5500 Cabling

The daisy-chained control cable connects to the ACB-5500 through a 34-pin edge card connector J1. The suggested mating connector is 3M P/N 3402-000. The pin assignment for J1 is shown in Table 5-1.

Table 5-1. J1 Connector Pin Assignment

GND RTN PIN	SIGNAL PIN	SIGNAL NAME
1	2	Reduced Write Current/Head Select 2^3
3	4	Head Select 2^2
5	6	Write Gate
7	8	Seek Complete
9	10	Track 0
11	12	Write Fault
13	14	Head Select 2°
15	16	Reserved
17	18	Head Select 21
19	20	Index
21	22	Ready
23	24	Step
25	26	Drive Select 1
27	28	Drive Select 2
29	30	Drive Select 3
31	32	Drive Select 4
33	34	Direction In

The radial data cables connect to the ACB-5500 through 20-pin header connectors J2, J3, J4, and J5. Drive 0 must be connected to J2 as drives 1 and 3 must be connected to J3 to J5 respectively. The suggested mating connector is 3M P/N 3421-0000. The pin assignment for J2, J3, J4, and J5 is shown in Table 5-2.

Table 5-2. J2, J3, J4, and J5 Connector Pin Assignment

GND RTN PIN	SIGNAL PIN	SIGNAL NAME
2	1	Drive Selected
4	3	Reserved
6	5	Reserved
8	7 9,10	Reserved Reserved
12	11 13 14	GND MFM Write Data MFM Write Data
16	15 17 18	GND MFM Read Data MFM Read Data
20	19	GND

The control signals used by the ST 506 interface are transferred using the driver/receiver circuit shown in Figure 5-1. The control signals are specified as:

True = 0.0 VDC to 0.4 VDC

False = 2.5 VDC to 5.25 VDC.

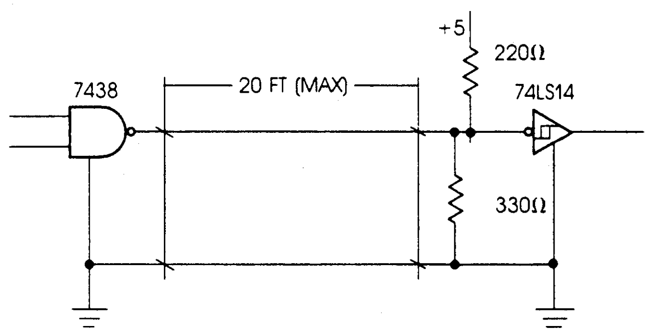

Figure 5-2. ST5Ø6 Control Signal Driver/Receiver Circuit

The MFM read and write data is transferred as differential signals using RS-422 drivers/receivers. Figure 5-3 shows the driver/receiver circuit used by the ACB-55ØØ.

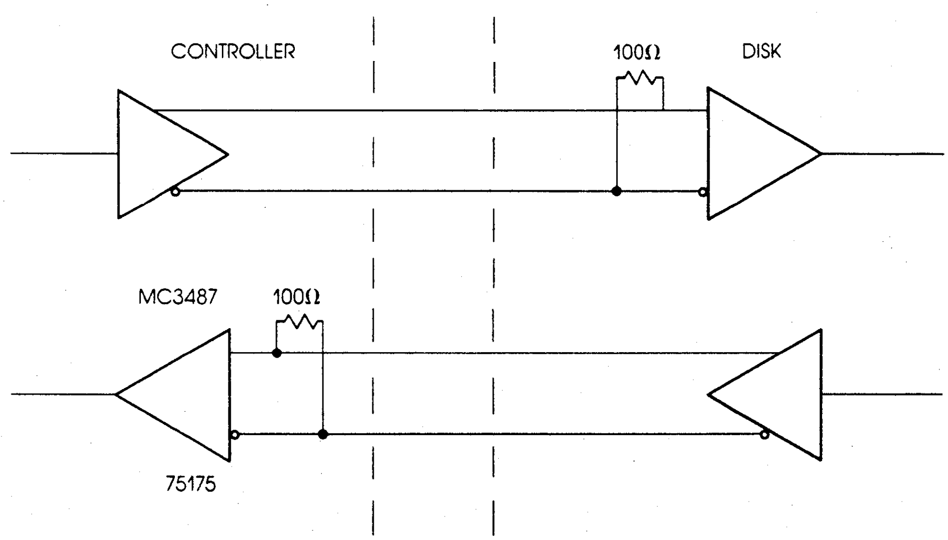

Figure 5-3. MFM Data Driver/Receiver Circuit

5.2.1 OPTIONAL LINES FOR HARD-SECTORED AND REMOVABLE DRIVES

Hard-sectored and removable drives require some additional signals across the drive interface. These are supported by the ACB-5500 when indicated by the proper board jumper condiguration and MODE SELECT command (15_H).

The hard sector drive interface requires a signal line to transmit sector pulses to the ACB-5500 for proper data transfers. This line is assigned to pin 16 of connectors J2 through J5. Installing jumpers E-F and/or G-H will cause the ACB-5500 to use this signal.

Removable drives provide two additional lines for monitoring the status of the removable cartridge. These are Change Cartridge, signaling the drive to spin down, and Cartridge Changed, signaling the controller the cartridge has been changed. These lines are assigned to pin 2 of J1 and pin 9 of J2 through J5 respectively. The ACB-5500 reports a changed cartridge with the next disk access through a Cartridge Changed (28_H) error code.

Write project is also used by removable drives to signal a protected cartridge. This line is assigned to pin 5 of connectors J2 through J5. The ACB-5500 reports a write protect violation through a Write Protect Violation (27_H) error code.

A more detailed description of these signals can be obtained from the disk driver OEM manual.

5.3 DISK FORMAT

The ACB-5500 disk format is based on the standard ST 506 format and is compatible with the ACB-4000 controller. Table 5-3 details the ACB-5500 disk format for soft-sectored drives. Table 5-4 details the disk format for hard-sectored drives.

Table 5-3. ACB-5500 Soft-Sectored Disk Format

INDEX — ONE SECTOR (Repeated) — INDEX

	GAP 1	SYNC	PRE ID AM	AM	CYL	HD	SEC	FLAG	ECC	GAP 2		PRE DATA AM	DATA AM	DATA FIELD	ECC	GAP 3		GAP 4	TOTAL BYTES PER SECTOR
# OF BYTES	4E	00	A1	FE	X	X	X	X	X	00	00	A1	FB	X	X	00	4E	4E	
256 Byte Sector 1:1 Interleave 32 Sectors/Trk	10	12	1	1	1	1	1	1	4	3	12	1	1	256	4	2	19	162	320
>2:1 Interleave 33 Sectors/Trk	10	12	1	1	1	1	1	1	4	3	12	1	1	256	4	2	9	172	310
512 Byte Sector 1:1 Interleave 17 Sectors/Trk	10	12	1	1	1	1	1	1	4	3	12	1	1	512	4	2	19	610	570
>2:1 Interleave 18 Sectors/Trk	10	12	1	1	1	1	1	1	4	3	12	1	1	512	4	2	9	214	566
1024 Byte Sector >1:1 Interleave 9 Sectors/Trk	10	12	1	1	1	1	1	1	4	3	12	1	1	1024	4	2	19	610	1088
1024 Byte Sector >2:1 Interleave 9 Sectors/Trk	10	12	1	1	1	1	1	1	4	3	12	1	1	1024	4	2	9	700	1070

Table 5-4. ACB-5500 Hard-Sectored Disk Format

INDEX

GAP 1	SYNC	PRE ID AM	AM	CYL	HD	SEC	FLAG	ECC	GAP 2		PRE DATA AM	AM	DATA FIELD	ECC
4E	00	A1	FE	X	X	X	X	X	00	00	A1	FB	X	X
9	12	1	1	1	1	1	1	4	2	13	1	1	256 512 1K	4

Note: The Cylinder Head and Sector bytes contain a single logical block address.

6.Ø COMMAND DESCRIPTIONS

The following section describes the command set of the ACB-55ØØ. Adaptec has followed the ANSI X3T9.2 SCSI Specification where possible. Deviations occur 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 and the exception Sense Error Code.

Table 6-1. Command Code Summary

Command Code	Command Name	Data/Parameter	Source*
ØØ(HEX)	Test Unit Ready	---	S
Ø1	Rezero Unit	---	S
Ø3	Request Sense	Sense Info In	S
Ø4	Format Unit	Defect List Out	SA
Ø8	Read	Data In	S
ØA	Write	Data Out	S
OB	Seek	---	S
OF	Translate	Info In	A
1Ø	Set Threshold	Info Out	A
11	Read/Reset Usage Counter	Info In	A
12	Inquiry	Info In	S
13	Write Buffer	Data Out	A
14	Read Buffer	Data In	A
15	Mode Select	Info Out	SA
16	Reserve	---	S
17	Release	---	S

Table 6-1. Command Code Summary (Continued)

Command Code	Command Name	Data/Parameter	Source*
1A(HEX)	Mode Sense	Info In	SA
1B	Start/Stop Unit	---	S
1C	Receive Diagnostic	Info In	SA
1D	Send Diagnostic	Info Out	SA
25	Read Capacity	Info In	S
28	Read (Extended)	Data In	S
2A	Write (Extended)	Data Out	S
2E	Write and Verify	Data Out	SA
2F	Verify	---	SA
31	Search Data Equal	Data Out	SA
33	Set Limits	---	S

* S = SCSI Standard Command
A = Adaptec Special Function
SA = SCSI Standard Command with Adaptec Subset.

6.1 TEST UNIT READY (ØØ$_H$)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
Ø1	Logical Unit Number			Reserved (Ø)				
Ø2	Reserved (Ø)							
Ø3	Reserved (Ø)							
Ø4	Reserved (Ø)							
Ø5	Reserved (Ø)						Flag	Link

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.

Valid Errors:

Error	Error Code
Drive Not Ready	Ø4$_H$
Write Fault	Ø3$_H$
Selection Failure	Ø5$_H$
Bad Argument	24$_H$

6.2 REZERO UNIT (01_H)

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)						Flag	Link

Figure 6-2. REZERO UNIT Command

This command sets the selected drive to track zero and then sends completion status. This may reset certain drive hardware failures.

Valid Errors:

Error	Error Code
No Seek Complete	02
Drive Not Ready	04
No Track 0	06
Selection Failure	05
Bad Argument	24

6.3 REQUEST SENSE (03_H)

BIT / BYTE	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)						Flag	Link

Figure 6-3. REQUEST SENSE Command

This command returns unit sense.

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 non-zero sense to report. Therefore, CHECK status should always be followed by a SENSE Command.

The ACB-5500 returns 4 bytes of sense information in response to this command. The number of bytes should equal 04, however, values of 00, 01, 02, and 03 will default to 04.

The REQUEST SENSE command is the most important mechanism for informing the host of abnormal states discovered by the ACB-5500.

BIT / BYTE	07	06	05	04	03	02	01	00
00	AdrVal	Error Class			Error Code (See Tables)			
01	Reserved (0)			(MSB) Logical Block Address				
02	Logical Block Address							
03	Logical Block Address (LSB)							

Figure 6-4. REQUEST SENSE Data

Valid Errors:

Error	Error Code
Bad argument	24_H
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$
SCSI HA/Initiator Detected Error	$2D_H$

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 Ø 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 Table 6-2.

The logical block address is either 21 or 32 bits long depending on the sense format option selected. It 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.

Table 6-2. Class ØØ Error Codes In Sense Byte (Drive Errors)

CODE	ERROR	MEANING
ØØ	NO SENSE	No error occurred or error cleared before REQUEST SENSE command.
Ø1	NO INDEX/SECTOR	No index or sector signal found during rd, wr, or format
Ø2	NO SEEK COMPLETE	Seek complete signal missing
Ø3	WRITE FAULT	Drive detected failure which disallows writes
Ø4	DRIVE NOT READY	Drive not ready
Ø5	SELECTION FAILURE	Incorrect Select indication returned.

Table 6-3. Class Ø1 Error Codes In Sense Byte (Target Errors)

CODE	ERROR	MEANING
1Ø	ID CRC ERROR	ID field could not be recovered by retry
11	UNCORRECTABLE DATA ERROR	Data field error could not be recovered by retry or correction
12	ID ADDRESS MARK NOT FOUND	Missing ID address mark
14	RECORD NOT FOUND	Logical block ID not on accessed tracks, but no ID CRC error
15	SEEK ERROR	Could not seek to track with correct ID
16-17	NOT ASSIGNED	
18	DATA CHECK IN NO RETRY MODE	See Send Diagnostic command
19	ECC ERROR DURING VERIFY	See Verify command
1A	NOT ASSIGNED	
1B	NOT ASSIGNED	
1C	UNFORMATTED OR BAD FORMAT ON DRIV	Format failed, no valid format on drive See Section 6.3.1
1D-1F	NOT ASSIGNED	

Table 6-4. Class 02 Error Codes (System-Related Errors)

CODE	ERROR	MEANING
20	ILLEGAL COMMAND	Command code is invalid or not implemented
21	ILLEGAL BLOCK ADDRESS	Block address outside address space by Logical Unit
22	NOT ASSIGNED	
23	VOLUME OVERFLOW	Illegal block address after first block
24	BAD ARGUMENT	Reserved bit not zero or invalid parameter
25	INVALID LOGICAL UNIT NUMBER	Logical Unit greater than 3 addressed
26	NOT ASSIGNED	
27	WRITE PROTECT	Drive has write protect option active
28	CARTRIDGE CHANGED	A disk drive cartridge was installed since the last time a command was executed.
29	MICROCODE DETECTED	Difference in drive parameter data and physical drive characteristics
2B	SET LIMIT VIOLATION	Read, Write, or Set Limit attempted in violation of previously linked Set Limit Command
2C	ERROR COUNT OVERFLOW	Posted when error count exceeds specified threshold
2D	SCSI HA/INITIATOR DETECTED ERROR	A message '05'$_H$ (Initiator Detected Error) was received from the host
2E	SCSI BUS OUT PARITY CHECK	A parity check was detected on SCSI bus outbound information transfer.
2F	ADAPTER PARITY CHECK	The ACB-5500 detected an internal hardware check.

6.3.1 BAD FORMAT ON DRIVE

The '1C' error code provides further information in the low order 3 bytes of address information, even though the address valid bit is not set.

Sense Byte	Content
Ø1	Progress code
Ø2	Sectors read before failure occurred.
Ø3	Error code detected at time error was found and progress code set.

The progress code indicates when the failure occurred, as described below:

Progress Code	Probable Failure
1Ø	Rezero failure. Typically the drive is not ready.
11	Index/Sector Detect and First Read. The drive is incorrectly cabled, unable to read, or the ACB-55ØØ has an internal failure. The drive may not be formatted.
12	Drive Parameter Read Failure. The drive media has failed or drive operation is marginal. The previous format may be incomplete.
13	Wrong Block Size/Invalid Data. The drive parameters read from the disk are not valid. The disk may not have been formatted by an Adaptec controller.
14	Seek to Last Track Failed. The drive cannot seek or fails during seeks. The drive may be formatted with the wrong number of cylinders.
15	Unable to Read Last Flag Byte. The drive is failing to read on inside tracks. The format operation may have been halted before drive formatting was completed.
16	Failure to Read Defect Information. The drive is unable to read certain tracks/heads.

For all progress codes, the error codes stored in byte 3 will be valid, although no block address information will be available.

6.4 FORMAT UNIT (04_H)

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	List Format Bits		
02	Data Pattern							
03	(MSB) Interleave							
04	Interleave (LSB)							
05	Reserved (0)						Flag	Link

Figure 6-5. FORMAT UNIT Command

The ACB-5500 will write from index to index all ID and DATA fields with the format specified by an immediately previous MODE SELECT (15_H) command. If no MODE SELECT command has been executed, the previous format will be used. On unformatted disks or those whose format cannot be determined (sense byte error code $1C_H$ returned following a READ), a MODE SELECT command is required prior to the format command. Data fields are completely written with $6C_H$ unless otherwise specified in the format command.

The ACB-5500 formats out all indicated disk defects during disk formatting.

Byte 01 is used to indicate if a list of defect locations is appended and whether unique fill characters are to be used.

Bits Ø, 2, 3, and 4 indicate the presence and format of the defect list. The ACB-55ØØ only supports bytes from index format. Bit 1 indicates whether a unique fill character is to be written into the data fields during format. Table 6-5 details the format options provided by the FORMAT UNIT command.

Table 6-5. Format Options

Data	Bit Cmplt	Format			Defect List	Fill Byte
4	3	2	1	Ø		
Ø	Ø	Ø	Ø	Ø	No defect list	$6C_H$
Ø	Ø	Ø	1	Ø	No defect list	Value in Byte Ø2
1	1	1	Ø	Ø	Complete defect list in bytes from index format	$6C_H$
1	1	1	1	Ø	Complete defect list in bytes from index format	Value in Byte Ø2

Sector interleaving may be required because 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 Ø4 of the CDB. The ACB-55ØØ controller does not require interleaving because of a high speed buffer control. An interleave number of 1 results in sequential ID fields being written on the disk. Any interleave number between 1 and the number of sectors per track results in interleaved formatting. A Ø in this field will cause the default interleave factor of 1 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 24_H (Bad Argument) will be returned if either of these rules are violated.

An example of an interleave number of 3 with 32 sectors per track follows:

```
P -  ØØ Ø1 Ø2 Ø3 Ø4 Ø5 Ø6 Ø7 Ø8 Ø9 1Ø 11 12 13 14 15 16
F -  ØØ 11 22 Ø1 12 23 Ø2 13 24 Ø3 14 25 Ø4 15 26 Ø5 27

  -  17 18 19 2Ø 21 22 23 24 25 26 27 28 29 3Ø 31 32
  -  27 Ø6 17 28 Ø7 18 29 Ø8 19 3Ø Ø9 2Ø 31 1Ø 21 32
```

P = Physical sector count
F = Formatted logical sector locations

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

Valid Errors:

Error	Error Code
All Class 0 Errors	$00\text{-}05_H$
Unformatted or Bad Format	$1C_H$
Bad Argument	24_H
Write Protect	27_H
Cartridge Changed	28_H
SCSI Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.4.1 DEFECT HANDLING

The ACB-5500 handles disk defects on a sector level. Instead of assigning alternate tracks, at the cost of performance and capacity, the ACB-5500 deletes only the sector which contains a disk defect. All subsequent logical sectors are then shifted down by one physical position. See Figure 6-6.

```
             -------------------------------------
CYLINDER 2   |98|99|100| . . . . . . . . .  | n |
             -------------------------------------
             No Defects


             -------------------------------------
CYLINDER 2   |98|99| D|100| D|101| . . . .  |n-2|
             -------------------------------------
             2 Defects
```

Figure 6-6. Sector Level Defect Skipping

To facilitate system applications where a consistent number of sectors are required per cylinder and to allow reformatting of single cylinders when required by field grown defects, the ACB-5500 allows a specified number of sectors per cylinder to be spared during formatting. The number of spare sectors allocated to each cylinder is variable from 0 to N-1 (N = # of sectors/track) and is specified in the FORMAT UNIT format information. For every spare sector allocated, one less sector will be available on each cylinder. To assure defects within a cylinder do not cause sectors to be shifted into the next cylinders, a number of spare sectors greater than the expected number of defects per cylinder should be chosen. Figure 6-7 shows the effect of sector sparing.

```
             ---------------------------------------------
CYLINDER 2   |98|99|100|· · · · · · |194|195| S | S | S |
             ---------------------------------------------
             No Defects;  3 Spare Sectors


             ---------------------------------------------
CYLINDER 2   |98|99| D |100|D|101|· · · ·   |194|195| S |
             ---------------------------------------------
             2 Defects;  3 Spare Sectors
```

Figure 6-7. Sector Sparing within Cylinders

If the number of defects within a cylinder should exceed the number of spare sectors, the additional sectors will overflow into the next cylinder. Assuming the next cylinder has enough spare sectors to account for defects within the cylinder and the overflow sectors, no other cylinders will be affected. This cylinder will now contain all of its assigned sectors plus the overflow. Figure 6-8 describes the effects of overflow sectors.

```
              ------------------------------------------------
CYLINDER 2    | 98| D | D |100| D |101|· · ·  |192|193|194|
              ------------------------------------------------
              4 Defects;  3 Spares

              ------------------------------------------------
CYLINDER 3    |195|196| D |197| · · · · · · · |292|293| S |
              ------------------------------------------------
              1 Defect;  3 Spares;  1 Overflow
```

Note: In this example cylinder 2 now contains 97 sectors and Cylinder 3 contains 99, the remaining cylinders on the disk contain 98.

Figure 6-8. Sector Sparing and Overflow Sectors

In the case of formatting out a grown defect(s) within a cylinder with no available spares, all subsequent cylinders must be reformatted until an adequate number of spares are available to account for all overflowing sectors.

6.4.2 FORMAT UNIT DATA

Two format options exist, one using the standard SCSI defect list for formatting an entire disk drive, the other using an Adaptec defect list for reformatting a single cylinder.

Figures 6-9 and 6-10 detail the data required for entire drive and cylinder level formatting.

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Format Option (00)							
01	Number of Spare Sectors							
02	Length of							
03	Defect List in Bytes (8N)							
04	(MSB) Cylinder Number of Defect #1							
05	Cylinder Number of Defect #1							
06	Cylinder Number of Defect #1							
07	Head Number of Defect #1							
08	(MSB) Bytes From Index							
09	Bytes From Index							
10	Bytes From Index							
11	Bytes From Index (LSB)							
. . .								
8N-4 to 8N+3	Nth Defect							

Figure 6-9. Format Unit Data Block (Drive Formatting)

Byte 00 indicates the formatting option for the drive. 00 indicates the entire unit is to be formatted; 01 indicates only the specified cylinder is to be formatted.

Byte 01 indicates the number of spare sectors to be allocated per cylinder. The number of spare sectors allocated must be the same for every cylinder for single cylinder formatting. A 00 in this byte will result in no spare sectors.

If no spare sectors are allocated, the defective sector pushdown algorithm limits the number of defects to 128. If bytes 2 and 3 specify more than 128 8-byte descriptors, a Bad Argument (24_H) error will be posted. If one or more spare sectors are allocated, a number of sectors, up the total number of spares, may be marked as defective. The number of spare sectors allocated on a cylinder must be less than the number of sectors on a single track of the cylinder.

Bytes Ø2 and Ø3 indicate the number of following data bytes containing defect descriptors and/or format information.

For entire unit formatting, bytes Ø4 through 11 indicate the physical location of the first defect descriptor (defect location in terms of cylinder, head and bytes from index). The defect descriptors must be listed in ascending order starting from cylinder Ø, head Ø.

For single cylinder formatting, bytes Ø4 through 11 indicate the cylinder to be formatted and the starting sector number of the cylinder. The starting sector number can be determined using the READ MAXIMUM CAPACITY (25_H) command on the previous cylinder.

Note: The user must caution when sectors overflow from one cylinder to another. If incorrect starting sector number is used, missing sector error will be detected during read, write or verify commands.

BYTE	BIT: Ø7 Ø6 Ø5 Ø4 Ø3 Ø2 Ø1 ØØ
ØØ	Format Option (Ø1)
Ø1	Number of Spare Sectors
Ø2	Length of Appended
Ø3	Data in Byte
Ø4	(MSB) Cylinder Number
Ø5	To Be
Ø6	Formatted (LSB)
Ø7	ØØ
Ø8	(MSB)
Ø9	Starting
1Ø	Sector Number
11	(LSB)
12 : : : 19	First Defect Descriptor

Figure 6-1Ø. Format Unit Data Block
(Cylinder Level Formatting)

6.5 READ (08_H)

BIT / BYTE	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)						Flag	Link

Figure 6-11. READ Command

This command transfers from the ACB-5500 the specified number of blocks starting at the specified logical starting block address of the selected ST 506 drive.

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-5500 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 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. Cylinder switching is transparent to the user. On a data ECC error, the block is re-read up to 5 times to establish a solid error syndrome. Only then is correction attempted. Correction is done directly into the data buffer, transparent to the host.

Blocks containing uncorrectable data errors will be transferred to the host prior to an ending check status. A REQUEST sense will return an uncorrectable data error (11_H) error code.

Valid Errors:

Error	Error Code
All Class Ø Errors	$ØØ\text{-}Ø5*_H$
I.D. CRC Error	$1Ø*_H$
Uncorrectable Data Error	$11*_H$
I.D. AM Not Found	$12*_H$
Data AM Not Found	$13*_H$
Record Not Found	$14*_H$
Seek Error	$15*_H$
Data Check (No Retry Mode)	$18*_H$
Bad Format	$1C_H$
Illegal Block Address	21_H
Volume Overflow	23_H
Bad Argument	24_H
Cartridge Changed	28_H
Media Error	29_H
Set Limit Violation	$2B_H$
SCSI HA Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

*Address will be valid in sense data

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

6.6 WRITE ($ØA_H$)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	Ø	Ø	1	Ø	1	Ø
Ø1	Logical Unit Number			(MSB) Logical Block Address				
Ø2	Logical Block Address							
Ø3	Logical Block Address (LSB)							
Ø4	Number of Blocks							
Ø5	Reserved (Ø)						Flag	Link

Figure 6-12. WRITE Command

This command transfers to the selected ST 5Ø6 drive on the ACB-55ØØ 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-55ØØ will disconnct 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.

Subsequent blocks of data are transferred until the block count is decremented to zero. Cylinder, head switching, and defect skipping are transparent to the user.

Valid Errors:

Error	Error Code
All Class Ø Errors	$ØØ\text{-}Ø5*_H$
I.D. CRC Error	$1Ø*_H$
I.D. AM Not Found	$12*_H$
Record Not Found	$14*_H$
Seek Error	$15*_H$
Bad Format	$1C_H$
Illegal Block Address	21_H
Volume Overflow	23_H
Bad Argument	24_H
Write Protected	27_H
Cartridge Changed	28_H
Microcode Detected Error	29_H
Set Limit Violation	$2B_H$
SCSI HA Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

*Address will be valid in sense data.

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

6.7 SEEK ($0B_H$)

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 (LSB)							
04	Reserved (0)							
05	Reserved (0)						Flag	Link

Figure 6-13. SEEK Command

This command causes the selected drive to seek to the specified starting address. If a head seek is required, the ACB-5500 will disconnect from the SCSI bus and reconnect upon seek completion. The ACB-5500 returns completion status immediately after the seek pulses are issued and head motion starts. Any command received for a unit with a seek in progress will immediately complete with a command completion status of busy (bit 3 set).

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

The ACB-5500 uses an implied seek on READ, WRITE and SEARCH commands eliminating the need for SEEK commands before each operation.

Valid Errors:

Error	Error Code
No Seek Complete	02_H
Drive Not Ready	04_H
Select Failure	05_H
Bad Format	$1C_H$
Illegal Block Address	21_H
Bad Argument	24_H
Invalid Logic Number	25_H
Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Error	$2E_H$
Adapter Parity Check	$2F_H$

6.8 TRANSLATE ($0F_H$)

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)						Flag	Link

Figure 6-14. 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 can be used to build a defect list for the FORMAT command.

To translate logical blocks, the ACB-5500 physically seeks the designated block and reads its physical location. 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 and use the track format shown in Tables 5-3 and 5-4 to determine the location of the target block. The presence of formatted (skipped) defects will require a more complicated algorythm for determination of the error location.

Eight bytes are returned in the format of defect descriptors required by the FORMAT UNIT command, Figure 6-15.

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 6-15. TRANSLATE Data

Valid Errors:

Errors	Error Code
All Class 0 Errors	$00\text{-}05_H$
I.D. CRC Error	10_H
I.D. AM Not Found	12_H
Record Not Found	14_H
Seek Error	15_H
Bad Format	$1C_H$
Illegal Block Address	21_H
Bad Argument	24_H
Cartridge Changed	28_H
SCSI HA/Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Error	$2E_H$
Adapter Parity Check	$2F_H$

6.9 SET THRESHOLD (10_H)

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 (0)							
03	Reserved (0)							
04	Bytes to be Transferred (01)							
05	Reserved (0)						Flag	Link

Figure 6-16. SET THRESHOLD Command

The ACB-5500 optionally provides an error logging capability for those errors that are normally retried without any notification to the host system. The ACB-5500 counts blocks transferred, seek errors, and retried and corrected 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.

One byte of parameter data will be transferred.

BYTE \ BIT	07	06	05	04	03	02	01	00
00	Threshold Value							

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 $2C_H$, 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:

Error	Error Code
Drive Not Ready	04_H
Bad Argument	24_H
Cartridge Changed	28_H
Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Error	$2E_H$
Adapter Parity Check	$2F_H$

6.10 READ/RESET USAGE COUNTER (11_H)

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 (0)							
03	Reserved (0)							
04	Bytes Allocated (09)							
05	Reserved (0)						Flag	Link

Figure 6-17. READ/RESET USAGE COUNTER Command

The READ/RESET USAGE COUNTERS command recovers the information stored by the ACB-5500 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, all subsequent commands for that device will terminate immediately with Check Condition status and an error code of $2C_H$, Error Counter Overflow. This will continue until execution of the READ/RESET USAGE COUNTER command, which recovers the 9 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				
05				Seek Usage Count				(LSB)
06				Uncorrectable Data Check Count				
07				Correctable Data Check Count				
08				Seek Check Count				

Figure 6-18. 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 a 11_H error code.

The Correctable Data Check Count counts all occurrences of the successful recovery of a logical block that was unsuccessfully read at first. This information is available only through error logging, since these errors are recovered without notifying the host unless a diagnostic 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:

Error	Error Code
Drive Not Ready	Ø4$_H$
Bad Argument	24$_H$
Cartridge Changed	28$_H$
Initiator Detected Error	2D$_H$
SCSI Bus Out Parity Error	2E$_H$
Adapter Parity Check	2F$_H$

6.11 INQUIRY (12$_H$)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	Ø	1	Ø	Ø	1	Ø
Ø1	Logical Unit Number			Reserved (Ø)				
Ø2	Reserved (Ø)							
Ø3	Reserved (Ø)							
Ø4	Allocation Length							
Ø5	Reserved (Ø)						Flag	Link

Figure 6-19. INQUIRY Command

The INQUIRY command requests parameters describing the ACB-55ØØ and attached devices.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returning Inquiry Data. The ACB-55ØØ will return the Allocation Length number of bytes or 4 bytes, whichever is less. Zero is a valid Allocation Length and indicates no data may be transferred.

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	ØØ (Direct Access Device Type)							
Ø1	RMB	Reserved (Ø)						
Ø2	Ø1							
Ø3	ØØ							

Figure 6-2Ø. INQUIRY Parameters

Byte ØØ of the parameter list is zero, indicating that the attached devices are direct access disk devices with a read and write capability. The RMB bit of byte Ø1 indicates whether the attached LUN is a fixed or removable drive. This bit equalling 1 indicates a removable drive. Removable media drive can be identified by the MODE SENSE command. Byte Ø2 is Ø1, indicating that the ACB-55ØØ meets the SCSI specifications, version 14. The only significant exception is the definition of the Format Cylinder Option and optional fill character. Byte Ø3 is ØØ, indicating that no other bytes are defined.

Valid Errors:

Error	Error Code
Bad Format	$1C_H$
Bad Argument	24_H
Cartridge Changed	28_H
Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.12 WRITE DATA BUFFER (13_H)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	Ø	1	Ø	Ø	1	1
Ø1	Logical Unit Number			Reserved (Ø)				
Ø2	Reserved (Ø)							
Ø3	Reserved (Ø)							
Ø4	Reserved (Ø)							
Ø5	Reserved (Ø)						Flag	Link

Figure 6-21. WRITE DATA BUFFER Command

This command serves buffer RAM diagnostic purposes. The controller will fill the buffer with 4K bytes of data from the host. There is no guarantee that this data will not be overwritten by other operations initiated by other Initiators.

Valid Errors:

Error	Error Code
Drive Not Ready	04_H
Bad Argument	24_H
SCSI HA/Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.13 READ DATA BUFFER (14_H)

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

Figure 6-22. READ DATA BUFFER Command

READ DATA BUFFER will pass the host 2K of data from the buffer. It is intended for RAM diagnostic purposes. Although data remains in the buffer after normal data operations, the ordering of the data found there may vary.

Valid Errors:

Error	Error Code
Drive Not Ready	04_H
Bad Argument	24_H
SCSI HA/Initiator Detecter Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter parity Check	$2F_H$

6.14 MODE SELECT (15_H)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	Ø	1	Ø	1	Ø	1
Ø1	Logical Unit Number			Reserved				
Ø2	Reserved (Ø)							
Ø3	Reserved (Ø)							
Ø4	Number of Bytes							
Ø5	Reserved (Ø)						Flag	Link

Figure 6-23. MODE SELECT Command

This command is used by the ACB-55ØØ to specify formatting parameters and should always preceed the FORMAT UNIT command. When a Blown Format error ($1C_H$) is detected due to the controller being unable to read the drive parameter information from a drive already formatted, the user may use this command to inform the controller about the drive information. Once initialized, most data on the drive may be recoverable. The information can then be recovered and the drive reformatted. Writes to the drive will not be permitted.

Byte Ø4 of the command specifies the number of information bytes to be passed with the command. The ACB-55ØØ will post an Invalid Argument error unless this equals 22 (16_H) or 24 (18_H) bytes.

The Mode Select parameters are architecturally divided by the SCSI document into a header (bytes ØØ-Ø3), a block descriptor (bytes Ø4-ØB), and vendor unique parameters. The following parameters are required by the ACB-55ØØ.

Note: After issuing a Mode Select Command, only the Read Command is executable before a new Format Command is executed.

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

Figure 6-24. Extent Descriptor List

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-5500 supports block sizes of 256 bytes, 512 bytes, and 1024 bytes.

BYTE \ BIT	7	6	5	4	3	2	1	Ø
ØØ	List Format Code = Ø1							
Ø1	MSB	Cylinder Count						
Ø2	Cylinder Count							LSB
Ø3	Data Head Count							
Ø4	MSB	Reduced Write Current						
Ø5	Reduced Write Current							LSB
Ø6	MSB	Write Precompensation						
Ø7	Write Precompensation							LSB
Ø8	Landing Zone Position							
Ø9	Step Pulse Rate							

Figure 6-25. Drive Parameter List for Soft-Sectored, Fixed Drives

The List Format Code must be set to Ø1 for soft-sectored drives and Ø2 for hard-sectored or removable drives.

The Cylinder Count is the numbe of data cylinders on the drive. The ACB-55ØØ 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 2Ø48.

The Data Head Count is the number of usable data surfaces. The minimum is 1, the maximum is 16. A drive with 9 or more heads will use the Reduced Write Current line as the high-order head select.

The Reduced Write Current cylinder is the cylinder number beyond which the controller will assert the Reduced Write Current line. The minimum value is Ø. Note that the reduced write current line is used as a fourth head select line for drives with more than 8 heads.

The Write Precompensation cylinder is the cylinder beyond which the controller will compensate for inner track bit shift. The minimum value is Ø.

Note: For drives which do not require Reduced Write Current and/or Write Precompensation, the user should set these cylinder values at the number of data cylinders plus 1.

The Landing Zone position is used with the START/STOP command to indicate the direction and number of cylinders from the last, or first, cylinders to the desired skipping or stopped position. The most significant bit indicates the direction. A Ø indicates the landing zone is beyond the maximum cylinder; a 1 indicates it is before track Ø. The other 7 bits indicate the number of cylinders in the desired direction the head will stop.

The Step Pulse Rate specifies the timing of seek steps. The three options are:

ØØ = Non-Buffered Seek (3.Ø ms/step)
Ø1 = Buffered Seek (28 us/step)
Ø2 = Buffered Seek (12 us/step)

BYTE \ BIT	7	6	5	4	3	2	1	Ø
ØØ	List Format Code = 2							
Ø1	MSB	Cylinder Count						
Ø2	Cylinder Count							
Ø3	Data Head Count							
Ø4	MSB	Reduced Write Current						
Ø5	Reduced Write Current							LSB
Ø6	MSB	Write Precompensation						
Ø7	Write Precompensation							
Ø8	Landing Zone Position							
Ø9	Step Pulse Rate							
OA	Drive Type Code							
OB	Sector Count							

Figure 6-26. Drive Parameter List for Hard-Sectored, Removable Drives

The Drive Parameter List for Hard-Sectored or removable drives must begin with a List Format Code of Ø2 and contains two additional bytes. This parameter list must be sent if the E-F or

G-H jumpers are installed.

The Drive Type Code indicates the characteristics of the drive, defined as:

```
Bit Ø-1 = Ø - Must be Ø
  Bit 2 = Ø - Soft-sectored
        = 1 - Hard-sectored
  Bit 3 = Ø - Removable Media Drive
        = 1 - Fixed Media Drive
Bit 4-7 = Ø - Must be Ø
```

The Sector Count equals the number of sectors on a track. Note that for hard-sectored drives this must equal the number of sectors set by the drive manufacturer.

6.15 RESERVE (16_H)

BIT / BYTE	7	6	5	4	3	2	1	0
ØØ	Ø	Ø	Ø	1	Ø	1	1	Ø
Ø1	Logical Unit Number			Reserved (Ø)				Extent
Ø2	Reservation Identification							
Ø3	(MSB) Extent List Length							
Ø4	Extent List Length (LSB)							
Ø5	Reserved (Ø)						Flag	Link

Figure 6-27. RESERVE Command

The Cylinder Count is the number of data cylinders on the drive. The ACB-55ØØ 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 4Ø94.

The Data Head Count is the number of usable data surfaces. The minimum is 1; maximum is 16. A drive with 9 or more heads will use the Reduced Write Current line as the high order head select.

The Reduced Write Current cylinder is the cylinder number beyond which the controller will assert the Reduced Write Current line. The minimum value is Ø. Note that the reduced write current line is used as a fourth select line for drives with more than 8 heads.

The Write Precompensation cylinder is the cylinder beyond which the controller will compensate for inner track bit shift. The minimum value is Ø.

Note: For drives which do not require Reduced Write Current and/or Write Precompensation, the user should set these cylinder values to the number of data cylinders plus 1.

The Landing Zone position is used with the START/STOP command to indicate the direction and number of cylinders from the last, or first, cylinders to the desired shipping or stopped position. The most significant bit indicates the direction. AO indicates the landing zone is beyond the maximum cylinder, as 1 indicates it is before track Ø. The other 7 bits indicate the number of cylinders in the desired direction the head will stop.

The Step Pulse Rate specifies the timing of seek steps. The three options are:

ØØ = Non-Buffered Seek (3.Ø ms/step)
Ø1 = Buffered Seek (28 us/step)
Ø2 = Buffered Seek (12 us/step).

The Drive Parameter List for hard-sectored or removable drives must begin with a List Format Code of Ø2 and contains two additional bytes. This parameter list must be sent if the E-F or G-H jumpers are installed (indicating hard-sectored drives).

The Drive Type Code indicates the characteristics of the drive, defined as:

Bits Ø-1	= Ø	Must be Ø
Bit 2	= Ø	Soft-sectored
	= 1	Hard-sectored
Bit 3	= Ø	Removable media drive
	= 1	Fixed Media Drive
Bits 4-7	= Ø	Must be Ø.

This command is used to reserve logical units or extents within units for the use of an Initiator.

The Reservation function is used to prohibit certain kinds of access from some Initiators so that the reserving Initiator can complete multi-step transactions without interference. Extra drives are also implicitly reserved to the active initiator during an active chain of linked commands. An Initiator may only have one reservation per logical unit.

Reserve Unit:

If the Extent bit (Bit Ø of Byte Ø1) is zero, and no extent within the unit is currently reserved by another Initiator, then this command shall cause the unit to be reserved for exclusive use of the Initiator until the reservation is released by a RELEASE UNIT command issued by the same Initiator or by a BUS DEVICE RESET message from any Initiator or a "Hard" RESET condition. It is permissible for an Initiator to reserve a logical unit that is currently reserved for that Initiator. The Reservation Identification (Byte Ø2) and the Extent List Length (Bytes

Ø3 through Ø4) are ignored. If the unit or any extent within the unit is previously reserved, then the unit shall respond by a RESERVATION CONFLICT Status.

If any other Initiator then subsequently attempts to perform a READ or WRITE operation on the reserved unit, that command shall be rejected with RESERVATION CONFLICT Status. If a REQUEST SENSE command is executed, a No Sense error code will be presented.

The Reservation Identification (Byte Ø2) provides a means for an Initiator to identify each Extent Reservation. This allows an Initiator in a multi-tasking environment to have multiple reservations outstanding. The Reservation Identification is used in the RELEASE command to specify which reservation is to be released.

Extent Reservation Within Units:

Extents within a unit may be reserved, each with a separate Reservation Type by setting the Extent bit to 1. If the reservation cannot be granted because of conflicts with a previous reservation, a RESERVATION CONFLICT status indication is posted. Reservations are only active when all extents are free from conflict with currently active reservations.

If the extent bit is one, then:

(1) The Extent List is checked for number of extents in the reservation request. The ACB-55ØØ supports only one extent. If the Extent List contains more than one extent, then the command shall be rejected with CHECK CONDITION Status and an ILLEGAL BLOCK REQUEST (21_H) error.

(2) The Extent List will be checked for valid extent block addresses. If any address is invalid for this unit, then the command is rejected with the CHECK CONDITION Status and a Sense Key of ILLEGAL BLOCK REQUEST (21_H).

(3) If there already is an active unit reservation for the unit, the command shall be rejected with CHECK CONDITION Status and a Sense Key of ILLEGAL REQUEST.

(4) If the requested reservation does not conflict with any active reservation, then the extent specified is reserved until release by a RELEASE command from this Initiator or by a BUS DEVICE RESET message from any Initiator or a "Hard" RESET condition.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Reserved					Rel/Adr	Reserv. Type	
01	Number of Blocks (MSB)							
02	Number of Blocks							
03	Number of Blocks (LSB)							
04	Logical Block Address (MSB)							
05	Logical Block Address							
06	Logical Block Address							
07	Logical Block Address (LSB)							

Figure 6-28. Extent Descriptor Format

The size of the Extent List is defined by the Extent List Length parameter in the CDB. The ACB-5500 requires the length to be either 8 or 0. The Extent Descriptor defines an extent beginning at the specified Logical Block Address (Bytes 04 through 07) for the specified Number of Blocks (Bytes 01 through 03). If the Number of Blocks is zero, the extent begins at the specified Logical Block Address and continue through the last Logical Block Address on the unit.

The Reservation Type field (Bits 1 through 0 of Byte 00) determines the type of reservation to be effected for each extent. Four types of reservations are possible as follows:

Code	Reservation Type
10	Read Exclusive
01	Write Exclusive
11	Exclusive Access
00	Read Shared.

While Read Exclusive is active, no other Initiator shall be permitted READ access to the indicated extent. This reservation shall not inhibit WRITE accesses from any Initiator or conflict with a Write Exclusive reservation; however, Read Exclusive, Exclusive Access, and Read Shared reservations which overlap this extent shall conflict with this reservation.

While Write Exclusive is active, no other Initiator shall be permitted WRITE access to the extent. This reservation shall not inhibit READ accesses from an Initiator or conflict with a Read Exclusive reservation from any Initiator. This reservation shall conflict with Write Exclusive, Exclusive Access, and Read Shared reservations which overlap this extent.

While Exclusive Access is active, no other Initiator shall be permitted any access to the indicated extent. All Reservation Types which overlap this extent shall conflict with this reservation.

While Read Shared is active, no WRITE accesses shall be permitted by any Initiator to the indicated extent. This reservation shall not inhibit READ accesses from any Initiator or conflict with a Read Shared reservation. Read Exclusive, Write Exclusive, and Exclusive Access reservations which overlap with this extent shall conflict with this reservation.

If the RELATIVE ADDRESS bit (Bit 2 of Byte 00) is 1, the Logical Block Address shall be treated as a two's complement displacement. This displacement shall be added to the Block Address last accessed on the unit to form the Block Address for this extent. This feature is only available when linking commands and requires that a previous command in the linked group has accessed a block of data on the unit; if not, the RESERVE Command shall be rejected with CHECK CONDITION Status and an error code of Bad Argument (24_H).

If an Initiator attempts to access (READ or WRITE) a block which has been reserved and that access is prohibited by the reservation, then the operation is not performed and terminates with RESERVATION CONFLICT Status. If any access conflict exists, none of the operation shall be performed. If any extent in a unit is reserved in any way, a FORMAT UNIT Command is rejected with RESERVATION CONFLICT Status.

Note that RESERVE commands, whether for a unit or for an extent, are not queued. Host software is responsible for queuing reserve functions, since careful management of host software is required to detect and circumvent potential deadlocks. In multi-host systems, deadlock prevention may require an auxiliary communication path or very restrictive programming conventions.

Host software is responsible for monitoring and clearing reservations generated by attached hosts that have failed with reservations outstanding. This may require an auxiliary communications path. The reservations for failing hosts may be cleared using the BUS DEVICE RESET message. Note that non-failing hosts must be aware of and provide permission for execution of a BUS DEVICE RESET since reservations on their behalf will also be destroyed.

Valid Errors:

Error	Error Code
Illegal Block Address	21_H
Bad Argument	24_H
Cartridge Changed	28_H
SCSI HA/Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.16 RELEASE (17_H)

BYTE \ BIT	7	6	5	4	3	2	1	0
00	0	0	0	1	0	1	1	1
01	Logical Unit Number			Reserved (0)				Extent
02	Reservation Identification							
03	Reserved (0)							
04	Reserved (0)							
05	Reserved (0)						Flag	Link

Figure 6-29. RELEASE Command

This command is used to release previously Reserved devices or previously reserved extents within units.

If the Extent bit (Bit 0 of Byte 01) is zero, this command causes the unit to terminate any active reservation from that Initiator. If the Extent bit is one, this command causes any reservation from the requesting Initiator with a matching Reservation Identification (Byte 02) to be terminated. Other reservations from the requesting Initiator shall remain in effect. It is not an error for an Initiator to attempt to release a reservation which is not currently active.

Valid Errors:

Error	Error Code
Bad Argument	24_H
Cartridge Changed	28_H
SCSI HA/Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adaptec Parity Check	$2F_H$

6.17 MODE SENSE ($1A_H$)

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	Reserved (0)							
03	Reserved (0)							
04	Number of Bytes							
05	Reserved (0)						Flag	Link

Figure 6-30. MODE SENSE Command

This command is used to interrogate the ACB-5500 device parameter table to determine the specific characteristics of any disk drive currently attached.

Byte 04 of the command specifies the number of data bytes allowed to be returned by the command. For soft-sectored drives, this list is 22 bytes (16_H) long and for hard-sectored or removable drives, this list is 24 bytes (18_H) long. Not all of the MODE SELECT data needs to be requested.

The returned information will be the four-byte Parameter List, the Extent Descriptor List and the Drive Parameter List (if requested). These lists take the exact format of the data in the MODE SELECT command, except that the first byte will be the expected data count of '1A'H.

The Mode Sense command information is only available if a previous Mode Select command was successfully executed or if the automatic initialization for the drive was successful. If the information is not available, an error status with 1C (Bad Format) error code is presented.

Valid Errors:

Error	Error Code
Bad Argument	24_H
Cartridge Changed	28_H
SCSI HA/Initiator Detected Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.18 START/STOP UNIT ($1B_H$)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	Ø	1	1	Ø	1	1
Ø1	Logical Unit Number			Reserved (Ø)				
Ø2	Reserved (Ø)							
Ø3	Reserved (Ø)							
Ø4	Reserved (Ø)							St/Stp
Ø5	Reserved (Ø)						Flag	Link

Figure 6-31. START/STOP UNIT Command

This command allows the host to preform power-on and power-down routines incorporating the ACB-55ØØ.

A STOP command will cause the ACB-55ØØ to step the drive heads to the Landing Zone Cylinder specified in the MODE SELECT command. The controller will not accept any further commands until a START command is issued.

A START command will cause the controller to perform a power-on initialization.

Bit ØØ, Byte Ø4 is used to indicate if the command is START or STOP. This bit equal to 1 indicates a START command.

Valid Errors:

Error	Error Code
Drive Not Ready	$Ø4_H$
Bad Argument	24_H
Cartridge Changed	28_H
SCSI HA/Initiator Detached Error	23_H
SCSI But Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.19 RECEIVE DIAGNOSTIC ($1C_H$)

BYTE \ BIT	7	6	5	4	3	2	1	Ø
ØØ	Ø	Ø	Ø	1	1	1	Ø	Ø
Ø1	Logical Unit Number			Reserved (Ø)				
Ø2	Reserved (Ø)							
Ø3	(MSB) Data Length							
Ø4	Data Length (LSB)							
Ø5	Reserved (Ø)						Flag	Link

Figure 6-32. RECEIVE DIAGNOSTIC Command

This command sends analysis data to the Host after completion of a SEND DIAGNOSTIC command. Bytes 3 and 4 designate the size of the available buffer (in bytes).

RECEIVE DIAGNOSTIC is used to transfer data to the host and must immediately follow a SEND DIAGNOSTIC command. If a READ DIAGNOSTIC command does not follow a SEND DIAGNOSTIC command or the SEND DIAGNOSTIC command has no associated data, a Bad Argument (24_H) error code will be posted.

The data length specified should be $1Ø4_H$ or more, although, if a smaller buffer is provided, only that much data will be transferred and the command will terminate normally.

The data buffer received as a result of a dump will be formatted as shown in Figure 6-34.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	(MSB)			Data Block Length (0104_H)				
01				Data Block Length				(LSB)
02	(MSB)			Starting Address of Dump				
03				Starting Address of Dump				(LSB)
04				Dumped Data (xx00)				
⋮								
103				Dumped Data (xxFF)				

Figure 6-33. RECEIVE DIAGNOSTIC Data

Valid Errors:

Error	Error Code
Bad Argument	24_H
SCSI HA/Initiator Detached Error	23_H
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.20 SEND DIAGNOSTIC ($1D_H$)

BYTE \ BIT	7	6	5	4	3	2	1	0
00	0	0	0	1	1	1	0	1
01	Logical Unit Number			Reserved (0)				
02				Reserved (0)				
03	(MSB)			Data Length				
04				Data Length				(LSB)
05				Reserved (0)			Flag	Link

Figure 6-34. SEND DIAGNOSTIC Command

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

Bytes 3 and 4 specify the length of the data to be sent.

The data length specified in the command must be at least 4 bytes long and should be equal to the length of the data block to be passed over to the controller. If the length specified is longer than needed, the excess is ignored and not transferred.

BYTE \ BIT	7	6	5	4	3	2	1	0
00	Diagnostic Specifier							
01	Reserved (0)							
02	High Byte of Start Address or Qualifier							
03	Low Byte of Start Address							
04	High Byte of Patch Length							
05	Low Byte of Patch Length							
06	Optional Patch Data							
	. . .							
N+5	Optional Patch Data							

Figure 6-35. SEND DIAGNOSTIC Parameter Format

Byte 00 of the Parameter List specifies the particular diagnostic function being requested. The following options are presently available.

60 -- Reinitialize Drive
61 -- Dump Hardware Area (4000-40FF)*
62 -- Dump RAM (8000-80FF, COOO-COFF)
63 -- Patch Hardware Area*
64 -- Patch RAM*
65 -- Set Read Error Handling Options
66 -- Initiate Trace
*Standard diagnostics do not require these functions

The detailed format for each of these options is described below.

6.2Ø.1 DIAGNOSTIC 6Ø -- REINITIALIZE DRIVE:

The selected drive runs through its itialization procedure, rezeroing, capturing the critical drive dimension parameters, determining the maximum capacity, and capturing defect skipping parameters. The parameter list is:

Byte	Contents
Ø	$6Ø_H$
1-5	$ØØ_H$

No RECEIVE DIAGNOSTIC information is available as a result of this diagnostic option.

6.2Ø.2 DIAGNOSTIC 61 -- DUMP HARDWARE AREA

The area specified by the dump address is transferred by the RECEIVE DIAGNOSTIC command immediately following this SEND DIAGNOSTIC command. The parameter list is:

Byte	Contents
1	61_H
1	$ØØ_H$
2	$4Ø_H$
3	Low Order Address of Hardware Area
4-5	Length of Transfer to be Performed.

6.2Ø.3 DIAGNOSTIC 62 -- DUMP RAM AREA

The area specified by the dump address is transferred by the RECEIVE DIAGNOSTIC command immediately following this SEND DIAGNOSTIC command. The parameter list is:

Byte	Contents
Ø	62_H
1	$ØØ_H$
2	$8Ø_H$ or $EØ_H$
3	Low Order Address of RAM area
4-5	Length of Transfer to be Performed.

6.2Ø.4 DIAGNOSTIC 63 -- PATCH HARDWARE AREA

6.2Ø.5 DIAGNOSTIC 64 -- PATCH RAM AREA

These commands will provide special diagnostic tools for analysis of certain very complex system interactions. No use should be made of these commands without contacting an Adaptec applications engineer, since temporary unavailability or loss of critical data may occur.

6.20.6 DIAGNOSTIC 65 -- SET READ ERROR HANDLING OPTIONS

The selected drive is set in the special error recovery mode established by the contents of byte 05. The error handling mode is set to the default value by a hard SCSI reset condition, a power on reset, and by a SEND DIAGNOSTIC command specifying the default error handling value.

Byte	Contents
0	65_H
1	00_H
2	00_H
3	00_H
4	00_H
5	Error Handling Option

The Error Handling options are specified below:

00_H Default value.

A correctable error will be corrected and all data transfer will be completed. No check status will be presented. If the error is not correctable, the controller will transfer the uncorrected data and post an error code of 11_H with the address valid bit set. The address will be the logical block address of the bad block.

01_H

If an ECC error occurs on the first read of a data field, the data transfer operation will be halted after transfer of the bad data block. A check condition will be presented. The error code will be 18 with the address valid bit set. The failing block address will be in the logical block address field of the sense information.

02_H

A correctable error will be corrected and the corrected data transferred. The operation will then stop and present check status and an error code of 18_H as described in option 01. An uncorrectable error will be handled as in option 00.

6.20.7 DIAGNOSTIC 66 -- INITIATE TRACE

A high-level state trace facility is provided in the ACB-5500. The purpose is to provide the user with a tool to analyze complex multi-host SCSI interactions.

The parameter list is:

Byte 00 -- 66_H
Byte 01 -- Trace control options
- Bit 3 = 1 -- Single device tracing
- Bit 2 = 1 -- Single buffer tracing (only EXXX Ram area will be used)
- Bit 1 = 1 -- SCSI status tracing
- Bit 0 = 1 -- Command tracing

Byte 02 -- Single device address
Byte 03 -- 00_H
Byte 04 -- 00_H
Byte 05 -- 00_H

The trace control options (byte 01) allow tuning of the trace contents to locate the particular system interaction of interest.

Bit 3 Single device tracing

When set, the ACB-5500 will trace all appropriate interactions on behalf of the LUN specified in byte 02. The information will be posted in RAM locations 8060-80DF for the selected device.

Bit 1 SCSI status tracing

When set, SCSI status contents will be included in the trace of activities.

Bit 0 SCSI command tracing

When set, the SCSI command will be included in the trace of activities.

If Byte 01 is 00, trace is inactive. Any activation of a trace function has a small unfavorable effect on performance of the ACB-5580. The trace is automatically inactivated by a power on reset process.

Trace storage exists in RAM Locations C060-C0DF. To request a trace dump, the host needs to send the controller diagnostic send/receive command with the appropriate 'dump ram' instruction.

Each trace entry consists of 2 bytes as follows:

Byte	7	6	5	4	3	2	1	0
00	STAT	CMD	TRACE INFORMATION					
01	LUN ID #				H.A. ID #			

Byte 00_H is the Trace Activity Indicator.

Bits 6 and 7 indicate the type of trace information provided.

Bit Ø7	Bit Ø6	Trace
Ø	Ø	SCSI Bus Trace
1	Ø	SCSI Command Trace
Ø	1	SCSI Status Trace

The SCSI Bus Trace provides information on a transaction across the SCSI bus. This information is contained in bits Ø-5.

Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit Ø	Information
Ø	Ø	Ø	Ø	Ø	Ø	Host Selection
Ø	Ø	Ø	Ø	1	Ø	Reconnection
Ø	Ø	Ø	Ø	1	1	Disconnection
Ø	Ø	Ø	1	Ø	Ø	Attention Handling
Ø	Ø	Ø	1	Ø	1	Command Linking
Ø	Ø	Ø	1	1	Ø	Command End
Ø	Ø	Ø	1	1	1	SCSI Reset
Ø	Ø	1	Ø	Ø	Ø	Bus Device

The SCSI Status Trace provides the completion status byte presented in Bits Ø-5.

The SCSI Command Trace provides the Command Operation Byte (Byte $ØØ_H$ of CDB) received.

Byte $Ø1_H$ contains the Device and Host Adapter SCSI ID numbers. These are the preconfigured SCSI bus addresses.

Trace storage is organized beginning with 2 bytes of trace pointer followed by the wrap-around trace buffer. The trace pointer, in the first two bytes returned, points to the address of the "tail" point of the buffer. Trace information is ordered chronologically from the "tail" pointer, through to the top of the buffer (8000_H or $C000_H$) and back around to 1 minus the "tail" pointer address.

Valid Errors:

Error	Error Code
Bad Argument	24_H
SCSI HA/Initiator Detached Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter parity Check	$2F_H$

6.21 READ CAPACITY (25_H)

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

Figure 6-36. 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 6-38 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 6-37. 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
All Class 0 Errors	$00\text{-}05_H$
I.D. ECC Error	10_H
I.D. AM Not Found	12_H
Record Not Found	14_H
Seek Error	15_H
Bad Argument	24_H
SCSI HA/Initiator Detached Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

6.22 READ (28_H)

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							
07	Number of Blocks							
08	Number of Blocks							
09	Reserved						Flag	Link

Figure 6-38. READ Command

This command is an extended address command which is otherwise identical to the Class 00 READ (08_H) 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 6.5)

6.23 WRITE (EXTENDED) ($2A_H$)

BIT / BYTE	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					
07			Number of Blocks					
08			Number of Blocks					
09			Reserved					

Figure 6-39. WRITE Command

This command is an extended address command otherwise identical to the Class 00 WRITE ($0A_H$) command. The Logical Block Address and Number of Blocks fields have been expanded for larger devices.

Valid Errors:

Write Operate Errors (See Section 6.6)

6.24 WRITE AND VERIFY ($2E_H$)

BYTE \ BIT	7	6	5	4	3	2	1	Ø
ØØ	Ø	Ø	1	Ø	1	1	1	Ø
Ø1	Logical Unit Number			Reserved (Ø)				
Ø2	(MSB)			Logical Block Address				
Ø3				Logical Block Address				
Ø4				Logical Block Address				
Ø5				Logical Block Address				(LSB)
Ø6				Reserved (Ø)				
Ø7				Number of Blocks				
Ø8				Number of Blocks				
Ø9				Reserved (Ø)			Flag	Link

Figure 6-4Ø. 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	19_H

6.25 VERIFY ($2F_H$)

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 6-41. 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 19_H

6.26 SEARCH DATA EQUAL (31_H)

BYTE \ BIT	Ø7	Ø6	Ø5	Ø4	Ø3	Ø2	Ø1	ØØ
ØØ	Ø	Ø	1	1	Ø	Ø	Ø	1
Ø1	Logical Unit Number			Invert	Reserved (Ø)			
Ø2	(MSB) Logical Block Address							
Ø3	Logical Block Address							
Ø4	Logical Block Address							
Ø5	Logical Block Address (LSB)							
Ø6	Reserved (Ø)							
Ø7	Number of Blocks							
Ø8	Number of Blocks							
Ø9	Reserved (Ø)						Flag	Link

Figure 6-42. 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 Ø1, Bit Ø4) inverts the sense of the search comparison operation. With Invert on, a SEARCH DATA EQUAL command would succeed on data not equal.

The link bit see to zero indicates that no command is linked to the SEARCH DATA EQUAL command. If the search is satisfied, the command is terminated with CONDITION MET status. A REQEST SENSE command following a successful SEARCH DATA EQUAL can be issued to determine the Logical Block Address at the matching record.

If the link bit is one, a command is linked to the SEARCH DATA EQUAL command. If the search is successful, the next command is executed. The next command may use the Relative Address Bit, in which case the logical block address is a displacement from the block at which the search was satisfied. If a linked search is not satisfied, the command is terminated with a Check Condition status. A Request Sense can then be issued to determine the nature of the termination.

When a search is satisfied, it will terminate with a Condition Met Status. 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 (00_H), provided no errors occurred.

2) Set the Valid bit to zero.

Figure 6-44 shows the SEARCH DATA EQUAL argument.

```
       BIT
BYTE    Ø7     Ø6     Ø5     Ø4     Ø3     Ø2     Ø1     ØØ
     |------|------|------|------|------|------|------|------|
 ØØ  | (MSB)              Record Size                        |
     |      -      -      -      -      -      -      -      |
 Ø1  |                    Record Size                        |
     |      -      -      -      -      -      -      -      |
 Ø2  |                    Record Size                        |
     |      -      -      -      -      -      -      -      |
 Ø3  |                    Record Size                  (LSB) |
     |-------------------------------------------------------|
 Ø4  | (MSB)           First Record Offset                   |
     |      -      -      -      -      -      -      -      |
 Ø5  |                 First Record Offset                   |
     |      -      -      -      -      -      -      -      |
 Ø6  |                 First Record Offset                   |
     |      -      -      -      -      -      -      -      |
 Ø7  |                 First Record Offset             (LSB) |
     |-------------------------------------------------------|
 Ø8  | (MSB)            Number of Records                    |
     |      -      -      -      -      -      -      -      |
 Ø9  |                  Number of Records                    |
     |      -      -      -      -      -      -      -      |
 1Ø  |                  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) |
     |-------------------------------------------------------|
 2Ø  |                    Data Pattern                       |
  .  |      -      -      -      -      -      -      -      |
  .
  .  |      -      -      -      -      -      -      -      |
M+19 |                    Data Pattern                       |
     |-------------------------------------------------------|
```

Figure 6-43. SEARCH DATA EQUAL Argument

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

Table 6-6. SEARCH DATA EQUAL Argument

BYTES	PARAMETER
00 TO 03	Record Size (Bytes) This must equal the blocksize or zero. Zero will be taken to mean the format blocksize.
04 to 07	First Record Offset (Bytes) For the ACB-5580 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	

6.27 SET LIMITS (33_H)

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

Figure 6-44. SET LIMITS Command

This command defines a logical block address outside of which all following linked commands may not operate and can be used to inhibit any subsequent linked reads or writes. A second SET LIMITS command may not be linked to a chain of commands in which a SET LIMITS command has already been issued.

Bits 0 and 1 of By te 01 define the legal operations within the limits of the specified addresses. Bit 0 indicates WRITE INHIBIT, and Bit 1 indicates READ INHIBIT.

When the Number of Blocks field (Bytes 07 to 08) is zero, the limits shall extend from the Logical Block Address (Bytes 02 to 05) to the last block on the unit. A non-zero value should not extend beyond the last block on the drive or an Illegal Block Address (21_H) error code will be post ed.

Valid Errors:

Error	Error Code
Illegal Block Address	21_H
Bad Argument	24_H
SCSI HA/Initiator Detached Error	$2D_H$
SCSI Bus Out Parity Check	$2E_H$
Adapter Parity Check	$2F_H$

APPENDIX A

DIAGNOSTIC MODE SELF TEST

The ACB-5500 operating microcode contains a diagnostic routine that is run when the DIAG jumper is installed. The primary purpose of this self test is to improve the reliability, maintainability and serviceability of the ACB-5500. The self test performs operational tests on the controller's major VLSI devices and has the ability to read/write disk data and reports errors by flashing the on-board LED.

Self test is initiated upon reset or power-on of the ACB-5500 when the DIAG jumper is installed. The self test is repeated allowing for the isolation of hardware problems in a customer environment.

Six possible error states can occur as a result of the self test. The LED signals indicating each error state are shown in Table A-1.

Table A-1. Self Test Error States

LED Flashes	Error Source
Solid Light	Board/8085 Microprocessor
1	27218 EPROM
2	8156 Local RAM
3	6116 Working RAM Failure
4	AIC-010 SERDES
5	AIC-300 Buffer Controller

The lack of any error states indicates successful passage through the controller self test.

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