MK-150FA SERIES
5.25-INCH FIXED DISK DRIVES
OEM MANUAL

TOSHIBA AMERICA, INC.
DISK PRODUCTS DIVISION

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SECTION 1

INTRODUCTION

1.1 PURPOSE OF MANUAL

The purpose of this manual is to describe the MK-150FA Series 5.25-inch fixed disk drives to the level of detail required for product integration.

System designers planning to develop a custom controller and others who require additional product information should refer to the MK-150FA Series Product Specification for more details.

1.2 RELATED DOCUMENTS

Detailed product and interfacing information is given in the MK-150FA Series Product Specification, document number 71Y101397.

Table 1 lists OEM Manuals that are available for other Toshiba disk products. The MK-150FA is included to indicate how its storage capacity compares to other disk products available from Toshiba.

Toshiba Product	Media Size	Storage Technology	Unformatted Capacity (MB)	Type Of Interface	Document Number
MK-134FA	3.5	Winchester	23 to 53	ST506/412	DW32-01-012
MK-50FB	5.25	Winchester	43 to 86	ST506/412	DW54-01-006
MK-150FA	5.25	Winchester	86 to 173	ESDI	DW54-01-007
MK-250FA	5.25	Winchester	382.5	ESDI	DW54-01-014
MK-180FB	8.0	Winchester	83 to 166	SMD	DW80-01-008
MK-280FC	8.0	Winchester	340 to 510	HSMD	DW80-01-009
MK-388FC	8.0	Winchester	720	HSMD	DW80-01-013

Table 1 — Related Documents

Contact your nearest Toshiba Disk Products Division Sales Representative to order a manual or obtain more detailed technical information.

1.3 GENERAL DESCRIPTION

The MK-150FA Series is a family of 5.25-inch Winchester disk drives designed primarily to be incorporated into systems supporting multi-user and multi-tasking applications. Three models comprise the MK-150FA Series: MK-153FA (86.5 MB), MK-154FA (121 MB) and MK-156FA (173 MB).

All drives comply with the ST506/412 size, mounting and power requirements

The MK-150FA Series supports the Enhanced Small Disk Interface (ESDI). ESDI provides device level capabilities for multi-spindle or highly optimized applications.

The positioning system utilizes a rare earth magnet and a rotary voice coil actuator to provide a 25 millisecond average seek time and a 45 millisecond maximum seek time.

The Head Disk Assembly (HDA) is enclosed in a die cast aluminum base plate and shroud and incorporates numerous safety features to maximize reliability:

> The base plate and shroud assembly provides mechnical mounting and EMI (Electronic Magnetic Interference) shielding for the heads, disks and actuator.
>
> The sealed assembly incorporates an air recirculatory system and a 0.3 micron lifetime filter to ensure a contamination-free environment and even thermal distribution.
>
> A barometric filter in the HDA provides ambient pressure equalization.
>
> When power is removed, a fail-safe system automatically returns the heads to a dedicated landing zone and a solenoid automatically locks the carriage in this location. This prevents head and media damage during transit.

Use of a center stack servo system improves head positioning accuracy across the full environmental operating range and allows servo writing to be performed with the disk stack mounted in the drive.

Careful planning in regard to the location of components on the circuit card, especially those with electrical noise potential, contributes to very low levels of read channel noise and enhances data recovery.

To further reduce read channel noise, DC voltages are filtered before being used on the read channel.

Extensive use of VLSI minimizes the number of components and optimizes MTBF (Mean Time Between Failures).

SECTION 2

SPECIFICATIONS

2.1 STORAGE CAPABILITY

STORAGE CAPACITY	MK-153FA	MK-154FA	MK-156FA
Unformatted Capacity	86.5 MB	121.0 MB	173.0 MB
Number of Disks	3	4	6
Number of Data Read/Write Heads	5	7	10
Number of Tracks	4,150	5,810	8,300

Table 2 — Storage Capability

2.2 FUNCTIONAL SPECIFICATIONS

Specifications are the same for all models	
Number of Cylinders	830
Track Capacity	20,832 Bytes
Tracks per Inch	900 TPI
Bits per Inch	18,766 BPI
Flux Changes per Inch	12,510 FCI
Recording Method	2,7 (RLL)
Data Transfer Rate	10.0 Megabits per Second
Head Recovery Time:	
Head Change	13 Microseconds
Write to Read	8 Microseconds
Seek Time: (includes settling)	
Track-to-Track	5 Milliseconds
Average	23 Milliseconds
Full Stroke	45 Milliseconds
Start Time	20 Seconds Typical - 30 Seconds Maximum
Stop Time	20 Seconds Typical - 30 Seconds Maximum
Rotational Speed	3,600 RPM ± 1%
Average Latency Time	8.33 Milliseconds
Maximum Latency Time	17.10 Milliseconds
Acoustic Noise	50 dBA at 3.0 Feet (1 Meter)

Table 3 — Functional Specifications

2.3 ENVIRONMENTAL SPECIFICATIONS

Specifications are the same for all models	
Operating Environment:	
Ambient Temperature	41° to 122° F (5° to 50° C)
Temperature Gradient	27° F per Hour (15° C) Maximum Wet Bulb 84° F (29° C)
Relative Humidity	20 to 80%, No Condensation
Altitude	-1000 to 10,000 Feet (-300 to 3,000 Meters)
Vibration (all axis)	0.25 G Peak at 5-200 Hz
Shock (recoverable errors allowed)	10.0 G Peak*
Cooling:	
Convection Cooling	Any enclosure (see Section 3) must allow the drive to operate within specified environmental limits.
Non-Operating (Unpacked) Environment:	
Ambient Temperature	14° to 122° F (-10° to 50° C)
Temperature Gradient	27° F per Hour (15° C)
Relative Humidity	10 to 80%, No Condensation
Altitude	-1,000 to 10,000 Feet (-300 to 15,000 Meters)
Vibration	0.5 G/0.04 Inch (1.0mm) at 5-200 Hz
Shock	40.0 G Peak*
Storage (Packed) Environment:	
Ambient Temperature	-40° to 140°F (-40° to 60° C)
Temperature Gradient	27° F per Hour (15° C)
Relative Humidity	5 to 90%, No Condensation
Altitude	-1,000 to 49,000 Feet (-400 to 15,000 Meters)
Vibration	2 G/0.1 Inch (2.5mm) at 5-400 Hz
Shock (maximum free drop)	27 Inches (0.7 Meter)

*When fixed to a rigid structure (excluding resonance) and when an 11 millisecond half-sine-wave impulse is applied to the rigid structure.

Table 4 — Environmental Specifications

2.4 RELIABILITY CHARACTERISTICS

CHARACTERISTIC	MK-153FA	MK-154FA	MK-156FA
Media Defects:			
Maximum Defects per Surface	20	20	20
Maximum Defects per Drive	50	70	100

At the time of factory shipment, Track 00, Heads 0 and 1 have no media defects and no defect is greater than 11 bits in length.

A defect map, identifying the location of known media defects by cylinder, head and number of bytes from Index, is attached to the drive. The defect map is also recorded on the disk in the ESDI specified format (see Section 5).

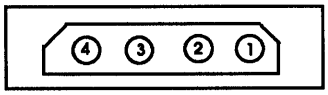
Error Rates:	
Recoverable	1 in 10^{10} Bits
Unrecoverable	1 in 10^{12} Bits
Seek	1 in 10^{6} Seeks
Preventive Maintenance	Not Required
Mean Time Between Failures (MTBF)*	30,000 Hours
Mean Time To Repair (MTTR)	Less than 30 minutes
Service Life	5 Years

* A failure is defined as the drive's inability to perform to specification when operated within the defined limits. Exclusions are shipping and handling damage and operator, user, service, environmental or system induced faults.

Table 5 — Reliability Characteristics

2.5 POWER REQUIREMENTS

Requirements are the same for all models	
+5 VDC ± 5%:	
Current	2.0 Amperes Maximum 1.5 Amperes Typical
Allowable Ripple/Noise	100 Millivolts Peak-to-Peak
+12 VDC ±5%:	
Power-On Current	4.0 Amperes Maximum 3.5 Amperes Average
Seek Operation Current	4.5 Amperes Maximum 3.0 Amperes Average
On-Track Current	2.2 Amperes Maximum 1.7 Amperes Average
Allowable Ripple/Noise	100 Millivolts Peak-to-Peak
Power Consumption	30 Watts Nominal 60 Watts Starting
DC Power Connector:	AMP 480424 with pin (strip) 3500784 or pin (loose) 61173-4, or equivalent.
Power Plug Pin Assignment:	



(as viewed from rear of drive)

Pin Number	Assignment
1	+12 VDC
2	+12 VDC Return
3	+ 5 VDC Return
4	+ 5 VDC

Table 6 — Power Requirements

2.6 PHYSICAL DIMENSIONS, WEIGHT AND MOUNTING

The Nominal dimensions and weight of the MK-150FA are as follows (also see Figure 1):

Height:	3.25 ± 0.04 Inches (82.5 ± 1 Millimeter)
Width:	5.75 ± 0.04 Inches (146.1 ± 1 Millimeter)
Depth:	8.0 ± 0.04 Inches (203 ± 3 Millimeters)
Weight:	6.6 Pounds (3 Kilograms)

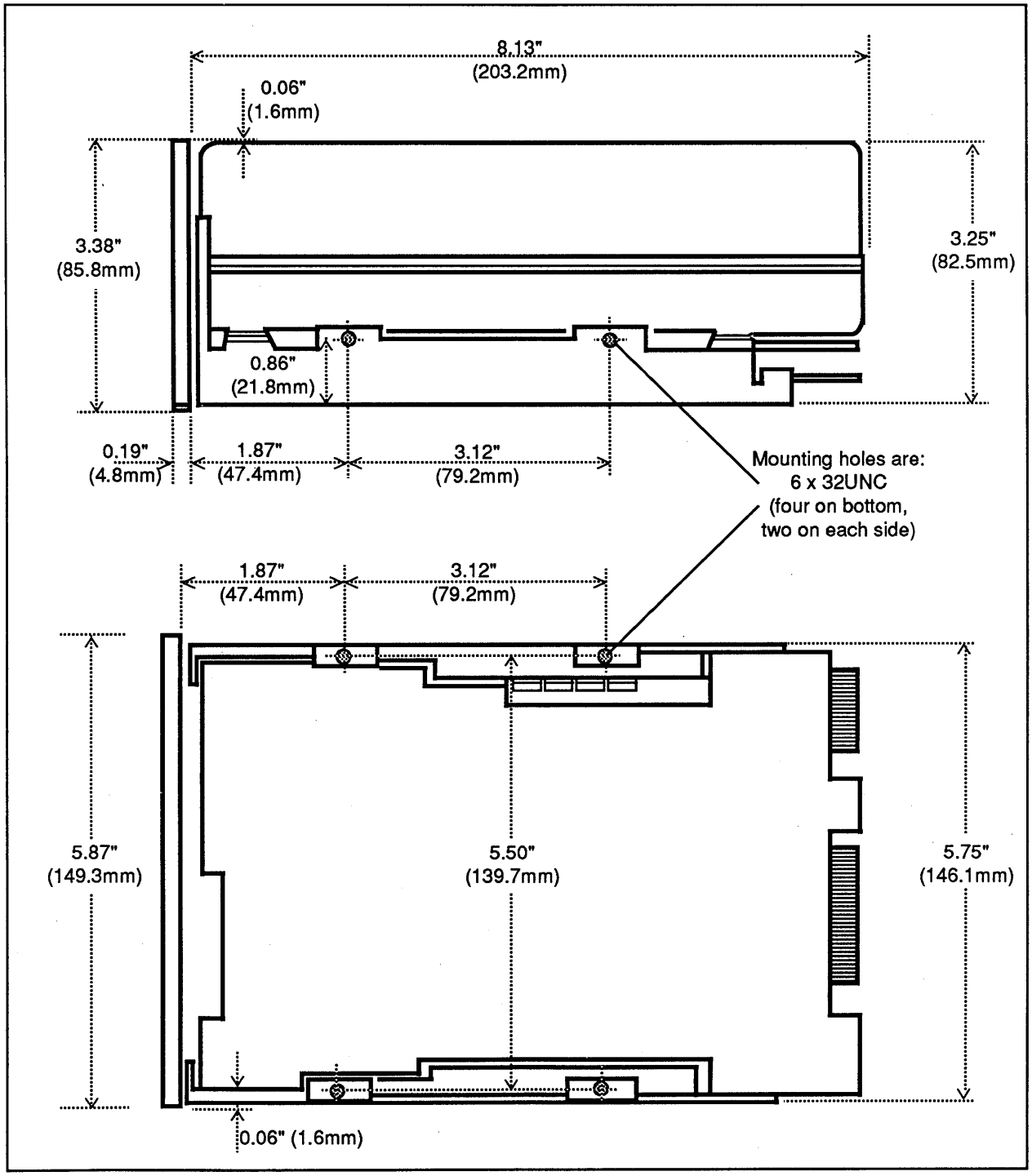


Figure 1 — MK-150FA Dimensions and Mounting Holes

SECTION 3

INSTALLATION

3.1 MOUNTING ORIENTATION

The location of the mounting holes is shown in Figure 1. Recommended mounting orientations are shown in Figure 2.

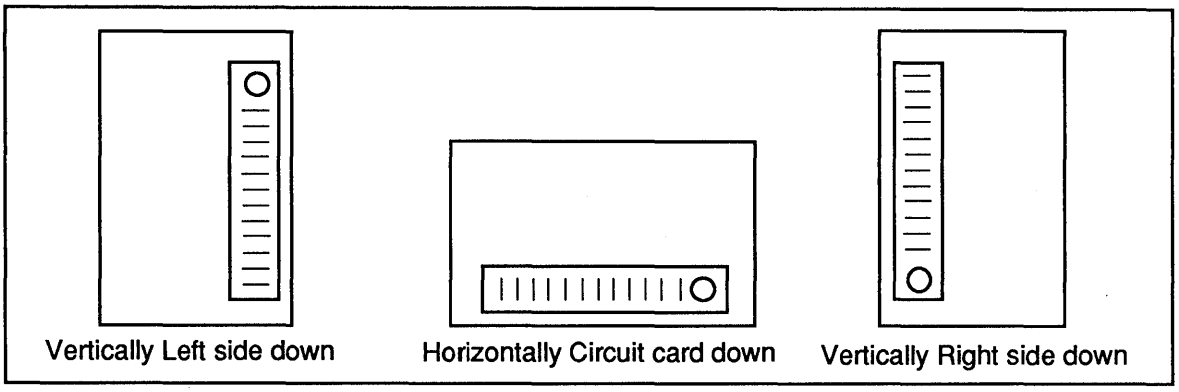


Figure 2 — Mounting Orientation

3.2 COOLING AND DISK DRIVE ENCLOSURE

Convection cooling is used. It is recommended that cabinetry design allow for air flow. The disk enclosure must be designed to maintain an even temperature within the drive's environmental limits and throughout the drive's various components. Minimum clearance requirements for a disk enclosure are shown in Figure 3.

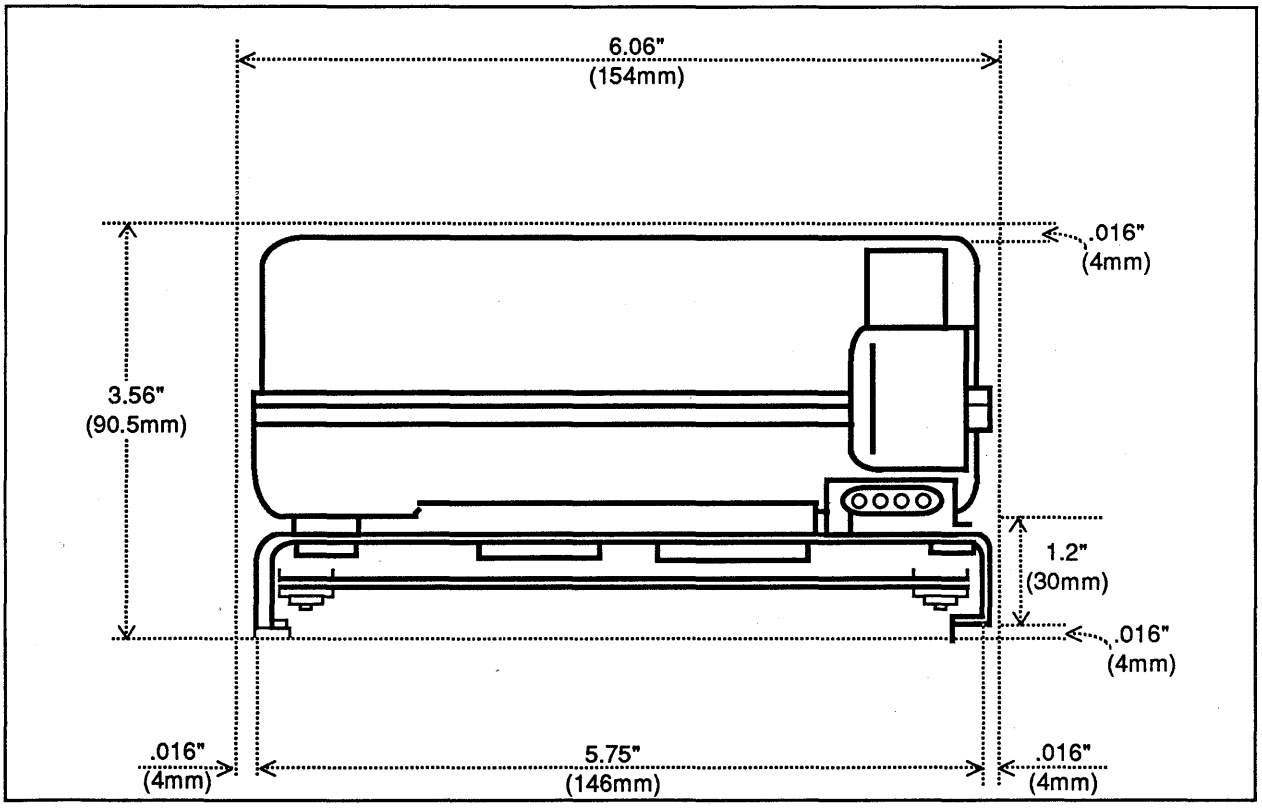


Figure 3 — Clearance Requirements

3.3 SWITCH AND JUMPER FUNCTIONS

Refer to Figure 4 for switch and jumper locations. All DIP switches and jumpers must be set before applying power to the drive. Switch 1 (SW1) functions are shown in Figure 5. Switch 2 (SW2) sets drive I.D. and short or long last sector mode. See Figure 6 for settings.

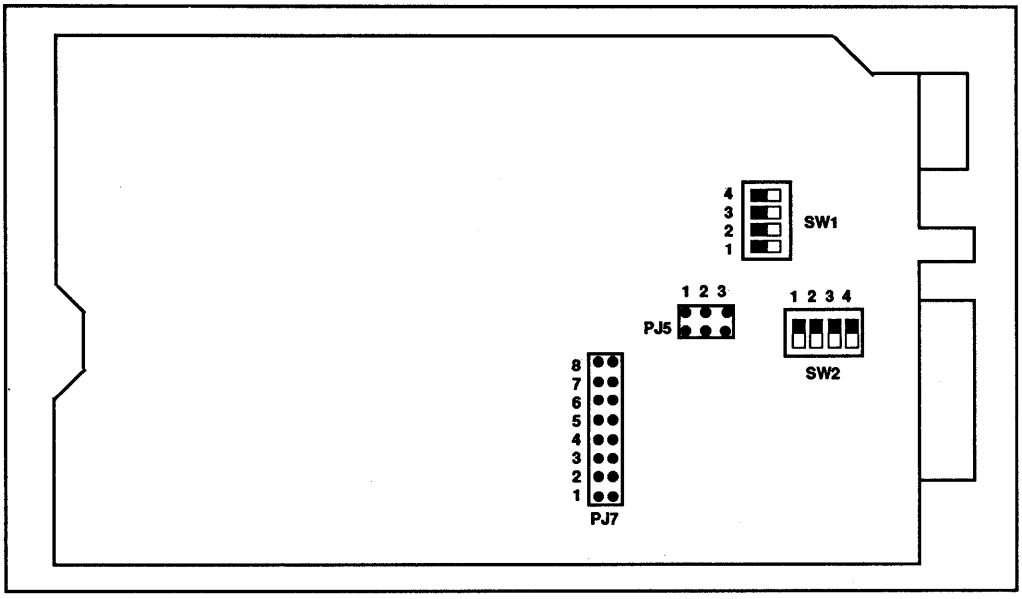
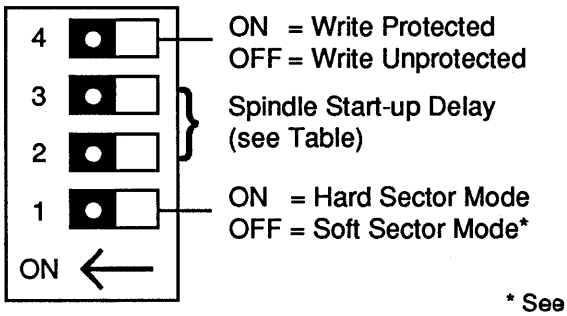


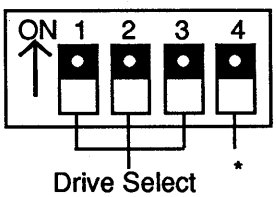
Figure 4 — Switch and Jumper Settings



SPINDLE START-UP DELAY	SWITCH POSITION 2	SWITCH POSITION 3
0 Seconds	OFF	OFF
8 Seconds	OFF	ON
16 Seconds	ON	OFF
24 Seconds	ON	ON

* See Section 5 for Data Format Information
See Page 3-3 for Hard Sector length selecting using PJ7
See Page 3-4 for PJ5 jumper definitions

Figure 5 — SW1 (Switch 1) Functions



* Switch 4 sets short or long last sector mode (see section 3.3.1)

DRIVE SELECT 1 (2^2)	2 (2^1)	3 (2^0)	DRIVE ID
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON	ON	OFF	6
ON	ON	ON	7

Figure 6 — SW2 (Switch 2) Functions

3.3.1 PJ7 Jumper Functions

When operating in the hard sector mode, jumpers PJ7 is used to set the sector length and the number of sectors per track.

To determine sector parameters, it is necessary to calculate the unformatted bytes per sector, which in turn depends on usable sector length and sector overhead, as follows:

Unformatted bytes per sector = usable sector length + overhead

Usable sector length is selected to meet system file size requirements. Overhead depends on controller format, but is typically 64 bytes in hard sector mode.

After the value of unformatted bytes per sector is determined, the number of sectors per track is calculated as follows:

$$\text{Sectors per Track} = \frac{20{,}832 \text{ (number of bytes per track)}}{\text{Unformatted bytes per sector}}$$

The result of this calculation is rounded to the next lower whole number. This number represents the number of whole sectors per track.

Example: Desired usable sector length = 256 user bytes plus 64 overhead bytes
Unformatted bytes per sector = 256 + 64 = 320
Sectors per Track = $\frac{20{,}832}{320}$ = 65.1
Number of whole sectors per track = 65 (next lower whole number)

To set number of sectors per track in the drive, the PJ7 jumpers are configured to a binary value that is one less than the number of whole sectors per track. In the above example (to set 65 sectors per track), the PJ7 jumpers are set to 64 (65 minus 1) (see Table 7).

Jumper Pin Position	8	7	6	5	4	3	2	1
Binary Value	128	64	32	16	8	4	2	1
PJ7 Jumper	OUT	IN	OUT	OUT	OUT	OUT	OUT	OUT
Note: Jumper In = 1; Jumper Out = 0								

Table 7 — PJ7 Jumpers for 65 x 256 byte Sectors per Track

In most cases, the sectors will not exactly fill the whole track, leaving some residual bytes, for example 32 as determined below.

Residual bytes = 20,832 - (unformatted bytes per sector x number of whole sectors per track)
20,832 - (65 x 320) = 32

If the SW2 position 4 is OFF, any residual bytes will be added into the last sector. In the above example, the first 64 sectors will have 320 bytes each and the last sector will have 352 bytes (320 + 32 residual bytes).

If SW2 switch position 4 is ON, any residual bytes will be added as an extra sector. In the above example, there will be 65 sectors with 320 bytes each plus one additional sector containing 32 bytes (the residual bytes). Table 8 shows common format selections.

Jumper Pin Position	8	7	6	5	4	3	2	1
Binary Value	128	64	32	16	8	4	2	1
108 Sectors with 128 User Bytes Binary value = 107	OUT	IN	IN	OUT	IN	OUT	IN	IN
65 Sectors with 256 User Bytes Binary value = 64	OUT	IN	OUT	OUT	OUT	OUT	OUT	OUT
36 Sectors with 512 User Bytes Binary value = 35	OUT	OUT	IN	OUT	OUT	OUT	IN	IN
19 Sectors with 1024 User Bytes Binary value = 18	OUT	OUT	OUT	IN	OUT	OUT	IN	OUT
Note: Jumper In = 1; Jumper Out = 0								

Table 8 — Common PJ7 Jumper Configurations

3.3.2 PJ5 and PJ31 Jumper Functions

For factory use only

3.3.3 PJ32 Jumper Functions

The PJ32 Jumper Selects the drive's LED color. R selects Red, G selects green. (see Figure 7).

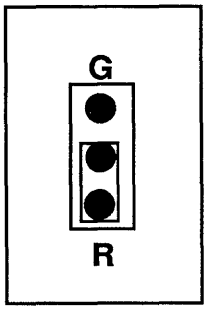


Figure 7 — PJ32 Jumper

SECTION 4

INTERFACE

4.1 CONTROL CABLE

The daisy-chained Control Cable is a flat cable consisting of 17 twisted pairs (34-conductors).

The 34-position connector recommended for the Control Cable is AMP part number 88373-3, or equivalent.

Maximum cable length is 20 feet (6 meters).

Control Cable signals are TTL compatible.

With the exception of DRIVE SELECT, Control Cable signals are inhibited until the drive is selected.

In a daisy-chain configuration, the 16-pin terminator chip, located on an IC socket on the main circuit card, must be installed on only the last drive in the daisy-chain.

Pin assignments for the Control Cable are shown in Table 9.

4.2 DATA CABLE

The star-configured Data Cable, is a flat cable consisting of 10 twisted pairs (20-conductors).

The 20-position connector recommended for the Data Cable is AMP part number 88373-6, or equivalent.

Maximum cable length is 10 feet (3 meters).

The following Data Cable signals are differential signal pairs:

Write Clock	(pins 7 & 8)
Read/Reference Clock	(pins 10 & 11)
NRZ Write Data	(pins 13 & 14)
NRZ Read Data	(pins 17 & 18)

The following Data Cable signals are TTL compatible:

Drive Selected	(pin 1)
Sector/Address Mark	(pin 2)
Address Mark Enable	(pin 4)
Index Mark	(pin 20)

Data Cable differential signals are enabled at all times, regardless of the drive's selected status. Pin assignments for the Data Cable are shown in Table 10.

4.3 CONTROL CABLE PIN ASSIGNMENTS

SIGNAL NAME	PIN NUMBERS		MK-150FA*
	SIGNAL	GROUND	
HEAD SELECT 2^3	2	1	Input
HEAD SELECT 2^2	4	3	Input
WRITE GATE	6	5	Input
CONFIG/STATUS DATA	8	7	Output
TRANSFER ACK	10	9	Output
ATTENTION	12	11	Output
HEAD SELECT 2^0	14	13	Input
SECTOR/ADDRESS MARK	16	15	Output
HEAD SELECT 2^1	18	17	Input
INDEX	20	19	Output
READY	22	21	Output
TRANSFER REQUEST	24	23	Input
DRIVE SELECT 1	26	25	Input
DRIVE SELECT 2	28	27	Input
DRIVE SELECT 3	30	29	Input
READ GATE	32	33	Input
COMMAND DATA	34	N/A	Input

* "Input" means input to drive; "Output" means output from drive

Table 9 — Control Cable Pin Assignments

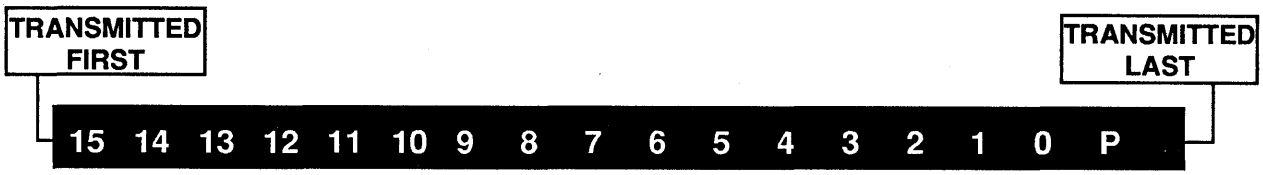
4.4 DATA CABLE PIN ASSIGNMENTS

SIGNAL NAME	PIN NUMBERS	MK-150FA*
DRIVE SELECTED	1	Output
SECTOR/ADDRESS MARK	2	Output
COMMAND COMPLETE	3	Output
ADDRESS MARK ENABLE	4	Input
RESERVED	5	N/A
GROUND	6	N/A
+ WRITE CLOCK	7	Input
- WRITE CLOCK	8	Input
RESERVED	9	N/A
+ READ/REFERENCE CLOCK	10	Output
- READ/REFERENCE CLOCK	11	Output
GROUND	12	N/A
+ NRZ WRITE DATA	13	Input
- NRZ WRITE DATA	14	Input
GROUND	15	N/A
GROUND	16	N/A
+ NRZ READ DATA	17	Output
- NRZ READ DATA	18	Output
GROUND	19	N/A
INDEX	20	Output

* "Input" means input to drive; "Output" means output from drive

Table 10 — Data Cable Pin Assignments

4.5 ESDI COMMAND CONFIGURATION AND FUNCTIONS



COMMAND DEFINITION	BITS 15 - 12	BITS 11 - 8 USED?	BITS 11 - 0 USED?
Seek	0 0 0 0	No	Yes
Recalibrate	0 0 0 1	No	No
Request Status	0 0 1 0	No	No
Request Configuration	0 0 1 1	Yes	No
Track Offset	0 1 0 0	–	–
Control	0 1 0 1	Yes	No
Data Strobe Offset	0 1 1 0	Yes	No
Track Offset	0 1 1 1	Yes	No
Initiate Diagnostics	1 0 0 0	No	No
Set Bytes per Sector	1 0 0 1	No	Yes
Reserved	1 0 1 0	–	–
Reserved	1 0 1 1	–	–
Reserved	1 1 0 0	–	–
Reserved	1 1 0 1	–	–
Set Configuration	1 1 1 0	Yes	Yes
Reserved	1 1 1 1	–	–

- All unused or non-applicable bits must be set to 0.
- All unimplemented or reserved commands are invalid.
- Data Strobe and Track Offset can be simultaneously enabled by sending two separate commands.

Table 11 — ESDI Command Configurations

COMMAND DEFINITION	BITS 15 - 12	DRIVE ACTION
Seek*	0 0 0 0	Seek to the track specified in bits 11-0
Recalibrate*	0 0 0 1	Seek to track 00
Initiate Diagnostics	1 0 0 0	Perform drive diagnostic test
Set Bytes per Sector	1 0 0 1	Set to binary value in bits 11 - 0

* Also resets Data Strobe offset and Track Offset

Table 12 — ESDI Command Functions

4.6 REQUEST STATUS COMMAND

BIT POSITION	DEFINITION	DRIVE RESPONSE
15	Reserved	0
14	Drive is not designed with removable media	1
13	Removable media is write protected	0
12	Fixed media is write protected	Note 1
11	Reserved	0
10	Reserved	0
9	Spindle motor is stopped	Note 2
8	Power-on reset condition	Note 3
7	Parity error detected in command data	0/1
6	Interface fault	Note 4
5	Invalid or unimplemented command received	0/1
4	Seek fault detected	Note 5
3	Write gate received with track offset implemented	0/1
2	Vendor unique status	0
1	Write fault condition	Note 6
0	Removable media changed since last status request	0
P	Odd Parity	0/1

Note 1: Response = 1 when write protect switch (SW1-4) is ON.
Response = 0 when write protect switch (SW1-4) is OFF.

Note 2: Response = 1 when the spindle motor is stopped by a control command or a power-on reset condition.
Response = 0 when spindle motor is stopped by another cause or when the spindle is rotating.

Note 3: Response = 1 if voltage fault, spindle speed out of tolerance, spindle speed not achieved in 20 seconds, abnormal servo signal, AGC error, or overheated voice coil is detected, or if the outer guard band or data zone is not detected.
Response = 0 when none of the above conditions are present.

Note 4: Response = 1 if a transfer request is received while Command Complete is false, or if the handshake between transfer request and transfer acknowledge is not completed within 10 milliseconds.
Response = 0 when none of the above conditions are present.

Note 5: Response = 1 if an over current in voice coil, no data zone, AGC error, or seek time-out is detected.
Response = 0 when none of the above conditions are present.

Note 6: Response = 1 if voltage is out-of-tolerance, write and read gates are simultaneously activated, write gate is OFF and write current is detected, write gate is ON and no write current is detected, no head is selected, write protect switch (SW1-4) is ON, heads are not on-cylinder.
Response = 0 when none of the above conditions are present.

Table 13 — General Status Data

4.7 CONFIGURATION DATA COMMAND MODIFIERS

COMMAND MODIFIER BITS 11	10	9	8	DEFINITION OF MODIFIER/ CONFIGURATION RESPONSE	DRIVE RESPONSE BITS 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	P
0	0	0	0	Configuration Data	Refer to Table 16																
0	0	0	1	Number of cylinders on fixed media (830)	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	0	0
0	0	1	0	Number of cylinders on removable media (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	1	1	Num. of data heads:																	
				bits 15-8=removable (MK153=5)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
				drive heads (MK154=7)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
				bits 7-0=fixed (MK156=10)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
0	1	0	0	Unformatted bytes per track (20,832)	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1
0	1	0	1	Unformatted bytes per sector (hard sector mode)	Refer to Page 3-3 (bytes per sector calculations)																
0	1	1	0	Number of sectors per track (hard sector mode)	Refer to Page 3-3 (sectors per track calculations)																
0	1	1	1	Minimum bytes in ISG (Inter-Sector Gap) (18) (not including Speed Variance Gap) bits 15-8=ISG bytes from Index bits 7-0=bytes per ISG	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0
1	0	0	0	Minimum bytes per PLO Sync Field (11) bits 15-8=spare bits 7-0=bytes per PLO Sync field	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0
1	0	0	1	Number of vendor status words available (0) bits 15-4=spare bits 3-0=available status words	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 14 — Configuration Data Command Modifiers

4.8 CONFIGURATION DATA RESPONSE

BIT POSITION	DEFINITION	DRIVE RESPONSE
15	Tape drive	0
14	Speed variance gap required	Note 1
13	Track offset available	1
12	Data strobe offset available	1
11	Rotational speed tolerance is ±0.5%	1
10	Transfer rate is greater than 10 MHZ	0
9	Transfer rate is between 5 and 10 MHZ	1
8	Transfer rate is less than 5 MHZ	0
7	Removable cartridge drive	0
6	Fixed media drive	1
5	Spindle motor control option implemented	1
4	Head switch time is greater than 15 microseconds	0
3	2,7 (RLL) encoded	1
2	Controller set for soft sector format	Note 2
1	Drive set for hard sector format	Note 3
0	Controller set for hard sector format	0
P	Odd Parity	0/1

Note 1	Response = 1	when the drive is in soft sector mode (SW1-1 set OFF)
	Response = 0	when the drive is in hard sector mode (SW1-1 set ON)
Note 2	Response = 1	when SW1-1 is set OFF (soft sector mode)
	Response = 0	when SW1-1 is set ON (hard sector mode)
Note 3	Response = 1	when SW1-1 is set ON (hard sector mode)
	Response = 0	when SW1-1 is set OFF (soft sector mode)

Table 15 — Configuration Data Reponse

4.9 CONTROL COMMAND MODIFIERS

MODIFIER BITS 11	10	9	8	FUNCTION PERFORMED
0	0	0	0	Reset interface and general status data (Bits 11-0)
0	0	0	1	Reserved
0	0	1	0	Stop spindle motor rotation
0	0	1	1	Start spindle motor rotation
0	1	0	0	
through				Reserved
1	1	1	1	

Table 16 — Control Command Modifiers

4.10 DATA STROBE OFFSET COMMAND

COMMAND MODIFIER BITS 11	10	9	8	FUNCTION PERFORMED
0	0	0	0	Restore offset to zero (0)
0	0	0	1	Restore offset to zero (0)
0	0	1	0	Early offset of 2 nanoseconds
0	0	1	1	Late offset of 2 nanoseconds
0	1	0	0	
through				Reserved
1	1	1	1	

Table 17 — Data Strobe Offset Command Modifier Bits

4.11 TRACK OFFSET COMMAND

COMMAND MODIFIER BITS 11	10	9	8	FUNCTION PERFORMED
0	0	0	0	Restore offset to zero (0)
0	0	0	1	Restore offset to zero (0)
0	0	1	0	Positive offset of 2 micrometers
0	0	1	1	Negative offset of 2 micrometers
0	1	0	0	
through				Reserved
1	1	1	1	

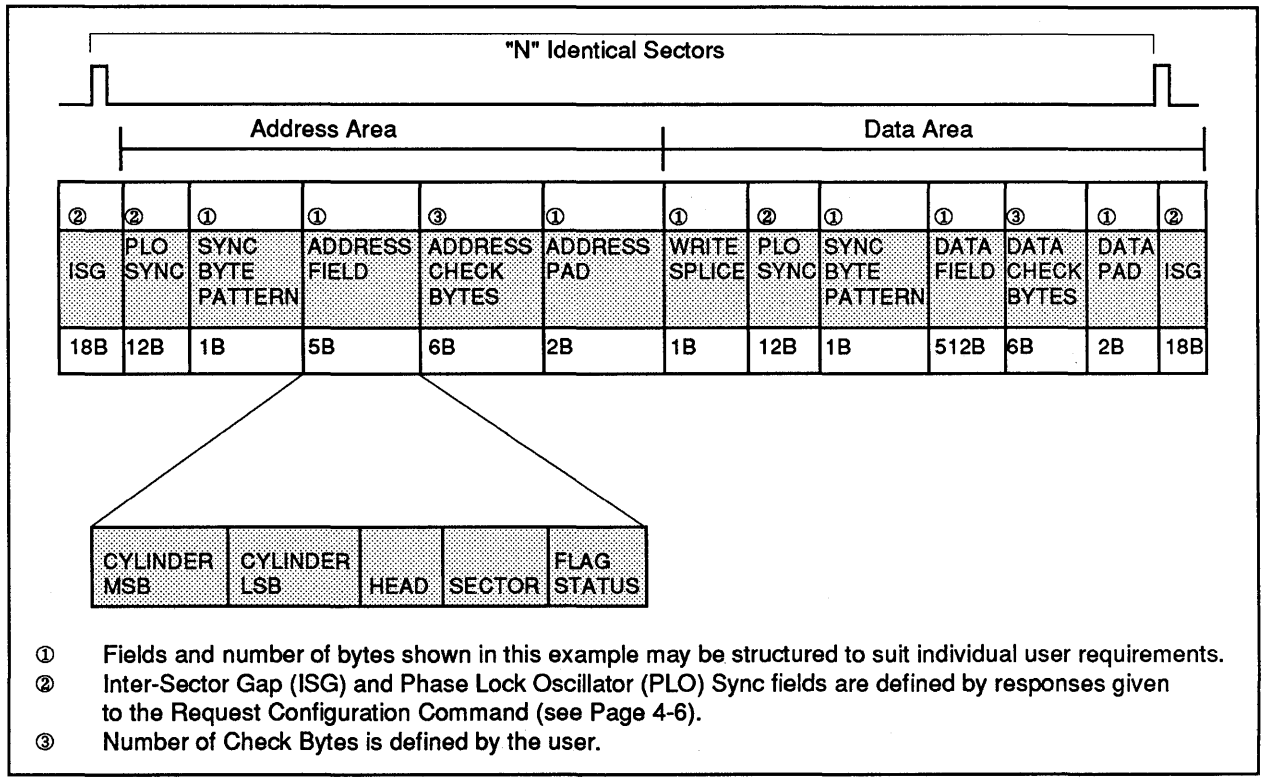
Table 18 — Track Offset Command Modifier Bits

SECTION 5

DATA FORMATS

5.1 HARD SECTOR FORMAT

Refer to Section 3 for information on switch and jumper options. Figure 8 shows a typical hard sector format. The *minimum* number of bytes is given for each field.



① Fields and number of bytes shown in this example may be structured to suit individual user requirements.
② Inter-Sector Gap (ISG) and Phase Lock Oscillator (PLO) Sync fields are defined by responses given to the Request Configuration Command (see Page 4-6).
③ Number of Check Bytes is defined by the user.

Figure 8 — Hard Sector Format

5.2 SOFT SECTOR FORMAT

Refer to Section 3 for information on switch and jumper functions. Figure 9 shows a typical soft sector format. The minimum number of bytes are given for each field, except the Speed Variance Gap (see Section 5.21).

NOTE: ***Write Splice is part of PLO Sync. It allows for Read Gate activation delay. The controller should treat the Write Splice as an additional PLO Sync byte.***

Speed Variance Gap is only required when in Soft Sector Mode.

Address Mark (AM) is a unique pattern generated by the drive (logically equivalent to a hard sector pulse).

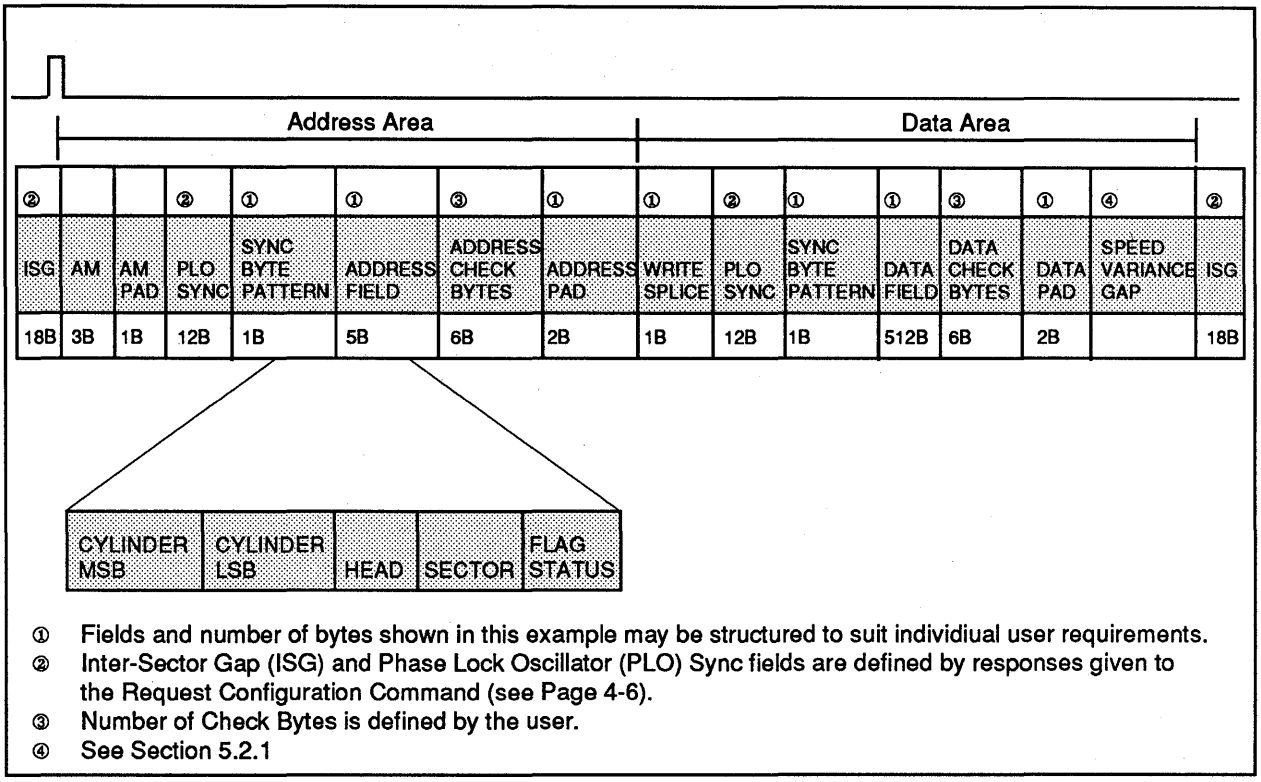


Figure 9 — Soft Sector Format

5.2.1 Speed Variance Gap

The Speed Variance Gap's purpose is to compensate for the tolerance of the Spindle Rotation Speed. If the AM Enable Timing is determined by the Host Controller IS Generated Clock, the minimum byte length of the Format Speed Tolerance Gap (FSTG) is calculated as follows:

$$\text{Min. FSTG} = \frac{\text{TRACK CAPACITY x ROTATIONAL SPEED TOLERANCE}}{\text{NUMBER OF SECTORS PER TRACK}}$$

Example: $\frac{20832 \times 0.01}{34} = 6.1$ (for MK150FA 34 Sectors)

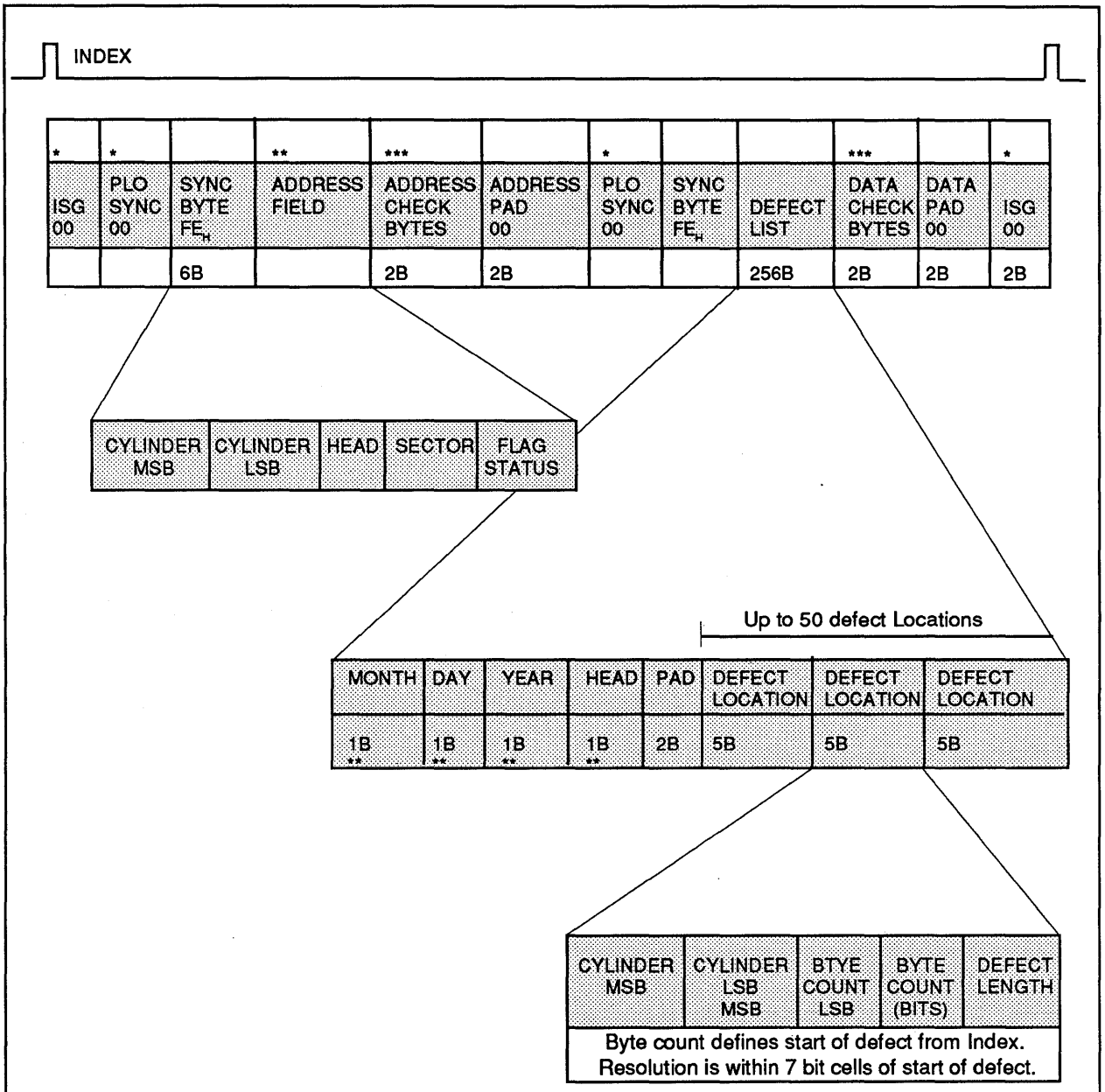
If the AM Enable Timing is determind by Ref. Clock, the Format Speed Tolerance Gap can be 0, since Rotational Speed Tolerance can be compensated by disk drive circuits.

5.3 DEFECT MAP FORMAT

The Figure 10 shows the format of the defect map. This defect map is recorded at the maximum cylinder number and repeated at the maximum cylinder number minus 8 per ESDI specifications.

Defect Locations are terminated by the end of the sector or with recorded 1's to the end of the data field (a minimum of five bytes of 1's is required).

NOTE: Algorithm for Check Bytes is $X^{16} + X^{12} + X^5 + 1$.



* Inter-Sector Gap (ISG) and Phase Lock Oscillator (PLO) Sync fields are defined by responses given to the Request Configuration Command (see Page 4-6).

** Month, day and year fields are represented by unsigned binary values (i.e., 01 - 12 = 01 - 0C; 01 - 31 = 01 - 1F; and 86 = 56).

*** Algorithm for Check Bytes is $X^{16} + X^{12} + X^5 + 1$.

Figure 10 — Defect Map Format

SECTION 6

MAINTENANCE CONSIDERATIONS

6.1 EQUIPMENT MAINTENANCE

Refer to Toshiba America, Inc., Disk Products Division (herein after referred to as "Toshiba America") Maintenance Policies and Procedures for a complete description of in-warranty procedures, terms and conditions.

6.1.1 In-Warranty Maintenance

Toshiba America will provide parts and labor at no charge to the customer for all in-warranty repair actions. The drive must be returned to Toshiba America's Customer Service point of repair (see paragraph 6.1.3 for instructions) at the customer's expense, inclusive of shipping and insurance costs.

6.1.2 Out-of-Warranty Maintenance

Toshiba America repairs major assemblies on a fixed cost basis and all other repairable assemblies on an hourly rate plus parts basis. The drive or repairable assembly must be returned to Toshiba America's Customer Service point of repair (see paragraph 6.1.3 for instructions) at the customer's expense, inclusive of shipping and insurance costs.

6.1.3 Equipment Return Instructions

A Return Authorization Number is required and must accompany any equipment returned for repair. Contact a Toshiba America Customer Service Representative for return instructions and a Return Authorization Number. All equipment must be returned to the address listed below.

Toshiba America, Inc.
Disk Products Division
Customer Service Center
9740 Irvine Boulevard
Irvine, CA 92718

(714) 583-3000

MK-150FA HARD DISK DRIVE INSTALLATION NOTES

Doc. #89037

TOSHIBA AMERICA INFORMATION SYSTEMS, INC.
DISK PRODUCTS DIVISION
9740 Irvine Blvd.
P.O. Box 19724
Irvine, CA 92713-9724

Congratulations and thank you for purchasing a Toshiba disk drive. Your disk drive is of the highest quality and should be fully compatible with industry standards. When properly installed and configured, your drive is designed to give you years of trouble-free operation.

GENERAL DESCRIPTION

The MK-150FA Series is a family of 5.25-inch hard disk drives designed primarily to be incorporated into systems supporting multi-user and multi-tasking applications. Three models comprise the MK-150FA Series: MK-153FA (86.5 MB), MK-154FA (121 MB) and MK-156FA (173 MB). The MK-150FA complies with the ST506/412 size, mounting and power requirements.

The MK-150FA Series supports the Enhanced Small Disk Interface ESDI. ESDI provides device level capabilities for multi-spindle or highly optimized applications.

The positioning system utilizes a rare earth magnet and a rotary voice coil actuator to provide a 23 millisecond average seek time and a 45 millisecond maximum seek time.

The Head Disk Assembly (HDA) is enclosed in a die cast aluminum base plate and shroud and incorporates numerous safety features to maximize reliability:

> The base plate and shroud assembly provides mechnical mounting and EMI (Electronic Magnetic Interference) shielding for the heads, disks and actuator. The sealed assembly incorporates an air recirculatory system and a 0.3 micron lifetime filter to ensure a contamination-free environment and even thermal distribution.A barometric filter in the HDA provides ambient pressure equalization. When power is removed, a fail-safe system automatically returns the heads to a dedicated landing zone and a solenoid automatically locks the carriage in this location. This prevents head and media damage during transit.

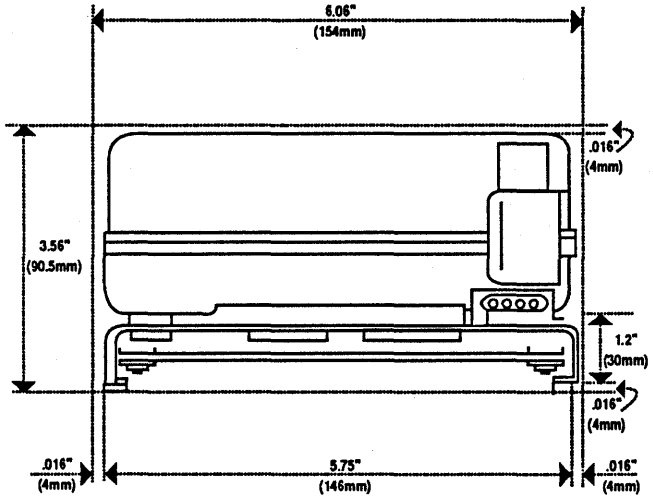
Use of a center stack servo system improves head positioning accuracy across the full environmental operating range and allows servo writing to be performed with the disk stack mounted in the drive.

Careful planning in regard to the location of components on the circuit card, especially those with electrical noise potential, contributes to very low levels of read channel noise and enhances data recovery. To further reduce read channel noise, DC voltages are filtered before being used on the read channel.

Extensive use of VLSI minimizes the number of components and optimizes MTBF (Mean Time Between Failures).

COOLING AND DISK DRIVE ENCLOSURE

The MK-150FA can be mounted vertically or horizontally. Convection cooling is used. It is recommended that cabinetry design allow for air flow. The disk enclosure must be designed to maintain an even temperature within the drive's environmental limits and throughout the drive's various components. Minimum clearance requirements for a disk enclosure is shown below.



CONTROL CABLE

The daisy-chained Control Cable consists of 17 signal pairs (34-conductors). The 34-position connector recommended for the Control Cable is AMP part number 88373-3, or equivalent. **Maximum cable length is 20 feet (6 meters).** Control Cable signals are TTL compatible. Control Cable signals, with the exception of DRIVE SELECT, are inhibited until the drive is selected. In a daisy-chain configuration the 16-pin terminator chip, located on an IC socket on the main circuit card, must be installled on only the last drive in the daisy-chain.

CONTROL CABLE PIN ASSIGNMENTS

SIGNAL NAME	PIN NUMBERS		MK-150FA *Input means input to drive. Output means output to drive.*
	SIGNAL	GROUND	
HEAD SELECT 2^{3*}	2	1	Input
HEAD SELECT 2^{2}	4	3	Input
WRITE GATE	6	5	Input
CONFIG/STATUS DATA	8	7	Output
TRANSFER ACK	10	9	Output
ATTENTION	12	11	Output
HEAD SELECT 2^{0}	14	13	Input
SECTOR/ADDRESS MARK	16	15	Output
HEAD SELECT 2^{1}	18	17	Input
INDEX	20	19	Output
READY	22	21	Output
TRANSFER REQUEST	24	23	Input
DRIVE SELECT 1	26	25	Input
DRIVE SELECT 2	28	27	Input
DRIVE SELECT 3	30	29	Input
READ GATE	32	31	Input
COMMAND DATA	34	33	Input

DATA CABLE

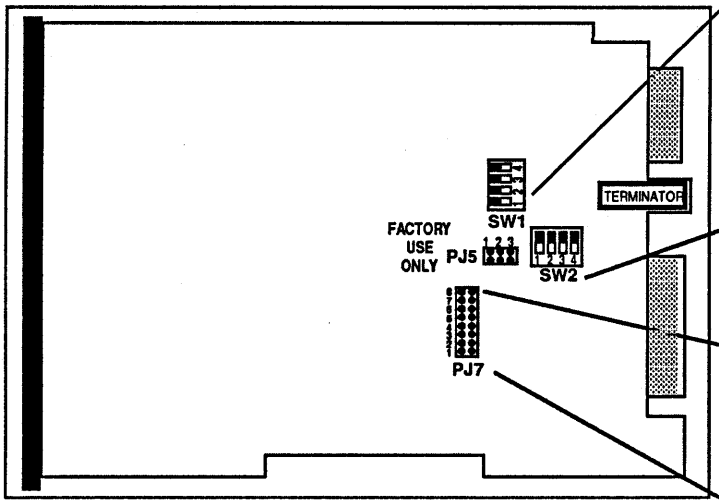
The star-configured Data Cable consists of 20 conductors. The 20-position connector recommended for the Data Cable is AMP part number 88373-6, or equivalent. **Maximum cable length is 20 feet** (6 meters). The following Data Cable signals are differential signal pairs: Write Clock (pins 7 & 8), Read/Reference Clock (pins 10 & 11) NRZ Write Data (pins 13 & 14) and NRZ Read Data (pins 17 & 18). The following data cable signals are TTL compatible: Drive Selected (pin 1) Sector/Address Mark (pin 2), Address Mark Enable (pin 4) and Index Mark (pin 20). All Data Cable signals are enabled at all times, regardless of the drive's selected status. Pin assignments for the Data Cable are as follows.

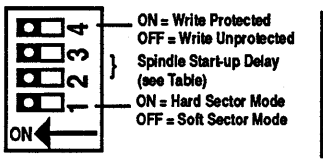
DATA CABLE PIN ASSIGNMENTS *Input means input to drive. Output means output to drive.*

SIGNAL NAME	PIN NUMBERS	MK-150FA
DRIVE SELECTED	1	Output
SECTOR/ADDRESS MARK	2	Output
COMMAND COMPLETE	3	Output
ADDRESS MARK ENABLE	4	Input
RESERVED	5	N/A
GROUND	6	N/A
+WRITE CLOCK	7	Input
- WRITE CLOCK	8	Input
RESERVED	9	N/A
+ READ REFERENCE CLOCK	10	Output
- READ REFERENCE CLOCK	11	Output
GROUND	12	N/A
+NRZ WRITE DATA	13	Input
- NRZ WRITE DATA	14	Input
GROUND	15	N/A
GROUND	16	N/A
+ NRZ READ DATA	17	Output
- NRZ READ DATA	18	Output
GROUND	19	N/A
INDEX	20	N/A

SWITCH AND JUMPER FUNCTIONS

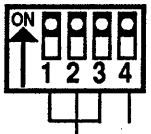
All switches and jumpers must be set **before** applying power to the drive. See the figure below for location of jumpers and switches on the PCB board and what functions they perform.





SPINDLE START-UP DELAY	SWITCH POSITION 2	SWITCH POSITION 3
0 Seconds	OFF	OFF
8 Seconds	OFF	ON
16 Seconds	ON	OFF
24 Seconds	ON	ON

SW1 (Switch 1) Functions



DRIVE SELECT 1 (2^0)	2 (2^1)	3 (2^2)	DRIVE ID
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON	ON	OFF	6
ON	ON	ON	7

SW2 (Switch 2) Functions

Jumper Pin Position	8	7	6	5	4	3	2	1
Binary Value	128	64	32	16	8	4	2	1
PJ7 Jumper	OUT	IN	OUT	OUT	OUT	OUT	OUT	OUT
Note: Jumper IN = 1; Jumper OUT = 0								

PJ7 Jumpers for 65 x 256 byte Sectors per Track

Jumper Pin Position	8	7	6	5	4	3	2	1
Binary Value	128	64	32	16	8	4	2	1
108 Sectors w/128 User Bytes Binary value = 107	OUT	IN	IN	OUT	IN	OUT	IN	IN
65 Sectors with 256 User Bytes Binary value = 64	OUT	IN	OUT	OUT	OUT	OUT	OUT	OUT
36 Sectors with 512 User Bytes Binary value = 35	OUT	OUT	IN	OUT	OUT	OUT	IN	IN
19 Sectors with 1024 User Bytes Binary value = 18	OUT	OUT	OUT	IN	OUT	OUT	IN	OUT
Note: Jumper IN = 1; Jumper OUT = 0								

Common PJ7 Jumper Configurations

PJ7 JUMPER FUNCTIONS:

When operating in the hard sector mode, jumper PJ7 is used to set the sector length and the number of sectors per track. To determine sector parameters, it is necessary to calculate the unformatted bytes per sector, which in turn depends on usable sector length and sector overhead, as follows:

Unformated bytes per sector = usable sector length = overhead.

Usable sector length is selected to meet system file size requirements. Overhead depends on controller format, but is typically 64 bytes in hard sector mode. After the value of unformatted bytes per sector is determined, the number of sectors per track is calculated as follows:

$$\text{Sectors per track} = \frac{20{,}832 \text{ (number of bytes per track)}}{\text{Unformatted bytes per sector}}$$

The result of this calculation is rounded to the next lower whole number. This number represents the number of whole sectors per track. To set number of sectors per track in the the drive, the PJ7 jumpers are configured to a binary value that is one less than the number of whole sectors per track. In most case, the sectors will not exactly fill the whole track, leaving some residual bytes. If SW2 switch position 4 is OFF, any residual bytes will be added into the last sector. If SW2 Switch position is ON, any residual bytes will be added as an extra sector.

TERMINATION:

When daisy chaining drives: the last physical drive in the daisy chain must be terminated. Removing the terminator pack un-terminates the drive.

DRIVE GEOMETRY	MK153FA	MK154FA	MK156FA
Capacity (unformatted)	86.5 MB	121 MB	173 MB
Number of Cylinders	830	830	830
Number of Heads	5	7	10
Number of Bytes Per Track (Unformatted)	20,832	20,832	20,832

TECHNICAL SUPPORT

Should you require any technical support, contact your computer distributor. If your distributor is unable to answer your questions, have them call the Toshiba Disk Products Divisional Office, on your behalf.

Call from in front of the computer. Know as much about your system software and hardware, particularly any non-standard hardware (which may have not been considered by designers). In general, technical support specialists have experience with a particular "wedge" of the computer market, and may not have the background to support your particular application(s). (Many problems are caused by the interaction of two or more products in your compter, not with your computer itself.)

TECHNICAL SUPPORT NUMBERS

Cambridge, MA -----617/354-6720 Dallas, TX ------214/991-5979
San Jose, CA --------408/452-8179 Irvine, CA -------714/455-0407