
QUANTUM

OEM
MANUAL

Q2000
8" Media Fixed Disk Drive

QUANTUM CORPORATION

2150 Bering Drive
San Jose, CA. 95131
(408) 262-1100

Publication P/N
81-40184

PREFACE

This manual describes the electrical and mechanical characteristics of the Q2000 Series Rigid Disk Drive required by customers who purchase it as an OEM device. It contains timing, electrical and mechanical specifications, and recommended circuitry necessary to interface it to a host controller and data separator.

TABLE OF CONTENTS

1.0	Introduction	1
1.1	General Description	1
1.2	Specification Summary	2
1.2.1	Physical Specifications	2
1.2.2	Reliability Specifications	3
1.2.3	Performance Specifications	3
1.2.4	Functional Specifications	3
2.0	Functional Characteristics	5
2.1	General Operations	5
2.2	Read/Write and Control Electronics	5
2.2.1	Transducer PCB	5
2.2.2	Main PCB	5
2.3	Drive Mechanism	6
2.4	Read/Write Heads and Disks	6
2.5	Head Positioning System	6
2.5.1	Rotary Torque Motor Actuator	6
2.5.2	Optical Track Position Encoder	6
2.5.3	Temperature Compensation Servo	6
2.6	Air Filtration System	8
3.0	Functional Operations	9
3.1	Power Sequencing	9
3.2	Drive Selection	9
3.3	Track Accessing	9
3.4	Head Selection	10
3.5	Read Operation	10
3.6	Write Operation	10
4.0	Interface Lines and Pin Assignments	11
5.0	Signal Interface	11
5.1	Control Input Lines	11
5.1.1	Drive Select 1 through 4	11
5.1.2	Direction In	12
5.1.3	Step	12
5.1.3.1	Normal Step Mode	12
5.1.3.2	Buffered Step Mode	12
5.1.4	Head Select 2 ⁰ , 2 ¹ , and 2 ²	12
5.1.5	Write Gate	18
5.1.6	Reduced Write Current	18
5.1.7	Rezero	18
5.2	Output Lines	18
5.2.1	Track 000	19
5.2.2	Index	19
5.2.3	Ready	19
5.2.4	Write Fault	19
5.2.5	Seek Complete	19
5.3	Data Transfer Lines	20
5.3.1	MFM Write Data	20
5.3.3	Timing Clock	20
5.4	Select Status	20

6.0	General Timing Requirements	23
7.0	Power Interface	25
7.1	AC Power	25
7.2	DC Power	26
8.0	Physical Outline	27
9.0	Physical Interface	27
9.1	J1/P1 Connector	29
9.2	J2/P2 Connector	29
9.3	J5/P5 Connector	29
9.4	J4/P4 Connector	29
10.0	Q2000 Recommended Track Format	31
10.1	Gap Length Calculations	31
10.1.1	Gap 1	32
10.1.1	Gap 2	32
10.1.3	Gap 3	32
10.1.4	Gap 4	32
10.2	Write Precompensation	32
11.0	Installation Instruction	35
11.1	Required Tools	35
11.2	Unpacking Instructions	35
11.3	Motor Locking Clip Disengagement	35
11.4	Actuator Lock	35
11.5	Drive Options	36
11.5.1	Jumper Options (Main PCB)	36
11.5.2	Cut Trace Options	36
11.6	Control Line Termination	36
12.0	Shipping Instructions	36
12.1	Actuator Lock	36
12.1	Motor Locking Clip Engagement	36
12.3	Packaging	36
	Appendix A — Definition of Terms	39
	Appendix B — Media Defects and Errors	43
	Appendix C — Ordering Information	45

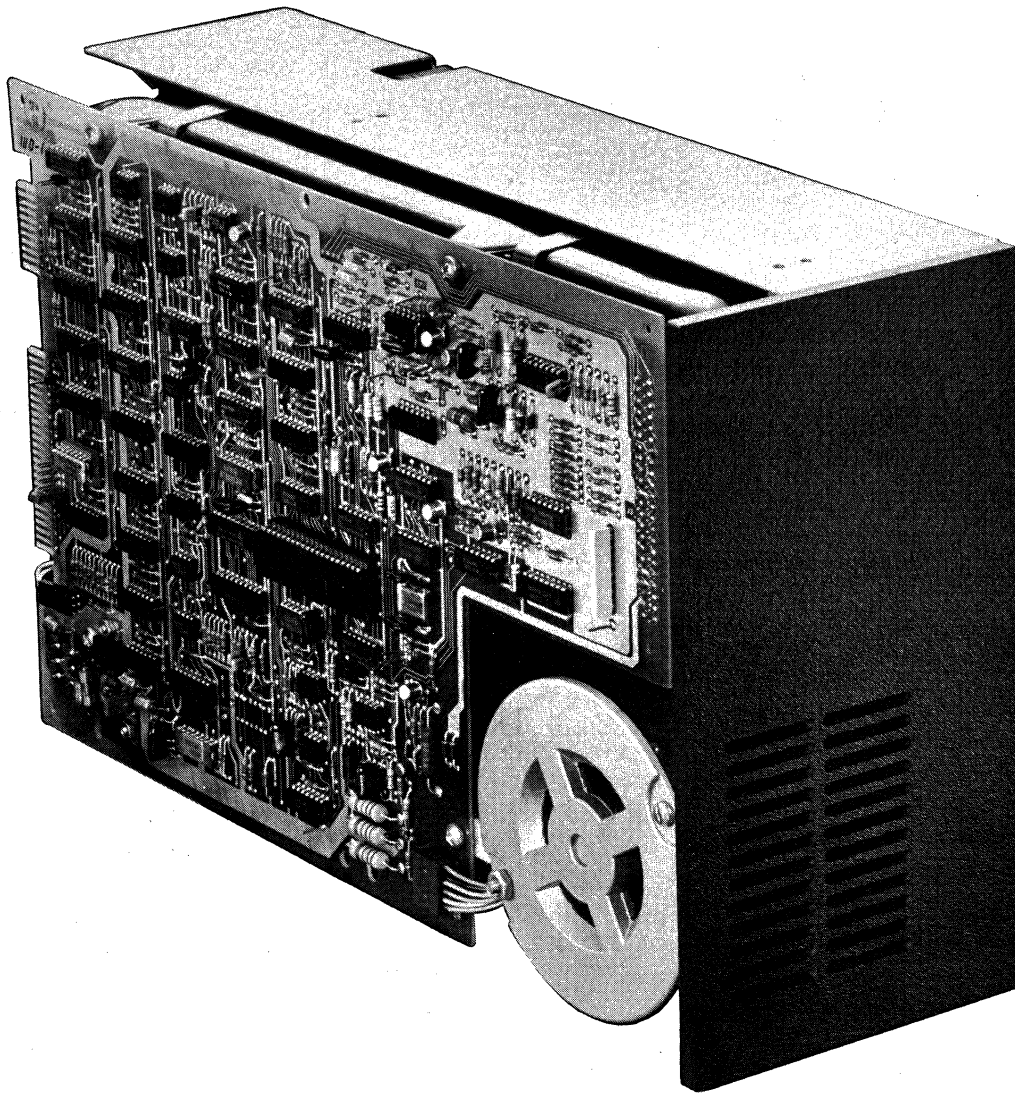
LIST OF ILLUSTRATIONS

Figure

1.	Q2000 Series Rigid Disk Drive	v
2.	Servo Information Location	6
3.	Head Positioning Mechanism	7
4.	Air Filtration System	8
5.	Typical Multiple Drive Connection	13
6.	Normal Step Mode Timing	13
7.	Buffered Step Mode Timing	15
8.	Control Signal Driver/Receiver Combination	18
9.	Index Timing	19
10.	Data Transfer Line Driver/Receiver	20
11.	MFM Write Data Timing	20
12.	MFM Read Data Timing	21
13.	General Control Timing Requirements	23
14.	Q2000 Mounting Dimensions	27
15.	Mechanical Dimensions and Connector Location	28
16.	J1 Connector Dimensions	29
17.	J2 Connector Dimensions	29
18.	J5 Connector	29
19.	J4 Connector	29
20.	Track Format	32
21.	Motor Locking Clip Location	35
22.	Actuator Lock	35
23.	PCB Jumper Locations	37
24.	Typical Quantum Disk Drive Organization and Terminology	41
25.	Data Area and Landing Zone	41

LIST OF TABLES

IA	J1/P1 Connector Pin Assignment	14
IB	J2/P2 Connector Pin Assignment	14
II	P5-DC Connector Pin Assignment	15
III	P4-AC Connector Pin Assignment	15
IV	Interface and Power Connections	16
V	J2 Interface Connection	17
VI	Head Select Decode	18
VII	AC Power Requirements	25
VIII	DC Power Requirements	26
IX	Write Precompensation	33
X	Product Selection Index	45
XI	Voltage and Frequency Conversion Information	45



Quantum's new Q2000 8-inch fixed disk drive compatible with industry standard Shugart Associates SA1000.

Figure 1. Q2000 Series Rigid Disk Drive

1.0 INTRODUCTION

1.1 General Description

The Quantum Series 2000 Disk Drive is a random access storage device with one, two, three, or four non-removable 8" rigid disks as storage media. Each disk surface employs one movable head to access the 512 data tracks. The four models of the Q2000 series are Q2010, Q2020, Q2030, and Q2040 with one, two, three, or four disk platters respectively. The Q2010 provides 10.66 megabytes of storage accessed by 2 movable heads. The Q2020 had 21.33 megabyte capacity, the Q2030 has 32.00 megabyte capacity and the Q2040 has 42.67 megabyte capacity with 4, 6 and 8 movable heads respectively. Low cost and drive reliability are achieved through the use of a unique positioning actuator design. The inherent simplicity of mechanical construction and electronic control allows operation with minimal maintenance throughout the life of the drive.

Mechanical and contamination protection for the heads, actuator, and disks is provided by an impact resistant plastic and aluminum enclosure. A self-contained recirculation system supplies clean air through a 0.3 micron filter with another absolute filter allowing pressure equalization with ambient air without contamination.

The Q2000 Series Disk Drive is also supplied with an actuator lock and a spindle lock for shipping protection. In addition, the heads are positioned in a landing and shipping zone on the disk surfaces which is inside track 511. The heads are always positioned in this zone when power is removed so that the heads never rest upon any area of the disk surface where data is written. Upon power up, the heads do not move from this area until the disk is rotating fast enough for the heads to fly.

An external data separator is required to provide MFM encoding/decoding, write precompensation, a crystal controlled write oscillator, and address mark writing and detecting. Quantum's Q2200 data separator may be used for these functions. Most controllers, however, integrate these functions into the controller design. The Q2000 fixed disk drive interface is similar to the Shugart

8" floppy drive and a superset of Shugart's SA1000 series disk drive interface. The Q2000 series disk drive is designed with the same form factor and power supply voltage requirements as 8" floppy drives.

Key Features:

- Storage Capacity of 10, 20, 30, or 40 megabytes
- Winchester design reliability
- Same physical size and mounting as 8" floppy drives
- Uses the same D.C. voltages as 8" floppy and SA1000 drives
- Proprietary, rotary, high resolution, quiet, head position actuator
- 4.34M bits/second transfer rate
- Shugart SA1000 interface compatible
- Microprocessor controlled temperature compensation servo

Depth = 14.25 in.
(362.0mm)
Weight = 17 lbs.
(7.7Kg)

HEAT DISSIPATION
= 235 BTU/HR. TYP (70 Watts)

1.2 SPECIFICATION SUMMARY

1.2.1 Physical Specifications

ENVIRONMENTAL LIMITS

Ambient temperature
= 50° to 115°F (10° to 46°C)
Relative Humidity
= 8% to 80%
Maximum wet bulb
= 78° non-condensing

AC POWER REQUIREMENTS

50/60Hz ±0.5Hz
100/115VAC Installations =
90-127V at 1.0A Typical
200/230VAC Installations =
180-253V at 0.5A Typical

DC VOLTAGE REQUIREMENTS

+24VDC ±10% 1.25A Typical
+5VDC ±5% 1.0A Typical
-5VDC ±5% (-7 to -16VDC
optional) 0.2A Typical

MECHANICAL DIMENSIONS

Height = 4.50 in.
(114.3mm)
Width = 8.55 in.
(217.2mm)

1.2.2 Reliability Specification

MTBF: 8,000 POH typical usage

PM: not required

MTTR: 30 minutes

Component Life: 5 years

Error Rates

Soft read errors: 1 per 10^{10} bits read

Hard read errors: 1 per 10^{12} bits read

Seek errors: 1 per 10^6 seeks

1.2.3 Performance specifications

	Q2010	Q2020	Q2030	Q2040
Capacity				
Unformatted				
Per drive	10.66Mb	21.33Mb	32.00Mb	42.66Mb
Per surface	5.33Mb	5.33Mb	5.33Mb	5.33Mb
Per track	10.40Kb	10.40Kb	10.40Kb	10.40Mb
Formatted (MFM)				
Per drive	8.40Mb	16.80Mb	25.20Mb	33.60Mb
Per surface	4.20Mb	4.20Mb	4.20Mb	4.20Mb
Per track	8.20Kb	8.20Kb	8.20Kb	8.20Mb
Per sector	256 Bytes	256 Bytes	256 Bytes	256 Bytes
Sectors/TK	32	32	32	32
Transfer Rate	4.34Mbits/sec	4.34Mbits/sec	4.34Mbits/sec	4.34Mbits/sec
Access Time				
TK to TK	15 ms	15 ms	15 ms	15 ms
Average	50 ms	55 ms	60 ms	65 ms
Maximum	100 ms	100 ms	100 ms	100 ms
Avg. Latency	10 ms	10 ms	10 ms	10 ms

1.2.3 Functional Specifications

Rotational speed	3000 RPM	3000 RPM	3000 RPM	3000 RPM
Recording Density	6600 bpi	6600 bpi	6600 bpi	6600 bpi
Flux Density	6600 fci	6600 fci	6600 fci	6600 fci
Track Density	345 tpi	345 tpi	345 tpi	345 tpi
Cylinders	512	512	512	512
Tracks	1024	2048	3072	4096
R/W Heads	2	4	6	8
Disks	1	2	3	4
Index	1	1	1	1

Rotational speed, recording, flux and track densities differ from SA1000 values to accommodate Quantum track position servo and higher disk capacity while retaining Shugart Associates SA1000 and SA1400 format and interface compatibility.

2.0 FUNCTIONAL CHARACTERISTICS

2.1 General Operation

The Series 2000 fixed disk drive consists of read/write and control electronics, read/write heads, head positioning mechanism, media, and air filtration system. These components perform the following functions:

- Interpret and generate control signals
- Position the heads over the selected track with appropriate corrections to compensate for thermal effects on track location
- Read and write data
- Provide a contamination free environment around the media
- Perform diagnostics on the head positioning and servo systems

2.2 Read/Write And Control Electronics

The electronics for the drive are packaged on two printed circuit boards, the control PCB and the Transducer PCB.

2.2.1 Transducer PCB

The Transducer PCB contains the following circuits:

- Coarse servo transducer detector circuit
- Raw track 0 detector circuit
- AGC circuit for servo and track 0 sensors
- Head select diode matrix

2.2.2 Control PCB

The main PCB contains the following circuits:

- Index detector circuit
- Head positioning actuator predrivers
- Microprocessor for diagnostics and fine servo control as well as step buffers.
- Read/write amplifier/drivers
- Head select circuits
- Drive select circuit

- Drive ready circuit
- Write fault detection circuit
- Power on reset circuit
- Track 0 indicator circuit

2.3 Drive Mechanism

The spindle rotates at 3000 rpm through a belt drive from an AC motor. Either 50 or 60Hz power is accommodated by changing the motor drive pulley and belt. 220/230VAC operation can be utilized by a motor change.

2.4 Read/Write Head And Disks

The recording media is a lubricated thin magnetic oxide coated on an 8 inch diameter aluminum substrate. This lubricated coating formulation, together with the low load force/low mass Winchester type flying heads permit reliable contact start/stop operation.

2.5 Head Positioning System

The head positioning system consists of three major elements: rotary torque motor actuator, optical track position encoder, and temperature compensation servo.

2.5.1 Rotary Torque Motor Actuator (Fig. 3)

The read/write heads are mounted on counterbalanced arms attached to the hub of the rotary torque motor. This configuration applies a pure torque to the rotor. The balance system maximizes bearing life and leads to high mechanical stability and maximum vibration resistance.

The motor is of simple construction consisting of a ring magnet, two flat plate pole pieces, a single plane moving coil and two bearings. This system is faster than stepper motors and its performance matches many voice coil actuator systems.

2.5.2 Optical Track Position Encoder

The optical track position encoder is a proven technology utilizing a highly reliable photo etched scale, an LED light source and photodiode sensors. The encoder components are located inside the bubble with the scale attached to the lowermost actuator arm. This system is accurate to over ten times the track density utilized in this product.

2.5.3 Temperature Compensation Servo

The temperature compensation, (fine) servo obtains position feedback directly from the disk surface 50 times each second. This track location coding is embedded between the last inter-record gap and the index pulse. This information is transparent to the controller or host since writing is inhibited by the drive during this servo operation. Compatibility is maintained with like drives by reducing the disk rotational speed by 4%. This servo method places no restrictions on format and allows platter capacities equal to other comparable competitive units.

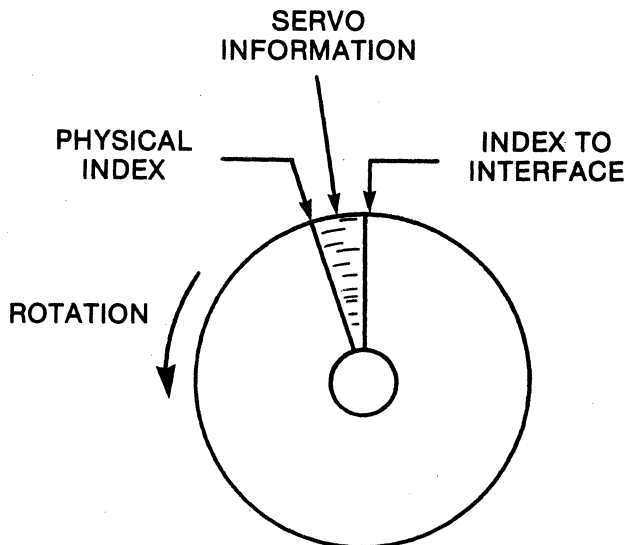


Figure 2. Servo Information Location

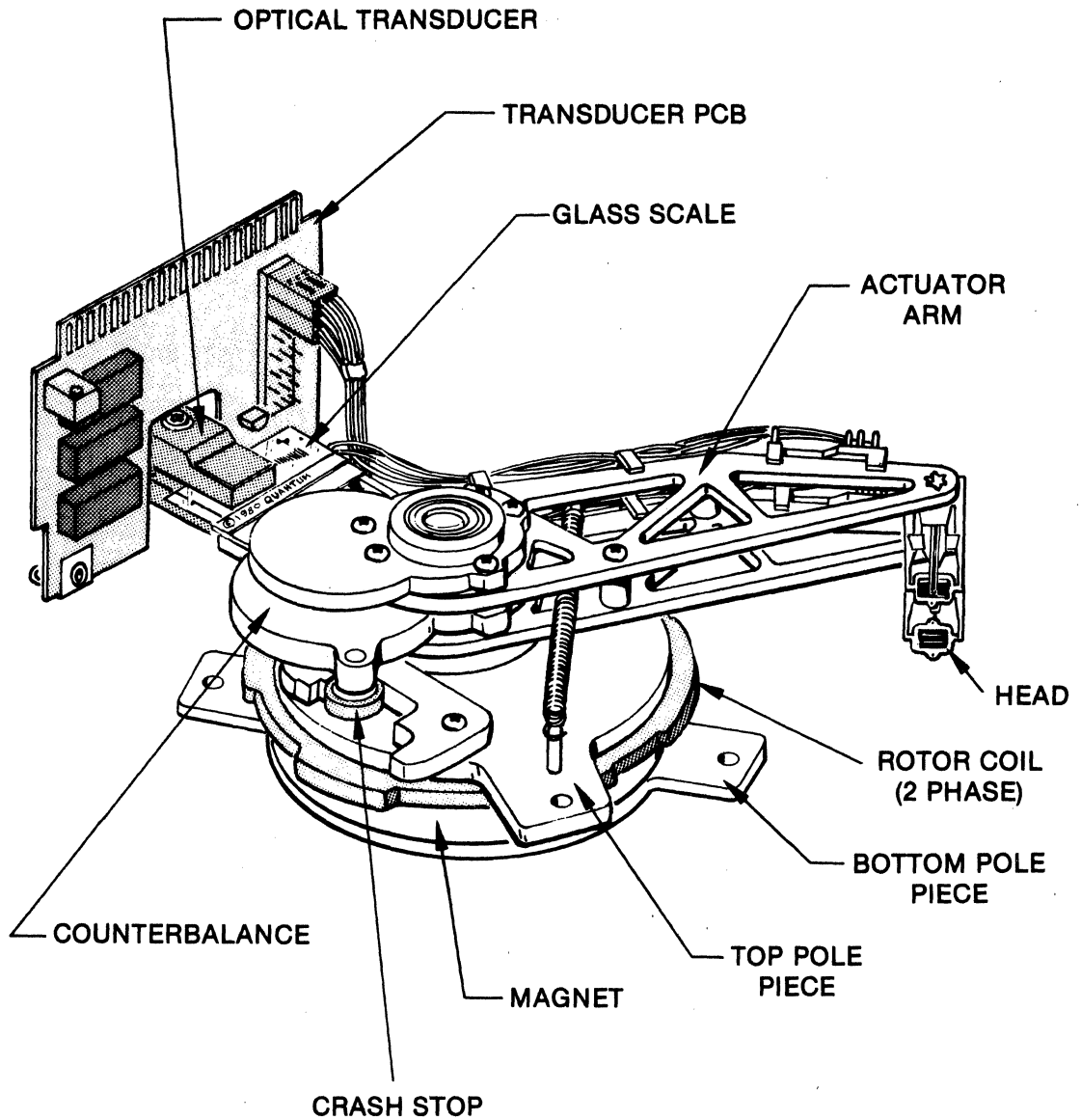


Figure 3. Head Positioning Mechanism

2.6 Air Filtration System (Fig. 4)

The disk(s) and read/write heads are fully enclosed in a module consisting of a casting and a plastic bubble. The module uses an integral recirculatory air system with an absolute (0.3 micron) filter to maintain a clean environment. A separate absolute filter is mounted in the bubble at the lowest pressure area in the system to allow pressure equalization with the ambient air without contamination.

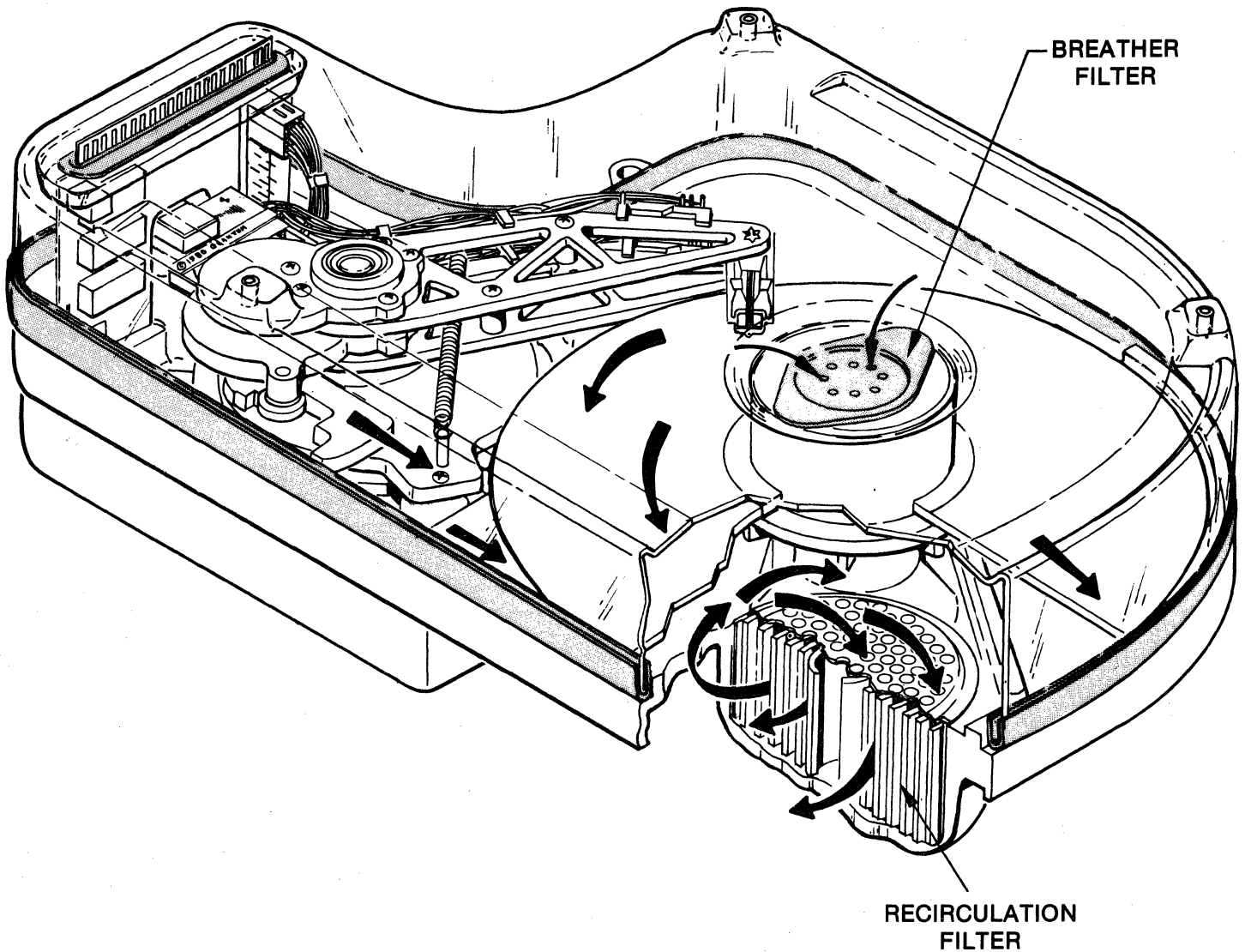


Figure 4. Air Filtration System

3.0 FUNCTIONAL OPERATIONS

3.1 Power Sequencing

No power sequencing is necessary with the Q2000 series drive. Upon power up, seeking is inhibited until the disk is at 90% of its normal rotational speed. Upon attaining 90% of the normal speed the READY signal will be presented to the controller interface and the drive will initiate a recalibrate sequence. The recalibrate sequence is:

1. Seek to track 0.
2. Seek to track 508.
3. Determine the offset value and store it in memory.
4. Repeat steps 2 and 3 for tracks 509, 510, and 511.
5. Seek to track 448.
6. Determine the difference between the offset required and the offset determined for track 508. Store this difference value in memory.
7. Repeat steps 5 and 6 for tracks 384, 320, 256, 192, 128, 64, and 0.

This procedure has established eight zones, each with its own thermal compensation value. These values will be updated with each revolution of the disk thereby providing real time tracking and adjustment for thermal drift. The initial recalibrate sequence takes approximately 3 seconds to complete and "SEEK COMPLETE" will be false during this time.

3.2 Drive Selection

Drive selection occurs when one of the 4 drive select lines is activated. Only the drive appropriately jumpered will respond to input signals and gate output signals to the controller.

3.3 Track Accessing

Read/write head positioning is accomplished by:

- a) Deactivating write gate
- b) Activating the appropriate drive select line

- c) Assuring that the drive is ready and seek complete is true by checking the ready and seek complete lines
- d) Select the appropriate direction
- e) Pulse the step line

Stepping can occur in either the normal or buffered modes. In the normal stepping mode, the heads are repositioned at the rate of the incoming step pulses. In the buffered step mode, incoming step pulses are buffered in the microprocessor. When all of the steps have been received, they are issued at a ramped stepping rate to the actuator motor.

Each pulse will cause the heads to move one track position in or out depending on the level of the direction in line. A true level on this line will cause steps to be inward while a false level will cause steps outward toward track 0.

3.4 Head Selection

Any of the 8 possible heads may be selected by placing that head's appropriate binary address on the 3 head select lines.

3.5 Read Operation

Reading data from the Q2000 drive is accomplished by:

- a) Deactivating the write gate signal
- b) Activating the appropriate drive select line
- c) Assuring that the drive is ready by checking the ready line
- d) Selecting the appropriate head

3.6 Write Operation

Writing data onto the disk is accomplished by:

- a) Activating the appropriate drive select line
- b) Assuring that the drive is ready by checking the ready line.
- c) Clearing any Write Fault conditions if they exist by reselecting the drive
- d) Selecting the appropriate head
- e) Activating Write Gate and placing MFM data on the Write Data line

4.0 INTERFACE LINES AND PIN ASSIGNMENTS

The interface of the drive is divided into three categories: Signal, DC power, and AC power. Tables I, II and III define the pin assignments for these interface lines. Tables IV and V show the recommended cable types and the grounding configurations at the drive and at the host systems. Signal pins marked SPARE are uncommitted. Those signal pins marked NA should not be used as alternate I/O signal pins if a controller having a floppy disk interface is used. A 4-drive subsystem is shown in Figure 5.

5.0 SIGNAL INTERFACE

The signal interface consists of two categories: Control, and data transfer. All control lines are TTL in nature and either provide signals to the drive (input) or provide signals to the host (output) via interface connector J1/P1. The data transfer signals are differential in nature. They provide data and clocking, either to or from the drive, via the J2/P2 Connector.

5.1 Control Input Lines

The control input signals are of two types: Those intended to be multiplexed in a multiple drive system and those intended to do the multiplexing. The control input signals to be multiplexed are STEP, DIRECTION, HEAD SELECT 2^0 , 2^1 and 2^2 , WRITE GATE, REDUCED WRITE CURRENT, and REZERO. The signal which is intended to do the multiplexing is DRIVE SELECT 1, DRIVE SELECT 2, DRIVE SELECT 3, or DRIVE SELECT 4.

The input lines have the following electrical specifications. Refer to figure 6 for the recommended circuit.

Logic "0" = True = 0.0V DC to 0.04V DC
@ I_{in} = 40 MA (max)

Logic "1" = False = 2.5V DC to 5.25V DC
@ I_{in} = 0 MA (Open)

5.1.1 Drive Select 1 thru 4

DRIVE SELECT when true logically connects the drive to the control lines. Only one DRIVE SELECT line may be active at a time and will allow the drive to respond to input signals and gate outputs.

5.1.2 Direction In

This signal defines direction of motion of the R/W heads when the STEP line is pulsed. An open circuit or logical one defines the direction as "out" and if a pulse is applied to the STEP line the R/W heads will move away from the center of the disk.

Conversely, if this input is shorted to ground or a logical zero level is applied, the direction of motion is defined as "in" and if a pulse is applied to the STEP line, the R/W heads will move toward the center of the disk. A 220/330 ohm resistor pack allows line termination.

5.1.3 Step

This interface line is a control signal which causes the R/W head to move with the direction of motion defined by the DIRECTION IN line.

The access motion is initiated at each logical zero to logical one transition on the trailing edge of this signal pulse. Any change in the DIRECTION IN line must be made at least 100ms before the leading edge of the step pulse.

There are two modes of operation of stepping the R/W heads, the normal mode and the buffered mode.

5.1.3.1 Normal Step Mode

In this mode of operation the R/W heads will move at the rate of the incoming step pulses. The minimum time between successive steps is 1.0ms. The minimum pulse width is 3.0us. See Figure 6 for normal step mode timing.

5.1.3.2 Buffered Step Mode

In this mode of operation the step pulses are received at a high rate and buffered into a counter. After the last pulse the R/W heads will then begin stepping the appropriate number of cylinders and Seek Complete (see section 4.2.5) will go true after the R/W heads settle at the cylinder.

This mode of operation is automatically selected when the time between step pulses is ≤ 200 usec.

100ns after the last step pulse has been sent to the drive, the DRIVE SELECT line may be dropped and a different drive selected.

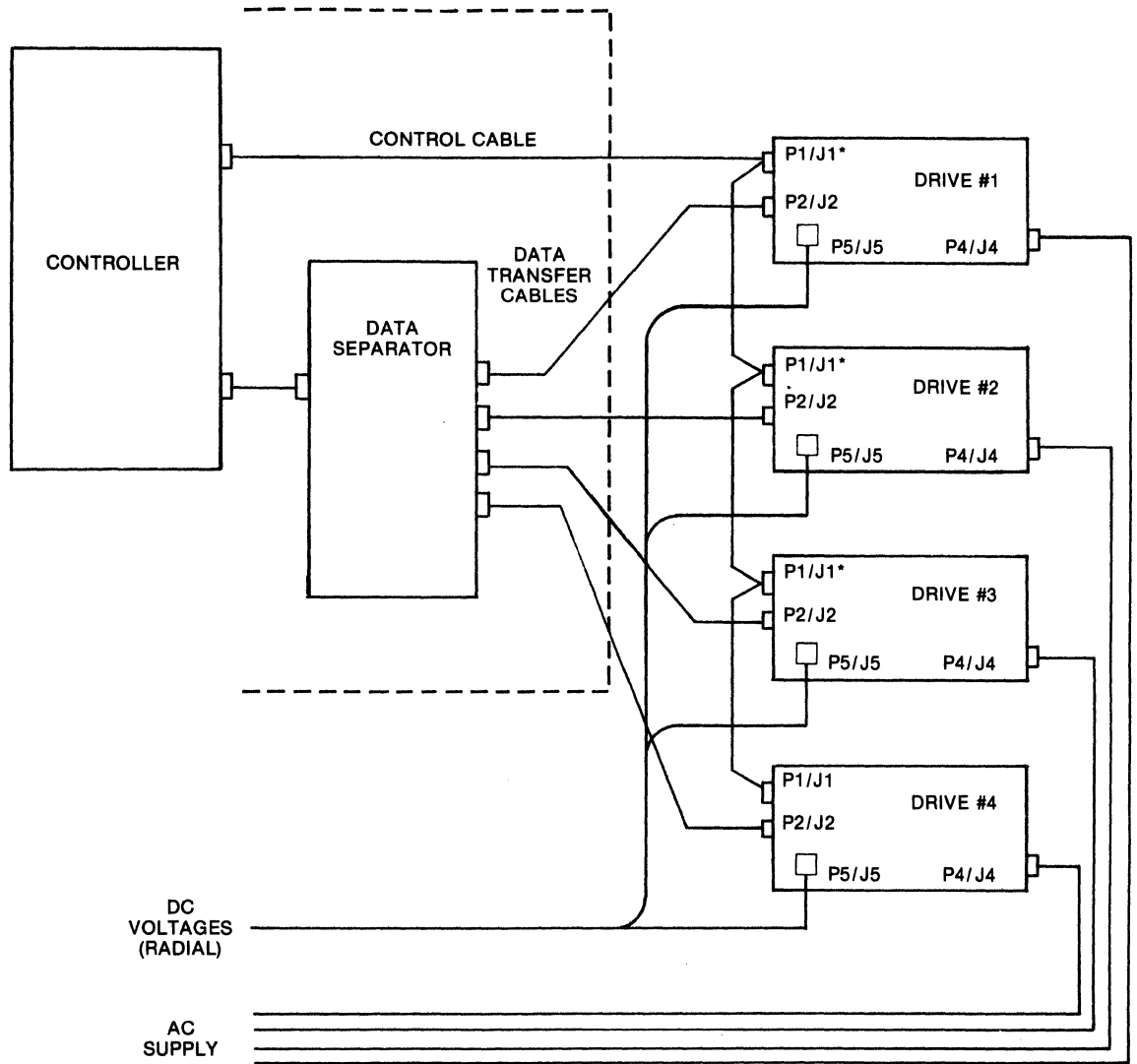
The minimum time between steps is 3.0us with a pulse width of 3.0us minimum. The maximum time between steps is 200us. Refer to Figure 6 for Buffered Step Mode Timing.

- Note:
1. Step pulses with periods between 200us and 1.0 ms are not allowed. Seek accuracy is not guaranteed if this restriction is violated.
 2. A 220/330 ohm resistor pack allows step line termination.

5.1.4 Head Select 2⁰, 2¹, & 2²

These three lines provide for the selection of each individual read/write heads in a binary coded sequence. HEAD SELECT 2⁰ is the least significant line. Heads are numbered 0 thru 7. When all HEAD SELECT lines are false, head 0 will be selected. Table VI shows the HEAD SELECT decode and model variations for the HEAD SELECT lines. See Figure 11 for timing considerations.

A 220/230 ohm resistor pack allows for termination on each line.



* TERMINATION NETWORK REMOVED

Figure 5. Typical Multiple Drive Connection

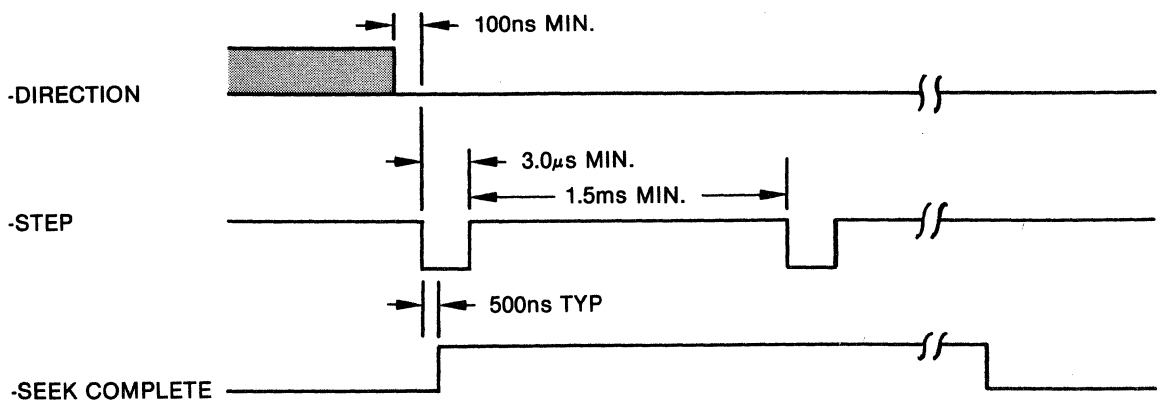


Figure 6. Normal Step Mode Timing

Table IA. J1/P1 Connector Pin Assignment

Ground Return	Signal Pin	Signal Name
1	2	- Reduced Write Current
3	4	- Head Select 2 ²
5	6	- Rezero (Jumperable Option)
7	8	- Seek Complete
9	10	- NA
11	12	- NA
13	14	- Head Select 2 ⁰
15	16	- NA
17	18	- Head Select 2 ¹
19	20	- Index
21	22	- Ready
23	24	- NA
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	- NA
39	40	- Write Gate
41	42	- Track 000
43	44	- Write Fault
45	46	- NA
47	48	- NA
49	50	- NA

Table IB. J2/P2 Connector Pin Assignment

Ground Return	Signal Pin	Signal Name
2	1	- Drive Selected
4	3	Spare
6	5	Spare
	7	Spare
8		GND
	9	+ Timing Clk
	10	- Timing Clk
11		GND
12		GND
	13	+ MFM Write Data
	14	- MFM Write Data
15		GND
16		GND
	17	+ MFM Read Data
	18	- MFM Read Data
19		GND
20		GND

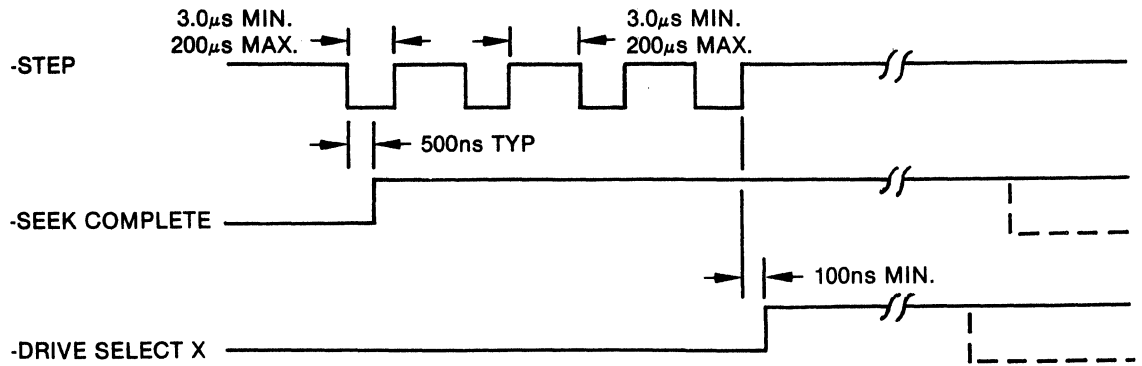


Figure 7. Buffered Step Mode Timing

VOLTAGE		GROUND	
Pin 1	+ 24 Volts DC	Pin 2	+ 24 Volt Return
Pin 2	- 7 to - 16 (- 5 OPT) Volts	Pin 3	- 7 to - 16 (- 5 OPT) Volt Return
Pin 5	+ 5 Volts	Pin 6	+ 5 Volt Return

Table II. P5 — DC Connector Pin Assignments

Pin 1	Motor Power "A"
Pin 2	Frame Ground
Pin 3	Motor Power "B"

Table III. P4 — AC Connector Pin Assignments

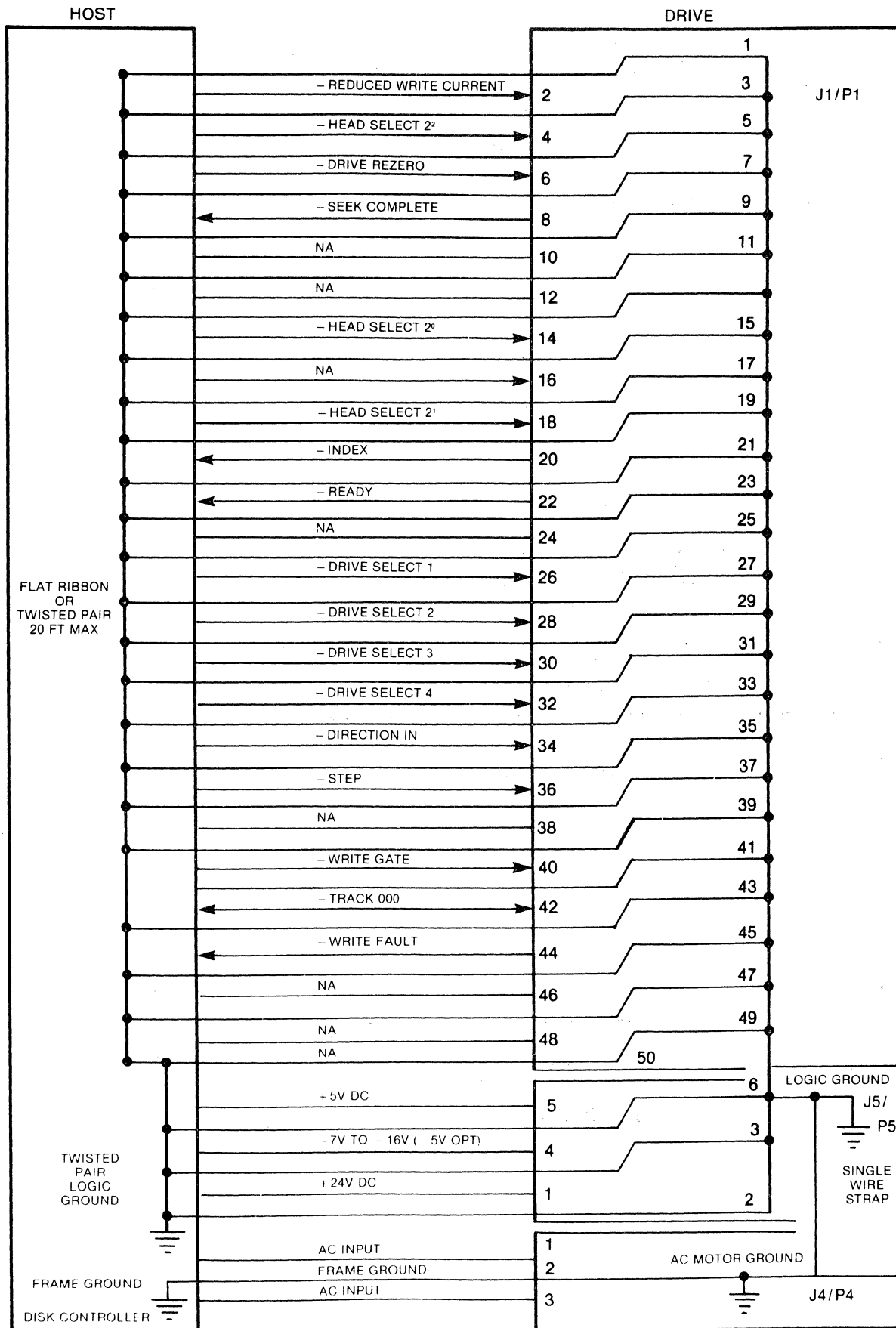


TABLE IV. Interface and Power Connections

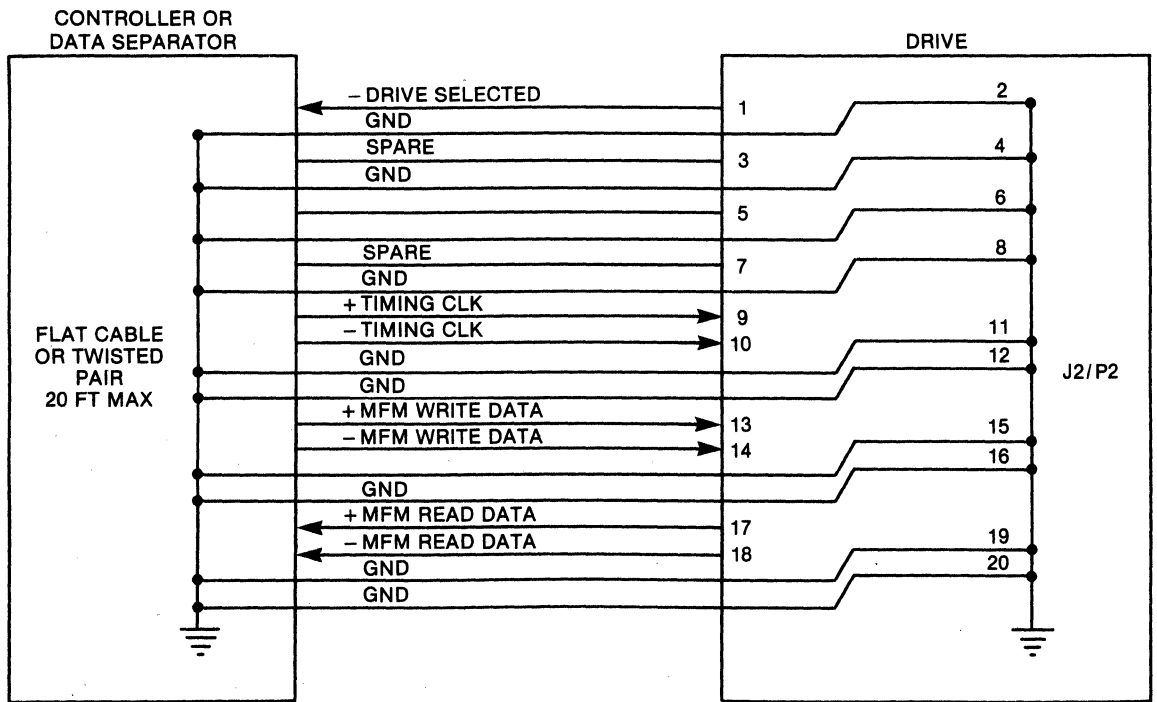


TABLE V. J2 Interface Connection

Head 2 ²	Select 2 ¹	Line 2 ⁰	Head Selected			
			Q2010	Q2020	Q2030	Q2040
0	0	0	0	0	0	0
0	0	1	1	1	1	1
0	1	0	-	2	2	2
0	1	1	-	3	3	3
1	0	0	-	-	4	4
1	0	1	-	-	5	5
1	1	0	-	-	-	6
1	1	1	-	-	-	7

Table VI. Head Select Decode

5.1.5 Write Gate

The active state of this signal, or logical zero, enables write data to be written on the disk. The inactive state of this signal, or logical one level, enables data to be transferred from the drive and enables the STEP pulses to reposition the head arms. A 220/330 resistor pack allows for termination on each line.

5.1.6 Reduced Write Current

When this interface signal is low (true) the lower value of Write Current is selected for writing. It is recommended that the lower value of write current be selected when writing on tracks 256 through 511 and the higher value be selected when writing on tracks 0 through 255. When this signal is high (false), the higher value of Write Current is selected for writing. A 220/330 ohm resistor pack allows for line termination.

5.1.7 Rezero (PCB Option)

When this interface signal is low (true) 50 microseconds minimum, the drive will reset internal microcomputer parameters and will recalibrate to cylinder 0. This feature can be enabled by adding a jumper at the "C" option near connector J1 on the PCB. A 220/330 ohm resistor pack allows for line termination.

5.2 Output Lines

The control output signals are driven with an open collector output stage capable of sinking a maximum of 40 ma at logical zero or true state with maximum voltage of 0.4V measured at the driver. When the line driver is in logical one or false state the driver transistor is off and the collector cutoff current is a maximum of 250 microamperes.

All J1 output lines are enabled by the respective DRIVE SELECT LINE.

Figure 8 shows the recommended control signal driver/receiver combination.

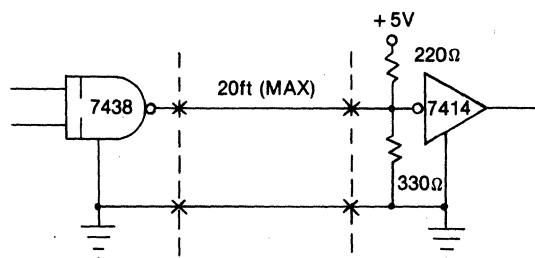


Figure 8. Control Signal Driver/Receiver Combination

5.2.1 Track 000

This interface signal indicates a true state only when drive's R/W heads are positioned at track zero (the outermost data track). This signal is a logical one level, or false state, when the selected drive's R/W head is not at track zero.

5.2.2 Index

The index signal is provided by the drive once each revolution (20.0ms) to indicate the beginning of a track. Normally, this signal is a logical one level and makes the transition to the logical zero level for a period of approximately 10 μ s once each revolution. The leading edge of this pulse must be used for all timing requirements including track format initialization. The 19.2 milliseconds following the leading edge of index are available for read and write during each disk rotation. During the last 800 microseconds before each index pulse, read and write functions are not available to the host (this time is used by internal drive logic for the thermal compensation servo function).

5.2.3 Ready

This interface signal, when true together with SEEK COMPLETE, indicates that the drive is ready to read, write, or seek and that the interface signals are valid. When this line is false, all reading, writing, and seeking are inhibited at the drive, and the R/W heads are automatically positioned at the landing zone (innermost disk radius).

READY will be true after the drive is 90 \pm 1% up to speed.

The typical time for READY to become true after power on is 20 seconds.

5.2.4 Write Fault

This signal is provided by the drive and is used to indicate that a condition exists at the drive that caused improper writing on the disk. When this line goes true, further writing is inhibited at the drive until the condition no longer exists AND that the DRIVE SELECT line for that particular drive made inactive for at least 500ns to reset the fault detection circuit. There is one FAULT condition detected and latched. It is:

WRITE CURRENT in the head without WRITE GATE active.

5.2.5 Seek Complete

This line will go true when the R/W heads have settled on the final track at the end of a seek. Reading or writing should not be attempted when SEEK COMPLETE is false.

SEEK COMPLETE will go false in two cases:

- (1) A recalibration sequence was initiated (by drive logic) at power on.
- (2) 500 ns (typ.) after the leading edge of a step pulse (or the first of a series of step pulses.)

SEEK COMPLETE is gated with DRIVE SELECT. See Figure 7.

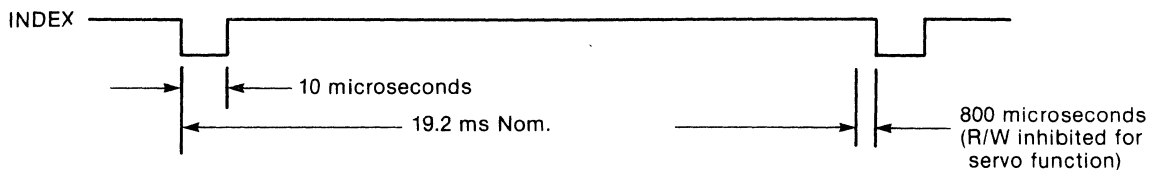


Figure 9. Index Timing

5.3 Data Transfer Lines

All lines associated with the transfer of data between the drive and the host system are differential in nature and may not be multiplexed. These lines are provided at the J2/P2 connector on all drives.

The pairs of balanced signals used for data transfer in a standard drive are: MFM WRITE DATA, MFM READ DATA, and TIMING CLK. Figure 10 illustrates the driver/receiver combination used in the Q2000 series drives for data transfer signals.

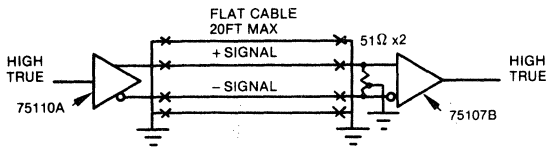


Figure 10. Data Transfer Line Driver/Receiver

5.3.1 MFM Write Data

This is a differential pair that defines the transitions to be written on the track. The transition of + MFM WRITE DATA line more positive than the - MFM WRITE DATA line will cause a flux reversal on the track provided - WRITE GATE is active. This signal pair must be driven to an inactive state (+ MFM WRITE DATA more negative than - MFM WRITE DATA) by the controller

when in a read mode. Figure 11 shows the timing for MFM WRITE DATA as required at the interface. The actual occurrence of the flux reversals may differ due to write pre-compensation.

5.3.2 MFM Read Data

The data recovered by reading a pre-recorded track is transmitted to the host system via the differential pair of MFM READ DATA lines. The transition of the + MFM READ DATA line more positive than the - MFM DATA line indicates a flux reversal was detected on the track provided the - WRITE GATE is inactive. Figure 12 shows the timing for MFM READ DATA as required at the interface.

5.4 Select Status

A status line is provided at the J2/P2 connector to inform the host system of the selection status of the drive.

The DRIVE SELECTED line is driven by a TTL open collector driver as shown in Figure 6. This signal will go active only when the drive is selected as drive "X" ("X" = 1,2,3 or 4) by proper placement of the shorting plug at the vicinity of J1, and the corresponding - DRIVE SELECT "X" line at J1/P1 is activated by the host system.

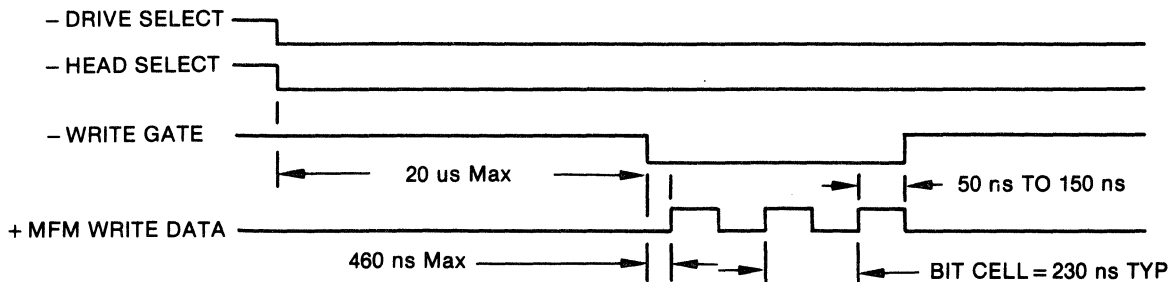


Figure 11. MFM Write Data Timing

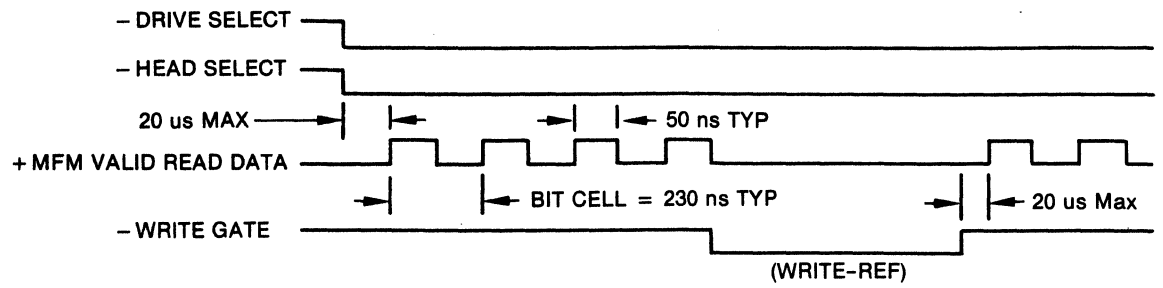


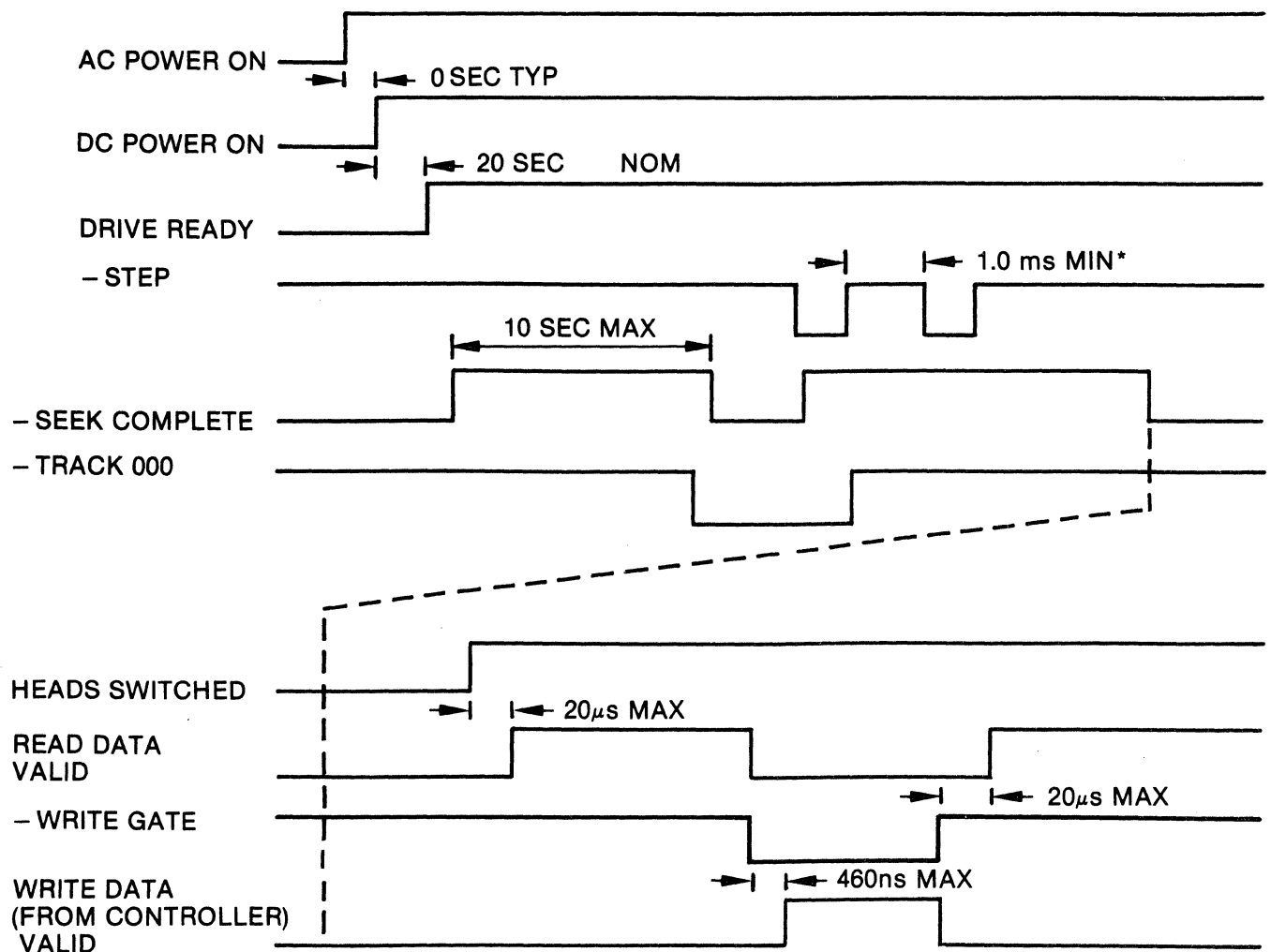
Figure 12. MFM Read Data Timing

6.0 General Timing Requirements

The timing diagram as shown in Figure 13 shows the necessary sequence of events (with associated timing restrictions) for proper operation of the drive:

Note that a recalibrate to track zero sequence is initiated automatically at every DC power on. For this auto-recal sequence to function, the Spindle must be spinning at normal speed (if AC and DC are switched on at the same time, seeking action will not occur until spindle is up to speed).

No AC or DC power sequencing is required.



*FOR NORMAL STEP MODE

Figure 13. General Control Timing Requirements

7.0 Power Interface

The drive requires both AC and DC power for operation. The AC power is used for the drive motor and the DC is used for the electronics and actuator.

7.1 AC Power

AC power to the drive is via J4/P4. The voltage, frequency and current requirements are given in Table VII.

	60HZ		50HZ	
CONNECTOR P4	110V (Standard)	208/230V	100V	220V
1 2 3	90-127V FRAME GND 90-127 RTN	180-253V FRAME GND 180-253V	90-127V FRAME GND 90-127 RTN	180-253V FRAME GND 180-253V
MAX INRUSH CURRENT (Duration*)	4.0 Amps	2.0 Amps	TBS	TBS
MAX RUN CURRENT	1.0 Amps	0.5 Amps	TBS	TBS
FREQ TOL	± 0.5 HZ		± 1.0HZ	

Table VII. AC Power Requirements

*1 sec. for Q2010
 2 sec. for Q2020
 3 sec. for Q2030
 4 sec. for Q2040
 @ 117V AC

7.2 DC Power

DC power to the drive is via P5/J5. The three required voltages and current requirements are given in Table VIII.

DC VOLTAGE	CURRENT	
	STEADY OR SEEKING	
	MAX.	TYP.
+ 24 ± 2.4V 1V P-P MAX RIPPLE	1.5A	1.25A
+ 5 ± 0.25V 50mV P-P MAX RIPPLE	1.5A	1.0A
17 ± to -16V (-5 ± 0.25V OPT) 50mV P-P MAX RIPPLE	.25A	.20A

Table VIII. DC Power Requirements

8.0 Physical Outline

The mechanical outline of the Q2000 is given in Figure 14.

WARNING: Exercise caution when selecting mounting screws. The screws must be short enough to not contact the bubble when installed and tightened. Failure to observe this warning may result in damage to the bubble.

9.0 Physical Interface

Electrical interface between the Q2000 and the host system is through four connectors: the first connector (J1) provides control signals for the drive; the second connector (J2) provides radial connection of read/write

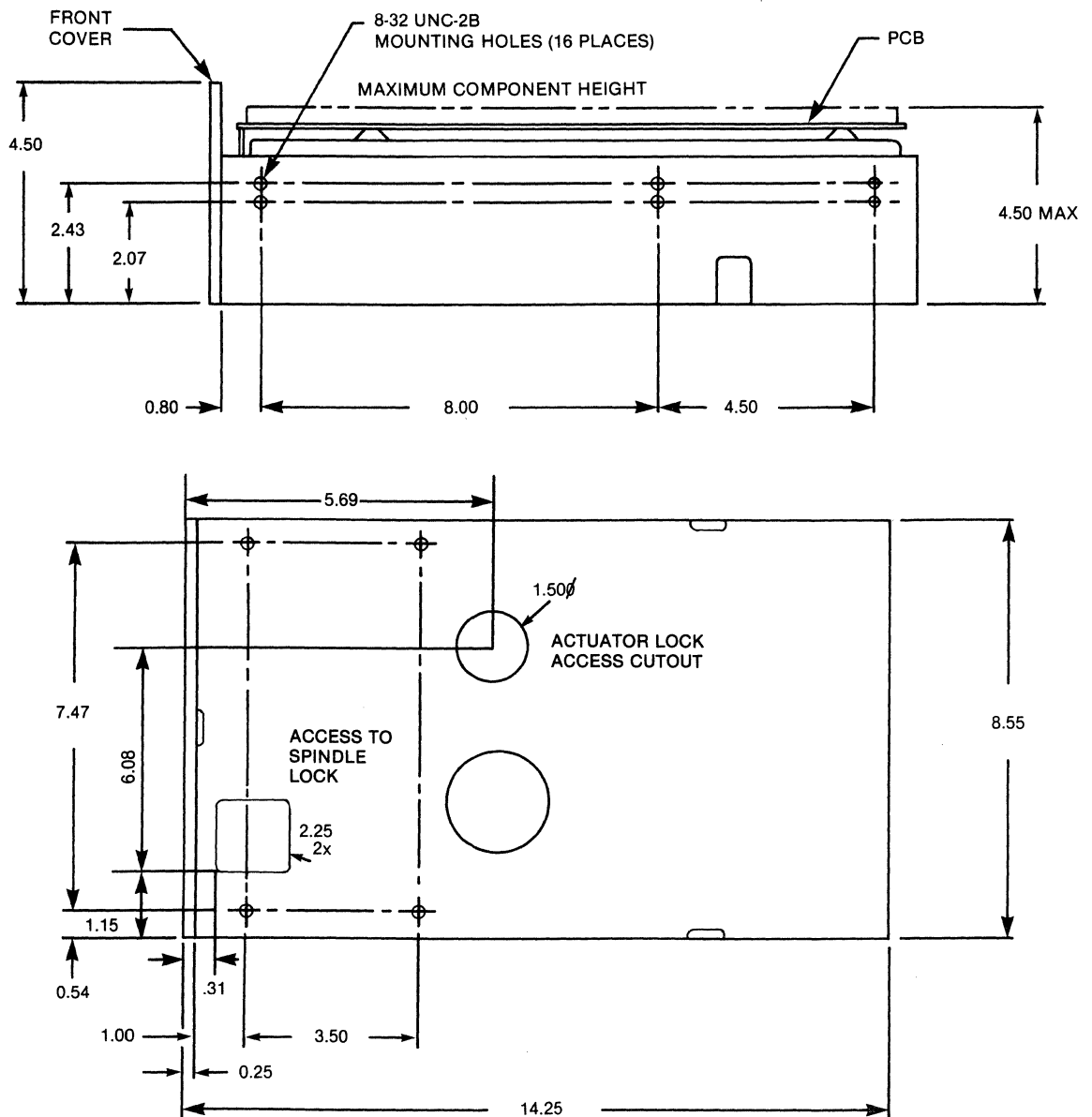
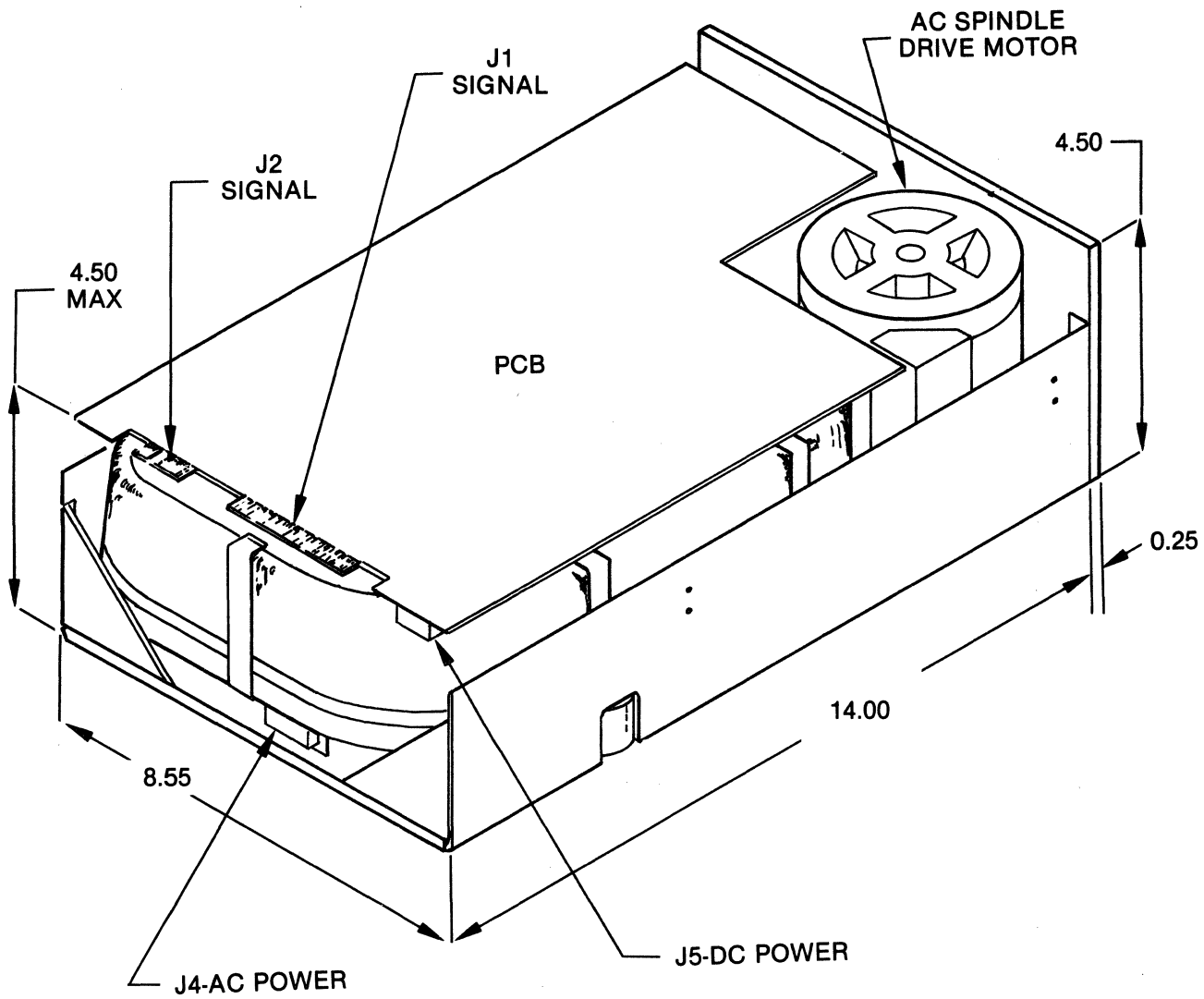


Figure 14. Q2000 Mounting Dimensions

data signals; the third connector (J5) provides for DC power; and the fourth connector (J4) provides for AC power and frame ground. Refer to Figure 15 for connector locations.



All dimensions in inches

Figure 15. Mechanical Dimensions and Connector Locations

9.1 J1/P1 Connector

Connection to J1 is through a 50 pin PCB edge connector. Connector dimensions are shown in Figure 16. The pins are numbered 1 through 50 with the even pins located on the component side of the PCB and odd pins located on the noncomponent side of the PCB. Pin 2 is located on the end of the PCB connector closest to the J2 connector and is labeled. A KEY SLOT is provided between pins 4 and 6. The recommended mating connector for P1 is Scotchflex ribbon connector P/N 3415-0001.

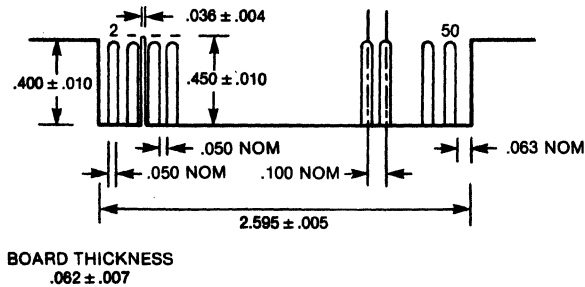


Figure 16. J1 Connector Dimensions

9.2 J2/P2 Connector

Connection to J2 is through a 20 pin PCB edge connector. Connector dimensions are shown in Figure 17. The pins are numbered 1 through 20 with the even pins located on the component side of the PCB. The recommended mating connector for P2 is Scotchflex ribbon connector P/N 3461-0001. A key slot is provided between pins 4 and 6.

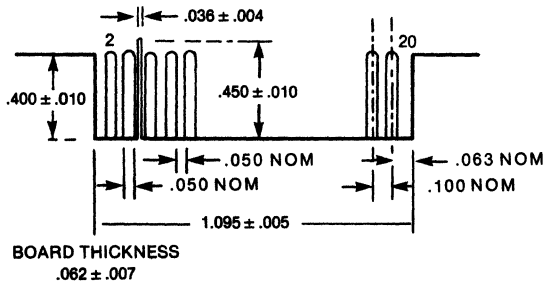


Figure 17. J2 Connector Dimensions

9.3 J5/P5 Connector

DC power connector (J5) is a 6 pin AMP Mate-N-Lok connector P/N 1-380999-0 mounted on the solder side of the PCB. The recommended mating connector (P5) is AMP P/N 1-480270 utilizing AMP pins P/N 60619-1. J5 pins are labeled on J5 connector.

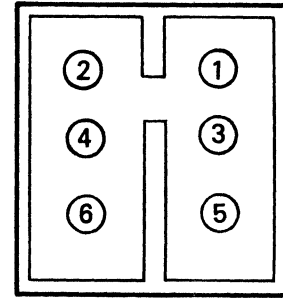


Figure 18. J5 Connector

9.4 J4/P4 Connector

AC power and frame ground are applied through a 3 pin connector. The pin housing (J4) is mounted in the drive and is AMP P/N 1-480701-0 with pins AMP P/N 350687-1 and 350654-1 (gnd pin). The recommended mating connector (P4) is AMP socket P/N 1-480700-0 with AMP pins P/N 350536-1.

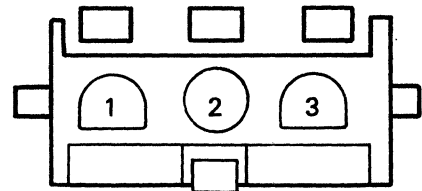


Figure 19. J4 Connector

The disk drive is shipped with DC ground (base casting) and AC ground (drive motor) connected together with a ground strap located on the drive motor and grounding clips. AC and DC grounds may be separated by removing a ground wire attached to the AC motor and the casting.

10.0 Q2000 Recommended Track Format (in Figure 20)

The purpose of a track format is to organize a data track into smaller, sequentially numbered blocks of data called sectors. The Q2000 disk drive is intended to have a soft sector format. Soft sector means that the beginning of each sector is identified by a prewritten identification (ID) field. (Hard sector disks use some type of mechanically fixed method of identifying sector beginnings.) The ID field of a soft sector drive contains the physical sector address plus cylinder and head information. The I.D. field is then followed by a user data field.

The format shown in figure 20 is for illustration only as the Q2000 drive does not dictate the format to be used. The soft sector format shown is a slightly modified version of the I.B.M. System 34 double density format, which is commonly used on 8 inch floppy disk drives. The encoding method used here is modified frequency modulation (MFM).

In the example shown (Figure 20), each track is divided into 32 sectors. Each sector has a data field of 256 bytes in length.

The beginnings of both the I.D. field and the data field are flagged by unique characters called address marks.

An address mark is 2 bytes in length. The first byte is always an "A1" data pattern. This is followed by either an "FE" pattern which is the pattern used to define an I.D. address mark, or an "FB" which is a data address mark pattern.

The "A1" pattern is made unique by violating the encoded rules of MFM by omitting one clock bit. This makes the address mark pattern unique to any other serial bit combination.

Each I.D. and data field is followed by 16 bits of cyclic redundancy check (CRC) or 24 or 32 bits of Error Correction Code (ECC) used for data verification and correction. Each CRC or ECC polynomial is unique for a particular data pattern.

Surrounding the I.D. and data field are gaps called interrecord gaps.

10.1 GAP LENGTH CALCULATIONS

10.1.1 Gap 1

Gap 1's purpose is to provide a head switching recovery period so that by switching heads from one surface to another, sequential sectors may be read without waiting for the rotational latency time. Gap 1 should be at least 11 bytes long which corresponds to the head switching time of 20 microseconds. Gap 1 is immediately followed by a sync field for the I.D. field of the first sector.

10.1.2 Gap 2

Following the I.D. field, and separating the I.D. field from the data field is gap 2. Gap 2 provides a known area for the data field write update splice to occur. The remainder of this gap also serves as the sync up area for the data field address mark. The length of gap 2 is determined by the data separator lock up performance.

10.1.3 Gap 3

Gap 3, following the data field, is a speed variation tolerance area. This allows for a situation where a track has been formatted while the disk is running 3% slower than nominal, then write updated with the disk running 3% faster than nominal (power line variations). Gap 3 should be at least 15 bytes in length.

10.1.4 Gap 4

Gap 4 is a speed tolerance buffer for the entire track. This allows the disk to rotate at least 3% faster than normal without overflowing the track during the format operation. The format operation, starts with the first encountered index and continues writing a fixed number of ID fields. These fields must be written prior to the next index.

10.2 Write Precompensation

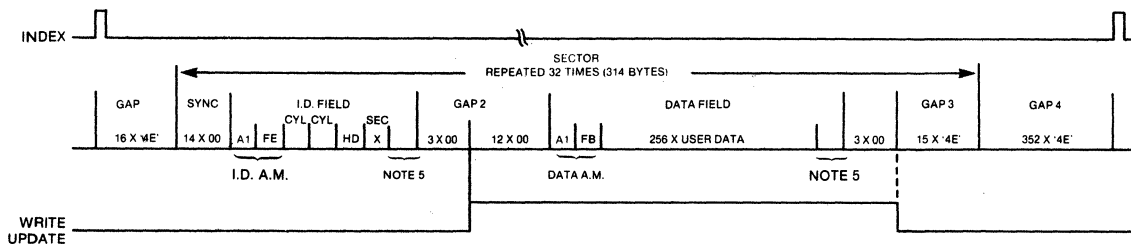
Whenever two bits are written in close proximity to each other, a phenomenon called pulse superposition occurs, which tends to cause the two bits to move away from each other. This is a large factor of bit shift.

Other phenomenon such as random noise, speed variation, etc., will also cause bit shift, but to a lesser degree.

The effect of bit shift can be reduced by a technique called write precompensation. This technique requires detecting those cases where bits will be written in close proximity to each other and alters the write timing of these bits. The bits are then written earlier or later than normal to compensate for the expected shift.

Since bit crowding is greatest on the innermost tracks, the effects of pulse superposition cause the greatest shift on these tracks. Therefore, write precompensation should only be used when writing on track numbers greater than 255.

The optimum amount of pre-compensation for the Q2000 is 12 nanoseconds for both early and late written bits.



- NOTES:
 1. NOMINAL TRACK CAPACITY - 10416 BYTES.
 2. MINIMUM TRACK CAPACITY - (NOMINAL - 3% SPEED VARIANCE) 10102 BYTES.
 3. WRITE TO READ RECOVERY TIME = 20 MICROSECONDS.
 4. HEAD SWITCHING TIME = 20 MICROSECONDS.
 5. CHECK BYTES MAY BE 2 BYTES OF CRC OR 3 OR 4 BYTES OF ECC.

Figure 20. Track Format

Table IX shows data bit patterns, the expected bit shift direction, the write precompensate direction and the type of pulse to write for MFM recording.

DATA PATTERN				EXPECTED SHIFT DIRECTION	PRECOMPENSATE DIRECTION	
4	3	2	1	OF PULSE FOR CELL 2*	AND PULSE FOR CELL 2*	
0	0	0	0	NONE	ON TIME	CLOCK
0	0	0	1	LATE	EARLY	CLOCK
0	0	1	0	NONE	ON TIME	DATA
0	0	1	1	EARLY	LATE	DATA
0	1	0	0	NONE	NO CLOCK OR	DATA WRITTEN
0	1	0	1	NONE	NO CLOCK OR	DATA WRITTEN
0	1	1	0	LATE	EARLY	DATA
0	1	1	1	NONE	ON TIME	DATA
1	0	0	0	EARLY	LATE	CLOCK
1	0	0	1	NONE	ON TIME	CLOCK
1	0	1	0	NONE	ON TIME	DATA
1	0	1	1	EARLY	LATE	DATA
1	1	0	0	NONE	NO CLOCK OR	DATA WRITTEN
1	1	0	1	NONE	NO CLOCK OR	DATA WRITTEN
1	1	1	0	LATE	EARLY	DATA
1	1	1	1	NONE	ON TIME	DATA

Table IX

The write data bits are shifted through a 4 bit shift register to detect those patterns that require precompensation and to determine what type of pulse to write. Data or clock pulses are written on the disk according to the rules for MFM recording, and are written on time, early or late in the cell period according to the direction of expected shift. Timing is such that the cell period for a pulse starts when the data bit is shifted into position three and ends when the bit is shifted into position four.

*Determination of pulse and precompensation is made in cell 2, however pulse is written from cell 3.

11.0 INSTALLATION INSTRUCTION

11.1 Required Tools:

1. Common Screwdriver
2. 11/32 inch socket or hex nut driver

11.2 Unpacking Instruction:

- a) Carefully remove drive from shipping container, inspect for damage. **Do Not Drop!**
- b) Do not set drive down on its printed circuit board.

11.3 Motor Locking Clip Disengagement

- a) Stand drive on edge to unlock drive motor. (See Figure 21.)
- b) Loosen 11/32 inch hex nut.
- c) Rotate locking clip away from pulley. Do not rotate pulley.
- d) Retighten 11/32 inch hex nut.

Figure 21.

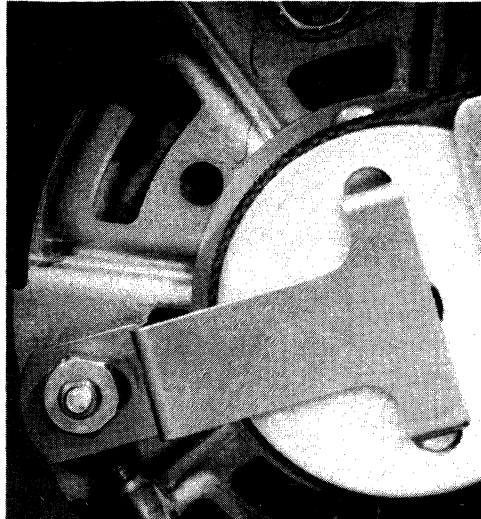
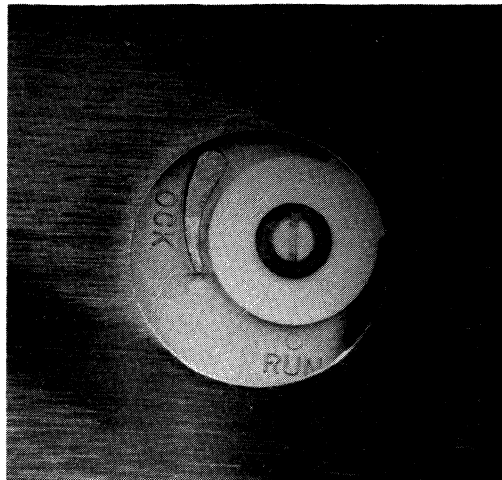


Figure 22.



11.4 Actuator Lock

Unlock actuator by rotating the actuator lock CCW as far as it will go (approx. ½ turn) **Do Not Force**. The actuator lock is located on the bottom of the drive. (See Figure 22.)

11.5 Drive Options

11.5.1 Jumper Options (Fig. 23)

Designator	Description
-5/-15	The drive requires -5V DC (-5V position) but will regulate higher negative voltages from -7 to -16 (-15 position). Drive is normally shipped with the jumper in the -15 position.
DS1,2,3,4	Four drive select jumpers allow logical drive assignment.
A	Causes drive to be selected constantly.
C	When jumpered, allows J1 pin 6 REZERO to be used to cause the drive to recalibrate. Use of this option is recommended since it is faster than standard recalibration sequences and the drive goes through an internal recalibration.
E3	When jumpered, disables the fine servo for maintenance purposes.
E4	When jumpered, causes the microprocessor to perform a seek diagnostic routine.

11.5.2 Cut Trace Options

Designator	Description
B	The third head select line (- head select 2 ³) is attached to pin 4 of J1. If it is desired to use a pin on J1 other than 4, this trace may be cut and a wire added from "B" to the desired pin.
T1-T5	These options are not for customer use. They are used for factory test only.

11.6 Control Line Termination

If drive is the last drive at the end of the control signal cable, a 220/320 terminator pack must be installed at PCB location 6J. The terminator pack must be removed from location 6J if this drive is not at the end of a string of drives. The Quantum P/N for the terminator pack is 13-12302.

12.0 Shipping Instructions

In the event that the Q2000 drive needs to be repacked for shipment, use the following procedure:

12.1 Actuator Lock

Lock the actuator by rotating the actuator lock CW as far as it will go (approx. ¼ turn). **Do not force!** (See Figure 22).

12.2 Motor Locking Clip Engagement

Engage drive motor locking clip (See Figure 21).

- Loosen 11/32 inch hex nut.
- Rotate locking clip until engaged in pulley.
- Tighten 11/32 inch hex nut.

12.3 Packaging

Carefully place the drive in a padded shipping container and enclose a copy of the packing/unpacking instructions, Quantum P/N 81-40162.

Secure container and ship.

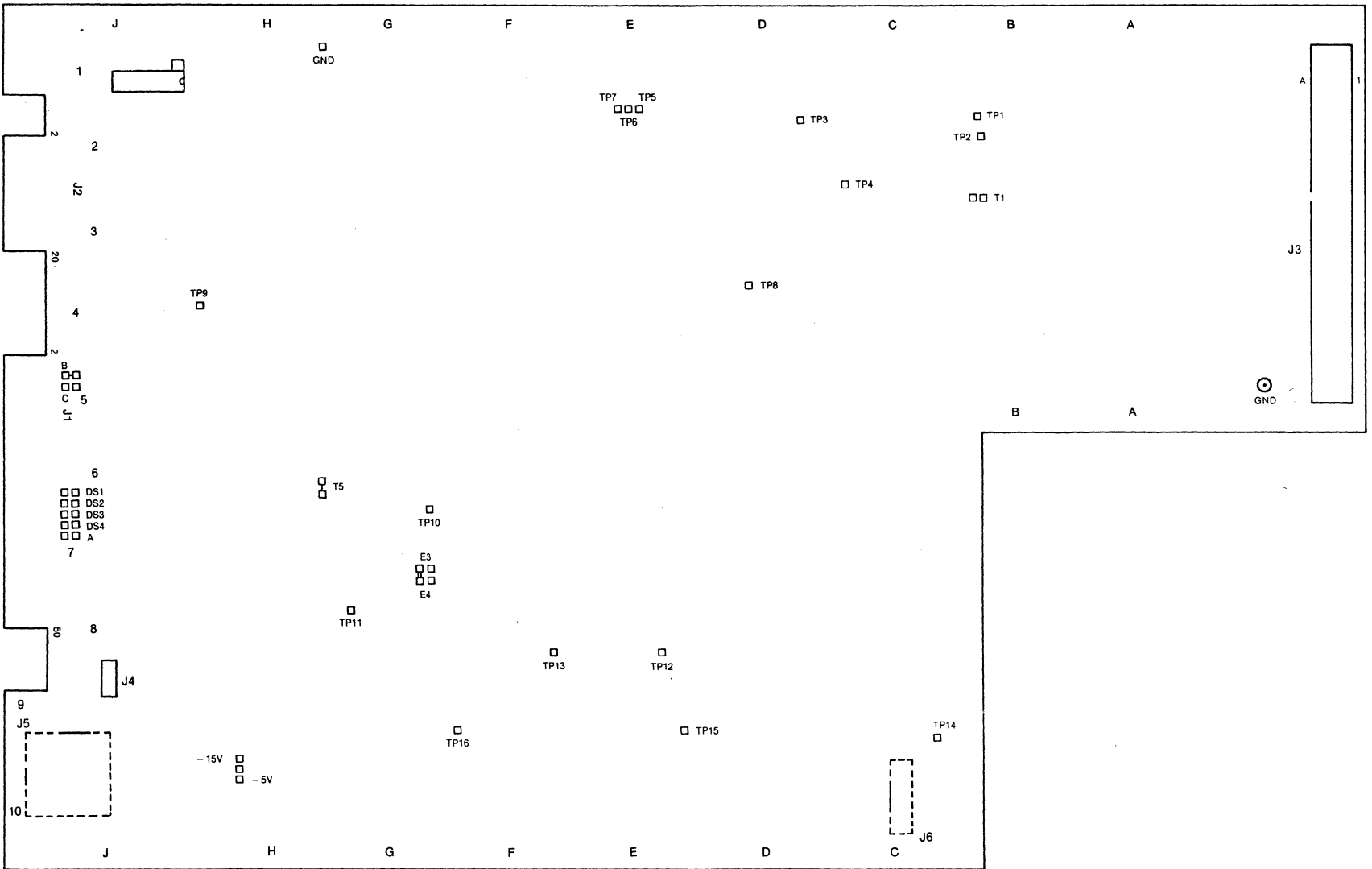


Figure 23. PCB Jumper Locations

APPENDIX A

Definition of Terms

A. Read/write head

The read/write head is a ferrite magnetic transducer element which writes data to or reads data from the magnetic media. The read/write heads for use on "Winchester" technology drives are aerodynamically constructed such that they fly over the surface of the media at a height of 20 microinches. The heads are in contact with the media when the media is not rotating. See Figure 24.

B. Media

The media is a magnetic oxide coated on an aluminum substrate (platter) which is very flat and in the shape of a disk. The media is lubricated to aid in the take off and landing of the heads without damage to either the media or heads. The media is also oriented to give maximum signal output.

C. Surface

A media surface is one side of a disk in the drive. Surface 0 is the area of a disk where read/write head 0 writes and reads data. See Figure 24.

D. Track

A track is a ring of constant radius on the surface of a disk where data is stored. A track is .0023 inches wide and the track spacing is .00285 center to center. Tracks are numbered 000 to 511 on the Quantum drive with track 511 being the innermost. See Figures 24 and 25.

E. Cylinder

A cylinder is a set of tracks on multiple recording surfaces at a given actuator position or location. See Figure 24. The Quantum 2000 series drive has 512 cylinders.

F. Actuator

An actuator positions the read/write heads over the desired track or cylinder. The actuator consists of a rotary torque motor and the actuator arms. The actuator arms are attached to the motor. The read/write heads are attached to the other end of the actuator arm. As the motor rotates, the heads are moved over the surface of the disks and can access any track.

G. Shipping and landing zone

The shipping and landing zone is a circular area inside of track 511. The heads are positioned over this area at power off or any time that the disks are not spinning at a minimum of 90% of the nominal speed of 3000 RPM. This area is a designated landing zone for the heads such that the heads do not contact the surface in usable data areas. This adds to the data reliability and integrity on the Quantum drives. See Figure 25.

H. Winchester Technology

The term "Winchester Technology" when used in reference to rigid disk drives means many things. Rigid disk drives utilizing Winchester Technology use continuously loaded, low mass high compliant head assemblies. These heads fly over the surface of the platter at a height of 20 microinches during normal operation but rest on the surface of the media when the platter is not spinning. The media used on the platters is lubricated such that there is no damage to head or media when the two come into contact.

The environment in which the heads and platters reside is sealed and contamination free to allow the 20 microinch head flying height.

I. Disk/Platter

A disk or platter is a very flat circular substrate upon which magnetic oxide is deposited or coated. Each disk/platter has two surfaces for recording information.

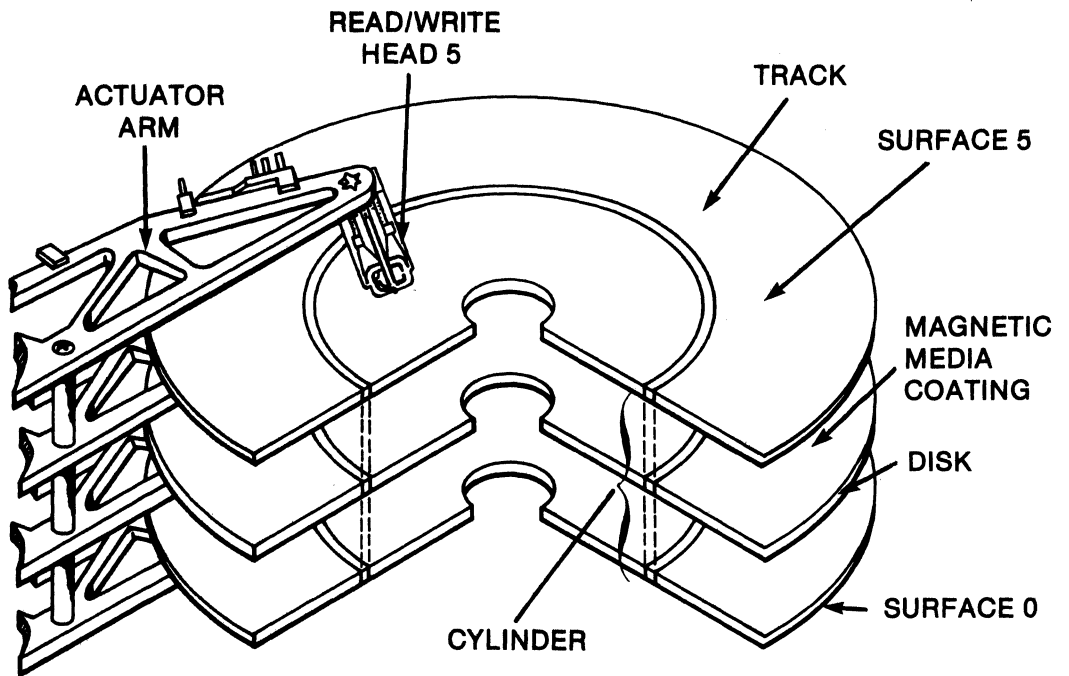


Figure 24. Typical Quantum Disk Drive Organization and Terminology

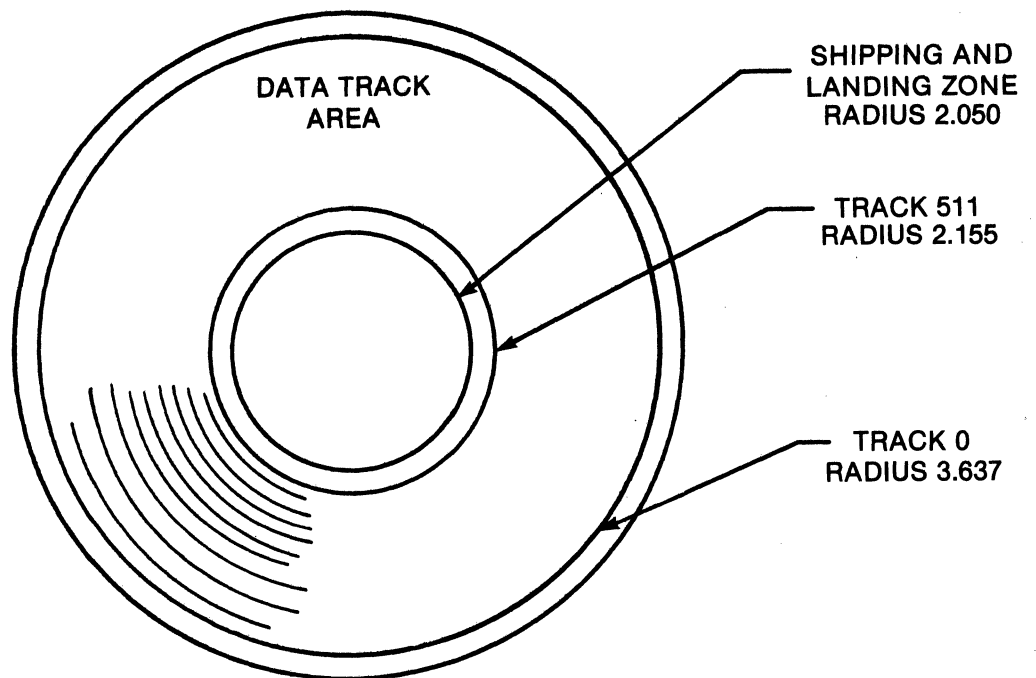


Figure 25. Data Area and Landing Zone

APPENDIX B

MEDIA DEFECTS & ERRORS

Introduction

In a high density digital recording storage system it is necessary to increase the reliability and improve the operational performance by providing an error detection and correction scheme. For disk storage systems, the predominant error pattern is a burst of errors occurring in one or more tracks. These errors are normally absent bits (dropouts) or additional bits. Errors may occur when bits are shifted further from nominal than can be tolerated by the data separator.

These errors are due to defects in the media as well as a low signal to noise ratio that contributes to probability of error occurrence. The error rate is dependent upon the noise and phase characteristics of the media, Read/Write circuits, and heads and the accuracy of actuator positioning.

What Is The Definition Of An Error?

An error is any discrepancy between recovered data and true, correctly recorded data. There can be an extra bit or a missing bit, i.e., a "zero" can be transformed into "one" or a "one" can be changed to zero. Errors can be classified into soft or hard errors. Soft errors are generally related to the signal to noise ratio of the system and represent marginal conditions of the head, media, and Read/Write circuits.

If an error is repeatable with a high probability, it is due most often to a media defect and is termed a hard error.

How will Quantum Find the Errors?

The errors will be identified prior to shipment and information incorporated in a usable format to enable the user to skip those defective locations per his system capability. Quantum has a unique media test system which exercises the drive in extreme marginal conditions and measures the amplitude and phase distortion of each bit recorded on the disk storage. All drives shipped will be accompanied by an error map reporting any media defects.

Error Reporting

An error map will be provided with each drive showing defective areas. The areas will be identified by cylinder and head address, number of bytes from index, and number of bits in length. Additionally, cylinder 000 is guaranteed to be error free.

Error Acceptance Criteria

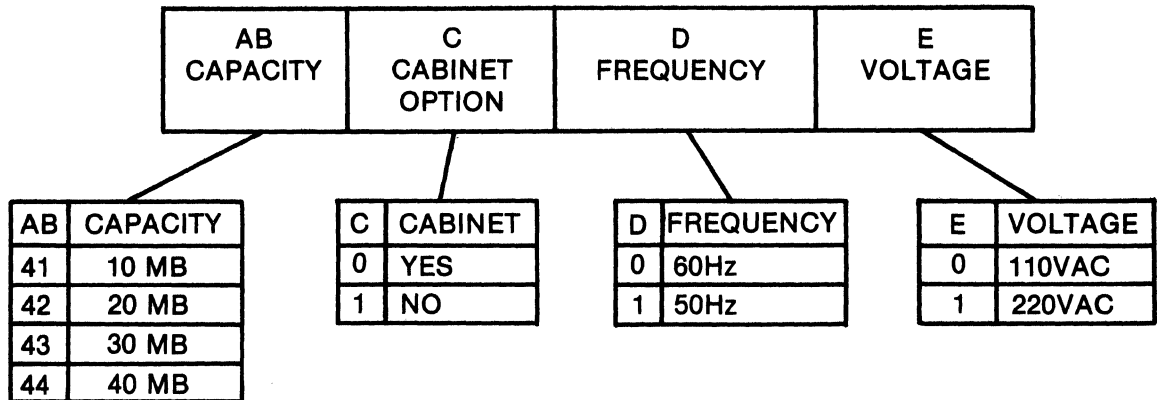
There will be no more than 12 tracks with defects per surface of which no more than 4 tracks will contain multiple defects.

A single defect is defined as an error less than 2 bytes long. A multiple defect is a defined as an error greater than 2 bytes long, or a single error in several sectors.

APPENDIX C

Ordering Information

- Table X provides the information necessary to construct a unique part number for a Q2000 rigid disk drive.



Example: 42010 = 20MB, Cabinet, 50 Hz, 110VAC

Table X. Product Selection Index

- Accessories
 - Signal Cable Connector Kit P/N 73-40157
 - DC Power Connector Kit P/N 73-40158
 - AC Power Connector Kit P/N 73-40159
- AC voltage or Frequency Conversion. If it is required to change AC power voltage and or frequency, the following table indicates the necessary components.

POWER	PART NUMBERS		
VOLTAGE AND FREQUENCY	MOTOR ASM	PULLEY	BELT
110VAC 60 Hz	74-40109	40-40015	50-40000
110VAC 50 Hz	74-40109	40-40032	50-40001
220VAC 60 Hz	74-40111	40-40015	50-40000
220VAC 50 Hz	74-40111	40-40032	50-40001

Table XI. Voltage and Frequency Conversion Information

