OMT, Inc.

MODEL 10A INTELLIGENT CONTROLLER

for

QUANTUM Q2000 and SHUGART SA1000 SERIES DISK DRIVES

and

MODEL 10B INTELLIGENT CONTROLLER

for

QUANTUM Q2000 and SHUGART SA1000 SERIES DISK DRIVES and
8" FLEXIBLE DISK DRIVES

JUNE 28, 1982

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1.0 INTRODUCTION

The OMTI Models 10A and 10B intelligent controllers are high-performance and low-cost controllers for fixed disks and combinations of fixed and flexible disks. They are designed to attach any Q2000 or SA1000 series winchester disk drive to various host computer systems.

The Model 10A intelligent controller will support up to four 8" fixed disk drives, while the Model 10B supports up to four disk drives which may be any combination of 8" fixed disk drives and 8" flexible disk drives. The flexible disk drives may be any single or double density, single or double sided drives with an industry standard 8" flexible disk interface.

The host interface is OMTI's standard implementation of the industry standard SASI BUS.

GENERAL FEATURES

HOST INTERFACE	Plug compatable with all SASI controllers.
INTEGRAL DATA SEPARATOR	Field-proven data separator design.
HOST BUS TRANSFER RATE	The maximum host bus transfer rate is less than 1.5 microseconds per byte.
ODD PARITY	Unless disabled, data are checked for odd parity.
SINGLE PCB	Models 10A and 10B are both single 8.25" x 13.7" printed circuit boards with provisions for mounting on the disk drive.
OVERLAPPED SEEK	Allows multiple drives to be positioned simultaneously.
IMPLIED SEEK	A seek command is implied in all data transfer commands. If the heads are not positioned on the correct cylinder, a seek is executed.
MULTIPLE SECTOR OPERATIONS	Up to 256 sectors can be transferred with a single command. Head and cylinder switching is accomplished automatically by the controller.

DATA SCAN COMMANDS	Up to 256 sectors can be searched for a specific data pattern.
ERROR CORRECTION	A powerful computer-designed 32-bit ECC polynomial is used. If ECC is selected, automatic correction of up to 5 bits will be transparent to the host computer.
ERROR RETRY	Error retry on seek or read errors is performed automatically unless disabled.
SECTOR BUFFER	A sector buffer is provided to ensure that no data overruns will occur.
SECTOR INTERLEAVING	Programmable interleave capability optimizes host throughput, making it possible to transfer a track in as little as two revolutions of the disk.
ERROR LOGGING	All disk related errors are logged, and the logs may be sensed by the host.

2.0 SPECIFICATION SUMMARY

2.1 ENVIRONMENTAL LIMITS

	OPERATING	STORAGE
Temperature	0 to 55 °C	-40 to 75 °C
Relative Humidity (@ 5 °C non condensing)	10 to 95 %	10 to 95 %
Altitude	0-10000 ft.	0-15000 ft.

2.2 POWER REQUIREMENTS

Model 10A

+ 5 VDC ± 5% at 4.0 Amps (max.)
-5 or -12 to -15 VDC ± 5% at 0.25 Amps (max.)

Model 10B

+ 5 VDC ± 5% at 4.0 Amps (max.)
-5 or -12 to -15 VDC ± 5% at 0.25 Amps (max.)

Power is applied to the controller via J7 which is a 6- pin AMP connector. The recommended mating connector, P7, is an AMP P/N 1-480270 using AMP pins P/N 60619-1, or equivalent.

2.3 PHYSICAL PARAMETERS

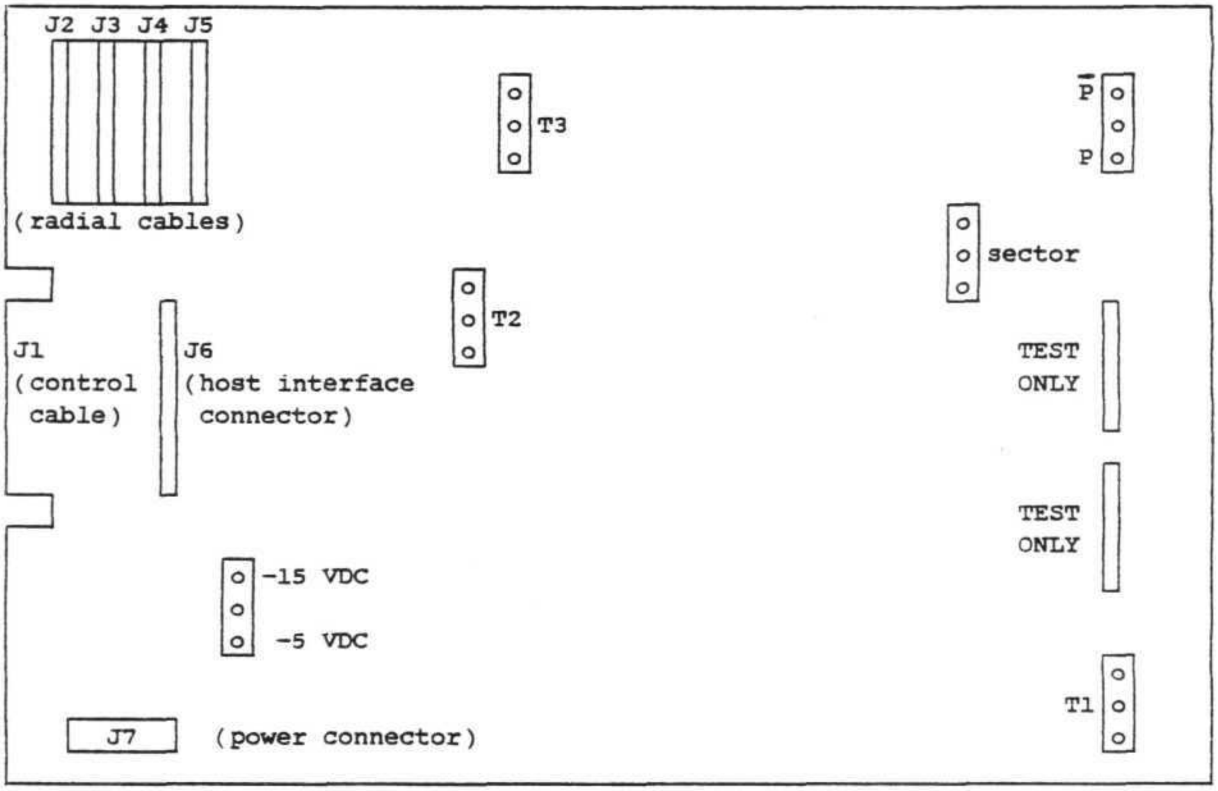
Model 10A

Width	8.25 inches	(21.0 cm)
Length	13.7 inches	(34.8 cm)
Heigth	0.5 inches	(1.3 cm)
Weight	1.12 lbs	(0.5 kg)

Model 10B

Width	8.25 inches	(21.0 cm)
Length	13.7 inches	(34.8 cm)
Heigth	0.5 inches	(1.3 cm)
Weight	1.12 lbs	(0.5 kg)

2.4 BOARD LAYOUT



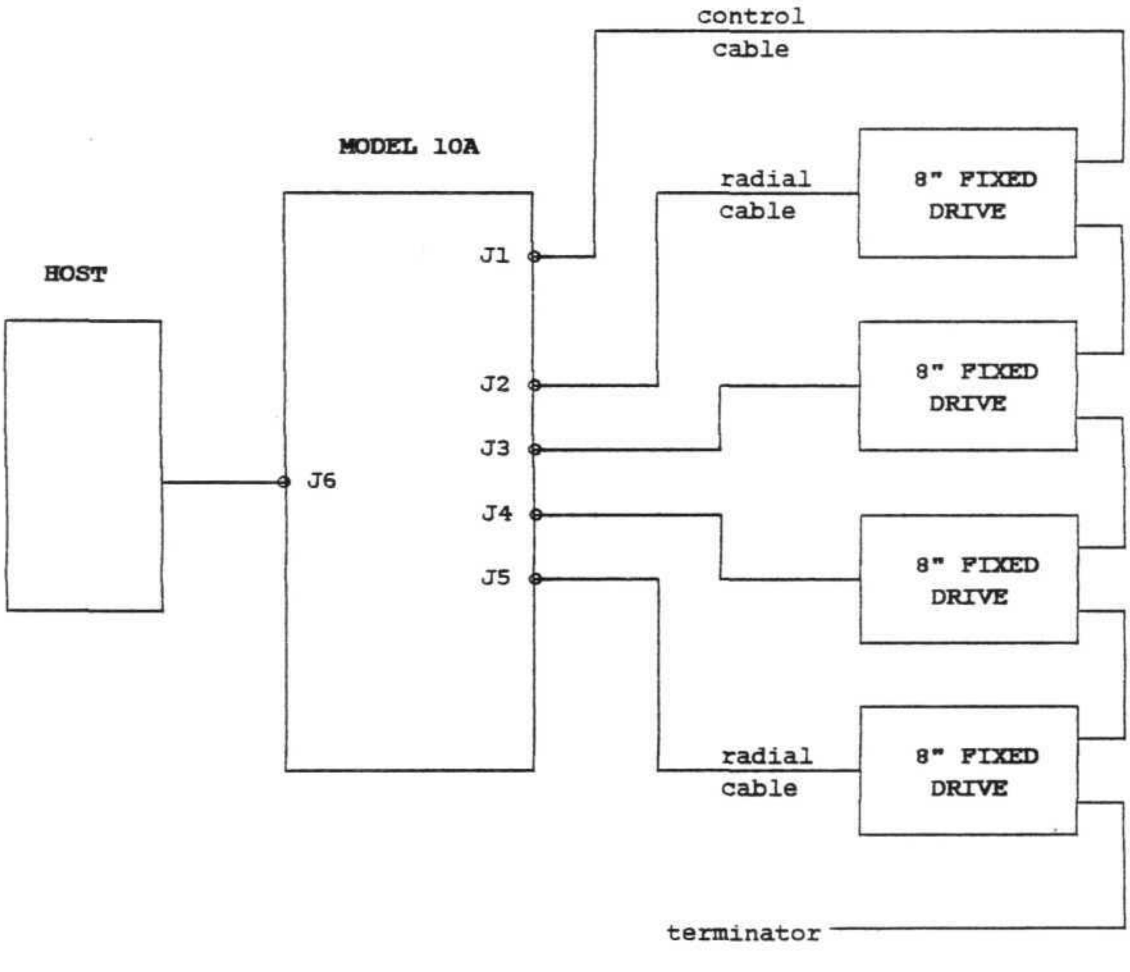
MODELS 10A and 10B: Connectors and Jumpers

3.0 SYSTEM CONFIGURATION

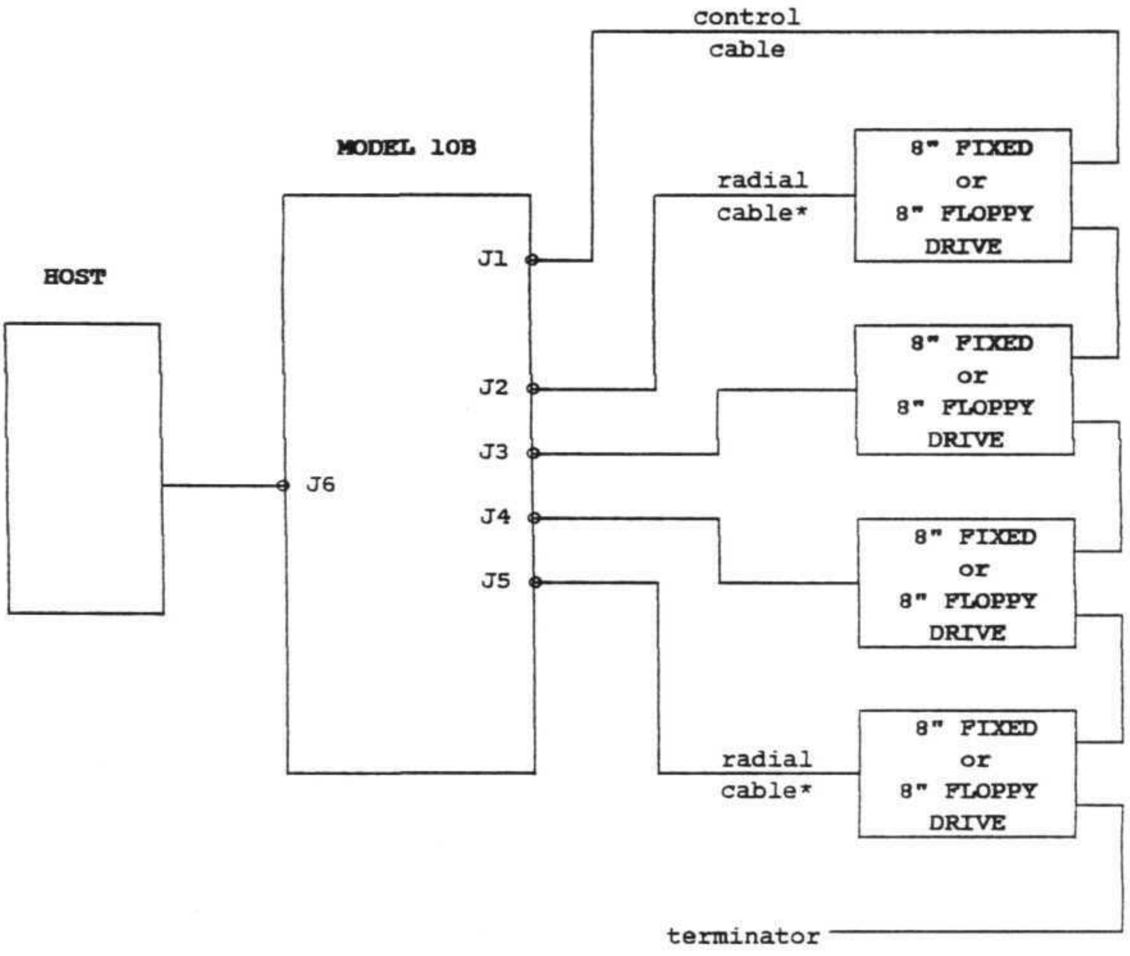
A maximum of four fixed disk drives (Model 10A) or four fixed and flexible disk drives (Model 10B) may be attached as shown below. The disk drives are interfaced to the controller via J1, J2, J3, J4 and J5.

J1 is a 50-pin card-edge connector cable that connects all disk drives in a daisy chain configuration. This cable carries control information for the fixed disk drives and, in the case of Model 10B, control and data information for the flexible disk drives. The maximum cable length should not exceed 20 feet (6 meters) or the drive manufacturer's limit, whichever is less. The recommended mating connector is the 3M 3415-series card-edge connector or equivalent.

J2, J3, J4 and J5 are 20-pin socket connector cables used to radially connect the fixed disk drive data lines to the controller. The maximum cable length should not exceed 20 feet (6 meters) or the drive manufacturer's limit, whichever is less. The recommended mating connector is the 3M 3421-series socket connector or equivalent.



MODEL 10A SYSTEM CONFIGURATION



* Radial cables are required only for fixed disks.

MODEL 10B SYSTEM CONFIGURATION

The flexible disk(s) must be the last disk(s) on the control cable, because the FLOPPY WRITE DATA line is not terminated on the fixed disk drives.

3.1 POWER CONNECTIONS

Power is applied to the controller via J7, which is a 6-pin AMP connector. The recommended mating connector, P7, is an AMP P/N 1-480270-0 using AMP pins P/N 60619-1, or equivalent.

J7

not used	2	1	not used
-5 to -15 VDC	4	3	-5 to -15 RTN
+ 5 RTN	6	5	+ 5 VDC

3.2 JUMPER SETTINGS

(-5/-15)	The -5V position may be used if a ± 5% source is available. An on-board voltage regulator is provided for negative voltages between 12 and 15 volts (-15V position). (Located in IC location 12L)
(P/$\bar{P}$)	P position is parity enabled, $\bar{P}$ is parity disabled. (Located in IC location 2C)
(Sec)	Selects between sector count -1 (shorted) and sector count (open). (Located in IC location 4C)
(T1)	Manufacturing test only, must be shorted. (Located in IC location 13B)
(T2)	Manufacturing test only, must be shorted. (Located in IC location 4J)
(T3)	Manufacturing test only, must be open. (Located in IC location 2H)

3.3 DEFAULT PARAMETERS

Models 10A and 10B are capable of controlling any fixed disk drive having a SA1000-type interface that does not exceed 8 heads or 65K cylinders. In addition, the Model 10B will control any industry-standard single- or double- density, single- or double-sided 8" flexible disk drive. If the controller is to be used with disk drives different than the drives specified in the following table, a DEFINE LIMITS command must be issued after power-on and/or after any RESET command.

On power-up or after any reset command, the controller will default to the following disk drive characteristics.

	MODEL 10A	MODEL 10B
LUN 0	FIXED (10MB)	FIXED (10MB)
LUN 1	FIXED (20MB)	FIXED (20MB)
LUN 2	FIXED (30MB)	FLOPPY (SINGLE DENSITY/ SINGLE SIDED)
LUN 3	FIXED (40MB)	FLOPPY (SINGLE DENSITY/ SINGLE SIDED)

3.4 Q2000 AND SA1000 DISK DRIVE INTERFACE

The following diagrams define the control cable and data cable pin assignments for the Q2000 and SA1000 series disk drives.

CONTROL CABLE (J1)

GROUND	1	2	REDUCED WRITE CURRENT
	3	4	HEAD SELECT 2
	5	6	REZERO (Q2000 only)
	7	8	SEEK COMPLETE
	9	10	SPARE
	11	12	SPARE
	13	14	HEAD SELECT 0
	15	16	SPARE
	17	18	HEAD SELECT 1
	19	20	INDEX
	21	22	READY
	23	24	SPARE
	25	26	DRIVE SELECT 1
	27	28	DRIVE SELECT 2
	29	30	DRIVE SELECT 3
	31	32	DRIVE SELECT 4
	33	34	DIRECTION IN
	35	36	STEP
	37	38	SPARE
	39	40	WRITE GATE
	41	42	TRACK 000
	43	44	WRITE FAULT
	45	46	SPARE
	47	48	SPARE
GROUND	49	50	SPARE

DATA CABLE (J2, J3, J4 and J5)

DRIVE SELECTED	1	2	GROUND
SPARE	3	4	GROUND
SPARE	5	6	GROUND
SPARE	7	8	GROUND
+ TIMING CLOCK	9	10	- TIMING CLOCK
GROUND	11	12	GROUND
+ MFM WRITE DATA	13	14	- MFM WRITE DATA
GROUND	15	16	GROUND
+ MFM READ DATA	17	18	- MFM READ DATA
GROUND	19	20	GROUND

NOTE: + and - TIMING CLOCK (pins 9 and 10) are used for the SA1000 only.

3.3 FLEXIBLE DISK DRIVE INTERFACE

The following diagrams define the control and data cable pin assignments for the flexible disk drives.

CONTROL CABLE (J1)

GROUND	1	2	WRITE CURRENT SWITCH
	3	4	SPARE
	5	6	SPARE
	7	8	SPARE
	9	10	TWO SIDED
	11	12	DISK CHANGE
	13	14	SIDE SELECT
	15	16	IN USE
	17	18	HEAD LOAD
	19	20	INDEX
	21	22	READY
	23	24	SPARE
	25	26	DRIVE SELECT 1
	27	28	DRIVE SELECT 2
	29	30	DRIVE SELECT 3
	31	32	DRIVE SELECT 4
	33	34	DIRECTION SELECT
	35	36	STEP
	37	38	WRITE DATA
	39	40	WRITE GATE
	41	42	TRACK 00
	43	44	WRITE PROTECT
	45	46	READ DATA
	47	48	SPARE
GROUND	49	50	SPARE

4.0 OPERATIONAL CHARACTERISTICS

4.1 Q2000/SA1000 STANDARD TRACK FORMAT

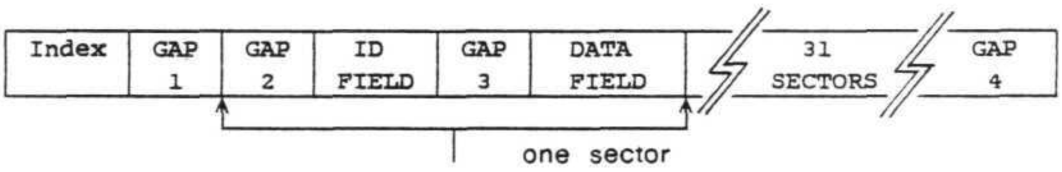
The standard track format for the fixed disk drives is 32 sectors per track with each sector containing 256 bytes of user data. Each sector consists of two fields separated by gaps to allow updating and recovery of the data.

The first field in the sector is the ID FIELD. This field contains four data bytes which uniquely identifies the sector. The four bytes are defined as follows:

1. CYLINDER ADDRESS HIGH
2. CYLINDER ADDRESS LOW
3. FLAG / HEAD ADDRESS
4. SECTOR ADDRESS

The second field contains the user data bytes.

Q2000/SA1000 STANDARD TRACK FORMAT



GAPS

1. 16 bytes of 4EH
2. 15 bytes of 4EH and
   12 bytes of 00H
3. 14 bytes of 00H
4. 352 (nom.) bytes of 4EH

ID FIELD

Byte #	1	A1H
	2	0FEH
	3	Cylinder Hi
	4	Cylinder Lo
	5	Head and Defective Track Flag
	6	Sector
	7-10	ECC

DATA FIELD

Byte #	1	0A1H
	2	0F8H
	3-258	User data field
	259-262	ECC

Write precompensation is applied to data written on tracks with track numbers greater than 128 for SA1000 drives and greater than 256 for Q2000 disk drives.

4.0 OPERATIONAL CHARACTERISTICS

4.2 FLEXIBLE DISK TRACK FORMAT

The standard track format for the flexible disk drives is the IBM FM or MFM compatable format. In the FM mode of operation, the format is 26 sectors per track with each sector containing 128 bytes of user information. In the MFM mode of operation, Track 0/Side 0 contains 26 sectors, each with 128 bytes, FM encoded. The remainder of the disk is formatted with 26 sectors per track, 256 bytes per sector, MFM encoded.

Upon power-on or reset, LUN's 3 and 4 (MODEL 10B) are set to operate with SINGLE DENSITY (FM), SINGLE SIDED flexible disk drives. Different format selections may be accommodated by issuing a DEFINE LIMITS command.

On double-sided disks, logical tracks alternate between heads.

IBM 128 BYTE FM TRACK FORMAT

INDEX	GAP 1	GAP 2	INDEX AM	GAP 3	SECTOR 0	SECTOR 25	GAP 6

IBM 128 BYTE FM SECTOR FORMAT

GAP 2	ID FIELD	GAP 4	GAP 2	DATA FIELD	GAP 5

GAP: 1 = 40 BYTES OF 0FFH
2 = 6 BYTES OF 00H
3 = 26 BYTES OF 0FFH
4 = 11 BYTES OF 0FFH
5 = 27 BYTES OF 0FFH
6 = 247 (nom.) BYTES OF 0FFH

INDEX AM: BYTES 1-3 = 0C2H
BYTE 4 = 0FCH

ID FIELD: BYTE 1 = 0FEH
BYTE 2 = TRACK
BYTE 3 = 00H
BYTE 4 = SECTOR
BYTE 5 = 00H
BYTES 6-7 = CRC

DATA FIELD: BYTE 1 = 0F8H
BYTES 2-129 = USER DATA
BYTES 129-130 = CRC

4.0 OPERATIONAL CHARACTERISTICS (cont.)

4.2 FLEXIBLE DISK TRACK FORMAT (cont.)

IBM 256 BYTE MFM TRACK FORMAT

INDEX	GAP 1	GAP 2	INDEX AM	GAP 3	SECTOR 0	SECTOR 25	GAP 6

IBM 256 BYTE MFM SECTOR FORMAT

GAP 2	ID FIELD	GAP 4	GAP 2	DATA FIELD	GAP 5

GAP: 1 = 80 BYTES OF 4EH
2 = 12 BYTES OF 00H
3 = 50 BYTES OF 4EH
4 = 22 BYTES OF 4EH
5 = 54 BYTES OF 4EH
6 = 598 (nom.) BYTES OF 4EH

INDEX AM: BYTES 1-3 = 0C2H
BYTE 4 = 0FCH

ID FIELD: BYTES 1-3 = 0A1H
BYTE 4 = 0FEH
BYTE 5 = TRACK
BYTE 6 = 00H
BYTE 7 = SECTOR
BYTE 8 = 00H
BYTES 9-10 = CRC

DATA FIELD: BYTES 1-3 = 0A1H
BYTE 4 = 0F8H
BYTES 5-261 = USER DATA
BYTES 262-263 = CRC

5.0 HOST BUS DEFINITION

The Model 10A and 10B controller interface is the general purpose 8-bit bidirectional bus popularly known as the SASI BUS.

All commands are issued to the controller over the host bus using a predefined protocol. The host always initiates a command sequence by first selecting the controller. After the selection process, the host then issues the appropriate command bytes.

Various checks are made on the command to ensure that drive limits, such as the number of tracks, are not exceeded. For data transfers, a sector buffer is provided to eliminate any possibility of data overruns. Upon completion (successful or not), the controller will issue a completion status byte and a message byte to the host. Additional completion status information is provided through appropriate sense commands.

The host computer is interfaced to the controller by a 50-pin cable connected to J6 on the controller. The length of the host interface cable should not exceed 20 feet (6 meters). The recommended mating connector for J2 is the 3M ribbon connector P/N 3425-6000.

5.1 ELECTRICAL INTERFACE

All host computer interface signals are negative true. The signals are "ASSERTED" or active at 0 to 0.4 VDC and "DEASSERTED" or inactive at 2.5 to 5.25 VDC.

5.1.1 INTERFACE TERMINATION

All host computer interface lines are terminated with a 220/330 ohm resister network as shown in figure _. The host adapter should be terminated in a similar fashion.

The devices driving the controller inputs should be open collector devices capable of sinking at least 48 milliamps at a voltage level of less then 0.5 VDC (7438 or equivalent).

Devices receiving the controller outputs should be of the "SCHMITT" trigger type to improve noise immunity (74LS14, 74LS240 or equivalent). The host adapter should not load the bus with more than 1 standard TTL input per line.

FIGURE__

5.1.2 SIGNAL INTERFACE

The host computer interface signals are as shown below.

GND	1	2	DATA BIT 0 (**DB0**)
	3	4	DATA BIT 1 (**DB1**)
	5	6	DATA BIT 2 (**DB2**)
	7	8	DATA BIT 3 (**DB3**)
	9	10	DATA BIT 4 (**DB4**)
	11	12	DATA BIT 5 (**DB5**)
	13	14	DATA BIT 6 (**DB6**)
	15	16	DATA BIT 7 (**DB7**)
	17	18	PARITY
	19	20	
	21	22	
	23	24	
	25	26	
	27	28	
	29	30	
	31	32	
	33	34	
	35	36	BUSY (**BSY**)
	37	38	ACKNOWLEDGE (**ACK**)
	39	40	RESET (**RST**)
	41	42	MESSAGE (**MSG**)
	43	44	SELECT (**SEL**)
	45	46	CONTROL / DATA (**C/D**)
	47	48	REQUEST (**REQ**)
GND	49	50	INPUT / OUTPUT (I/O)

5.1.3 SIGNAL DESCRIPTION

RESET (**RST**)

Assertion by the host causes the controller to cease all operations and return to the IDLE condition. This signal is normally used during a power up sequence. A RESET during a write operation would cause incorrect data to be written on the disk. The RESET pulse should be at least one microsecond wide.

SELECT (**SEL**)

Assertion by the host with the controller address bit **DB0** causes the controller to be selected. The **SEL** signal must be deasserted when the controller asserts the **BSY** signal.

BUSY (**BSY**)

Assertion by the controller indicates that the controller has control of the interface bus and cannot be interrupted.

CONTROL / DATA (**C/D**)

Assertion by the controller indicates that command or status information is to be transferred on the data bus. Deassertion of this signal indicates that data information is to be transferred on the data bus.

INPUT / OUTPUT (**I/O**)

Assertion by the controller indicates that information will be transferred to the host from the controller. Deassertion indicates that information will be transferred to the controller from the host.

REQUEST (**REQ**)

Assertion by the controller indicates that an 8-bit byte is to be transferred on the data bus. The **REQ** signal is deasserted following assertion of the **ACK** signal.

ACKNOWLEDGE (**ACK**)

Assertion by the host indicates that data have been accepted by the host or that data are ready to be transferred from the host to the controller.

MESSAGE (**MSG**)

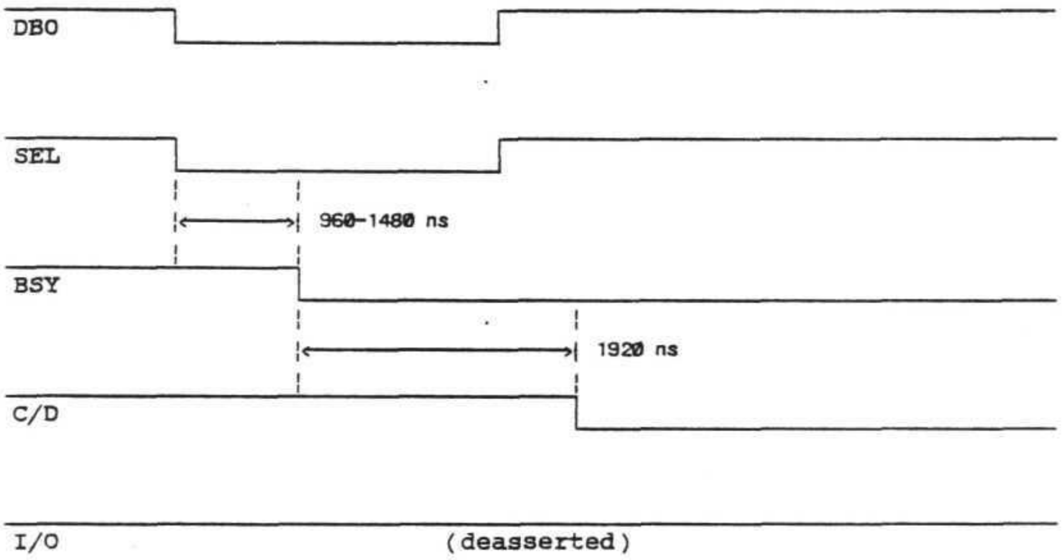
Assertion by the controller indicates that a status byte transfer has been accomplished. When **MSG** is asserted, **REQ** will be asserted in order to transfer an 8-bit byte indicating the end of the operation. When the **REQ/ACK** handshake is complete, the controller will deassert all interface signals and will return to the idle state.

DATA BITS 0-7 (**DB0-7**)

The 8 bidirectional data lines are used to transfer 8-bit parallel data to and from the host computer. Bit 7 is the most significant bit.

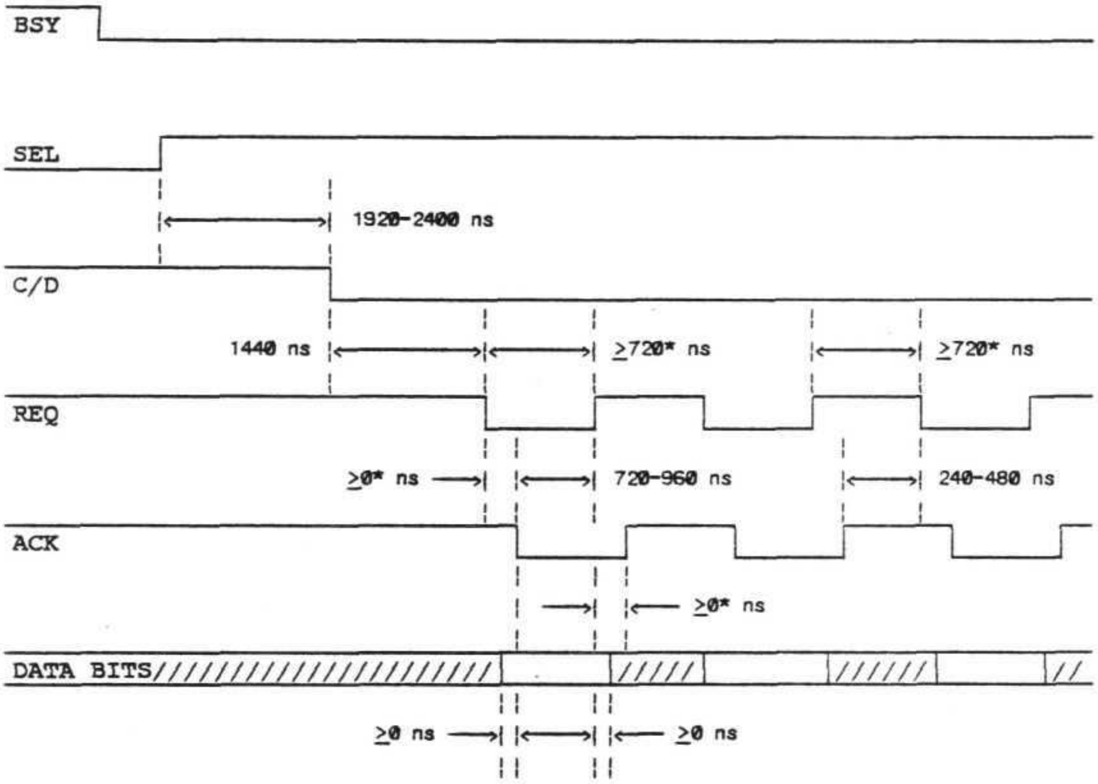
5.1.4 SELECTION SEQUENCE

In order to gain the attention of the controller, it is necessary to perform the following selection sequence: The host must first test **BSY** to determine if the controller is available. If **BSY** and all other I/O lines are deasserted, the host must first assert **DB0** (controller ID) and then **SEL**. The controller will then respond by asserting **BSY**. At this point, the host must deassert **SEL** and **DB0**. The controller responds to the deassertion of **SEL** by asserting **C/D**. The **I/O** signal remains deasserted throughout the selection sequence.



!I5.1.5 COMMAND TRANSFER SEQUENCE

Following the selection sequence. the controller will assert **REQ**. The host must then place the first byte of the device command field on the data bus and then assert **ACK**. The controller will then respond by reading the byte on the data bus. followed by deasserting **REQ**. The host must then deassert **ACK** to begin the next **REQ/ACK** handshake. The handshake continues until all bytes of the command have been transferred.

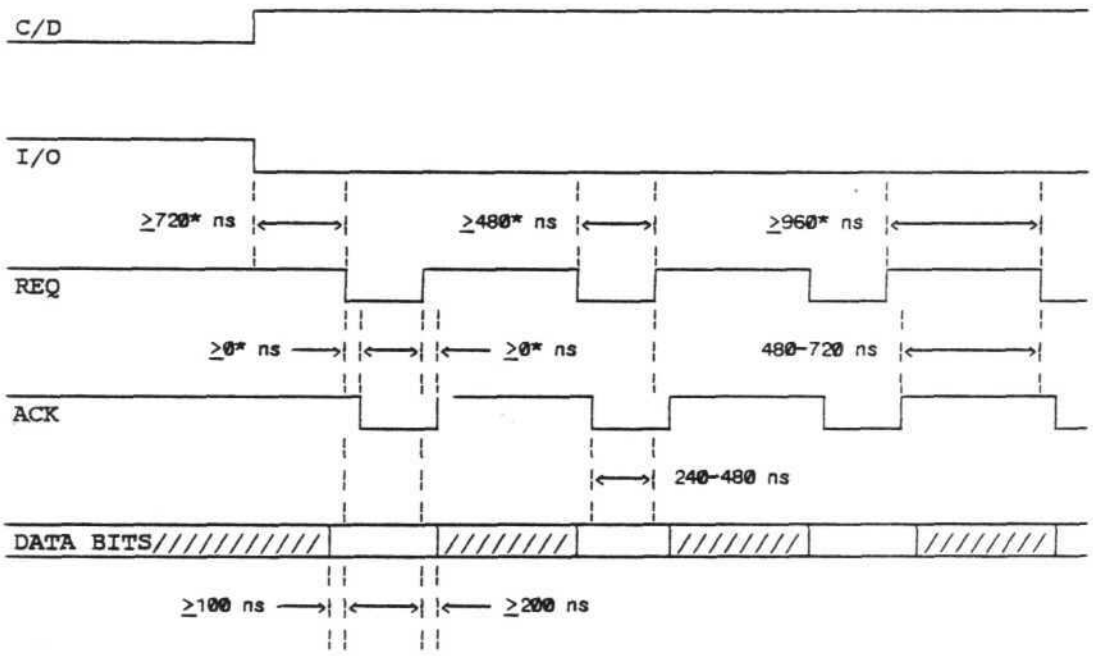


*Maximum time is host-dependent.

5.1.6 DATA TRANSFER SEQUENCE

If the command sent to the controller involves a data transfer, the controller will deassert the **C/D** signal to indicate a data transfer. If the data transfer is from the host to the controller (write data), the **I/O** signal will be deasserted. If the data transfer is from the controller to the host (read data), the **I/O** signal will be asserted. The controller will then assert the **REQ** signal to request a byte transfer. The host must then respond by transferring a byte across the data bus, followed by asserting **ACK**. This handshake continues until all data bytes have been transferred.

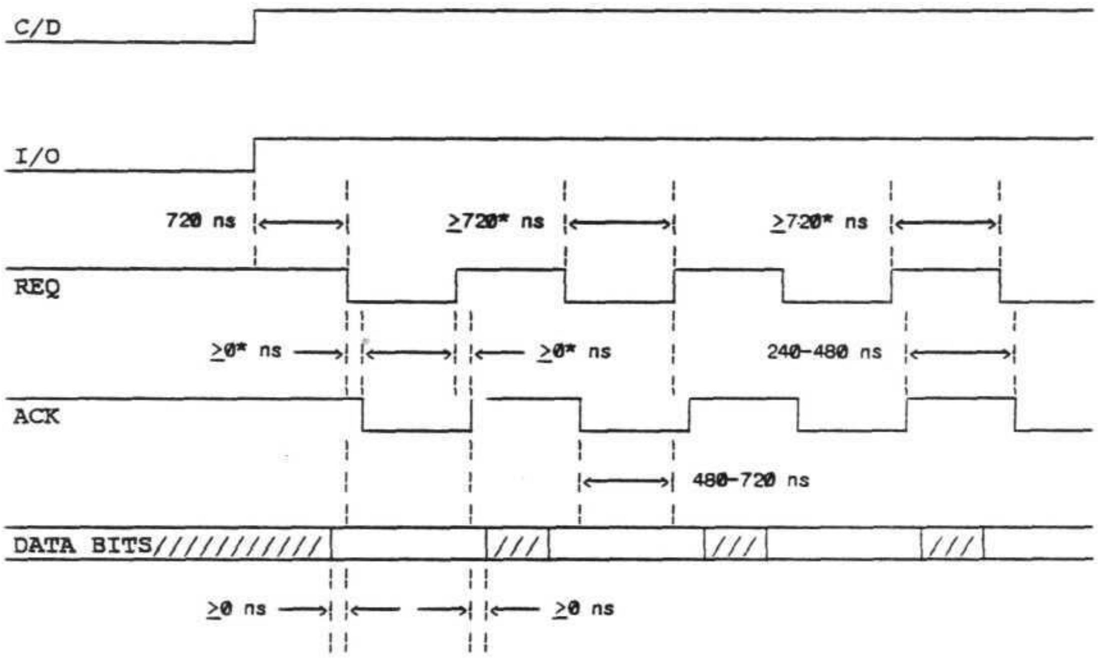
DATA TO THE HOST



*Maximum time is host-dependent.

5.1.6 DATA TRANSFER SEQUENCE (cont.)

DATA FROM HOST



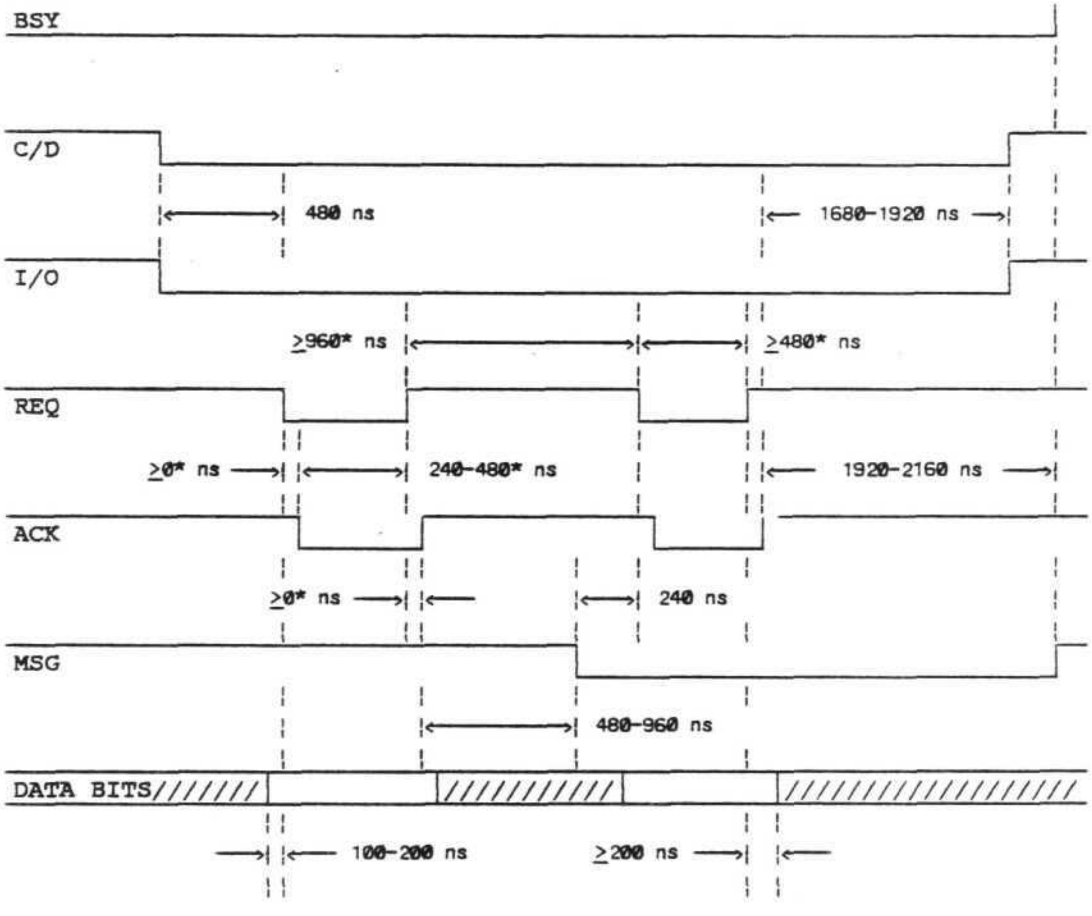
*Maximum time is host-dependent.

5.1.7 STATUS AND MESSAGE TRANSFER SEQUENCE

Following a command or data transfer, the controller will initiate a status byte and completion message transfer.

When a status byte is required, the controller will assert **C/D** and **I/O**. The controller will then assert **REQ**. The host must then accept the status byte on the data bus and assert **ACK**. The controller will then deassert **REQ**, and the host must follow by deasserting **ACK**.

Following the status byte transfer, a completion message will be transferred to indicate that the operation is complete. The controller will assert the **MSG** signal (along with **C/D** and **I/O**) then will assert **REQ**. After the host accepts the completion message byte on the data bus, it must assert **ACK**. The controller will respond by deasserting **REQ**, and the host must respond in turn by deasserting **ACK**. At this point, **BSY** and all other controller signals will be deasserted, and the controller will return to an idle state.



*Maximum time is host-dependent.

6.0 DISK COMMAND SPECIFICATIONS

Following the controller selection sequence, the controller will always request a Device Command Field (DCF), which is either 6 or 10 bytes in length. The first byte of the DCF must always contain the command. The remaining bytes specify the drive logical unit number (LUN), logical sector address, number of sectors to be transferred, and a control byte.

The controller will check the validity of all incoming DCFs and will also check both DCFs and the data for odd parity. An error in the command structure will terminate the command and wil cause a status byte transfer to occur upon completion of the DCF transfer.

6.1 COMMAND FORMAT

SIX BYTE FORMAT

<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>BYTE 1</td><td colspan="8">COMMAND CODE</td></tr>
<tr><td>BYTE 2</td><td>0</td><td colspan="2">LUN</td><td colspan="5">LOGICAL ADDR 2 (MS)</td></tr>
<tr><td>BYTE 3</td><td colspan="8">LOGICAL ADDR 1</td></tr>
<tr><td>BYTE 4</td><td colspan="8">LOGICAL ADDR 0 (LS)</td></tr>
<tr><td>BYTE 5</td><td colspan="8">NUMBER OF SECTORS/INTERLEAVE CODE</td></tr>
<tr><td>BYTE 6</td><td colspan="8">CONTROL FIELD</td></tr>
</table>

TEN BYTE FORMAT

<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>BYTE 1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>BYTE 2</td><td>0</td><td colspan="2">SRC LUN</td><td colspan="5">LOGICAL ADDR 2 (MS)</td></tr>
<tr><td>BYTE 3</td><td colspan="8">LOGICAL ADDR 1</td></tr>
<tr><td>BYTE 4</td><td colspan="8">LOGICAL ADDR 0 (LS)</td></tr>
<tr><td>BYTE 5</td><td colspan="8">SECTOR TRANSFER COUNT</td></tr>
<tr><td>BYTE 6</td><td>0</td><td colspan="2">DST LUN</td><td colspan="5">LOGICAL ADDR 2 (MS)</td></tr>
<tr><td>BYTE 7</td><td colspan="8">LOGICAL ADDR 1</td></tr>
<tr><td>BYTE 8</td><td colspan="8">LOGICAL ADDR 0 (LS)</td></tr>
<tr><td>BYTE 9</td><td colspan="8">NOT USED</td></tr>
<tr><td>BYTE 10</td><td colspan="8">CONTROL FIELD</td></tr>
</table>

CONTROL FIELD

7	6	5	4	3	2	1	0
X	X	0	0	0	0	0	0

disable error correction = 1

disable retry = 1

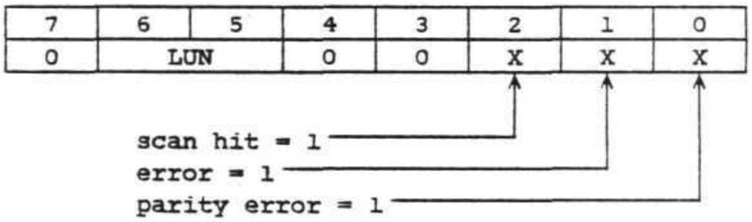
6.1 COMMAND FORMAT (cont.)

COMPLETION STATUS BYTE

At the normal termination of a command or following an error, the controller will cause a status byte to be transferred from the controller to the host. Bit 0 will be set to 1 if a parity error is detected. Bit 1 will be set to 1 if the controller detects an error condition during command execution. Bits 5 and 6 represent the LUN of the device where the error occurred. If no error occurs, bits 0-4 will be set to 0.

Following the transfer of the status byte, the **MSG** signal will be asserted to indicate a completion message. This message consists of a single byte transfer with all bits set to 0 if no error occurred. If an error occurred, the byte will contain the error code.

COMPLETION STATUS BYTE FORMAT



7	6	5	4	3	2	1	0
0	LUN		0	0	X	X	X

scan hit = 1
error = 1
parity error = 1

Bit 0	Parity error
Bit 1	Error occurred during command execution
Bit 2	Scan hit
Bits 3-4	Spare (set to 0)
Bits 5-7	Logical unit number of the disk drive

6.3 TYPE 0 COMMAND SPECIFICATIONS

SENSE STATUS (HEX 00) The device addressed by the LUN is selected and tested for ready. The completion status byte indicates the state of the addressed device.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	0	0	0
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

COMPLETION STATUS

7	6	5	4	3	2	1	0
0	LUN		0	0	0	X	X

0 = device ready

1 = parity error

RECALIBRATE (HEX 01) The fixed or flexible disk drive specified by the LUN is stepped toward the outside track until either:

1. the Track 0 flag is detected, or
2. more steps have been issued than available tracks for the device type.

Since the recalibrate command must step and look for track 0, all steps are non-overlapped (i.e., step, look for seek complete and track 0, repeat if no track 0).

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	0	0	1
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. No seek complete	(HEX 02)
2. Drive not ready	(HEX 04)
3. Track 0 flag not detected	(HEX 06)

Note: Error code 02H is valid only for fixed disk drives.

REQUEST SYNDROME (HEX 02) The controller transfers four bytes of ECC correction data to the host. These four bytes include two bytes of data to indicate byte displacement and two bytes of data to indicate the error correction pattern.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	0	1	0
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

The format of these four bytes is as follows:

	7	6	5	4	3	2	1	0
BYTE 1	NOT USED							
BYTE 2	BYTE DISPLACEMENT (LS)							
BYTE 3	CORRECTION PATTERN (MS)							
BYTE 4	CORRECTION PATTERN (LS)							

Byte displacement is from the beginning of the record, counting the first byte as zero. The least significant correction pattern byte must be exclusive-or'ed with the byte at the indicated displacement, and the most significant correction pattern byte must be exclusive-or'ed with displacement plus one.

A special case is encountered when the byte displacement is 255 (HEX 0FF). In this case, the error is fully contained in the last data byte, and byte three will be zero and can be effectively thrown away.

If the correction pattern was automatically applied to the data passed to the host, the two correction pattern bytes will be zero. Byte one is not used with 256-byte records.

REQUEST SENSE (HEX 03) Following an error indication from the status byte, the host may perform this command to obtain more detailed information about the error. The REQUEST SENSE command will transfer four bytes of error information to the host. Each unique command description contains a list of valid error codes.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	0	1	1
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

The format of the four sense bytes is as follows:

	7	6	5	4	3	2	1	0
BYTE 1	ERROR CODE							
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							

ERROR CODE FORMAT

7	6	5	4	3	2	1	0
X	0	TYPE		CODE			

1= sector address valid

ERROR TYPE bits 4 and 5 are decoded as follows:

Bits		
5	4	
0	0	Drive errors
0	1	Data errors
1	0	Command errors
1	1	Reserved

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

VALID DISK ERROR CODES

Bits 3 2 1 0	Fixed Disk Drives	Flexible Disk Drives
0 0 0 0	No error	No error
0 0 0 1	No index	No index
0 0 1 0	No seek complete	Invalid
0 0 1 1	Write fault	Write protected
0 1 0 0	Drive not ready	Drive not ready
0 1 0 1	Equipment check	Equipment check
0 1 1 0	No track 0 on recal.	No track 0 on recal.
0 1 1 1 thru 1 1 1 1	Reserved	Reserved

VALID DATA ERROR CODES

Bits 3 2 1 0	Fixed Disk Drives	Flexible Disk Drives
0 0 0 0	ECC error in ID field	CRC error in ID field
0 0 0 1	Uncorrectable error in data field	CRC error in data field
0 0 1 0	No ID address mark	No ID address mark
0 0 1 1	No data address mark	No data address mark
0 1 0 0	No record found	No record found
0 1 0 1	Seek error	Seek error
0 1 1 0	Data transfer timeout	Data transfer timeout
0 1 1 1	Reserved	Reserved
1 0 0 0	Correctable data error	Invalid
1 0 0 1	Bad track flag set	Invalid
1 0 1 0	Illegal interleave code	Illegal interleave code
1 0 1 1	Reserved	Deleted data AM found
1 1 0 0 thru 1 1 1 1	Reserved	Reserved

VALID COMMAND ERROR CODES

Bits 3 2 1 0	Fixed Disk Drives	Flexible Disk Drives
0 0 0 0	Invalid command	Invalid command
0 0 0 1	Illegal sector address	Illegal sector address
0 0 1 0	Reserved	Reserved
0 0 1 1	Reserved	Reserved
0 1 0 0	Volume overflow	Volume overflow
0 1 0 1 thru 1 1 1 1	Reserved	Reserved

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

FORMAT DRIVE (HEX 04) This command causes the specified LUN to be formatted using the interleave factor specified in byte 5. Formatting starts from track 0 of cylinder 0 and continues until all tracks have been written. Data fields are written with a HEX 6C. Invalid interleave factors are those that are greater than one half the number of sectors per track. An interleave factor of 0 is set to 1. Track and cylinder overflow is handled automatically by the controller.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	1	0	0
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	INTERLEAVE FACTOR							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. No index detected	(HEX 01)
2. Write fault	(HEX 03)
3. Drive not ready	(HEX 04)
4. Format error	(HEX 1A)

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

CHECK TRACK FORMAT (HEX 05) The track specified by the logical sector address in bytes 2 - 4 is checked to see that its interleave scheme matches that specified by the interleave factor in byte 5. The data field is also read to verify that a valid address mark exists and that there are no uncorrectable errors. Reading begins with the first sector after the index.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	1	0	1
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	INTERLEAVE FACTOR							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. Drive not ready	(HEX 04)
2. ECC error in the ID field	(HEX 10)
3. Uncorrectable error in the data field	(HEX 11)
4. No ID Address mark detected	(HEX 12)
5. No data address mark detected	(HEX 13)
6. No record found	(HEX 14)
7. Seek error	(HEX 15)
8. Bad track flag set	(HEX 19)
9. Format error	(HEX 1A)
10. Illegal sector address	(HEX 21)

FORMAT TRACK (HEX 06) This command causes the track specified by the logical sector address in bytes 2-4 to be formatted using the interleave factor specified in byte 5. The track is written starting with the index, and all data fields are filled with a HEX 6C. The first sector after the index is always sector 0. The second sector is 0 plus the interleave factor. Interleave factors greater than one half the number of sectors per track are invalid. An interleave factor of 0 is set to 1. An automatic check of the track is performed to ensure that there are no bad sectors (see CHECK TRACK FORMAT command).

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	1	1	0
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	INTERLEAVE FACTOR							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. No index detected	(HEX 01)
2. Write fault	(HEX 03)
3. Drive not ready	(HEX 04)
4. Format error	(HEX 1A)
5. Illegal sector address	(HEX 21)

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

FORMAT BAD TRACK (HEX 07) This command is identical to the format track command, except that the defective bit is set in the ID field (byte 3-bit 7).

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	0	1	1	1
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	INTERLEAVE FACTOR							
BYTE 6	CONTROL FIELD							

READ DATA (HEX 08) This command causes the number of sectors specified by byte 5 to be transferred to the host. The starting sector is specified by the logical sector address in bytes 2, 3 and 4. Up to 256 sectors (Byte 5 = 0) can be transferred with a single READ command.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	1	0	0	0
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	SECTOR TRANSFER COUNT							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1.	Drive not ready	(HEX 04)
2.	Uncorrectable error in the data field	(HEX 11)
3.	No ID address mark detected	(HEX 12)
4.	No data address mark detected	(HEX 13)
5.	No record found	(HEX 14)
6.	Seek error	(HEX 15)
7.	Correctable error	(HEX 18)
8.	Bad track flag set	(HEX 19)
9.	Illegal sector address	(HEX 21)
10.	Volume overflow	(HEX 24)

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

CONTROL RESET (HEX 09) This command provides the host with the ability to selectively reset the controller without the use of the RST interface signal. All system areas are cleared, and the default parameters are reestablished. A DEFINE LIMITS command must be issued if parameters other than default parameters are in use.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	1	0	0	1
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

WRITE DATA (HEX 0A) The number of sectors specified by byte 5 are written to the selected LUN beginning with the sector specified by the logical sector address in bytes 2, 3 and 4.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	1	0	1	0
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	SECTOR TRANSFER COUNT							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. Write fault	(HEX 03)
2. Drive not ready	(HEX 04)
3. ECC error in the ID field	(HEX 10)
4. No ID address mark detected	(HEX 12)
5. No record found	(HEX 14)
6. Seek error	(HEX 15)
7. Data transfer time out	(HEX 16)
8. Illegal sector address	(HEX 21)
9. Volume overflow	(HEX 24)

6.2 TYPE 0 COMMAND SPECIFICATIONS (cont.)

SEEK (HEX 0B) This command causes the fixed or flexible disk drive addressed by the LUN to be physically positioned to the cylinder as defined by the logical sector address in bytes 2, 3 and 4. The cylinder address is automatically computed by the controller.

No attempt to verify seek position is made until a read or write command is issued. The completion status is returned to the host immediately after receipt of the seek command.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	1	0	1	1
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. No seek complete (fixed disk only)
2. Drive not ready

READ DATA BUFFER (HEX 0C) The controller data buffer is transferred to the host as if a single sector read had occurred. LUN can be any number since no device participates. The host can use this command following a WRITE DATA BUFFER command to verify READ and WRITE sequences without drive participation or, if a permanent ECC error in the data field is encountered, to obtain the bad record. Recovery of DELETED DATA records on flexible disk drives can also be accomplished with this command.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	1	1	0	0
BYTE 2	0	NOT USED						
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. None

REQUEST LOGOUT (HEX 0D) The four bytes of the error log area are transferred to the host. The log area is set to zero upon completion of the transfer.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	0	0	1	1	0	1
BYTE 2	0	LUN		NOT USED				
BYTE 3	NOT USED							
BYTE 4	NOT USED							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

The format of these four data bytes is as follows:

	7	6	5	4	3	2	1	0
BYTE 1	RETRY COUNT HI							
BYTE 2	RETRY COUNT LO							
BYTE 3	PERMANENT ERROR COUNT HI							
BYTE 4	PERMANENT ERROR COUNT LO							

VALID ERROR CODES

1. ECC error in the ID field	(HEX 10)
2. Uncorrectable error in the data field	(HEX 11)
3. No ID address mark detected	(HEX 12)
4. No data address mark detected	(HEX 13)
5. No record found	(HEX 14)
6. Seek error	(HEX 15)

6.3 COPY COMMAND SPECIFICATIONS

COPY COMMAND (HEX 20) This command copies a specified number of records from a source LUN to a destination LUN. If either device reaches the end of a volume prior to the sector count being exhausted, a volume overflow error is posted. Source and destination LUNs may be the same.

	7	6	5	4	3	2	1	0
BYTE 1	0	0	1	0	0	0	0	0
BYTE 2	0	SRC LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	SECTOR TRANSFER COUNT							
BYTE 6	0	DST LUN		LOGICAL ADDR 2 (MS)				
BYTE 7	LOGICAL ADDR 1							
BYTE 8	LOGICAL ADDR 0 (LS)							
BYTE 9	NOT USED							
BYTE 10	CONTROL FIELD							

VALID ERROR CODES

1. Write fault	(HEX 03)
2. Drive not ready	(HEX 04)
3. ECC error in ID field	(HEX 10)
4. Uncorrectable error in data field	(HEX 11)
5. No ID mark found	(HEX 12)
6. No data mark found	(HEX 13)
7. No record found	(HEX 14)
8. Seek error	(HEX 15)
9. Correctable read error	(HEX 18)
10. Bad track flag set	(HEX 19)
11. Illegal sector address	(HEX 21)
12. Volume overflow	(HEX 24)

6.3 SCAN DATA COMMAND SPECIFICATIONS

The controller supports three scan commands that allow the user to search successive data fields for a specific data pattern. The search argument is one sector in length. Any portion of the search argument not to be used as part of the sector search must be set to HEX FF. Once the controller has received the search argument, data are read from the drive and compared byte by byte to the search argument (except for argument bytes equal to HEX FF). If the search is satisified, the host is notified through the scan hit flag in the completion status byte (bit 2 = 1). The sector with the "hit data" may then obtained by issuing a REQUEST SENSE command.

SCAN EQUAL (HEX 40) The argument sent by the host is compared with the data from the disk, starting with the logical sector specified and continuing until either an equal data field is found or the sector count is exhausted. "Don't care" positions are indicated by a HEX FF in the search argument.

If the sector count is exhausted without finding a "hit", then the completion status byte will contain only the LUN.

	7	6	5	4	3	2	1	0
BYTE 1	0	1	0	0	0	0	0	0
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	SECTOR TRANSFER COUNT							
BYTE 6	CONTROL FIELD							

VALID SCAN ERROR CODES

1.	Drive not ready	(HEX 04)
2.	ECC error in the ID field	(HEX 10)
3.	Uncorrectable error in the data field	(HEX 11)
4.	ID mark not found	(HEX 12)
5.	Data mark not found	(HEX 13)
6.	No record found	(HEX 14)
7.	Seek error	(HEX 15)
8.	Bad track flag set	(HEX 19)
9.	Illegal sector address	(HEX 21)
10.	Volume overflow	(HEX 24)

6.3 SCAN DATA COMMAND SPECIFICATIONS (cont.)

SCAN HIGH OR EQUAL (HEX 41) This command operates in the same manner as the SCAN EQUAL command, except the "hit" can be made on any data that are algebraically greater than or equal to the argument.

	7	6	5	4	3	2	1	0
BYTE 1	0	1	0	0	1	0	0	1
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	SECTOR TRANSFER COUNT							
BYTE 6	CONTROL FIELD							

6.3 SCAN DATA COMMAND SPECIFICATIONS (cont.)

SCAN LOW OR EQUAL (HEX 42) This command operates in the same manner as the SCAN EQUAL command except the "hit" can be made on any data that are algebraically less than or equal to the argument.

	7	6	5	4	3	2	1	0
BYTE 1	0	1	0	0	0	0	1	0
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	SECTOR TRANSFER COUNT							
BYTE 6	CONTROL FIELD							

6.4 TYPE 6 COMMAND SPECIFICATIONS

DEFINE LIMITS (HEX C0) This command changes the device default parameters associated with the specified LUN.

	7	6	5	4	3	2	1	0
BYTE 1	1	1	0	0	0	0	0	0
BYTE 2	0	LUN		TYPE				
BYTE 3	CYLINDER HI (-1)							
BYTE 4	CYLINDER LO (-1)							
BYTE 5	TRACKS / CYLINDER (-1)							
BYTE 6	SECTORS / TRACK (-1)							

BYTE 2, Bits 0-4 identify the type of device and are defined as follows:

7	6	5	4	3	2	1	0
0	LUN		0	0	0	X	X

Format Select (FM = 1, MFM = 0)

Primary/Secondary (Secondary = 1)

BYTES 3-6 define the physical limits of the devices. The values in these bytes are the actual values minus 1.

At reset or power-on, the default parameters are:

MODEL 10A

	TYPE	HICYL	LOCYL	HEADS	SECTORS
LUN 00	00H	01H	0FFH	01H	1FH
LUN 01	00H	01H	0FFH	03H	1FH
LUN 02	00H	01H	0FFH	05H	1FH
LUN 03	00H	01H	0FFH	07H	1FH

MODEL 10B

	TYPE	HICYL	LOCYL	HEADS	SECTORS
LUN 00	00H	01H	0FFH	01H	1FH
LUN 01	00H	01H	0FFH	03H	1FH
LUN 02	03H	00H	4CH	00H	19H
LUN 03	03H	00H	4CH	00H	19H

6.4 TYPE 7 COMMAND SPECIFICATIONS

READ IDENTIFIER (HEX E3) The ID field of the sector specified by the logical sector address is transferred to the host. Only one sector is processed. The data length will be 4 bytes.

	7	6	5	4	3	2	1	0
BYTE 1	1	1	1	0	0	0	1	1
BYTE 2	0	LUN		LOGICAL ADDR 2 (MS)				
BYTE 3	LOGICAL ADDR 1							
BYTE 4	LOGICAL ADDR 0 (LS)							
BYTE 5	NOT USED							
BYTE 6	CONTROL FIELD							

VALID ERROR CODES

1. Drive not ready	(HEX 04)
2. ECC error in the ID field	(HEX 10)
3. No ID address mark detected	(HEX 12)
4. No record found	(HEX 14)
5. Seek error	(HEX 15)
6. Data transfer time out	(HEX 16)
7. Illegal sector address	(HEX 21)

APPENDIX A

MODEL 10A and 10B COMMAND SUMMARY

COMMAND	OP-CODE (HEX)
SENSE STATUS	00H
RECALIBRATE	01H
REQUEST SYNDROME	02H
REQUEST SENSE	03H
FORMAT DRIVE	04H
CHECK TRACK FORMAT	05H
FORMAT TRACK	06H
FORMAT BAD TRACK	07H
READ DATA	08H
CONTROL RESET	09H
WRITE DATA	0AH
SEEK	0BH
REQUEST DATA BUFFER	0CH
REQUEST LOGOUT	0DH
WRITE DATA BUFFER	0EH
RESERVED	0FH
COPY	20H
SCAN EQUAL	40H
SCAN HIGH OR EQUAL	41H
SCAN LOW OR EQUAL	42H
DEFINE LIMITS	0C0H
READ ID	0E2H

APPENDIX B

MODEL 10A and 10B ERROR CODE SUMMARY

ERROR	ERROR CODE (HEX)
NO ERROR	00H
NO INDEX FOUND	01H
NO SEEK COMPLETE (fixed only)	02H
WRITE FAULT (fixed only)	03H
DRIVE NOT READY	04H
EQUIPMENT CHECK	05H
NO TRACK ZERO FOUND	06H
RESERVED	07H-0FH
ECC ERROR IN ID FIELD	10H/90H
UNCORRECTABLE DATA FIELD ERROR	11H/91H
NO ID ADDRESS MARK FOUND	12H/92H
NO DATA ADDRESS MARK FOUND	13H/93H
NO RECORD FOUND	14H/94H
SEEK ERROR	15H/95H
RESERVED	16H/96H
WRITE PROTECTED	17H/97H
CORRECTABLE DATA ERROR	18H/98H
BAD TRACK FLAG	19H/99H
ILLEGAL INTERLEAVE CODE	1AH/9AH
DELETED DATA AM FOUND	1BH/9BH
RESERVED	1CH-1FH
INVALID COMMAND	20H
DEVICE PARAMETER VIOLATION	21H
RESERVED	22H-23H
VOLUME OVERFLOW	24H
RESERVED	25H-0F8H

INTERLEAVE FACTOR

LOGICAL SECTOR NUMBERS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	1
3	3	6	9	12	15	18	21	24	27	30	1	1	1	1	1	17
4	4	8	12	16	20	24	28	1	1	1	12	13	14	15	16	2
5	5	10	15	20	25	30	1	9	10	11	23	25	27	29	31	18
6	6	12	18	24	30	1	8	17	19	21	2	2	2	2	2	3
7	7	14	21	28	1	7	15	25	28	31	13	14	15	16	17	19
P 8	8	16	24	1	6	13	22	2	2	2	24	26	28	30	3	4
H 9	9	18	27	5	11	19	29	10	11	12	3	3	3	3	18	20
Y 10	10	20	30	9	16	25	2	18	20	22	14	15	16	17	4	5
S 11	11	22	1	13	21	31	9	26	29	3	25	27	29	31	19	21
I 12	12	24	4	17	26	2	16	3	3	13	4	4	4	4	5	6
C 13	13	26	7	21	31	8	23	11	12	23	15	16	17	18	20	22
A 14	14	28	10	25	2	14	30	19	21	4	26	28	30	5	6	7
L 15	15	30	13	29	7	20	3	27	30	14	5	5	5	19	21	23
16	16	1	16	2	12	26	10	4	4	24	16	17	18	6	7	8
S 17	17	3	19	6	17	3	17	12	13	5	27	29	31	20	22	24
E 18	18	5	22	10	22	9	24	20	22	15	6	6	6	7	8	[illegible]
C 19	19	7	25	14	27	15	31	28	31	25	17	18	19	21	23	25
T 20	20	9	28	18	3	21	4	5	5	6	28	30	7	8	9	10
O 21	21	11	31	22	8	27	11	13	14	16	7	7	20	22	24	26
R 22	22	13	2	26	13	4	18	21	23	26	18	19	8	9	10	11
23	23	15	5	30	18	10	25	29	6	7	29	31	21	23	25	27
24	24	17	8	3	23	16	5	6	15	17	8	8	9	10	11	12
25	25	19	11	7	28	22	12	14	24	27	19	20	22	24	26	28
26	26	21	14	11	4	28	19	22	7	8	30	9	10	11	12	13
27	27	23	17	15	9	5	26	30	16	18	9	21	23	25	27	29
28	28	25	20	19	14	11	6	7	25	28	20	10	11	12	13	14
29	29	27	23	23	19	17	13	15	8	9	31	22	24	26	28	30
30	30	29	26	27	24	23	20	23	17	19	10	11	12	13	14	15
31	31	31	29	31	29	29	27	31	26	29	21	23	25	27	29	31

HOW TO USE THIS TABLE: As indicated in the above table, the interleave factor determines the order in which the controller assigns logical sector numbers to the physical sectors on the disk. This factor is normally chosen so as to minimize the number of disk rotations required to read or write an entire track, and can be determined by comparing the time required for one sector to be read or written (exclusive of seek time) to the time required by the operating system to process one sector of data.

Example: Consider a system in which the time required by the operating system to process a sector of data is 4 times that required by the disk to access a sector. In such a system, after the operating system has received and processed sector 0, the next sector that the disk will access is physical sector #4. From the table, interleave factors of 8, 9 and 10 will assign the next logical sector (#1) to the next physical sector (#4). After processing these data, the operating system will be ready for logical sector #2, while the disk will be ready to access physical sector #8. Again, interleave factors of 8, 9 and 10 will satisfy this situation. Continuing this analysis through one disk revolution will show that only an interleave factor of 8 will minimize the amount of time the disk has to wait to be able to access the next logical record.