

PERKIN-ELMER
Memory Products Division

SUPER SERIES
(SF AND ST)

MAGNETIC DISK DRIVE

OPERATION AND MAINTENANCE
VOLUME 1

PERKIN-ELMER
Memory Products Division

SUPER SERIES
(SF AND ST)

MAGNETIC DISK DRIVE

OPERATION AND MAINTENANCE
VOLUME 1

Super Series Disk Drive
Manual 301462
Revision Level

Revision Letter	Description	Date														
Prelim.	<p>Released to cover 1500 and 2400 rpm, 2200 BPI machines only. Though listed in Appendix B Index, Dwgs. 301422 (Data Control – MFM), 301632 (DCB), 301650 (Spindle Drive Limiter PWB and Schematic), and 301653 (High Impedance Spindle Switch PWB) were not available for inclusion in the manual.</p> <p>Though listed in Appendix C Index, Schematics 301691 (Interconnection Diagram), 301423 (Data Control – MFM), 301633 (DCB), 301637 (EIB), 301654 (High Impedance Spindle Switch), and 301063 (I/O Connector – D31/33) were not available for inclusion in the manual.</p> <p>The manual was written to cover high-impedance DC spindle drive motors; therefore, an Addendum was included to cover early produced units with low impedance motors.</p> <p>Though position, number, and title were indicated, photographs for the following illustrations were not available.</p> <table data-bbox="418 1066 1047 1276"> <thead> <tr> <th>Figure</th> <th>Title</th> </tr> </thead> <tbody> <tr> <td>3-3</td> <td>Series T Cartridge Loading</td> </tr> <tr> <td>5-3</td> <td>Front-Load with Cover Removed</td> </tr> <tr> <td>5-4</td> <td>Top-Load with Cover Removed</td> </tr> <tr> <td>5-5</td> <td>Assy. Identification – Bottom View</td> </tr> <tr> <td>5-7</td> <td>Simplified Front View</td> </tr> <tr> <td>5-10</td> <td>Power Supply Assy.</td> </tr> </tbody> </table> <p>Appendix A – A Master Spares List was not available.</p>	Figure	Title	3-3	Series T Cartridge Loading	5-3	Front-Load with Cover Removed	5-4	Top-Load with Cover Removed	5-5	Assy. Identification – Bottom View	5-7	Simplified Front View	5-10	Power Supply Assy.	4/76
Figure	Title															
3-3	Series T Cartridge Loading															
5-3	Front-Load with Cover Removed															
5-4	Top-Load with Cover Removed															
5-5	Assy. Identification – Bottom View															
5-7	Simplified Front View															
5-10	Power Supply Assy.															
A	<p>This release also covered 1500 and 2400 rpm, 2200 BPI machines only; however all drawings missing from Appendix B in the Preliminary Release were now included except Dwg. 301422, Data Control MFM, which was for 4400 BPI operation.</p> <p>All schematics missing from Appendix C in the Preliminary Release were included with the exception of Data Control MFM Schematic 301423.</p> <p>SECTION 3 – OPERATION</p> <p>The photograph for Figure 3-3 was included.</p> <p>SECTION 4 – THEORY OF OPERATION</p> <p>Major signal lines were added to Figure 4-9 Block Diagram.</p> <p>Updated Descriptions and new simplified diagrams were added to the DCB writeup under para. 4.5, Logic Board Circuit Analysis. Other new paragraphs were also added under para. 4.5 explaining Speed Dection and AC/DC loss Recovery logic. Minor errors in technical writeups were corrected.</p>	5/76														

SUPER SERIES DISK DRIVE
MANUAL 301462
REVISION LEVEL

RECORD OF REVISIONS

Revision	Description	Date
B	<p>SECTION 5 – MAINTENANCE</p> <p>Photographs and art work necessary to complete 5-3, 5-4, 5-5, 5-7, and 5-10 were included.</p> <p>Under paragraph 5.5, ADJUSTMENT AND CALIBRATION PROCEDURES, a CAUTION for Adjustment of the SVA with P15 removed was added.</p> <p>Appendix A – A Master Spares List was not available.</p> <p>This release constituted the full release of the Super Series manual and included all information necessary for 4400 BPI operation. Dwg. 301422 for the Data Control – MFM PWB was not available for Appendix B, but its schematic, Dwg. 301423 was added to Appendix C.</p> <p>SECTION 2 –</p> <p>Figure 2-1 was changed to coordinate with newly created Table 2-1 in order to provide the user with more information on unpacking or reshipping machines.</p> <p>SECTION 4 –</p> <p>Writeups were added as required to cover the Data Control MFM PWB which also required two new illustrations: one for Read; one for Write.</p> <p>SECTION 5 –</p> <p>Writeups were added as required to cover the Data Control MFM PWB which also revised Detent Waveform Figures 5-33 and 5-34.</p> <p>Throughout Section 5, grid coordinates were added to test point references as an assist for technicians in the field. Table 5-2 was expanded to include new accessories and maintenance aids.</p> <p>A CAUTION was added against removing Positioner head load cams or the head mounting block during removal and replacement. The CAUTION was also applied to the Positioner illustration on the IPB.</p> <p>The SVA Adjustment procedure was completely revised and rewritten for the field to reflect improved procedures developed for the lab by Perkin-Elmer Engineering (paragraphs 5.5.5 through 5.5.8).</p> <p>SECTION 6 –</p> <p>This section was completely revised and reprepared.</p> <p>APPENDIX A – Master Spares List completed and included.</p>	7/76

SUPER SERIES DISKDRIVE
MANUAL 301462
REVISION LEVEL

Revision Letter	Description	Date
C	<p>SECTION 1 – GENERAL DESCRIPTION Revised Write Protect and Write Inhibit Circuitry descriptions (para. 1.1.1).</p> <p>SECTION 4 – THEORY OF OPERATION Updated Safety Features (para. 4.3.2).</p> <p>SECTION 5 – MAINTENANCE Revised SVA Adjustment procedure and Operational Checks (paras. 5.5.5 and 5.5.6). Added Fine Offset and Access Time Adjustments (paras. 5.5.5.4 and 5.5.5.5). Revised Temp. Compensation Check* (para. 5.5.7) and added Ready Inhibit Check (para. 5.5.8). Changed VCO Clock to 10.5 MHz on MFM PWB (5.5.13.1).</p> <p>Figure 5-32: Added Thermistor callout. Added new Figures 5-33 and 5-34 for 100 and 200 TPI Detent waveforms. Added Figure 5-35, Fine Offset Adjustment.</p> <p>* Chart of Figure 5-36, Temp. Compensation Voltage Chart, deleted. Data now in new Table 5-4.</p> <p>APPENDIX B – ENGINEERING DWGS. AND MATL. LISTS Updated Dwgs.: 400000, Disk Drive, 100/200 TPI ST (A – B); 301457, Detent Amplifier PWB (B – C); 301483, SVA (E – G); 301636, EIB (A – B) 301650, Spindle Drive Limiter PWB and Schematic (A – B); 301206, DEB (D – F); 301632, DCB (C – E), and 301047, Line Terminator PWB, D31/33 Female (A – B). Dwg. for MFM PWB (301422A) added.</p> <p>All drawings re-indexed to numerical order, and dash versions of material lists added for: CIB (301174), DEB (301206), I/O Connector PWB (301291), DIB (VFO 301321), DCB (301633), and MFM PWB (301422).</p> <p>APPENDIX C – SCHEMATICS Updated Dwgs: 301458, Detent Amplifier (A – B); 301484, SVA (D – F); 301637, EIB (A – B); 301207, DEB (D – E), and 301633, DCB (B – D).</p> <p>APPENDIX D – IPB Figure D-11 (P. D-29): Item 46 added to callouts. Page D-31, Item 42, quantity changed from 31 to 29.</p>	9/76

SUPER SERIES DISK DRIVE
MANUAL 301462
REVISION LEVEL

Revision Letter	Description	Date
D	<p>Revision D constitutes a major revision of the SF-ST manual due to Engineering redesign which replaced four PWB's and modified the MFM PWB as described under Appendices B and C below. This manual, which incorporates these changes, has been reassigned the dash number -002. All data pertinent to the four replaced PWB's and presented in Revisions A, B, and C of this manual, has been assigned dash number -001 and is contained in Appendix E.</p> <p>Section 2: Figure 2 and Table 2 – Added shroud. Paragraphs 2.4.2 through 2.4.7.4 revised and rewritten.</p> <p>Section 4: Paragraphs 4.5.1.5, 4.5.9.2, 4.5.10, and 4.5.12 rewritten to accomodate new PWB's.</p> <p>Section 5: Paragraph 5.3.6.3: procedure for screw removal added. Paragraph 5.5.3 rewritten to accomodate new PWB's.</p> <p>Section 6: Completely revised to include IC reference data.</p> <p>Appendix A: Page A-1: Item 6 changed. Page A-2: Item 2 Next Assembly changed.</p> <p>Appendix B: Commutator PWB 301170 replaced by 301920. I/O Connector D-40 PWB 301453 replaced by 301936. Spindle Drive Limiter +5V Drive PWB 301650 replaced by 301794. Spindle Switch PWB 301653 replaced by 301789. Updated: Disc Drive, ST, 400000 (B-C); Disk Drive, SF, 400001 (B-C); Line Terminator D31/33 Female 301047 (B-C); Line Terminator D31/33 Male 301055 (B-C); CIB 301174 (B-C); DEB 301206 (F-G); I/O 301291 (A-A1); DIB-VFO 301320 (C-D); PS 301361 (B-C); MFM-DCB 301422 (A-C); SVA 301483 (G-H); DCB 301632 (E-E₁); EIB 301636 (B-E); SLB 301687 (B-C).</p> <p>Appendix C: I/O D40 Schematic 301454 replaced by 301937. Spindle Switch Schematic 301654 replaced by 301790. Updated: CIB 301175 (C-D); I/O Connector 301292 (A-A₁); Power Supply 301361 (B-C); MFM Data Control-2 301423 (A-B); SVA 301484 (F-G); DCB 301633 (D-D₁); EIB 301637 (B-C).</p> <p>Appendix D: Figure D-4 Item 14, Home Switch changed. Page D-9, Item 14 changed. Page D-18: Items 15 and 16 changed (figure D-7 callouts changed to agree). Page D-6: Item 11 changed. Page D-12: Items 2, 3, and 7 changed.</p> <p>Appendix E: Added to cover information applicable to four replaced PWB's (ref. Appendices B and C above). Updated: Commutator PWB 301170 (B – C1); Spindle Switch PWB 301653 (A – A1).</p>	3/77

Super Series Disk Drive
Manual 301462
Revision Level

Revision Letter	Description	Date
E	<p>SECTION 4</p> <p>Paragraph 4.5.13: Added explanation of Emergency Retract PWB modification for 20 megabyte drives (ACN 41877).</p> <p>SECTION 5</p> <p>Air filter CAUTION added to pp. 5-17, 5-28, 5-29, and 5-51 (ACN 4877). Page 5-70: Dimension in Note changed to "0.020-inch" (ACN 52077). Pages 5-71 through 5-75 revised and rewritten (ACN 3377).</p> <p>WARNING added to paras. 5.4.3.16 and 5.5.114 (ACN 41377).</p> <p>Page 5-80, para. 5.5.13.4: Added 20 megabyte emergency retract check. Also added Figure 5-44, "Two-speed Emergency Retract" (ACN 41877).</p> <p>Appendix B: Updated: Disk Drive, ST, 400000 (C-E); Disk Drive, SF, 400001 (C-D); I/O Connector D31/33, 301062 (B-C); C1B, 301174 (C-C1); DEB, 301206 (G-H); Power Supply, 301361 (C-D); MFM, 301422 (C-C1); EIB, 301636 (E-F); SLB, 301687 (C-B); Spindle Switch, 301789 (B-B1); Spindle Limiter/5V Drive, 301794 (A-B1); Commutator, 301920 (A-B); and I/O PWB D40, 301936 (A-B). Added: Emergency Retract, 302064.</p> <p>Appendix C: Updated: DEB, 301207 (E-F); Power Supply, 301361 (C-D), and DCB, 301633 (D1-D2). Added: Emergency Retract 302065.</p> <p>Appendix E: Deleted Pages E-29, E-30, E-31, E-32, E-33, and E-34.</p>	6/77
F	<p>Appendix B: Updated: MFM Data Control, 301422 (C1-D); Servo Amplifier, 301483 (H-J); Electronics Interconnect, 301636 (F-G); Commutator Board PWB and Schematic, 301920 (B1-C1); Emergency Retract, 302064 (X1-A). Appendix C: Updated: MFM Data Control-2, 301423 (B-C); Emergency Retract, 302065 (X1-A).</p>	7/77

Super Series Disk Drive
Manual 301462-002
Revision Level

Revision Level	Description	Date
G	<p>SECTION 4</p> <p>Paragraph 4.6.2, Schematic Designators, deleted. All subsequent paragraphs renumbered and changed to call/out PWB's by abbreviated names.</p> <p>SECTION 5</p> <p>Paragraphs 5.3.3, READ/WRITE HEAD INSPECTION AND CLEANING; 5.3.4, FIXED DISK CLEANING; 5.3.5, CARTRIDGE REMOVAL AND HANDLING: New recommended head cleaning products added (ACN 8877). Paragraph 5.5.9, INDEX ALIGNMENT: Step I revised.</p> <p>APPENDIX A</p> <p>Page A-1, Item 3: Changed (ACN 81677).</p> <p>APPENDIX B: Updated Dwgs: S-T 400000 (E-F); S-F 400001 (D-E); Line Term D40 Male 301074 (B-C); DEB 301206 (H-J); DCB 301632 (E-G); EIB 301636 (G-H); Spind. Lim./5V 301794 (B-C); I/O D-40 301936 (B-C).</p> <p>APPENDIX C: Updated Schematics: DCB 301633 (D-F); I/O D40 (A-B).</p> <p>APPENDIX D</p> <p>Page D-15, Item 1 P/N changed. Page D-25, Items 2 and 7: P/N changed. Page D-26, Figure D-10: Items 36, 37, and 40 deleted from Brush Access Cover hardware. Page D-27, Items 1 and 34: P/N changed; Item 36 and 37: quantity changed. Page D-28: Item 40 deleted. Page D-30, top item, Assy., Fixed Disk Cover, Items 11, 17: P/N changed (ACN 81677). Page D-8, Figure D-4: Art changed to use WAN-0978-004.</p> <p>APPENDIX E</p> <p>Page E-1: WARNING and Figure E-1 added following Table E-1.</p> <p>LOW IMPEDANCE ADDENDUM</p> <p>Page 4: WARNING and Figure 3 added.</p>	10/77

Super Series Disk Drive
Manual 301462-002
Revision Level

Revision Level	Description	Date
H	<p>SECTION 2 Paragraph 2.4.6: Note added re: head alignment (ACN 11277).</p> <p>SECTION 5 Paragraph 5.5.4.2: Step H revised (ACN 111277). Paragraphs 5.4.3.4 and 5.4.2.5 revised (ACN 91477).</p> <p>APPENDIX B Updated Spindle Switch PWB 301789 (B1-C).</p> <p>APPENDIX C Updated DIB 301321 (B-C). Pages renumbered.</p> <p>APPENDIX D Page D-21: Item 3 changed; Item 4 added. Page D-22: Item 51 changed. Page D-27: Item 5 changed; Item 6 added. Item 19 changed. Page D-30: Item 17 changed.</p>	12/77
J	<p>SECTION 2 Revised: Paragraphs 2.3, 2.4.7.2, 2.4.7.3 and 2.4.7.4 (ACN 11778).</p> <p>SECTION 4 Revised: Page 4-8, last paragraph, and paragraph 4.5.3.4.4.</p> <p>SECTION 5 Revised: Paragraph 5.5.5.2 and 5.5.5.5. Added new Figure 5-36 (ACN 1478).</p> <p>APPENDIX B Updated: Disk Drive ST, 400000 (F-G); Disk Drive SF, 400001 (E-F); CIB 301174 (C-D); PS 301361 (D-E), SVA 301483 (L-M).</p> <p>APPENDIX C Updated: CIB 301175 (D-E); PS 301361 (D-E), SVA 301484 (J-K).</p>	2/78
K	<p>APPENDIX D (IPB), E (-001 Data), and the Low Impedance Addendum deleted from manual. To be supplied on request.</p>	5/78
L	<p>SECTION 5 Paragraph 5.5.5.5: Change step B and Figure 5-36 (ACN 32478).</p> <p>SECTION 6 Deleted. To be supplied on request.</p> <p>APPENDIX B Updated: Disk Drive ST, 400000(G-H); Disk Drive SF, 400001(F-G); DIB (VFO), 301320(D-E); PS, 301631(E-G); SVA, 301483(L-M); EIB, 301636 (H-J); Spindle Switch, 301789 (C-D); Spindle Limiter, 301794 (C-D);</p> <p>APPENDIX C Updated: DIB (VFO); 301321(C-D); PS, 301361(E-G); DCB, 301633 (F-G); EIB, 301637 (C-D)</p>	6/78

Super Series Disk Drive
Manual 301462-002
Revision Level

Revision Level	Description	Date
M	<p>SECTION 1 Changed: Table 1-1, 100 TPI track-to-track access time to 10 msec. Revised: Paragraph 1.3.2.</p> <p>SECTION 2 Revised: Figure 2-1; Table 2-2 Input Line column</p> <p>SECTION 5 Page 5-51, para. 5.5.4.2, Step H: 600 mV changed to 800 mV. Page 5-83: para. 5.5.14, CIB Adjustment added (ACN 8478).</p> <p>APPENDIX A Master Spares List, p. A-1, Item 1, Mag. Rec. Hd. for 4400 BPI R/W: 301401-001 and -002 changed to 301489-005 and -006.</p> <p>APPENDIX B Updated: Disk Drive, 100/200 TPI, ST, 400000 (G-L); Disk Drive, 100/200 TPI, SF, 400001 (F-K); Control Interface PWB, 301174 (D-E); Data Electronics PWB, 301206 (J-K); Servo Amplifier PWB, 301483 (M-N); Electronic Interconnect PWB, 301636 (J-K); Spindle Drive Limiter/5V Drive PWB, 301794 (D-E); I/O Connector D40, 301936 (C-D₁).</p> <p>APPENDIX C Updated: Control Interface PWB, 301175 (E-F); MFM Data Control-2, 301423 (C-D); Detent Amplifier, 301458 (B-C); Servo Amplifier, 301484 (J-L); Servo Logic PWB, 301688 (A-B); I/O PWB -D40, 301937 (C-D).</p>	9/78

Super Series Disk Drive
Manual 301462-002
Revision Level

Revision Level	Description	Date
N	<p>SECTION 1 Changed: Table 1-1 access times.</p> <p>SECTION 2 Changed: Table 2-2 (ACN 11178).</p> <p>SECTION 4 Figure 4-5 revised (ACN 11178). Figure 4-24 revised.</p> <p>SECTION 5 Revised: paras. 5.5.5.1 (Step G); 5.5.5.2; 5.5.5.5 (Step A). Figure 5-31 revised.</p> <p>APPENDIX B Updated: Disk Dr. 100/200 TPI, ST, 400000 (L-N); Disk Dr. 100/200 TPI, SF, 400001 (K-M); Spind. Sw. 301789 (D-E).</p> <p>APPENDIX C Updated: Det. Amp. 301458 (C-D).</p>	12/78
P	<p>APPENDIX B Added: PWB I/O Connector W/Interrupt Option, 301947 (A); Assy, Piggyback I/O Connector W/Interrupt Option, 301952 (C).</p> <p>APPENDIX C Added: I/O Connector W/Interrupt Option, 301948 (A); Piggyback--I/O Connector With Interrupt Option, 301953 (A).</p>	2/79
Q	<p>Revised manual for two-volume split. Volume 1 contains all text and associated art in five sections. Volume 2 contains logic schematics, PWB assembly drawings and material lists, and a Master Spare Parts List.</p> <p>SECTION 1 Revised completely.</p> <p>SECTION 3 Added: Paragraph 3.4 and Figures 3-6 through 3-12 (flow charts)</p> <p>SECTION 5 (ACN 22279) Page 5-55, paragraph 5.5.5.1, step H: Revised Page 5-60, CAUTION, line 4, changed: POSITIVE-GROUND to POSITIVE-GOING Page 5-62, paragraph 5.5.5.4: Updated. Page 5-62, Added: New Figure 5-35, incremented subsequent figures by one. Page 5-63, paragraph 5.5.5.5, steps B and C: Updated. Page 5-64, Figure 5-37 (was 5-36): Updated variation callouts.</p>	6/79

RECORD OF REVISIONS

Revision	Description	Date
R	SECTION 5 (ACN 71279) Revised: Page 5-79, paragraph 5.5.13.1 Revised: Page 5-80, Figure 5-43	11/79

TABLE OF CONTENTS

Section	Paragraph	Page
1	GENERAL DESCRIPTION	
	1.1 SCOPE	1-1
	1.2 INTRODUCTION	1-1
	1.2.1 Special Features	1-1
	1.3 SPECIFICATIONS	1-3
	1.4 ARRANGEMENT AND FUNCTION OF MAJOR ASSEMBLIES.	1-3
	1.4.1 Operator Controls and Status Indicators	1-5
	1.4.2 Door Assembly	1-5
	1.4.3 Cartridge Receiver Assembly	1-5
	1.4.4 Spindle Assembly	1-5
	1.4.5 Head-Positioner Assembly	1-6
	1.4.6 Electronic Assemblies	1-6
	1.4.7 Rear Panel Assembly	1-7
	1.5 FORCED-AIR CLEANING SYSTEM	1-7
2	INSTALLATION AND CHECKOUT	
	2.1 INTRODUCTION	2-1
	2.2 UNPACKING AND INSPECTION	2-1
	2.3 CARRIAGE SHIPPING RESTRAINT REMOVAL	2-1
	2.4 INSTALLATION	2-3
	2.4.1 Input Power Requirements	2-3
	2.4.2 Interface Requirements	2-5
	2.4.3 Electrical Characteristics	2-9
	2.4.4 Input Lines	2-9
	2.4.5 Output Lines	2-10
	2.4.6 Rack-Mounted Installation	2-12
	2.4.7 Initial Checkout	2-14
3	OPERATION	
	3.1 SCOPE	3-1
	3.2 OPERATOR CONTROL PANEL	3-1
	3.2.1 Functions of Operator Panel Controls	3-2
	3.3 CARTRIDGE LOADING	3-3
	3.3.1 SF Disk Drive	3-3
	3.3.2 ST Disk Drive	3-7
	3.3.3 Operating the Disk Drive	3-8
	3.3.4 Timing	3-10
	3.3.5 Temperature Characteristics	3-10
	3.4 FLOW CHARTS	3-11
4	THEORY OF OPERATION	
	4.2 INTRODUCTION	4-1
	4.3 SCOPE	4-1
	4.3 MECHANICAL DESCRIPTION	4-1
	4.3.1 Spindle/Drive Motor Assembly	4-1
	4.3.2 Positioning Assembly	4-4
	4.4 SYSTEM ELECTRONIC THEORY	4-11
	4.4.1 Functional Block Diagram Description	4-11
	4.5 LOGIC BOARD CIRCUIT ANALYSIS	4-17
	4.5.1 I/O Connector Board (IOB)	4-17
	4.5.2 Electronics Interconnect Board (EIB)	4-20

TABLE OF CONTENTS (continued)

Section	Paragraph	Page		
4	4.5.3	Disk Control Board (DCB).....	4-20	
	4.5.4	Servo Logic Board (SLB).....	4-27	
	4.5.5	Servo Amplifier Board (SVA).....	4-32	
	4.5.6	Data Electronics Board (DEB).....	4-37	
	4.5.7	Control Interface Board (CIB).....	4-43	
	4.5.8	Data Interface Board VFO II (DIB).....	4-45	
	4.5.9	Modified Frequency Modulation (MFM) Board.....	4-50	
	4.5.10	Spindle Drive Limiter Board.....	4-53	
	4.5.11	Motor Drive Power Switch Board.....	4-53	
	4.5.12	Commutator Board.....	4-54	
	4.5.13	Emergency Retract Board.....	4-55	
	4.6	SCHEMATIC DIAGRAM ANALYSIS.....	4-55	
	4.6.1	Scope of Analysis.....	4-55	
	4.6.2	Initial Seek Operation.....	4-56	
	4.6.3	Programmed Seek.....	4-61	
	4.6.4	Restore Operation.....	4-61	
	4.6.5	Read/Write Operation.....	4-64	
	5	MAINTENANCE		
		5.1	INTRODUCTION.....	5-1
5.2		SCOPE OF MAINTENANCE.....	5-1	
5.3		PREVENTIVE MAINTENANCE.....	5-3	
5.3.1		Preventive Maintenance Schedule.....	5-3	
5.3.2		Read/Write Head Inspection and Cleaning.....	5-4	
5.3.3		Fixed Disk Cleaning.....	5-5	
5.3.4		Cartridge Removal and Handling.....	5-5	
5.3.5		Disk Drive Top Cover Removal.....	5-7	
5.4		CORRECTIVE MAINTENANCE.....	5-7	
5.4.1		General Description.....	5-7	
5.4.2		Removal and Replacement of Major Assemblies.....	5-16	
5.4.3		Removal and Replacement of Subassemblies.....	5-27	
5.5		ADJUSTMENT AND CALIBRATION PROCEDURES.....	5-45	
5.5.1		Table of Adjustments.....	5-45	
5.5.2		Power Supply Adjustment.....	5-46	
5.5.3		Spindle Phasing.....	5-47	
5.5.4		Index/Sector Transducer Adjustment.....	5-47	
5.5.5		SVA Adjustment Procedures.....	5-54	
5.5.6		SVA Operational Checks.....	5-65	
5.5.7	Temperature Compensation Check.....	5-66		
5.5.8	Ready Inhibit Check.....	5-68		
5.5.9	Index Alignment.....	5-69		
5.5.10	Write Current Check.....	5-71		
5.5.11	Read/Write Head Alignment.....	5-73		
5.5.12	Data Separator Operational Check.....	5-78		
5.5.13	MFM Adjustments (4400 BPI Disk Drives Only).....	5-79		
5.6	TROUBLESHOOTING.....	5-83		

LIST OF ILLUSTRATIONS

Figure	Title	Page
	Frontispiece, Super Series Magnetic Disk Drives	xviii
2-1	Shipping Container and Parts	2-2
2-2	Carriage Shipping Restraint.	2-4
2-3	Multiple Disk Drive Installation (Daisy Chaining)	2-6
2-4	Rear Panel and I/O Connector Board	2-8
2-5	Rack-Mounted Installation Instructions	2-13
2-6	By-Passing Top Cover Interlock Switch.	2-15
3-1	Operator Controls.	3-1
3-2	Series F Disk Drive Cartridge Loading	3-4
3-3	Series T Disk Drive Cartridge Loading	3-5
3-4	Operating the SF or ST Disk Drive	3-6
3-5	Power ON/Off Sequence	3-10
3-6	Power-up and Cartridge Loading (Load Mode)	3-11
3-7	Run Mode – Initial Cycle	3-12
3-8	Run Mode – Cylinder 000 Seek	3-13
3-9	Run Mode – New Address Seek	3-14
3-10	Run Mode – Write Operation	3-15
3-11	Run Mode – Read Operation	3-16
3-12	Turn-off Cycle.	3-17
4-1	Simplified Block Diagram	4-2
4-2	Spindle/Drive Motor Assembly	4-3
4-3	Three Types of Sector Rings	4-5
4-4	Positioner Assembly	4-6
4-5	Optical Transducer Diagram	4-7
4-6	Movable Optical Glass	4-7
4-7	Read/Write Heads	4-9
4-8	Head Unloading Mechanism	4-10
4-9	Block Diagram – Super Series (major signal lines)	4-13
4-10	Block Diagram – Super Series (major signal lines) 4400 BPI only	4-14
4-11	Functional Block Diagram – Head Positioning System	4-15
4-12	Functional Block Diagram – Read/Write Circuit.	4-16
4-13	Block Diagram – I/O Board	4-18
4-14	Spindle Motor Speed Detection and Control Functional Block Diagram.	4-21
4-15	Spindle Motor Control Simplified Logic Diagram	4-21
4-16	Motor Speed Control Timing Diagram.	4-22
4-17	Removable Disk Index/Sector Separation	4-24
4-18	Removable IDX/STR Pulse Timing Diagram	4-24
4-19	Disk Control Signals – Simplified Logic Diagram	4-25
4-20	Block Diagram of Servo Logic Board (SLB)	4-28
4-21	Subtractor Circuit – 200 TPI	4-30
4-22	Illegal Address Gating Circuits.	4-31
4-23	Block Diagram of Servo Amplifier Board (SVA)	4-33
4-24	New Address Seek Operation Waveforms	4-35
4-25	Positioner Servo	4-37
4-26	Block Diagram of Data Electronics Board (DEB)	4-38
4-27	Disk/Head Selection Decoder	4-39
4-28	Block Diagram of Read/Write Amplifier	4-40
4-29	Read/Write Signals – Relative Timing.	4-41
4-30	Edge Erasing	4-42
4-31	Block Diagram of CIB	4-44
4-32	Current Sector Identification (CIB).	4-46
4-33	Output of Double-Edge Discriminator.	4-47
4-34	Data Interface and VFO Timing Diagram	4-48

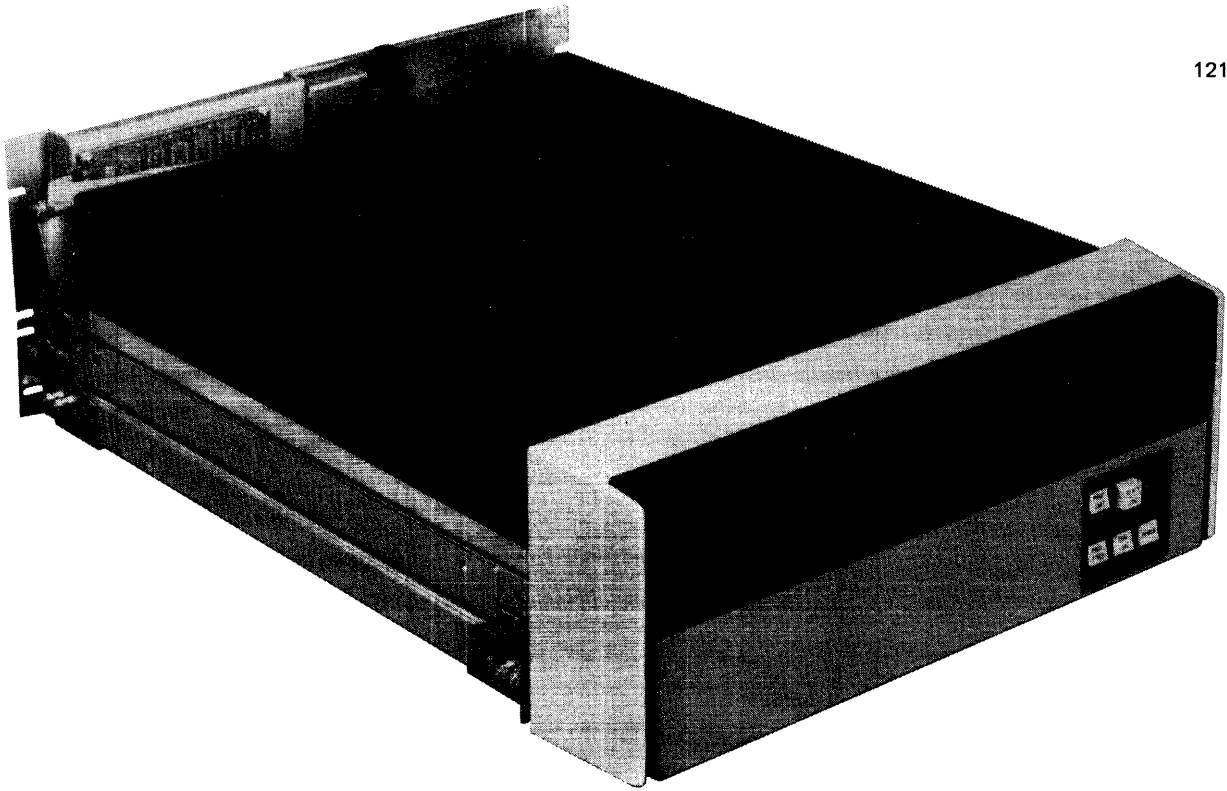
LIST OF ILLUSTRATIONS (continued)

Figure	Title	Page
4-35	Double-Frequency-Modulated Waveshape	4-49
4-36	Simplified Logic Diagram — Read Circuitry	4-51
4-37	Simplified Logic Diagram — Write Circuitry	4-52
4-38	Simplified Diagram of Brushless Motor Circuit	4-54
4-39	Head Load Timing Diagram.	4-59
4-40	Programmed Seek (1 and 2 Cylinder Seeks)	4-62
4-41	Timing Diagram of Restore Operation.	4-63
5-1	Fixed Disk Cleaning Hole Location	5-6
5-2	Cartridge Interlock Switch Actuation — ST.	5-6
5-3	SF with Cover Removed.	5-8
5-4	ST with Cover Removed.	5-9
5-5	SF and ST Disk Drives, Assembly Identification — Bottom View	5-10
5-6	Series F Disk Drive — Simplified Front View.	5-11
5-7	Series T Disk Drive — Simplified Front View.	5-12
5-8	Removal/Replacement Guide — Major Assemblies	5-17
5-9	Top Cover Hole Alignment	5-18
5-10	Power Supply Assembly	5-19
5-11	Positioner Assembly	5-21
5-12	Spindle Assembly	5-25
5-13	Disk Brush Drive Mechanism	5-27
5-14	Removal/Replacement Guide — Subassemblies	5-28
5-15	Air Filter Installation	5-30
5-16	Blower Shaft Ground Brush — Mounting.	5-33
5-17	Spindle Shaft Ground Brush — Mounting	5-34
5-18	Disk Cleaning Brushes — Installation/Replacement Guide	5-34
5-19	Cartridge Interlock Switch Assembly	5-35
5-20	Removable Index/Sector Transducer — Series F Only.	5-37
5-21	Fixed and Removable Index/Sector Transducer	5-38
5-22	Read/Write Head Assembly.	5-40
5-23	Torque Wrench No. T-00425 Application	5-42
5-24	Emergency Retract PWB Assembly	5-44
5-25	Power Supply Connections — Commutator Board Phasing Adjustment.	5-48
5-26	Shutter Adjustment — Commutator Board	5-49
5-27	Cartridge Sector/Index Transducer Waveshape	5-50
5-28	Fixed Disk Sector/Index Transducer Waveshape	5-52
5-29	Input to Differentiator Board (SF).	5-53
5-30	Detent Signal Output Waveform (manual).	5-56
5-31	Phasing Adjustment Waveform	5-56
5-32	Optical Detent Assembly — Phasing Adjustment.	5-58
5-33	100 TPI Drive — Detent Waveform — Alternate One Track Seek.	5-61
5-34	200 TPI Drive — Detent Waveform — Incrementing One Track Seek.	5-61
5-35	Fine Balance Adjustment	5-62
5-36	Fine Offset Adjustment.	5-63
5-37	Detent Signal Output Waveforms	5-64
5-38	Index-to-Data Alignment (2400 rpm shown).	5-70
5-39	Write Current Waveform — Track 000.	5-72
5-40	Write Current Waveform — Innermost Track.	5-72
5-41	Read/Write Head Alignment Waveforms (Removable Disk).	5-74
5-42	Data Separator Output Waveform	5-79
5-43	MFM Timing Relationships Diagram	5-80
5-44	Timing Relationship Between MFM DATA and CLOCK for Error Checking with an Exerciser	5-81
5-45	Write Clock to Data Timing Adjustment.	5-82
5-46	Two-speed Emergency Retract	5-83

LIST OF TABLES

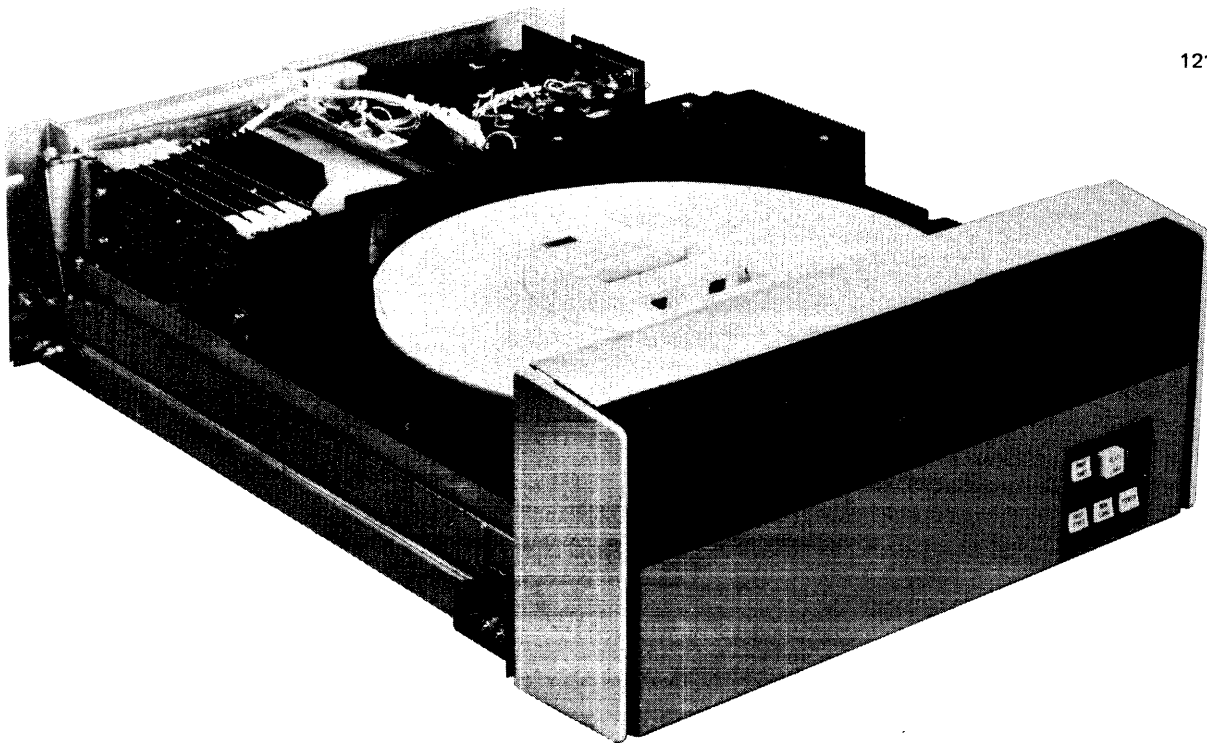
Table	Title	Page
1-1	Specifications — Super Series Disk Drives	1-4
2-1	Packaging Container Parts	2-3
2-2	Interface Pin Assignments	2-5
2-3	Printed Wiring Board Acronyms	2-6
2-4	Glossary of Mnemonic Terms	2-7
4-1	Normal Run Switching Sequence	4-55
5-1	Preventive Maintenance Schedule	5-2
5-2	Standard and Special Accessories and Service Aids	5-14
5-3	Table of Adjustments	5-46
5-4	Temperature Compensation Voltage	5-68
5-5	CE Cartridge Head Alignment Tracks	5-75
5-6	Fault Isolation Chart.	5-84

1217



Front Load - Series SF

1216



Top Load - Series ST

Frontispiece - Super Series Magnetic Disk Drives

SECTION 1

GENERAL DESCRIPTION

1.1 SCOPE

This manual describes operation and maintenance of Super Series Disk Drives manufactured by Perkin-Elmer Memory Products Division, and is divided into two volumes. Volume 1 contains the following five sections:

Section 1	General Description
Section 2	Installation and Checkout
Section 3	Operation
Section 4	Theory of Operation
Section 5	Maintenance

Volume 2 contains the following three sections:

Section 1	Logic Schematics
Section 2	Assembly Drawings
Section 3	Master Spare Parts List

1.2 INTRODUCTION

Super Series Disk Drives are front-loading (SF) or top-loading (ST), 100 or 200 tracks-per-inch (TPI) (tracks per 2.54 cm), random-access, high-capacity data storage devices whose compact size, optimum performance, and reliability make them exceptionally suitable for use in computer systems of small and medium size. Several models are available in each series with a choice in storage capacities and transfer rates.

In standard versions the units incorporate, in either series, an integral permanent disk and a removable disk of the cartridge-type offering a gross storage capacity of up to 200 megabits. Recording density is 2200 or 4400 bits per inch (BPI) (bits per 2.54 cm).

NOTE

Throughout this manual all references to tracks per inch (TPI) or bits per inch (BPI) are intended to relate to tracks per 2.54 centimeters (cm) or bits per 2.54 centimeters (cm).

The SF Disk Drive uses a front-loading cartridge of the IBM 2315-type; the ST Disk Drive uses a top-loading cartridge of the IBM 5440-type. All 4400 BPI models use modified cartridges with IBM 3300-type media.

The SF and ST Disk Drives incorporate an interface compatible with, or adaptable to, controllers for most major disk file systems. Integral daisy-chain provisions permit the interconnection of up to four Disk Drives.

The disk drives in either series feature modern functional exterior styling and are rack-mounted in cabinets of standard RETMA dimensions. The SF unit requires only 7 inches (17.78 cm) of vertical rack space; the ST unit requires only 7-¾ inches (19.68 cm).

1.2.1 SPECIAL FEATURES

The SF and ST Disk Drives incorporate advanced electronic and mechanical design features that contribute to their exceptional performance and reliable operation. Routine service requirements are minimal, and corrective maintenance, should it become necessary, is facilitated through the efficient layout and accessibility of all components. Some of the notable design features are:

- A. The disk spindle and the drive motor are combined in an integral assembly; thus eliminating a drive belt and pulleys.
- B. The spindle motor is a DC brushless unit, and its speed is held constant within ± 1 percent regardless of line voltage and frequency fluctuations. Therefore, the storage of data in any given sector of the disks can be maximized.
- C. Either of two spindle speeds are available: 1500 or 2400 rpm (4400 BPI available at 2400 rpm only).
- D. The head-positioning system uses a highly efficient electromagnetic actuator which although it permits fast access times, has low power dissipation and very low flux leakage. Final head positioning is implemented through an optical-electronic – not mechanical – detenting system.
- E. Write Protect circuitry, selectable at the operator control panel (OCP), is provided for protection of previously recorded data on either the fixed or cartridge disk. Write Inhibit circuitry is provided to inhibit writing before the Ready signal is sent to the Controller. An option for 200 TPI disk drives only is available to inhibit writing until a temperature balance is achieved in the Temperature Compensation Circuitry.
- F. A highly efficient clean-air system, continuously purges the interior of the disk drive and pressurizes it. Intake air is passed through a dual filter element, purges the disks and heads, and cools the electronic assemblies before exiting the disk drive.

- G. Internal flexible I/O signal and AC power cables interconnect the receptacles mounted on the rear panel of the disk drive with the corresponding electronic assemblies in the disk drive. This feature permits permanent mounting of the rear panel in the cabinet and makes it possible to slide the disk drive out without disconnecting or manipulating the external cables.
- H. A built-in universal power supply allows operation on any of the world's standard AC power voltages and frequencies.

1.3 SPECIFICATIONS

Specifications for the SF and ST Disk Drives are listed in Table 1-1.

1.4 ARRANGEMENT AND FUNCTION OF MAJOR ASSEMBLIES

The SF and ST Disk Drives are identically constructed except for mechanical differences in the cartridge loading and seating mechanisms and door and cabinet locks. Assemblies and characteristics common to both series are shown and described in the following paragraphs. Three-quarter front views showing component locations are included in Section 5.

1.4.1 OPERATOR CONTROLS AND STATUS INDICATORS

Controls and associated status indicators are located on a panel below the plastic door. These include the switches with which the operator starts and stops the Disk Drive, selects the unit address (in multiple-disk drive installations) and write protect indicator/switches for both the removable and fixed disks. The function and operation of each switch and indicator is described in Section 3.

1.4.2 DOOR ASSEMBLY

In the SF Disk drive, the door rotates forward approximately 60 degrees, and the cartridge is inserted through the resultant opening. When the door is opened, the cartridge receiver is simultaneously elevated and advanced.

In the ST Disk Drive, the door rotates forward approximately 30 degrees. As the door is pulled open, a locking mechanism disengages the stationary mounting slides. The disk drive can then be slid out of the rack, and the cartridge can be loaded on the spindle as described in Section 5.

1.4.3 CARTRIDGE RECEIVER ASSEMBLY

This assembly is used only in the SF Disk Drive. The receiver is mechanically coupled to the door-loading assembly. It holds the cartridge and automatically positions it over the spindle. The cartridge is locked on the spindle chuck as the door is closed.

Table 1-1. Specifications — Super Series Disc Drives

Parameter	100 TPI	200 TPI
Gross Capacity	25 or 50 Megabits	50, 100 or 200 Megabits
Transfer Rate	1562, 2500 Kbits/sec	1562, 2500 or 5000 Kbits/sec
Track Density	100 TPI	200 TPI
Recording Density	2200 BPI	2200 or 4400 BPI
Maximum Speed Variation	± 1%	± 1%
Access Times		
Track-to-track	11 msec	10 msec
Average	37.5 msec	37.5 msec
Maximum	67 msec	67 msec
Recording Mode	Double freq. encoded	Double freq. encoded or modified freq. modulation
Disk Speed	1500 or 2400 rpm	1500 or 2400 rpm
Cartridge Unload/Load Cycle		
Load Cycle	60 seconds	60 seconds
Cartridge — Series SF	IBM 2315-type	IBM 2315-type
Cartridge — Series ST	IBM 5440-type	IBM 5440-type, modified IBM
Built-in Power Supply		3300-type media for 4400 BPI
Requirements	100,110,120,130,200,220,230,240,250,260 VAC ± 10%, 47-63Hz, 250 VA	100,110,120,130,200,220,230,240,250,260 VAC ± 10%, 47-63Hz, 250 VA
Physical Dimensions		
Height — Series SF	7.00 in. (17.78cm)	7.00 in. (17.78cm)
Height — Series ST	7.75 in. (19.68 cm)	7.75 in. (19.68 cm)
Width —Series SF and Series ST	17.60 in. (44.70 cm)	17.60 in. (44.70 cm)
Weight	100 lb. (45.36 kg)	100 lb. (45.36 kg)
Environment, Operational		
Temperature	50 to 100°F (10 to 38°C)	50 to 100°F (10 to 38°C)
Relative Humidity	10–80%, noncondensing	10–80%, noncondensing
Environment, Shipping and Storage		
Temperature	–40 to +150°F (–40 to +65°C)	–40 to +150°F (–40 to +65°C)
Relative Humidity	5 – 95%	5 – 95%

1.4.4 SPINDLE ASSEMBLY

The spindle assembly provides the mechanical coupling between the recording disks and the drive motor. The fixed disk is mounted directly on the spindle hub. The cartridge disk engages the spindle only when the cartridge is fully seated in the disk drive. Coupling is accomplished by means of a spindle-mounted/magnetic chuck; i.e., a ring magnet and a circular pole piece, and an armature plate fastened to the cartridge disk.

A conical point on the center of the spindle engages an identically machined opening in the center of the cartridge disk; thereby accurately aligning the disk on the spindle hub. The fixed disk sector ring also is mounted on the spindle hub. The spindle motor is coupled directly to the spindle assembly without using a belt; therefore, it becomes an integral part of the spindle assembly. The spindle is dynamically braked when a Stop cycle is initiated (see Section 4).

1.4.5 HEAD-POSITIONER ASSEMBLY

The head-positioner mechanism positions the read/write heads over the selected cylinder (track) on the fixed or removable disk.

The head-positioner assembly contains the following components: an electromagnetic linear actuator, carriage, carriage guides, head loading/unloading cams, and a positioner transducer. All components of the head positioner form an integral assembly that can be independently removed from the disk drive.

1.4.6 ELECTRONIC ASSEMBLIES

The disk drive contains seven plug-in printed wiring boards (PWB's) and a central interconnect PWB on which the connectors for the plug-in PWB's are mounted. The frame adjacent to the head-positioner assembly contains the following PWB's (see Section 5 for physical locations):

- A. Data Interface Board (DIB) at connector J1
- B. Control Interface Board (CIB) at connector J2
- C. Disk Control Board (DCB) at connector J3
- D. Servo Logic Board (SLB) at connector J4
- E. Servo Amplifier Board (SVA) at connector J5

The Detent Amplifier Board (DAB) is a small daughter-board that plugs into J14 between the power supply and the head positioner.

Connector numbering is from left to right as viewed from the front of the disk drive; i.e., connector J1 is located nearest to the edge of the casting. The Data Electronics Board (DEB) at connector J7 is located on the opposite side of the disk drive in front of the power supply.

The power supply assembly furnishes the operating voltages (± 18 VDC unregulated; +5 VDC regulated) for all electronic assemblies, the head-positioner, and the spindle and brush motors. DC fuses are provided on this assembly. The power supply can be removed as one integral unit.

1.4.7 REAR PANEL ASSEMBLY

The I/O Connector Board (IOB) is mounted on the rear panel and contains the signal input/output connectors, line drivers, and receivers.

In cabinet installations, the rear panel is stationary; that is, it does not slide out with the disk drive but remains in the cabinet. The electrical connections between the panel and the disk drive are established by means of flexible cables.

1.5 FORCED-AIR CLEANING SYSTEM

The SF and ST Disk Drives contain a forced-air system that purges the disk and head areas with highly filtered air. Air is drawn from outside the cabinet and cools the electronic assemblies. During operation, the interior of the disk drive is at slightly elevated pressure, with respect to the ambient, which serves to keep dust from entering the disk drive.

The components of the forced-air system are accessible from below the base casting. The dual air-filter element is contained in the rectangular cavity next to the spindle assembly. The blower fan is located on the opposite side of the spindle. Both components are covered by individual sheet-metal plates (see Section 5 for the physical location of these components).

Intake air enters the disk drive at the front panel from above. With this arrangement, only fresh ambient air is circulated through the disk drive. The incoming air is accelerated by the blower, passes through the plenum chamber then through the filter element and over the disk surfaces. It exits via the head entry door of the cartridge and through the lower head area.

SECTION 2

INSTALLATION AND CHECKOUT

2.1 INTRODUCTION

This section contains unpacking and installation instructions and a description of the interface for the Perkin-Elmer Super Series SF (front-loading) and ST (top-loading) Disk Drives.

2.2 UNPACKING AND INSPECTION

SF and ST Disk Drives are shipped in special containers designed to provide full protection under normal transit conditions. Immediately upon receipt, the shipping container should be inspected for evidence of possible damage incurred in transit. Any obvious damage to the container, or indications of actual or probable equipment damage, should be reported to the carrier company in accordance with instructions on the form included in the container.

Figure 2-1 shows an exploded view of the palletized packaging container and its parts. Table 2-1 lists the parts with full descriptions in accord with item numbers used in the figure.

To unpack the disk drive, open the top side of the shipping container and remove the two Etha-foam flotation frames, packaging spacers, and rectangular cardboard sleeve. Then carefully remove the plastic bag and use care to avoid tearing the bag. All of these components should be saved in case it may be necessary to relocate the unit at a later date. A shipping package (P/N T-00287 may be ordered from the Company.

When the plastic bag has been removed, grip the unit along both sides of the casting while lifting it out of the container. Do NOT support the unit by the handle on the front panel. The finished surfaces and the plastic part of the front panel should also be handled with reasonable care to avoid marring.

2.3 CARRIAGE SHIPPING RESTRAINT REMOVAL

For protection during shipping, the carriage of the positioner assembly is held back against the rear stop by a shipping restraint shown in Figure 2-2. This restraint immobilizes the carriage, heads, and associated parts. Plug P16 on the Power Supply is shipped disconnected to preclude possibility of power being inadvertently applied to the disk drive while the shipping restraint is still installed.

The shipping restraint must be removed before the disk drive can be operated. To remove the shipping restraint, remove the restraint retaining screw located at the rear of the positioner. This screw is shown in the INSTALLED POSITION (see Figure 2-2). Reinstall the shipping restraint as shown in the STOWED POSITION (see Figure 2-2).

NOTE

The restraint retaining screw holds the carriage rear stop and must be reinstalled.

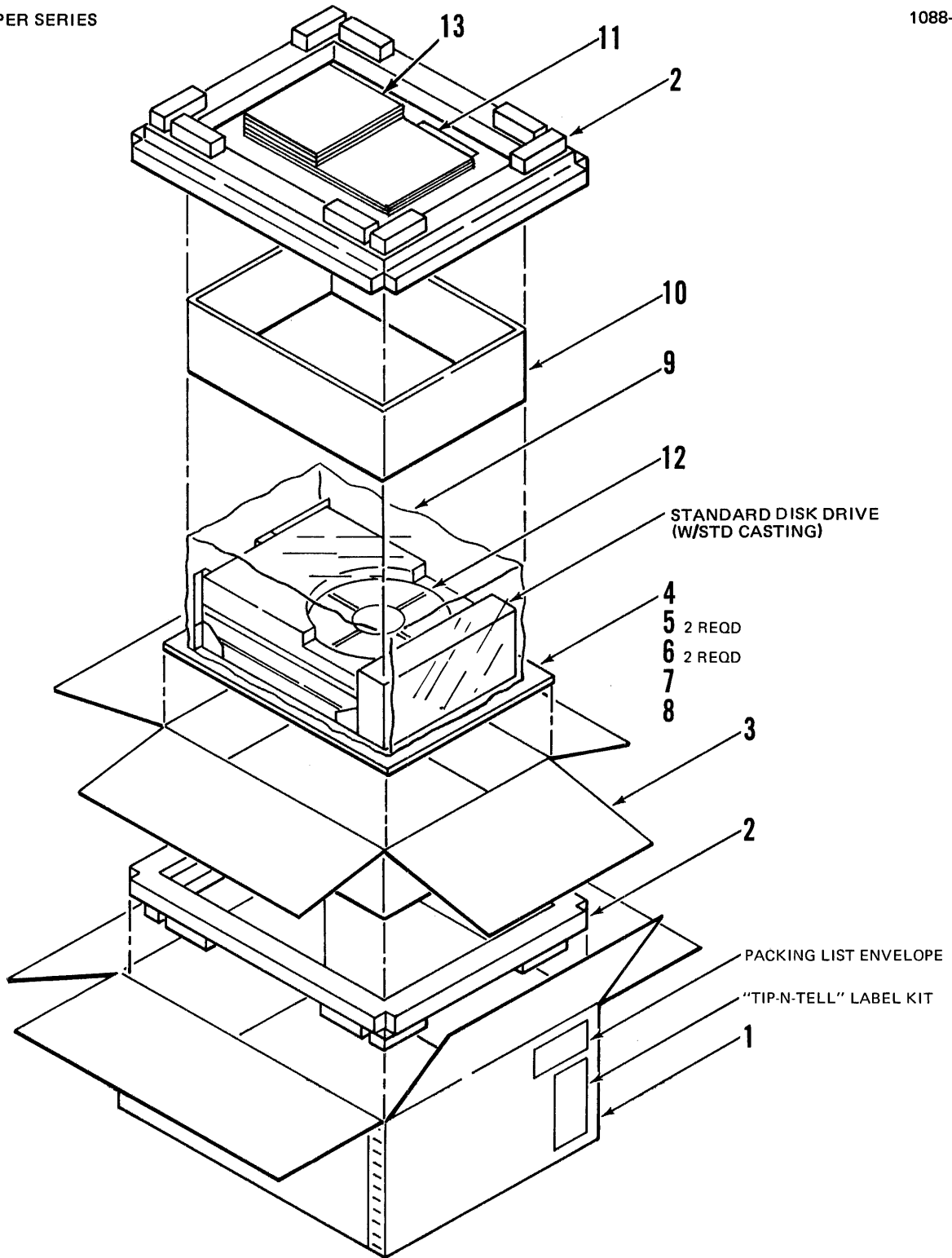


Figure 2-1. Shipping Container and Parts

Table 2-1. Packaging Container Parts (see Figure 2-1)

Item No.	Part No.	Description
1	T-00287-001	Outer Stitched Box
2	T-00287-002	Flotation Frame
3	T-00287-003	Inner Box
4	T-00287-004	Mounting Base
5	Bolt, Hex	1/4-20 UNC x 1-1/2
6	Washer	1/4 ID x 3/4 OD
7	Bolt, Hex	3/8-16 UNC x 1-1/2
8	Washer	3/8 ID x 3/4 OD
9	5003	Polystyrene Bag
10	T-00287-005	Sleeve
11	T-00128	Shipping Damage Notice Form
12	T-00180-007	Dust Cover, Shroud (series "T" only)
13	200951-001	Technical Manual Vol. 1 and 2

NOTE

The Shipping restraint must be removed before the Disk Drive can be operated.

2.4 INSTALLATION

2.4.1 INPUT POWER REQUIREMENTS

The standard Perkin-Elmer Super Series Disk Drive contains an integral power supply which can accept any one of the AC input voltages (see Table 1-1). The power supply frequency may range from 47Hz to 63Hz. The appropriate input connections are established via a voltage selection plug located next to the power transformer.



PRIOR TO CONNECTING THE AC LINE CORD TO THE POWER SOURCE, VERIFY THAT THE VOLTAGE PLUG IS COMPATIBLE WITH THE LINE VOLTAGE AT THE INSTALLATION SITE. EXAMINE THE POWER SPECIFICATION DECAL ON THE REAR PANEL OF THE UNIT.

If the transformer tap connections are changed to accommodate a different primary power source, the voltage marking decal should be changed to show the correct voltage rating for the disk drive. Precut decal markers of nonconductive B-500 vinyl cloth are available from Perkin-Elmer for this purpose. These decals can be ordered in the following configurations:

Perkin-Elmer P/N	Legend	Perkin-Elmer P/N	Legend	Perkin-Elmer P/N	Legend
133501-100	100 VOLTS	133501-120	120 VOLTS	133501-230	230 VOLTS
133501-110	110 VOLTS	133501-210	210 VOLTS	133501-240	240 VOLTS
133501-115	115 VOLTS	133501-220	220 VOLTS	133501-250	250 VOLTS

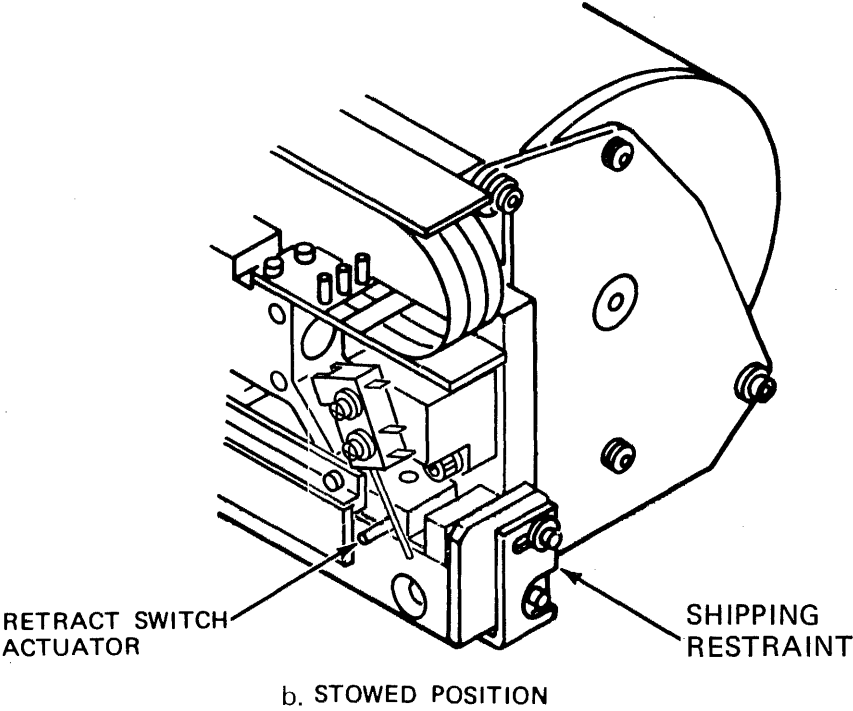
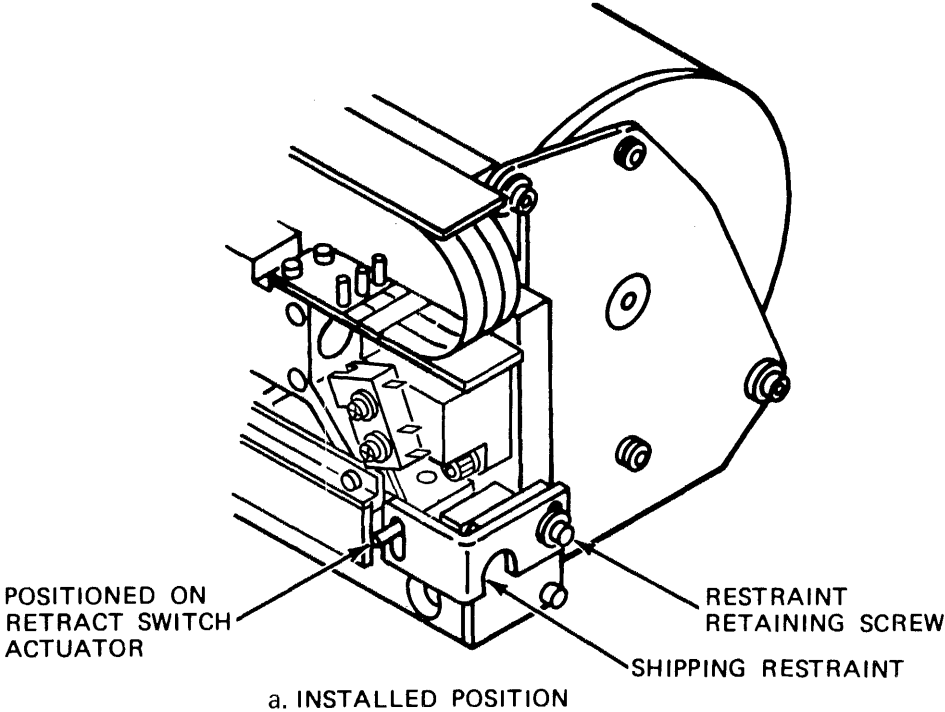


Figure 2-2. Carriage Shipping Restraint

2.4.2 INTERFACE REQUIREMENTS

The physical configuration and electrical requirements for SF and ST Disk Drives are described in the following subparagraphs. See Table 2-2 for interface signal pin assignments. See Table 2-3 and 2-4 for explanation of acronyms and mnemonics used throughout this manual.

Table 2-2. Interface Pin Assignments

Input Line	Pin	Output Line	Pin
Cyl Add 2 ⁰	44	Ready	11
Cyl Add 2 ¹	39	Seek Complete	16
Cyl Add 2 ²	43	Address Acknowledge	14
Cyl Add 2 ³	42	Seek Incomplete	15
Cyl Add 2 ⁴	45	Illegal Address	13
Cyl Add 2 ⁵	47	Attention Unit 0	20
Cyl Add 2 ⁶	48	Attention Unit 1	17
Cyl Add 2 ⁷	50	Attention Unit 2	19
Cyl Add 2 ⁸	29	Attention Unit 3	18
Cyl Add Strobe	32	Read Data	7
Restore	38	Data Clock	8
Disk Select	31	Index	9
Head Select	33	Sector	6
Write Gate	36	Sector Address 2 ⁰	4
Erase Gate	40	Sector Address 2 ¹	2
Write Data	41	Sector Address 2 ²	26
Read Gate	49	Sector Address 2 ³	1
Unit Select 0	34	Sector Address 2 ⁴	3
Unit Select 1	35	Pseudo Sector	5
Unit Select 2	27	Write Check	10
Unit Select 3	28	Termination Voltage	25
Termination Voltage	25	Write Protected	12
Track Offset Fwd.	46	Ground	21
Track Offset Rev.	37	Ground	22
		Ground	23
		Ground	24
		200 TPI Status	30

Table 2-3. Printed Wiring Board Acronyms

Acronym	Meaning	Location
CIB	Control Interface Printed Wiring Board	J2
DCB	Disk Control Printed Wiring Board	J3
DEB	Data Electronics Printed Wiring Board	J7
DIB	Data Interface Printed Wiring Board	J1
EIB	Electronics Interconnect Printed Wiring Board	*
IOB	Input/Output Connector Printed Wiring Board	**
MFM	Modified Frequency Modulation Printed Wiring Board	***
SLB	Servo Logic Printed Wiring Board	J4
SVA	Servo Amplifier Printed Wiring Board	J5

* Mother board upon which jacks J1 through J7 are located.
 ** Board mounted directly to rear panel.
 *** Board only used in 4400 BPI machine. Replaces DIB in J1.

2.4.2.1 Cabling. Interface between disk drive and Controller is accomplished with one cable. The connector at the disk drive is Amphenol No. 57-10500-27 (Perkin-Elmer PN 101036-001). The corresponding mating connector for the cable is Amphenol No. 57-20500-31 (Perkin-Elmer PN 101037-001) and is supplied with the drive.

I/O signal cables are 28 AWG twisted pairs. Total (system) cable length should not exceed 50 feet (15.24 meters) or 30 feet (9.144 meters) for 4400 BPI. An AC power cable, Perkin-Elmer PN 101153, and all described cables are supplied with the drive.

2.4.2.2 Interconnection (Daisy Chaining) of Disk Drives. Daisy chaining of up to four drives is permitted by an integral system of two connectors mounted on the I/O board. The last drive in the chain must be terminated with a detachable Line Terminator Assembly (Perkin-Elmer PN 300095-001). A daisy chain interconnecting cable Perkin-Elmer PN 300118-XXX; XXX = length in inches) is used to interconnect the drives. See Figures 2-3 and 2-4.

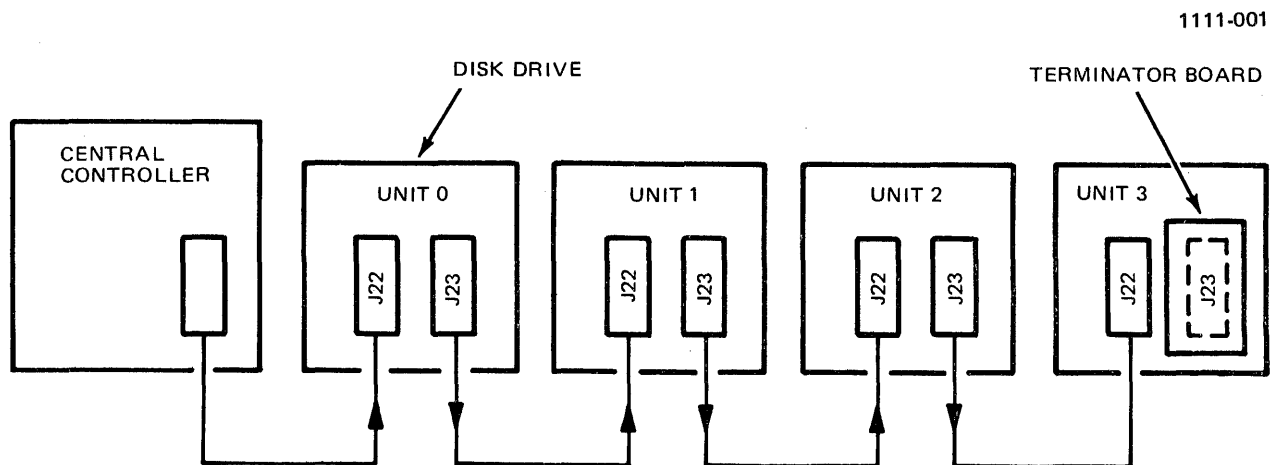


Figure 2-3. Multiple Disk Drive Installation (Daisy Chaining)

Table 2-4. Glossary of Mnemonic Terms

Mnemonic	Meaning	Origin
ADD1-128/256	Track (Cylinder) Address	Controller
ADD ACK	Address Acknowledge	CIB
AC LOSS	Alternating Current Loss	DCB
ATTEN	Attention	CIB
BOT	Beginning of Travel pulse	Detent Amplifier board
CAR	Cylinder Address Register	SLB
D DAC	Output of Digital-to-Analog Converter	SLB
DC LOSS	Direct Current Loss	DEB
DET EN	Detent Enable	SLB
DET EVEN	Detent pulse generated during Even numbered track crossings	SVA
DET ODD	Detent pulse generated during Odd numbered track crossings	SVA
DISK SEL	Disk Select (decode signal)	Controller
DLY SK	Delay Seek	SLB
EOT	End of Travel pulse	Detent Amplifier board
FIDX	Fixed Disk Index pulse	DCB
FSTR	Fixed Disk Sector pulse	DCB
FWD	Forward; direction of Positioner movement	SLB
HD SEL	Head Select (decode signal)	Controller
ILL ADD	Illegal Address decode signal	SLB
NAR	New Address Register	SLB
RDY	Ready signal to Controller	CIB
RDY INH	Ready Inhibit	SVA
RIDX	Removable Disk Index pulse	DCB
RSTR	Removable Disk Sector pulse	DCB
RTZ	Return To Zero	DCB
SAC1-16	Sector Address Count	CIB
SK	Seek	CIB
SKC, SK COMP	Seek Complete	CIB
SK INC	Seek Incomplete	CIB
SP DET, SP DETEC	Speed Detect	DCB
STR	Sector	CIB
TC DAC	Temperature Compensation Digital-to-Analog	SLB
TCV	Temperature Compensation Voltage	SVA
TRK OFFSET	Track Offset	Controller
UNLD (L)	Unload (low active)	SLB

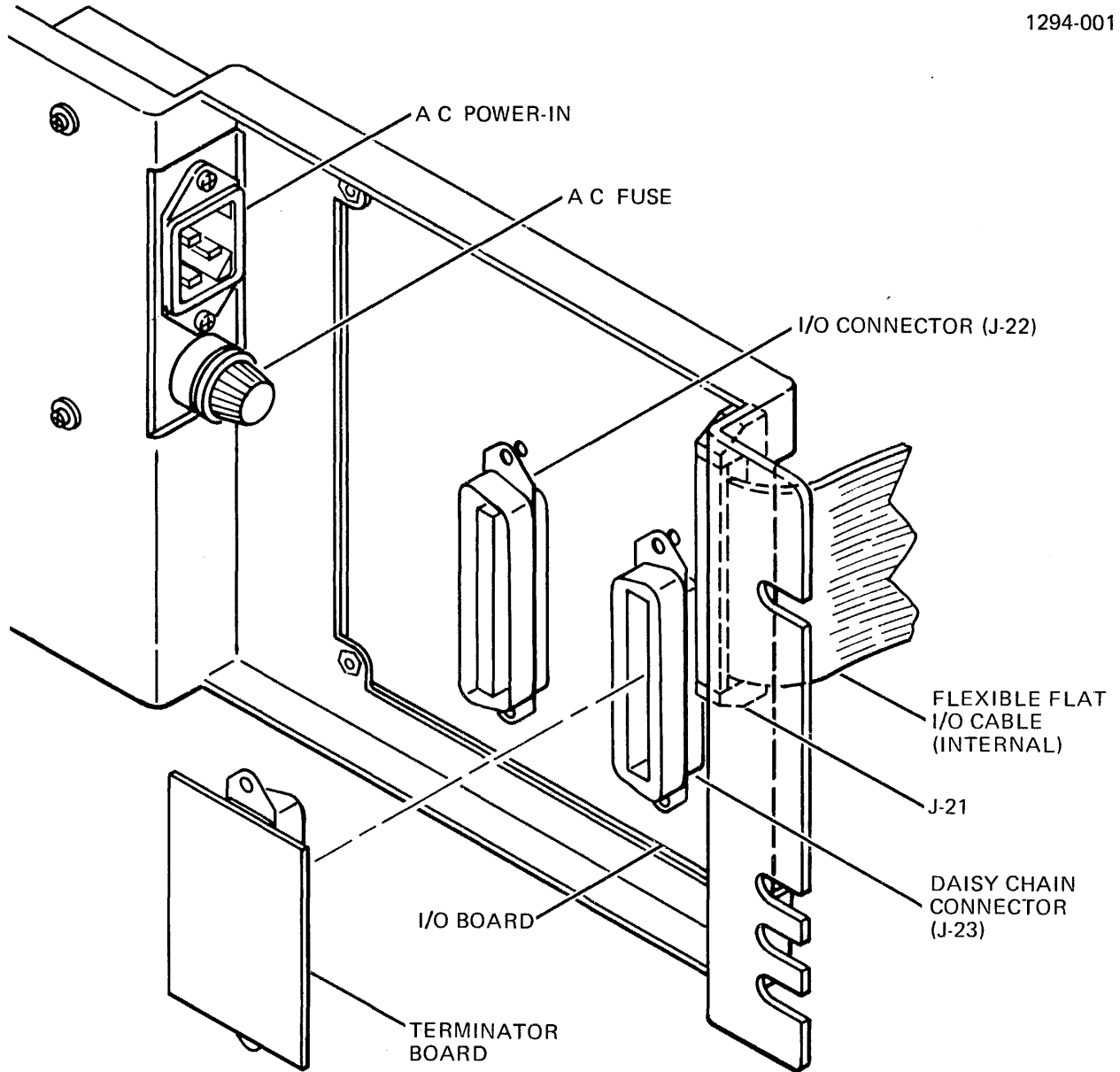


Figure 2-4. Rear Panel and I/O Connector Board

2.4.3 ELECTRICAL CHARACTERISTICS

2.4.3.1 Line Receivers. All line receivers within the drive are of high noise immunity-type 8T380 or 8836. All incoming lines are terminated with 110 ohms to 4.0 V.

2.4.3.2 Line Drivers. The line driver circuit used in the drive is of the open collector-type. In a daisy chain configuration, all output lines are terminated within the system at the last drive on the chain to minimize line reflections due to unterminated stubs. The driver is capable of sinking 50 mA in addition to that used within the disk drive.

2.4.3.3 Terminating Voltage. Provision is made to terminate all lines to an externally supplied voltage.

2.4.3.4 Logic Levels. Logic "0", within the drive, is defined as a level between 0 and 0.5 V.

2.4.4 INPUT LINES

All input lines are defined as being true (active) when at logic "0" level.

2.4.4.1 Cylinder Address. Eight (nine on 200 TPI) lines which accept an absolute address from the controller. These are strobed into an address register by the Cylinder Address Strobe Line.

2.4.4.2 Cylinder Address Strobe. One line which strobes the Cylinder Address lines into the internal address register.

2.4.4.3 Restore. One line which causes the drive to reposition the heads over cylinder "0".

2.4.4.4 Disk Select. One line which selects the disk upon which the controller will operate.

2.4.4.5 Head Select. One line which selects the disk surface to be operated upon.

2.4.4.6 Write Gate. One line which turns on the write amplifier and allows current to flow in the selected head.

2.4.4.7 Erase Gate. One line which turns on the erase amplifier. No internal delay is provided to compensate for the distance between erase and read/write gaps.

2.4.4.8 Write Data. One line which carries the double frequency encoded data from controller to drive. Each pulse on this line will cause a flux reversal to occur. Time delay from leading edge of Clock pulse to leading edge of Data pulse must be 200 ± 5 ns (2400 rpm); 320 ± 5 ns (1500 rpm). If the NRZ option is chosen, (required for 4400 BPI) this line will carry the data in level format, and the double frequency or MFM encoding will be done within the Drive.

2.4.4.9 Read Gate. One line which enables the Read Data and Read Clock lines.

2.4.4.10 Track Offset Fwd. (Available on 200 TPI Only). One line which causes the heads to move 1/10 track.

2.4.4.11 Track Offset Rev. (Available on 200 TPI Only). One line which causes the heads to move 1/10 track.

2.4.4.12 Unit Select. Four lines used in conjunction with the Unit Select Switch which allows any drive to be given any of four logical addresses.

2.4.5 OUTPUT LINES

All outputs are defined as being true when containing logic "0." All lines gated with Unit Select except Attention.

2.4.5.1 Ready. When true, this line indicates drive is ready to accept external commands.

2.4.5.2 Seek Complete. When true, this line indicates drive has completed a Seek operation.

2.4.5.3 Address Acknowledge. When true, this line notifies the controller that a Seek operation has commenced.

2.4.5.4 Seek Incomplete. When true, indicates a Seek operation has not been completed in a predetermined time.

2.4.5.5 Illegal Address. When true, indicates an invalid address has been issued by the controller. The drive will not obey such a command, and the heads will remain positioned over the previously addressed location.

2.4.5.6 Attention. Four lines not gated with Unit Select which alert the controller that the corresponding drive has completed a Seek operation (when true).

2.4.5.7 Read Data. One line which transmits the Read Data to the Controller. The data format is optional and selected by jumpers within the Drive.

2.4.5.8 Data Clock. This line transmits the Read Clock which has been separated from the data. If the NRZ option is selected, this line also transmits the Write Clock from the drive when the Read Gate is false.

2.4.5.9 Index Pulse. This line supplies one pulse for each disk revolution. The pulse is derived from the physical notch on the cartridge hub, or a similar notch on the fixed disk hub. This hub is selected with Disk Select. Optionally, when the internal sector counter is not specified, the user may specify two index lines. In that case, both index marks are supplied simultaneously, and they are not selected by Disk Select.

2.4.5.10 Sector Pulse. This line supplies one pulse for each notch on the cartridge hub; or, for the fixed disk hub, one pulse for every n^{th} notch ($n = 1$ to 16 selected by switches on the Disk Control Board). The hub is selected with Disk Select. Optionally, two lines may be supplied as indicated in 2.4.5.9.

2.4.5.11 Sector Address. Five lines which define, in binary form, the particular sector under the Read/Write Head. The Sector Address Counter is reset to zero by the first sector mark following the index mark.

2.4.5.12 Pseudo Sector Mark. One line which provides 2000 ± 20 pulses per revolution to the Controller. This line may be used to subdivide the disk into any number of sectors.

2.4.5.13 Write Protect Status. One line which indicates, to the controller, the status of the Write Inhibit Switch pertaining to the selected disk.

2.4.5.14 Write Check. One line which indicates that a Write Operation may not take place due to one of the following conditions:

- A. Voltages below specified levels.
- B. More than one head selected.
- C. Disk speed out of tolerance.
- D. Write Gate true and no Write or Erase Current.
- E. Write Current and no Write Gate.
- F. Erase Current and no Write or Erase Gate.
- G. Erase Gate and no Erase Current.

2.4.5.15 200 TPI Status. One line true if drive is selected and a switch on the I/O connector board is set to indicate 200 TPI.

2.4.6 RACK-MOUNTED INSTALLATION

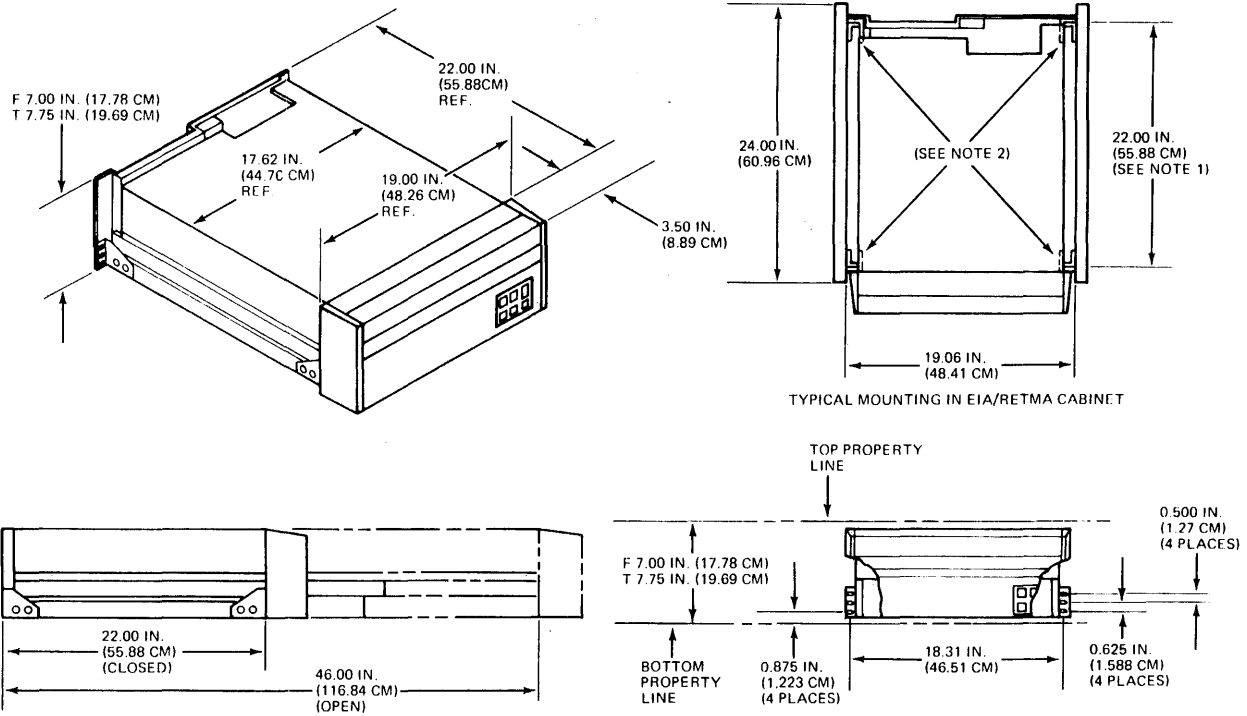
The Disk Drives are equipped and shipped with standard cabinet slides; therefore, installation in a standard rack involves only mounting the stationary slide members. The I/O Connector Board, the AC power cord receptacle, and the AC fuse holder are mounted on the rear panel. The panel is bolted to the stationary members of the slides as shown in Figure 2-5. Therefore, this panel will remain at the rear of the rack or cabinet when the Disk Drive is pulled out on its slides. A flexible flat cable assembly, internal to the Disk Drive, provides the I/O line connections between the I/O Connector board and the Disk Drive. Similarly, a spiral-wound AC cord provides the power connection. These features facilitate unrestricted access to the unit without disrupting internal connections.

The mounting dimensions for the SF and ST Disk Drives are shown in Figure 2-5. The unit should be installed in a standard rack or cabinet in accordance with the information shown.

When only one person is available to mount the Disk Drive in the rack, it will be necessary to install the slide members (see Figure 2-5) on the rack first. Then, the Disk Drive can be lifted into position and slid into place on the slider inside the rack.

NOTE

Head alignment, after rack installation, is not guaranteed. Read/Write head alignment should be accomplished, as outlined in Section 5, after rack installation.



TYPICAL MOUNTING IN EIA/RETMA CABINET

- NOTES:
- (1) IF 30.00 IN. (76.20 CM) DEEP CABINET IS USED, POSITION REAR RETMA BOLT RAILS 22.00 IN. TO 23.00 IN. (55.88 CM TO 58.42 CM) BEHIND FRONT RAILS.
 - (2) SLIDE MOUNTING BRACKETS ARE NORMALLY MOUNTED ON EXTERIOR SIDE OF CABINET.

Figure 2-5. Rack-Mounted Installation Instructions

2.4.7 INITIAL CHECKOUT

2.4.7.1 Preliminary Procedure. After the Disk Drive has been installed and connected to the external Controller, all I/O cables should be rechecked to ensure correct connections. Make certain all connectors are mated securely and that the correct voltage is being supplied to the Disk Drive before the unit is installed in the rack. The top cover of the Disk Drive must be removed to gain access to subassemblies to be checked during initial checkout procedures. Procedures for removing the top cover are outlined in Section 5.

2.4.7.2 Visual Inspection. Make the following checks before applying power to the Drive.

- A. Ascertain all plugs and connectors are properly seated except P16 (Power Supply) which must remain disconnected when using a (C.E.) test hub.
- B. Check for proper fuses.
- C. Check card cage to ensure printed wiring boards are properly seated.

2.4.7.3 Preliminary Power-On Procedure. With the top cover removed and using a customer engineer (C.E.) test hub, the top cover interlock switch will not be activated. Power cannot be applied to the Spindle Drive Motor. In the SF unit, this is a button-type switch protruding from the base. Place a piece of masking tape over the switch. In the ST unit, install a matchbook cover (or similar device) between pack sensor and switch actuator. See Figure 2-6.

CAUTION

ENSURE PLUG P16 ON THE POWER SUPPLY IS STILL DISCONNECTED. THIS WILL PREVENT HEADS FROM LOADING WHEN USING THE (C.E.) TEST HUB.

2.4.7.4 Power-Up Sequence Check. Perform the following steps to verify proper power-up sequencing:

- A. Place POWER switch ON.
- B. Verify that the door unlocks and that POWER and LOAD indicators light.
- C. Place the RUN/LOAD switch to RUN.
- D. Verify that the LOAD indicator extinguishes, door locks, and the spindle begins to spin CCW.
- E. Verify that brushes sweep the disk once, then park underneath the receiver. The brushes should not be crushed against the casting.
- F. A slight flickering of control panel indicator lamps indicates spindle speed control circuitry is active.

If a problem occurs, power down the Drive and refer to appropriate part of Section 5.

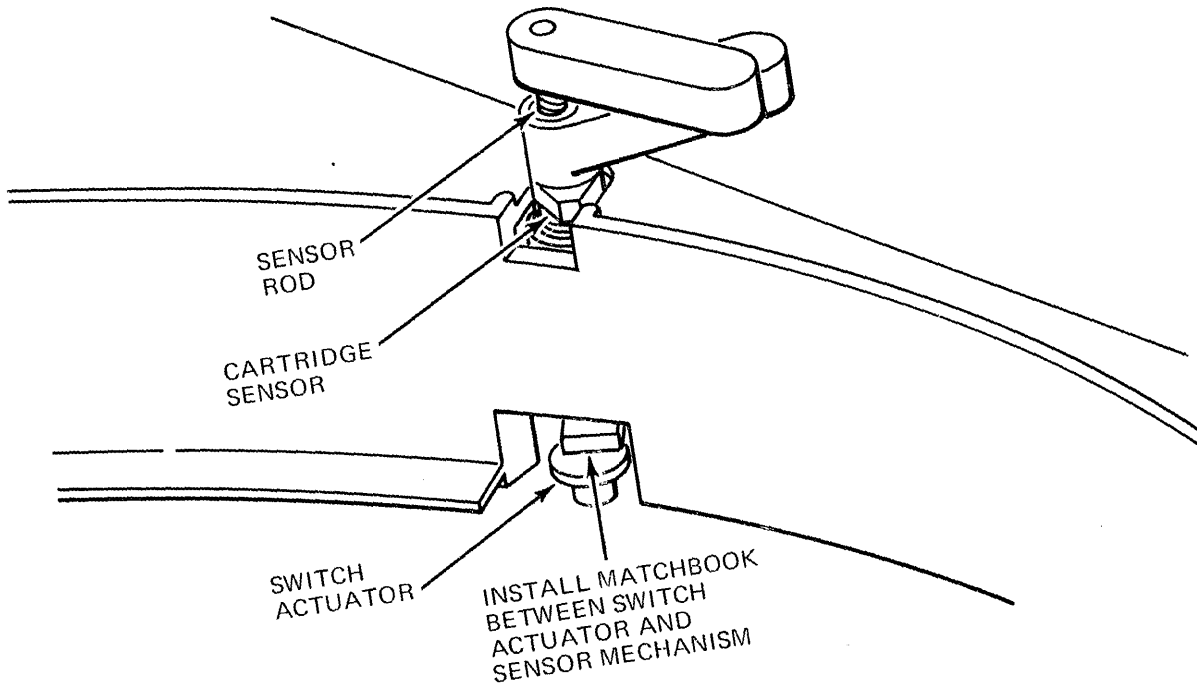


Figure 2-6. By-Passing Top Cover Interlock Switch

SECTION 3

OPERATION

3.1 SCOPE

This section provides information for operation of the Super Series Front Loading (SF) and Top Loading (ST) Disk Drives. Description of front-panel controls and indicators and a summary of the operational commands used by the unit are included.

3.2 OPERATOR CONTROL PANEL

Operational controls and status indicators are mounted on a panel located on the front of the Disk Drive. Some of the controls feature integral indicator lamps which, if activated, illuminate the translucent engraved control pushbuttons. The control cluster is shown in Figure 3-1, and individual functions of the controls and indicators are described in paragraphs 3.2.1.1 through 3.2.1.6.

SUPER SERIES

1115B-001

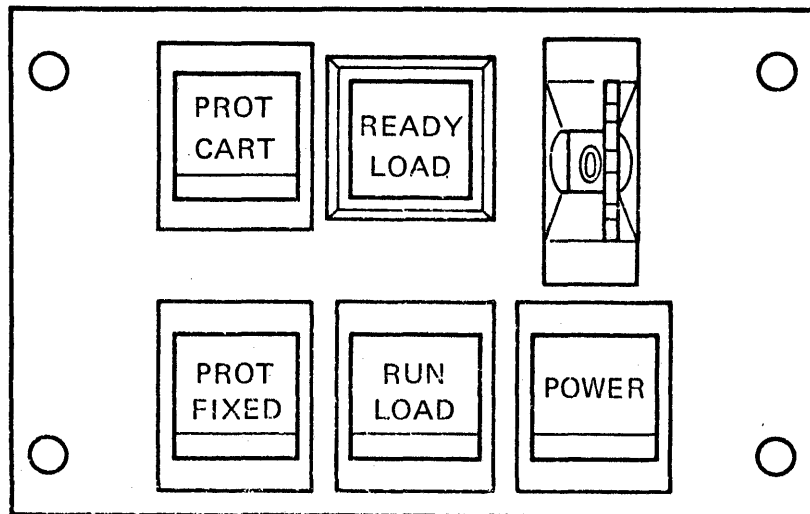


Figure 3-1. Operator Controls

3.2.1 FUNCTIONS OF OPERATOR PANEL CONTROLS

3.2.1.1 Power Switch/Indicator. This is a two-position switch/indicator marked POWER. When the switch is pressed upward, line power is applied to the Disk Drive integral power supply. The lamp inside the switch lights and remains lit until the switch is placed in its OFF (down) position.

3.2.1.2 Run/Load Switch. This is a two-position rocker switch whose upper position is marked RUN. When the upper part of the switch is depressed, the Disk Drive is in Run mode with the disk rotating and the Read/Write heads loaded. When the lower (LOAD) part of the switch is depressed, the Disk is stopped and the Disk Drive is in Load mode. At this time, the front door of an SF Disk Drive can be opened or the lock on an ST Disk Drive is unlocked so that the chassis can slide out of the cabinet, and the removable disk cartridge can be removed.

3.2.1.3 Ready/Load Indicator. This is a status indicator incorporating a divided lens cap. The upper portion of the lens is marked READY. When the READY portion of the switch lights, the operator is aware that the cycle has been completed and the unit is able to accept Seek or Data Commands from the external Controller. When the LOAD portion of the switch lights, the operator is notified that the spindle has stopped rotating. At this time, the removable disk cartridge can be loaded or unloaded.

3.2.1.4 Protect Cartridge (Disk) Switch/Indicator. This switch/indicator is a two-position rocker switch marked PROT CART. When pressed upward, the switch activates associated Write Inhibit circuits. At this time, data can not be written on the cartridge disk. The lamp inside the switch also lights. When the switch is depressed downward, the lamp goes out and data can be written on the cartridge disk.

3.2.1.5 Protect Fixed (Disk) Switch/Indicator. This is a two-position rocker switch/indicator marked PROT FIXED. When the upper area of the switch is pressed, the switch activates associated Write Inhibit circuits and data can not be written on the fixed disk. The lamp inside the switch also will light. When the lower area of the switch is depressed, the lamp will go out and the Write Inhibit circuit is inactivated.

3.2.1.6 Unit Select Switch. This is a thumbwheel switch with respective markings 0, 1, 2, and 3. When the switch is set to any of these four active positions, a corresponding logical address is assigned to the Disk Drive for the purpose of external control.

3.3 CARTRIDGE LOADING

3.3.1 SF DISK DRIVE

The cartridge used in the SF Disk Drive is the IBM 2315-type. Before the cartridge can be inserted, AC power must be applied to the unit. Removable cartridge loading for both SF and ST is shown in Figures 3-2 and 3-3. This enables the safety interlock mechanism to be released and the loading door at the front of the Disk Drive can be opened. The turn-on and loading sequences are diagrammed on the flow chart in Figure 3-4.



DO NOT ATTEMPT TO FORCE OPEN THE DOOR BEFORE AC POWER HAS BEEN APPLIED TO THE DISK DRIVE OR THE DOOR ASSEMBLY MAY BE DAMAGED. WHEN THE POWER AND LOAD INDICATORS ARE ILLUMINATED, THE INTERLOCK IS RELEASED AND THE DOOR CAN BE OPENED EASILY.

NOTE

The 2200 and 4400 BPI cartridges are keyed differently.

To load the cartridge, perform the following steps:

- A. Apply power to the Disk Drive by pressing the POWER switch. Observe that the lamp inside the switch/indicator lights.
- B. When the LOAD indicator lights, pull the loading door forward and down. The cartridge receiver should then be elevated and moved to a position in which it can accept the cartridge.
- C. Orient the cartridge so that its head entry opening faces the interior of the drive (12 o'clock position).
- D. Push the disk cartridge into the receiver.

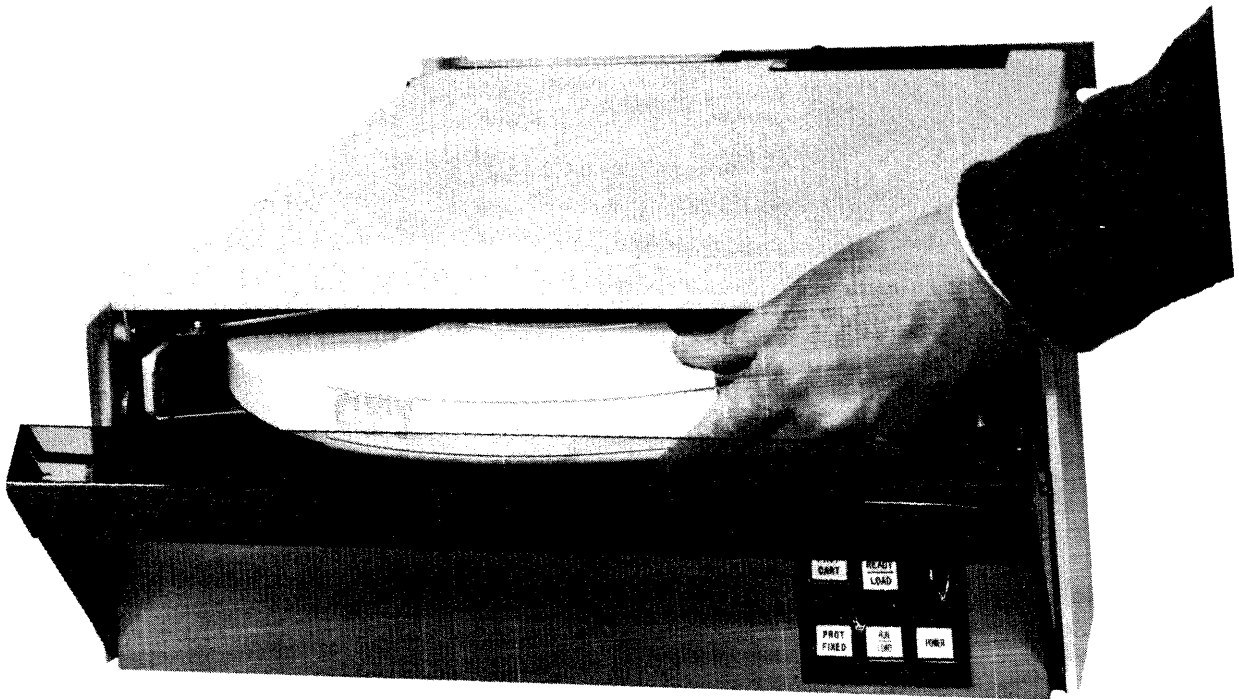


Figure 3-2. SF Disk Drive Cartridge Loading

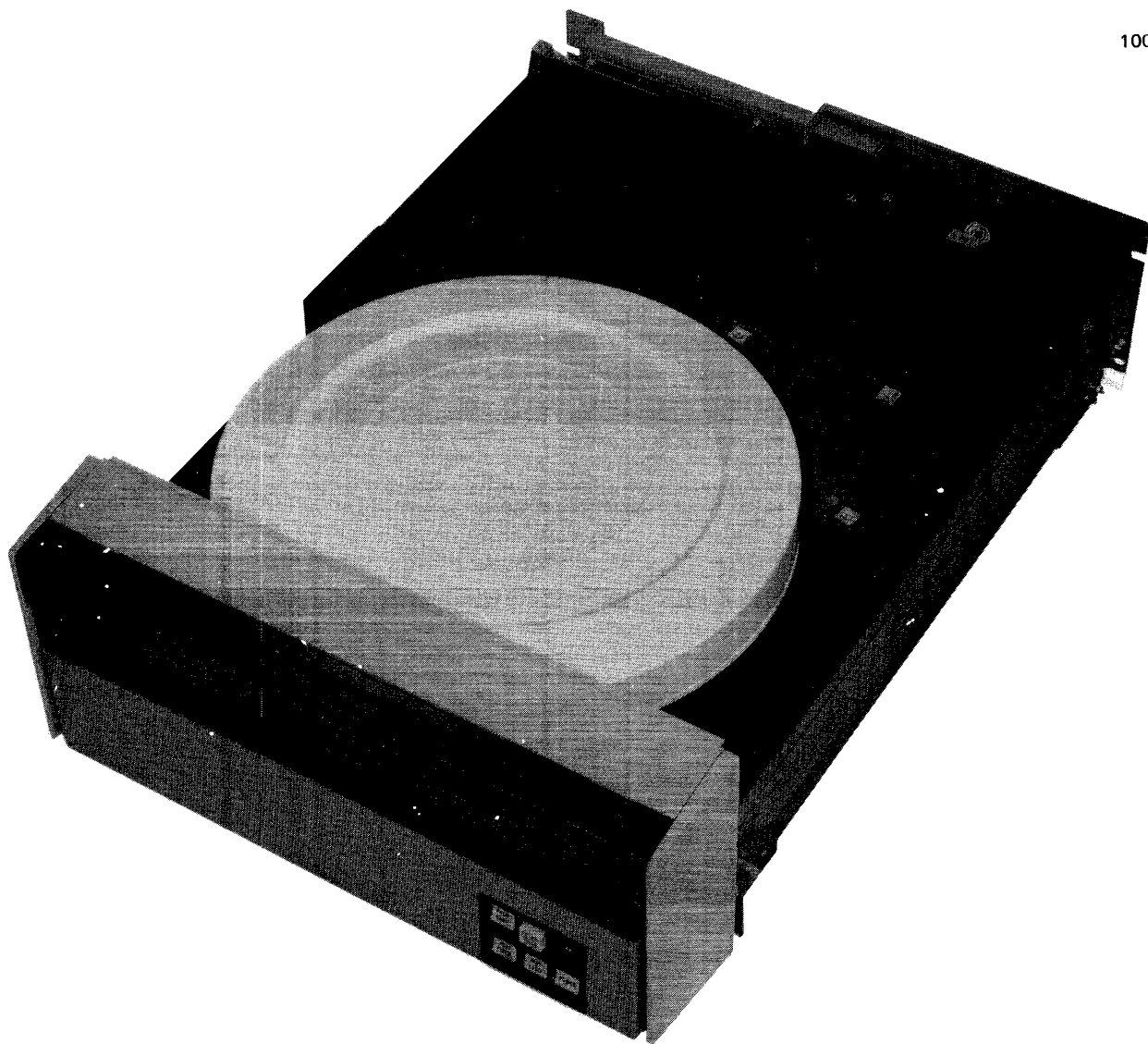


Figure 3-3. ST Disk Drive Cartridge Loading

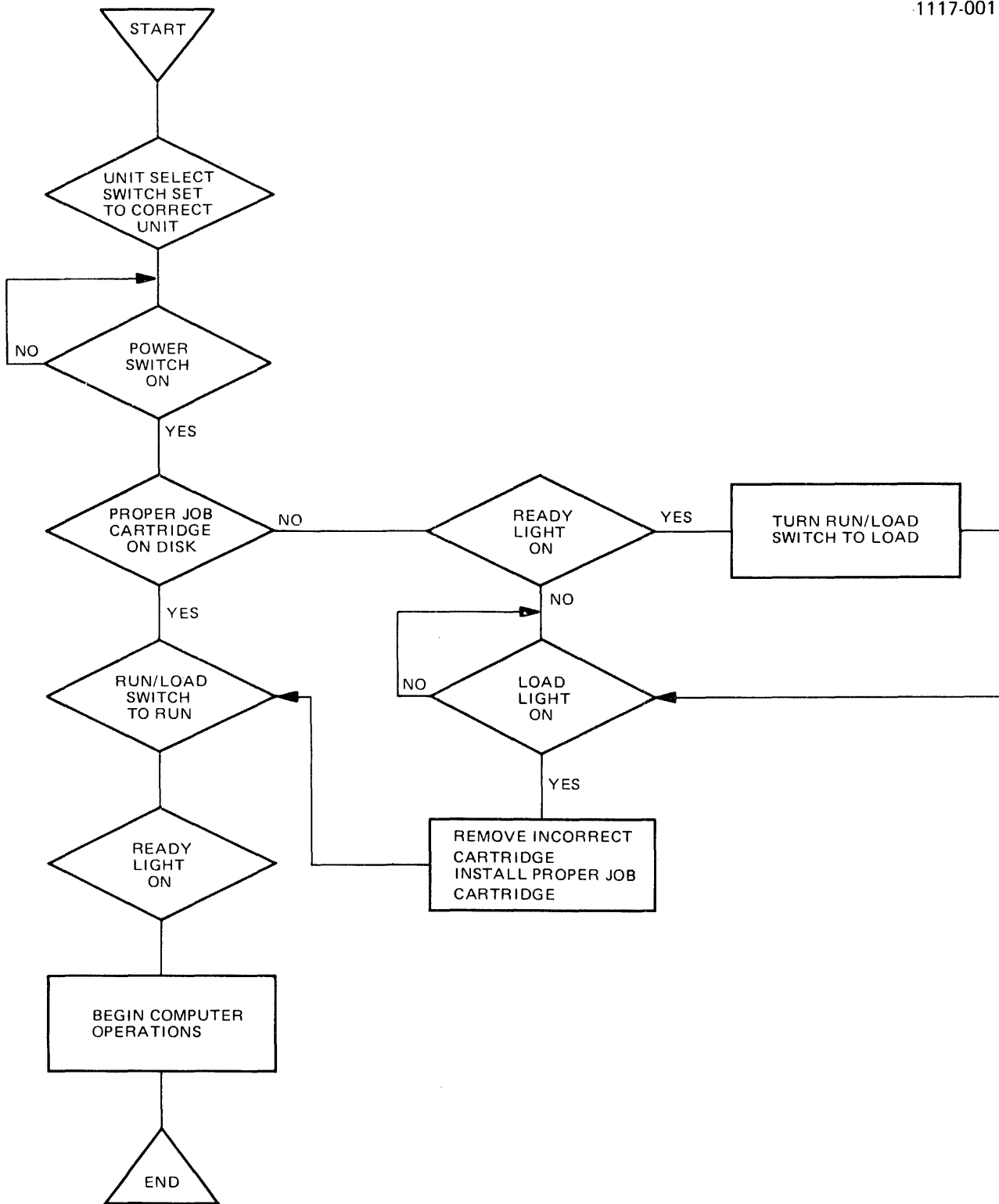


Figure 3-4. Operating the SF or ST Disk Drive

- E. When the disk cartridge is almost fully inserted in the receiver, it will reach a preliminary stop at the point where the wire bail opens the small entry door in the cartridge. Continue to push the cartridge into the receiver until it comes to a final stop.
- F. The loading door can be closed and the start cycle can be initiated.

3.3.2 ST DISK DRIVE

The cartridge used in the top-loading ST Disk Drive is the IBM 5440-type (see Figure 3-3). To load the cartridge, perform the following steps:

- A. Apply power to the Disk Drive by pressing the POWER switch. Observe that the lamp inside the switch/indicator lights.
- B. When the LOAD indicator lights, pull the Disk Drive out of the rack; its loading door should open automatically as the unit slides out.
- C. Before the cartridge can be inserted, its bottom cover must be removed. Raise the cartridge handle to a vertical position while pushing the release button sideways.
- D. The bottom cover is then released and can be removed. It will be installed later on top of the cartridge.
- E. Orient the cartridge so that the cartridge logo or letters are facing the front of the Disk Drive. The cartridge is keyed and may be installed only if oriented correctly.
- F. Lower the cartridge into the shroud and make certain it is seated firmly on the shroud.
- G. Fold the cartridge handle down. This action unlocks the cartridge release button.
- H. Invert the bottom cover and place it over the top of the cartridge.

NOTE

The cartridge **MUST** be installed as described or the start cycle can not be initiated.

- J. Close the locking door by pushing the Disk Drive back into the rack. The Start cycle can then be initiated.

NOTE

In both the SF and ST Disk Drives, the loading door remains locked if the POWER switch is pressed downward while in the RUN mode; therefore, the cartridge can not be removed. If this occurs, the Disk Drive must again be placed in the Load mode, with power applied, to enable the loading door to be unlocked.

3.3.3 OPERATING THE DISK DRIVE

The controls on the Operator Control Panel (OCP) of the SF and ST Disk Drives are identical and there is no difference in operating the two types of Disk Drives.

3.3.3.1 Power On and Load Status. When AC power is supplied to the Disk Drive, two events should occur:

- A. Power and Load indicator lamps should light.
- B. The loading door should unlock.

At this time, the removable cartridge may be removed from, or inserted into, the Disk Drive.

NOTE

Inspect the cartridge for dirt or contamination before installing in Disk Drive.

3.3.3.2 Establishing the Ready Status from the Load Status. To initiate this operation, transfer the RUN/LOAD switch from LOAD position to RUN position. The following events should then occur:

- A. The loading door should lock.
- B. The disks should come up to operational speed.
- C. The disk brushes should go through their cleaning cycle and return to their home position.
- D. The positioner should move forward and load the heads at track 000.
- E. The READY indicator should light after the cartridge has warmed up.

Ready status is then established and the Disk Drive should respond to external commands from the Controller.

NOTE

A customer option provides cartridge protect light illumination and inhibits writing until full temperature stabilization has occurred.

3.3.3.3 Establishing Load Status from Ready Status. To initiate this operation, transfer the RUN/LOAD switch from the RUN position to the LOAD position. The following events should occur:

- A. The READY indicator should go out.
- B. Disk rotation should gradually decrease until rotation stops.
- C. The LOAD indicator should light (approximately 15 seconds).
- D. The loading door should unlock.

At this time, the cartridge may be removed and replaced, or power to the Disk Drive may be removed.

NOTE

When the cartridge is removed from an ST Disk Drive, it should be placed in its cover immediately to preclude damage to, or contamination of, the cartridge. On an SF Drive, the cartridge should be stored in a clean environment and handled in a manner that will not damage any of the critical parts of the cartridge.

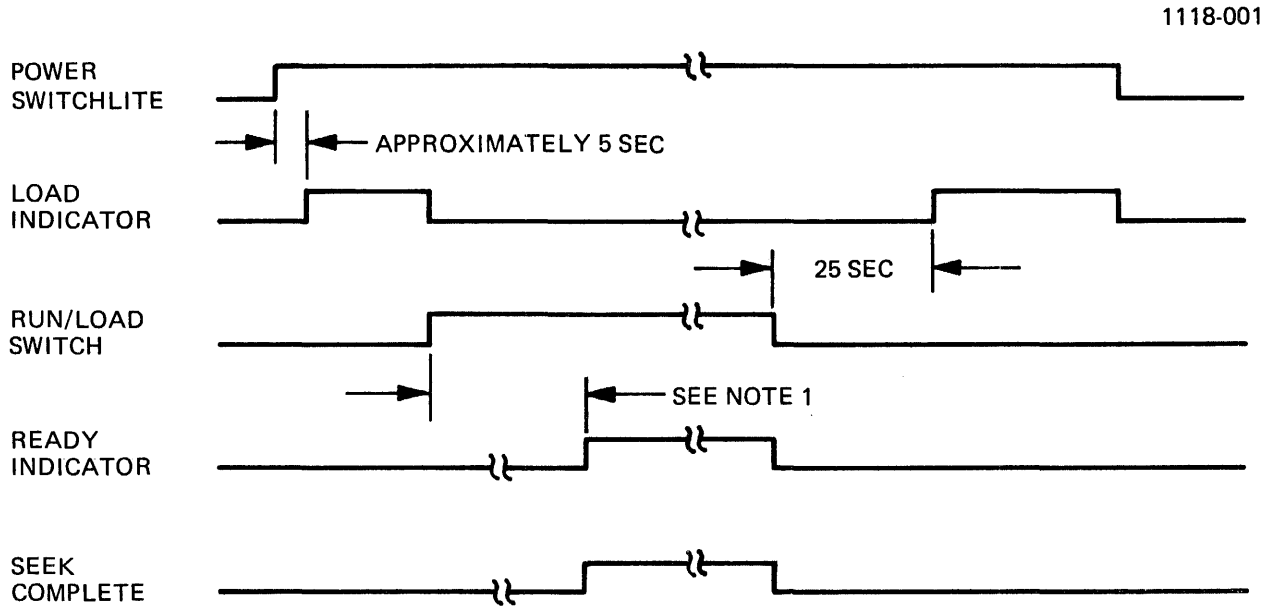
3.3.3.4 Operator Maintenance. Before installing a cartridge into the Disk Drive, inspect the cartridge for contamination. On the SF and ST Disk Drives, inspect the spindle chuck and shroud for contamination. For cleaning techniques and frequency, check with the local customer service representative.

CAUTION

WHEN INSERTING A REPLACEMENT CARTRIDGE IN THE DISK DRIVE, MAKE CERTAIN THE CARTRIDGE HAS BEEN IN THE SAME AMBIENT CONDITIONS AS THE DISK DRIVE FOR A MINIMUM OF 2 HOURS. IF THIS PROCEDURE IS NOT FOLLOWED, WARM-UP PROBLEMS MAY BE ENCOUNTERED ON 200 TPI UNITS.

3.3.4 TIMING

Figure 3-5 shows typical timing relationships encountered during the Disk Drive Power On/Off timing sequence. In this figure, a high level indicates the true or on state of the particular function.



NOTE 1: ELAPSED TIME IS DETERMINED BY THE TIME IT TAKES FOR A TEMPERATURE MATCH TO OCCUR BETWEEN BASEPLATE AND CARTRIDGE DISC.

Figure 3-5. Power On/Off Sequence

3.3.5 TEMPERATURE CHARACTERISTICS

When operating the Disk Drive, the casting temperature near the location of the temperature sensor is controlled to within 10°F (5.5°C) of ambient. If a cold cartridge is placed in a drive in which the unit has been operating, the difference in temperatures will inhibit transfer to the ready state, with associated lighting of the READY indicator, until the two temperatures are approximately equal.

3.4 FLOW CHARTS

Flow charts of modes, cycles, and operations are shown in Figures 3-6 through 3-12.

0418

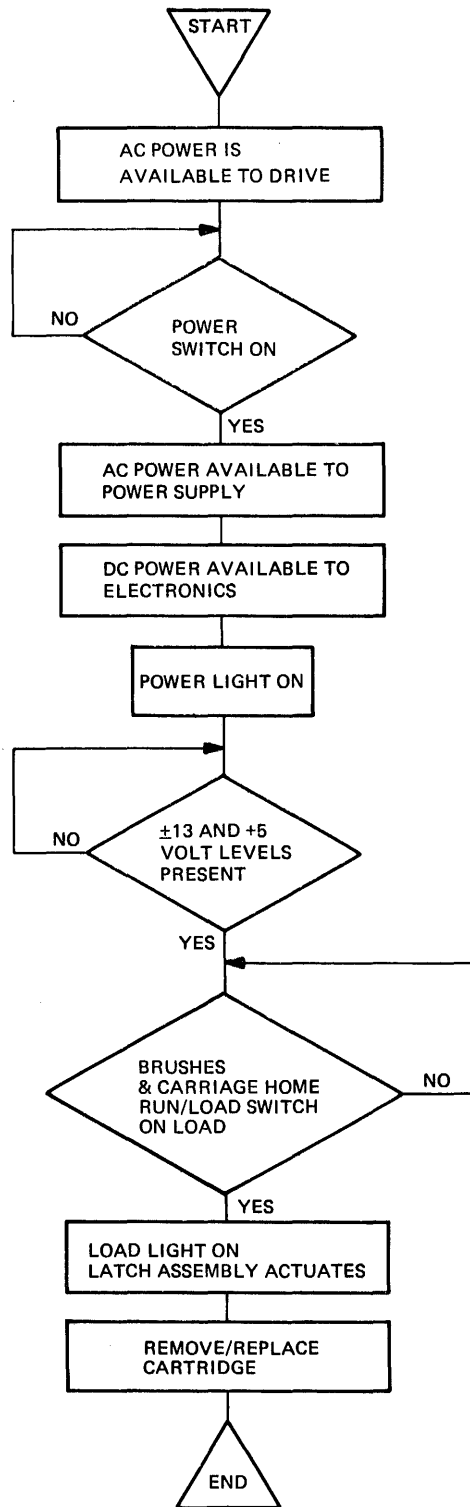


Figure 3-6. Power-up and Cartridge Loading (Load Mode)

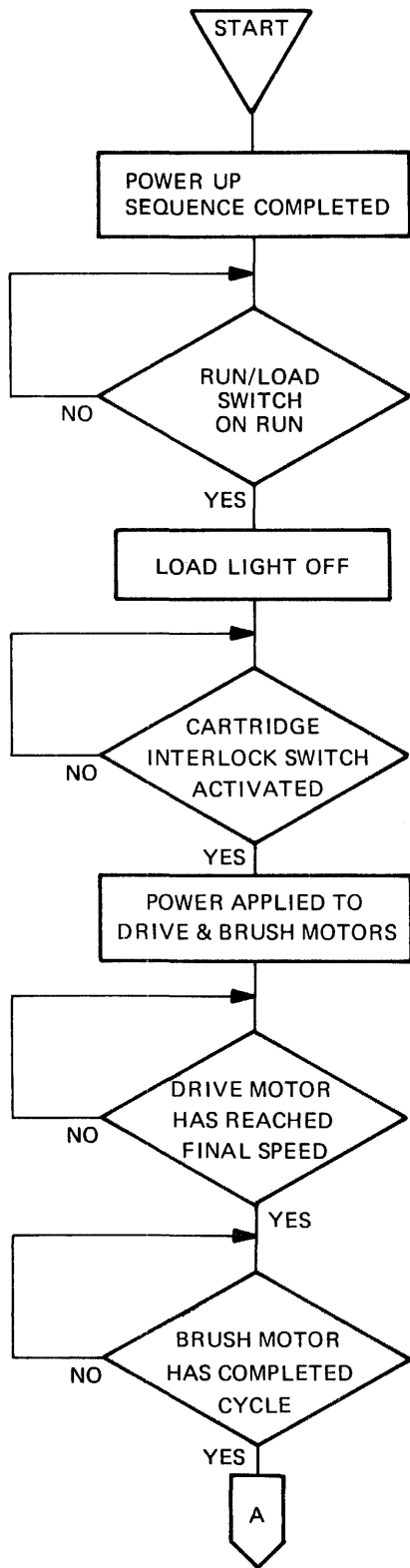


Figure 3-7. Run Mode – Initial Cycle

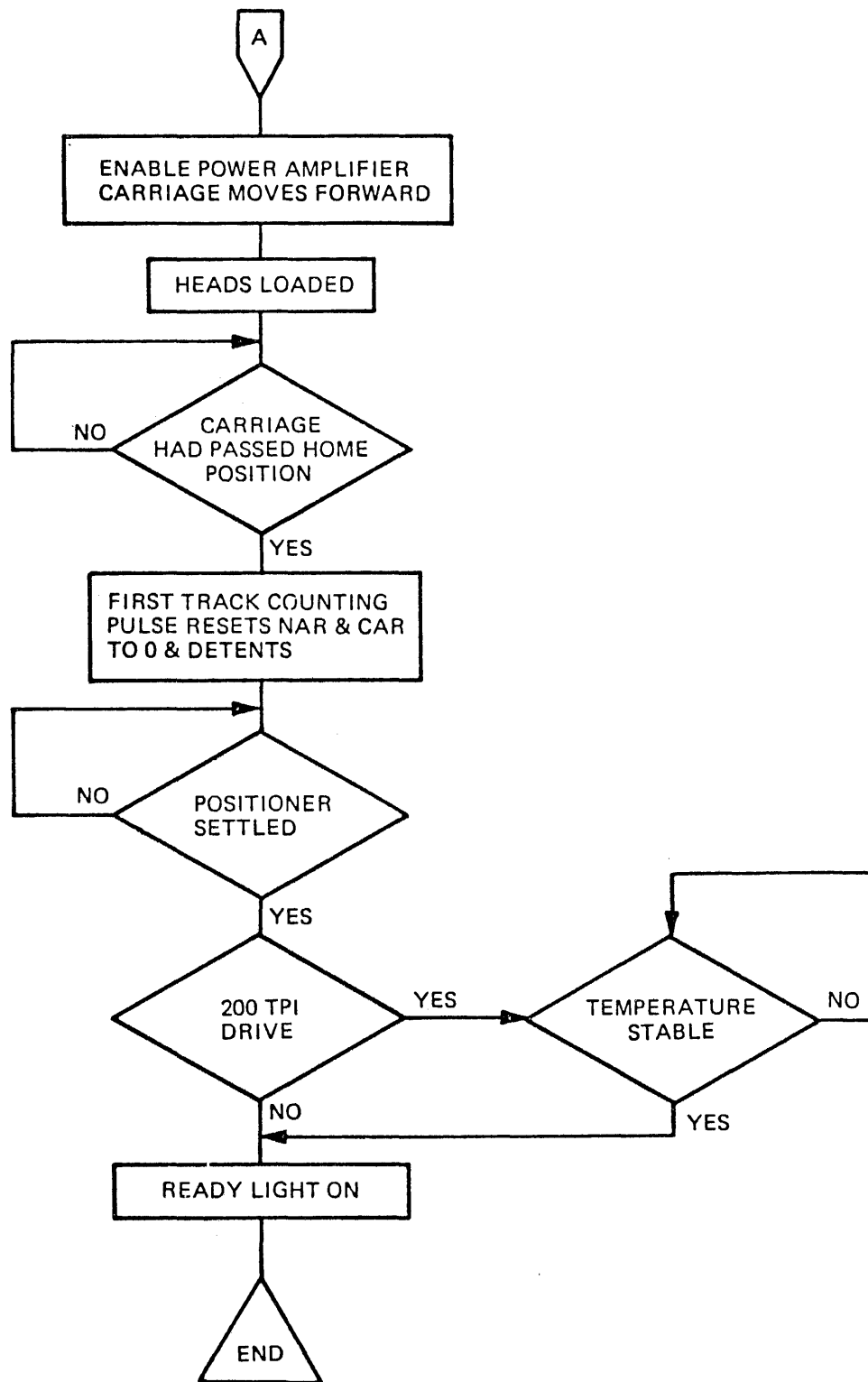


Figure 3-8. Run Mode – Cylinder 000 Seek

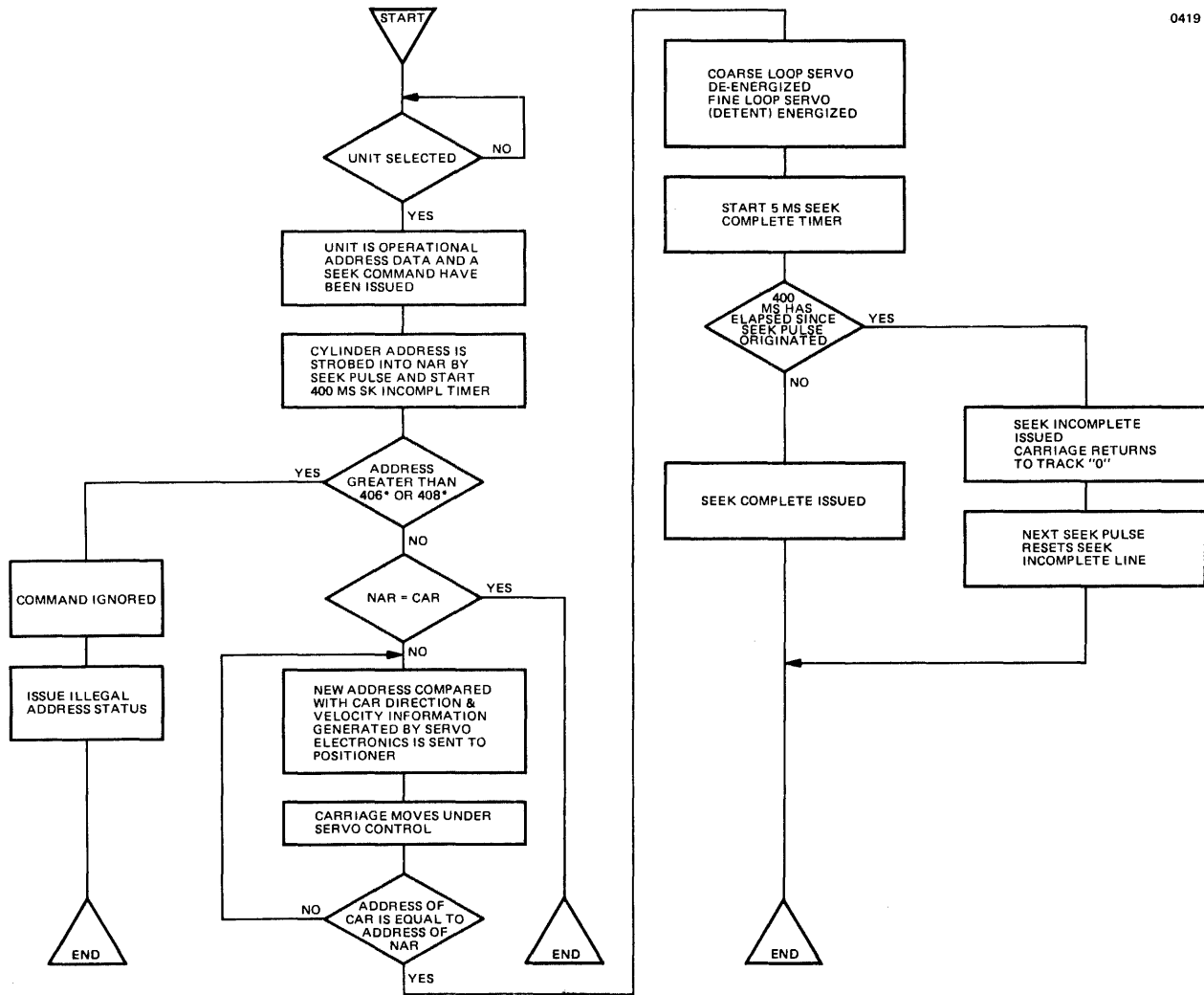


Figure 3-9. Run Mode – New Address Seek

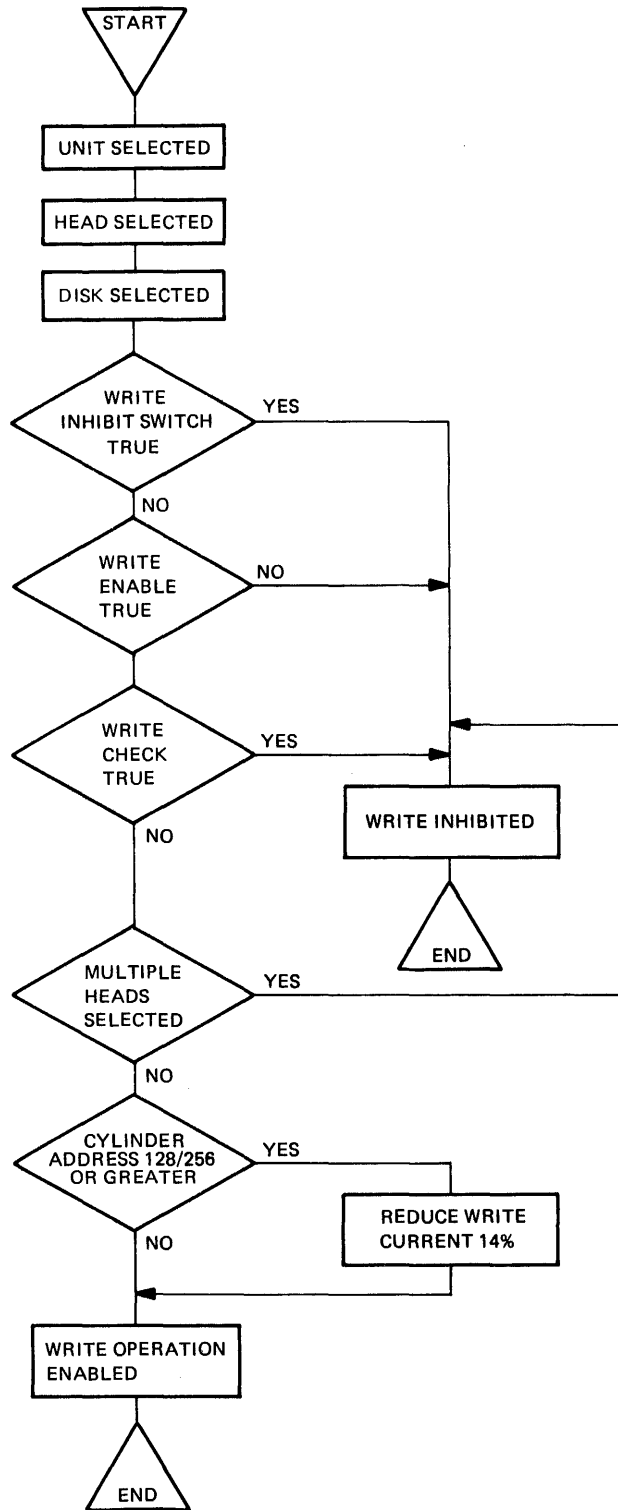


Figure 3-10. Run Mode – Write Operation

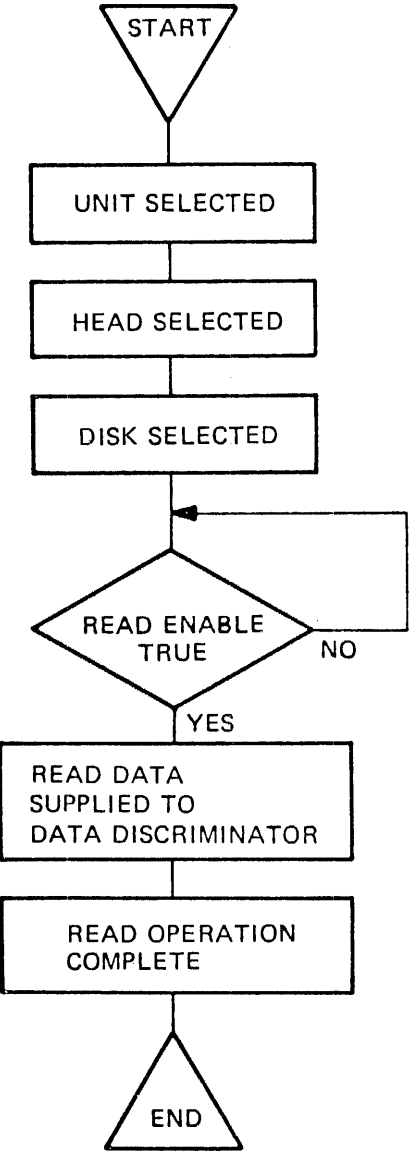


Figure 3-11. Run Mode – Read Operation

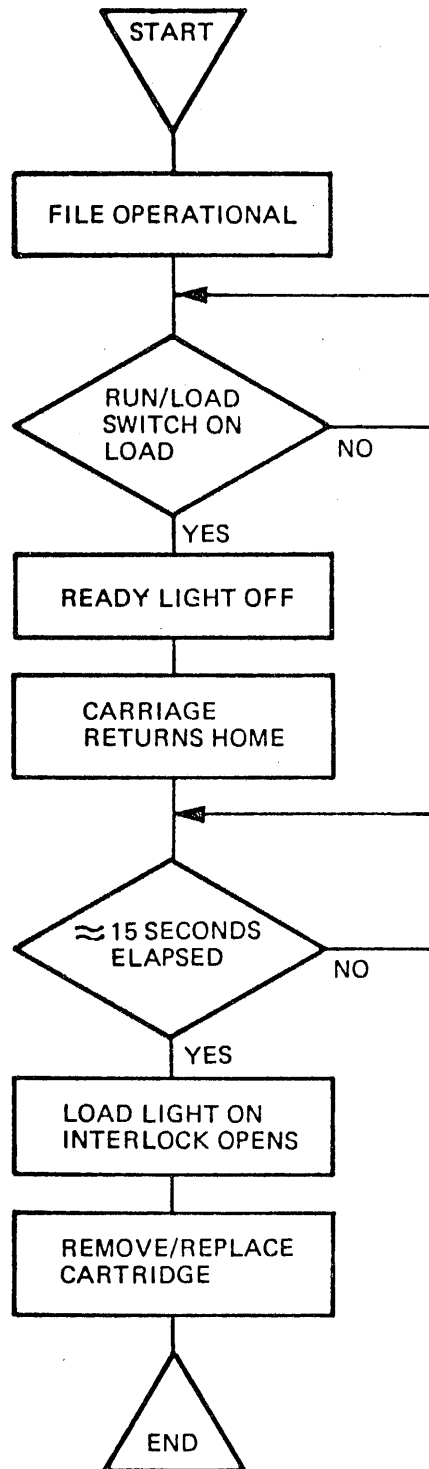


Figure 3-12. Turn-off Cycle

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

In general electronic theory, 100 and 200 TPI SF and ST Disk Drives are basically identical. Throughout this section only pertinent differences will be pointed out. Data recording or retrieval method is double frequency-encoded, except in the case of the 200 TPI 4400 BPI option, which is modified frequency modulation (MFM).

4.2 SCOPE

This section is divided into two principal parts: mechanical description and electronic theory. The mechanical part is sub-divided into two areas; Spindle/Drive Motor Assembly and Positioning Assembly. The electronic part is further sub-divided into: System Electronic Theory, Logic Board Circuit Analysis, and Schematic Diagram Analysis. The simplified block diagram for the Disk Drive is shown in Figure 4-1.

4.3 MECHANICAL DESCRIPTION

4.3.1 SPINDLE/DRIVE MOTOR ASSEMBLY

The spindle drive motor is combined into an integral assembly, as shown in Figure 4-2. The spindle is directly driven by a DC brushless motor. Speed is held constant to within $\pm 1\%$, regardless of line voltage or frequency fluctuations. The blower drive belt and pulley assemblies are shown in Section 5, Figure 5-5. Static eliminators are included on both the spindle and blower shafts to dissipate electrical noise. The blower and its associated filter provide a constant flow of cool, clean air to the unit.

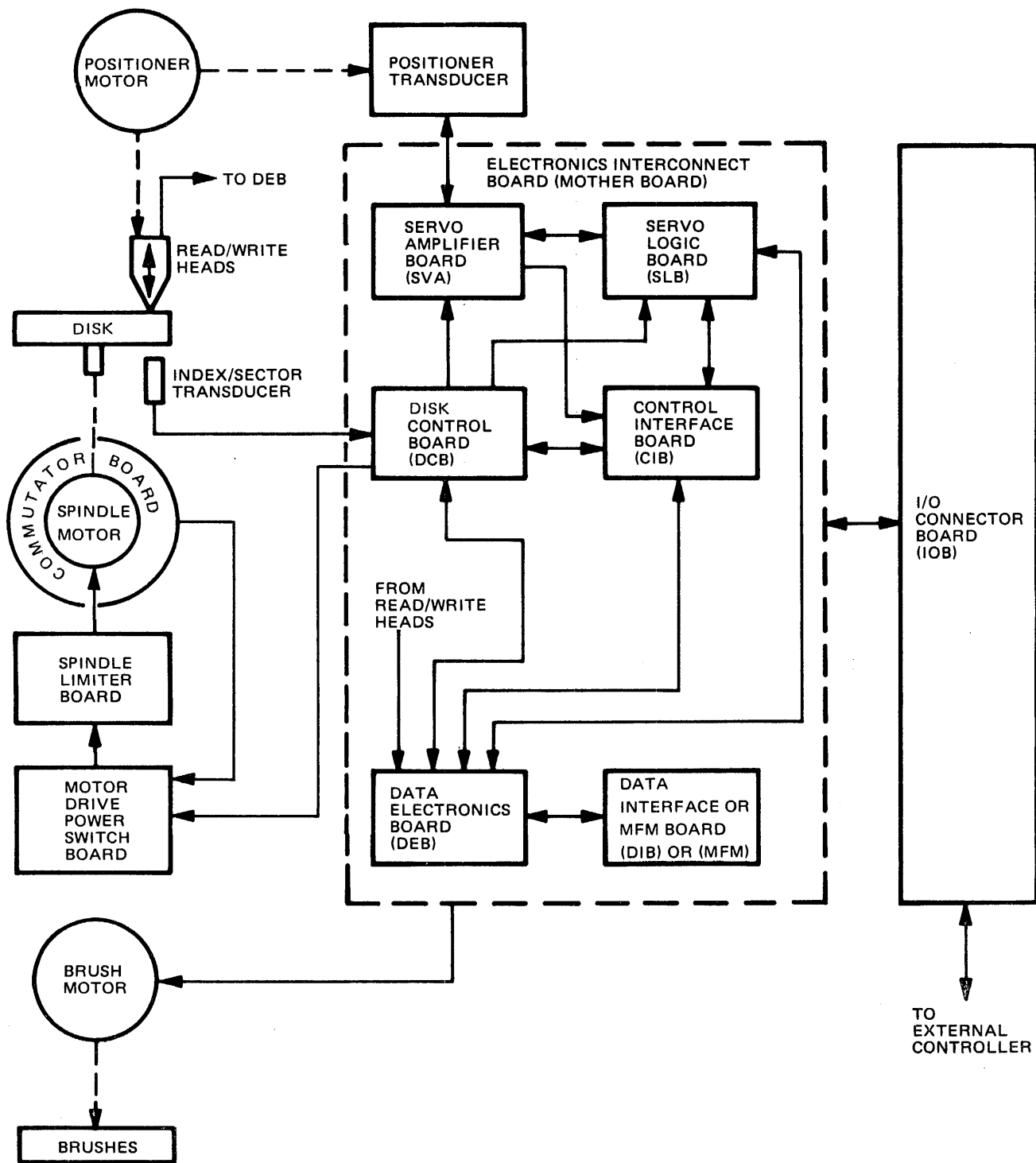


Figure 4-1. Simplified Block Diagram

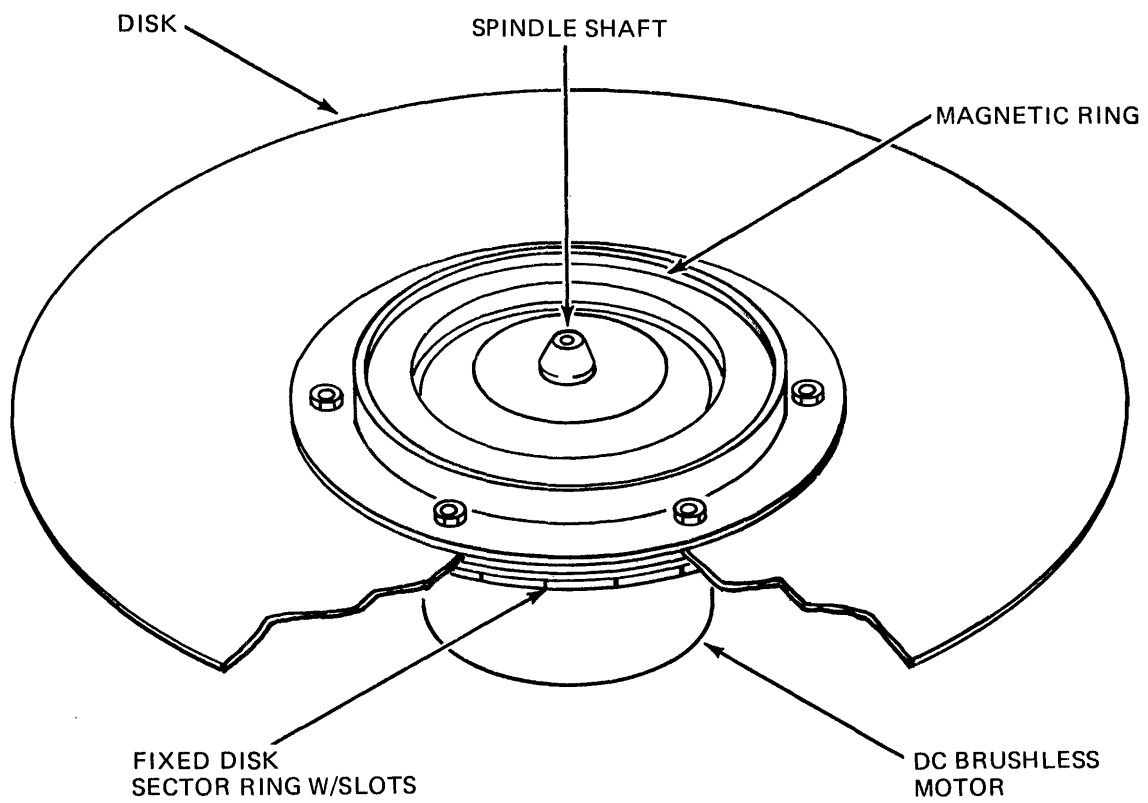


Figure 4-2. Spindle/Drive Motor Assembly

Magnetic transducers detect slots machined into the edge of sector rings from which to produce index and sector pulses. Three types of sector rings are shown in Figure 4-3. The fixed disk ring is mounted directly on the Spindle/Drive Motor Assembly. Since there are two types of cartridge disks (front or top-loading), there are two types of cartridge disk sector rings. The top-loading type has slots machined in the outer edge in a manner similar to those of the fixed disk. The front-loading type has a lip that extends downward. The front-loading type also has a different type of magnetic transducer. In all cases, the transducers are positioned so that the slots can be easily detected.

4.3.2 POSITIONING ASSEMBLY

The positioning system shown in Figure 4-4 consists of three major parts: the linear motor (actuator), the carriage assembly, and the optical detenting assembly. All three parts are necessary to move and position the Read/Write heads to the proper track on the disk. The linear motor is driven by the servo system which is explained in the electronic theory portion of this section.

The Read/Write heads mount on the carriage assembly which rides on ball bearings over precision guide rails. Extending or retracting the carriage along the guide rails moves the heads radially across the disk surface. An optical position transducer produces analog signals necessary for monitoring head position and detent operations. This unit contains a light emitting diode (LED), lens, and reticle assembly. The reticle assembly has a PWB with photo diodes and a glass mask with a series of etched vertical lines. A matching glass, with corresponding lines etched on it, moves between the lens and reticle assembly and is mounted on the carriage assembly.

The lines on each piece of glass comprise an optical grid made up of alternate dark and light areas. The arrangement of these lines is such that when maximum light is allowed to impinge on one of the solar cells, the other is cut off as shown in Figure 4-5. The outputs of the solar cells is summed to provide a modified sine-wave. A null point (marked X on figure 4-5), or the point at which both of the solar cells conduct equally, is identified as the crossing of a track. A third solar cell is used to detect the Beginning of Travel (BOT) and End of Travel (EOT) pulses. These pulses are produced by slots etched on the lower portion of the movable glass as shown in Figure 4-6.

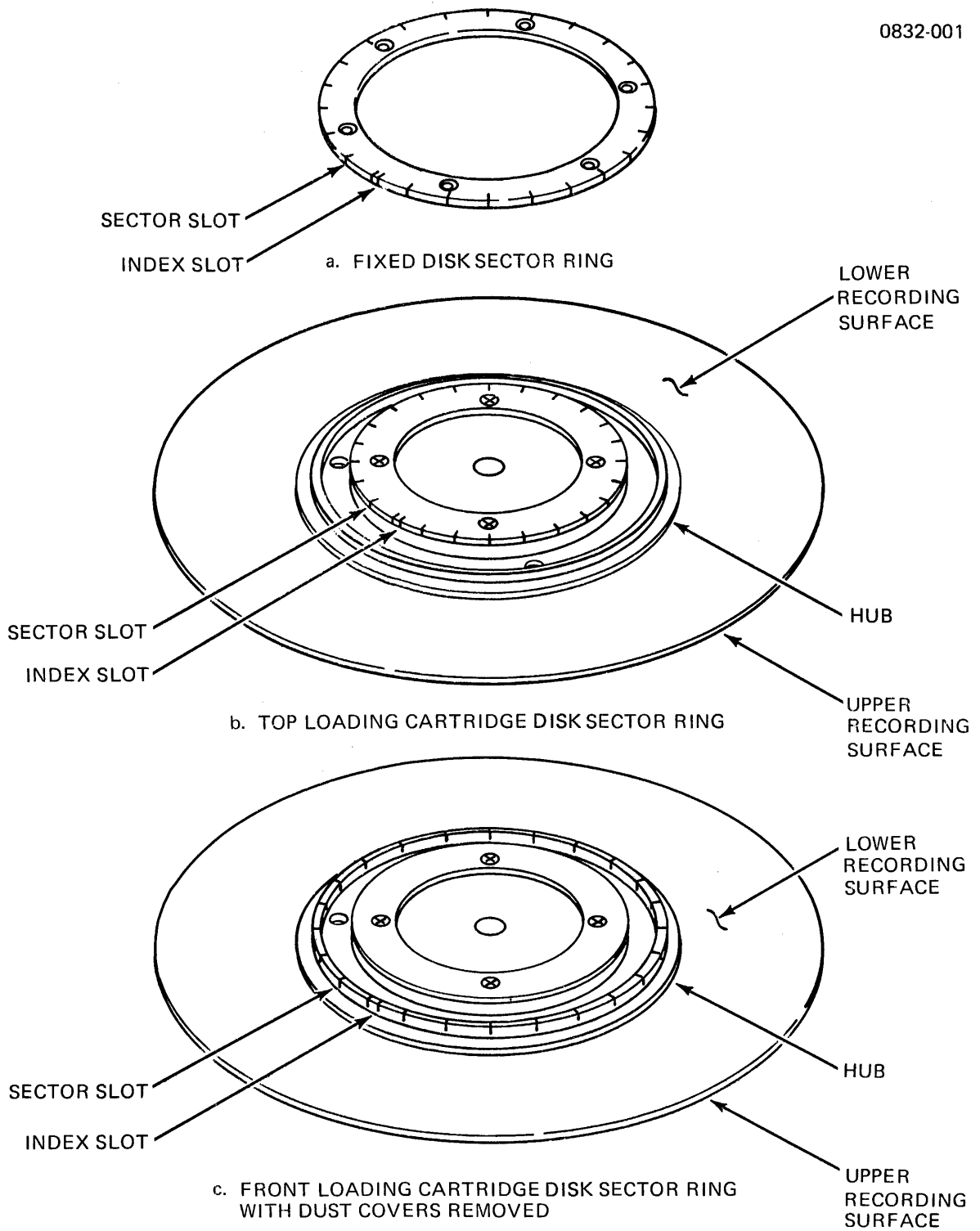


Figure 4-3. Three Types of Sector Rings

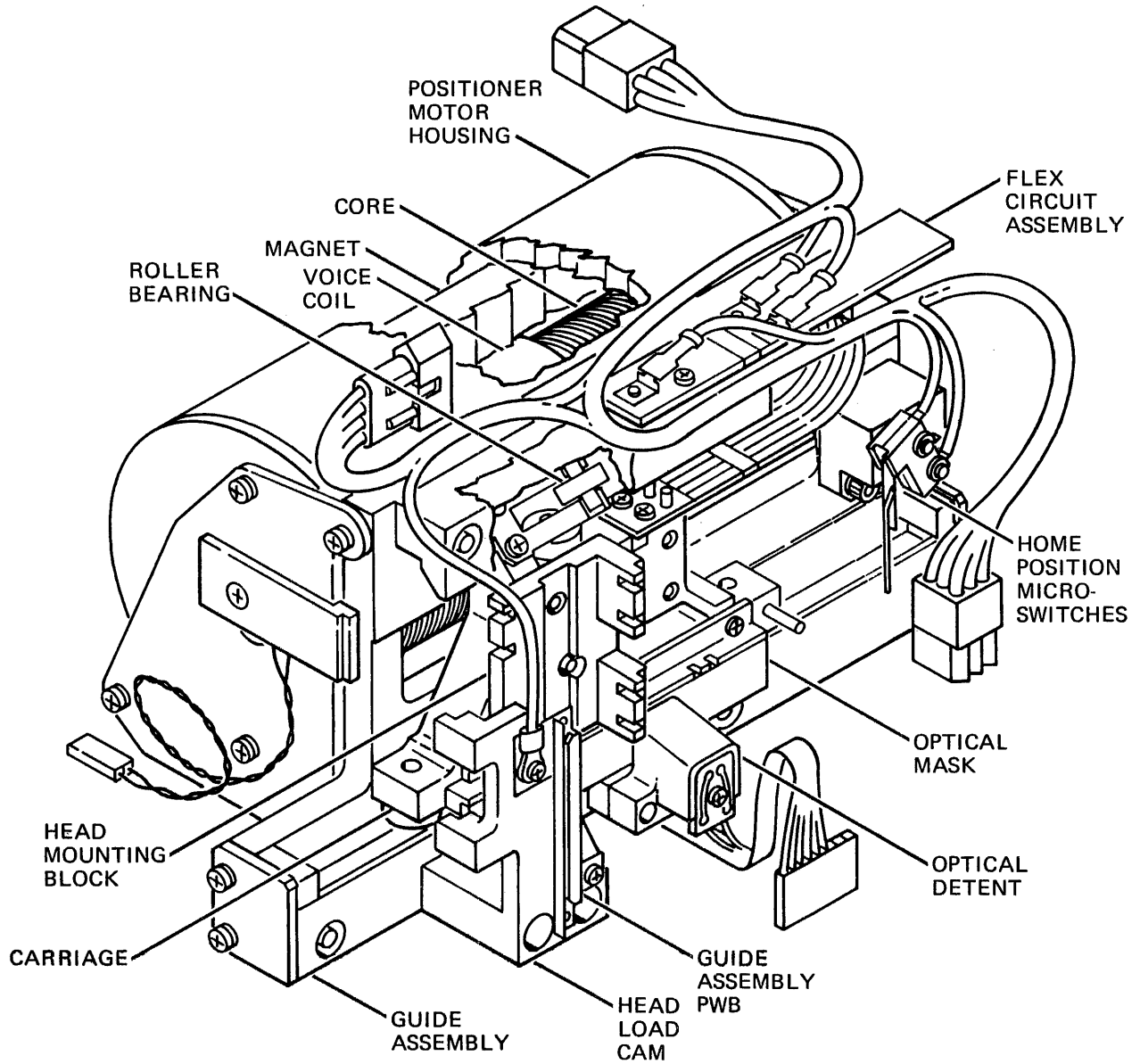


Figure 4-4. Positioner Assembly

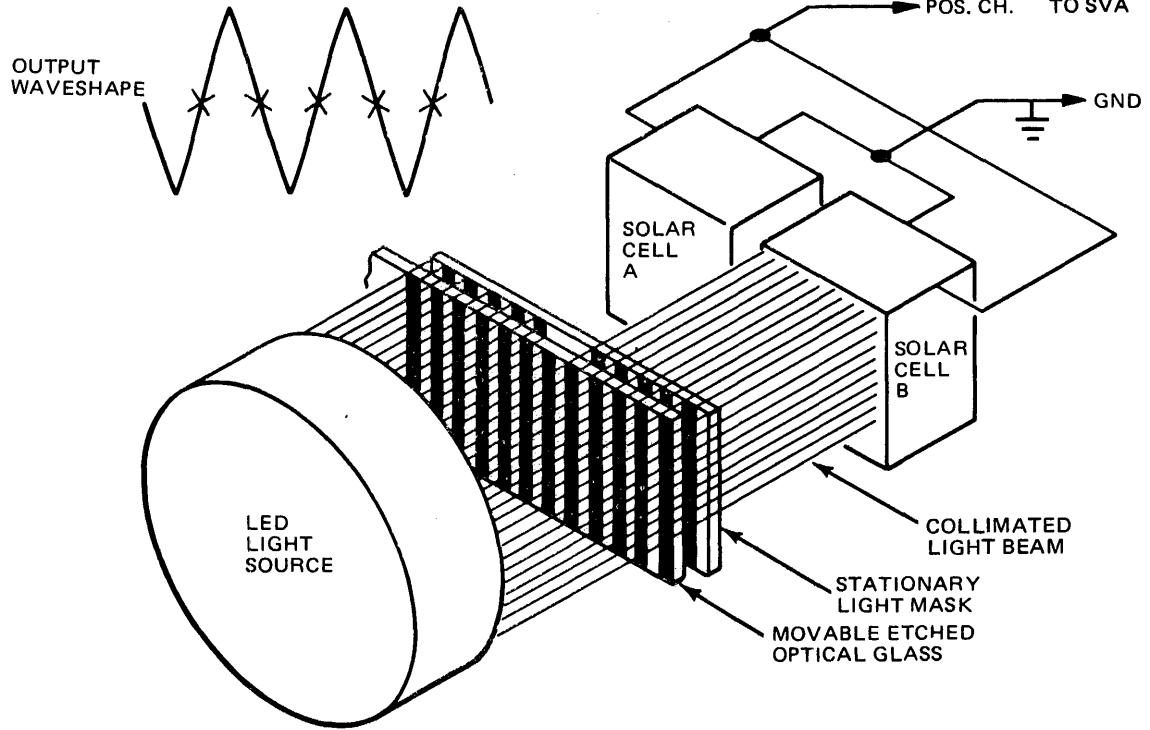
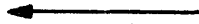


Figure 4-5. Optical Transducer Diagram

CARRIAGE DIRECTION



0873-001

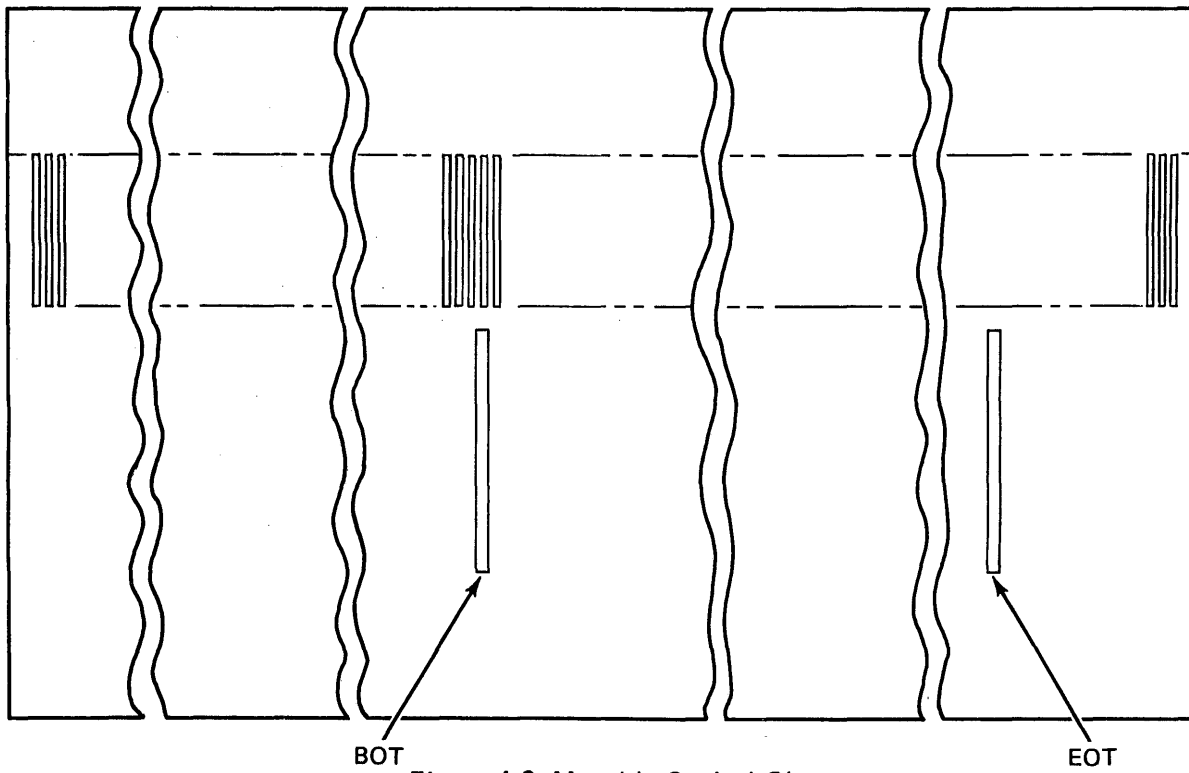


Figure 4-6. Movable Optical Glass

The Read/Write heads "fly" over the recording track with the clearance ranging from 80 microinches (0.002032 mm) at the innermost concentric track to 130 microinches (0.003202 mm) at the outermost track. The difference in head clearance is due to increased surface speed at the outer tracks and causes increased pressure against the heads. Approximately two inches (5.08 cm) of the disc area is actually used for recording data in both the 100 TPI and 200 TPI models; however, the tracks in the 200 TPI model are spaced twice as close together. In Read operation, the head picks up data previously recorded on the addressed track. In Write operation, the head magnetizes the area directly below the head.

As shown in Figure 4-7, the head assembly contains a Read/Write/Erase core whose center tap is energized when the head is selected for either a Read or Write operation. The remaining components include a ceramic shoe, a head support arm which is used to attach the head assembly to the carriage, and a gimbal spring which allows the head to follow the disk contour. The use of the mechanical ramp is explained in the following paragraph. The functions performed by circuits associated with the Read or Write operations are included in the discussions of these circuits as associated with the circuit analysis descriptions.

The Read/Write heads are automatically unloaded during a power-down procedure and are automatically loaded when the RUN switch on the Operator Control Panel (OCP) is actuated. The Read/Write heads are ramp-loaded, a technique requiring minimal components while retaining close control over rate of head load. The assembly rides up a mechanical ramp when retracted and is lifted further away from the disk surface. Figure 4-8 shows the ramp-loaded heads in the unloaded position. As the heads move forward, they slide down the ramps and are loaded directly over the surface of the disk.

To protect user data as well as the disk surfaces and Read/Write heads, several safety features have been designed into the unit. Voltage sensing circuitry constantly monitors both AC and DC operating voltages. An AC loss for the duration of three or more consecutive cycles, or a DC loss, would cause the carriage to be retracted which would automatically unload the heads, and the spindle would begin to slow down. Circuitry is provided to automatically restart the Drive if the voltage concerned has returned to normal and the position of the POWER and RUN/LOAD switches has not been changed.

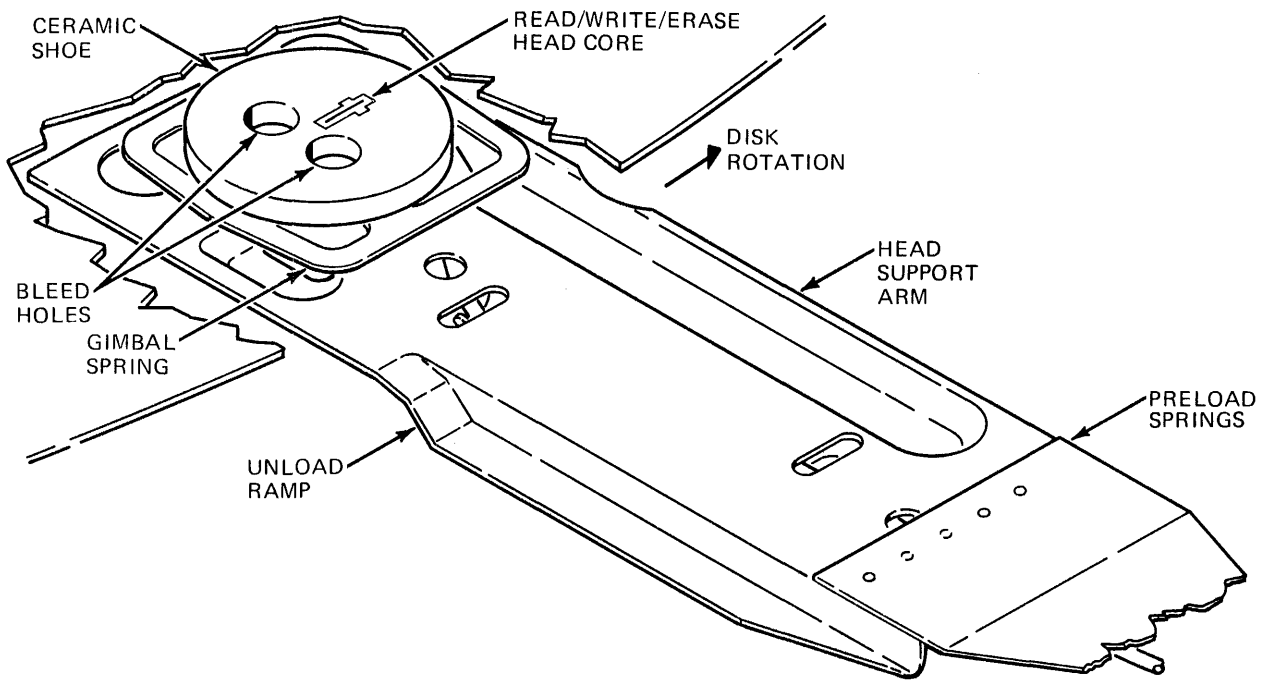


Figure 4-7. Read/Write Heads

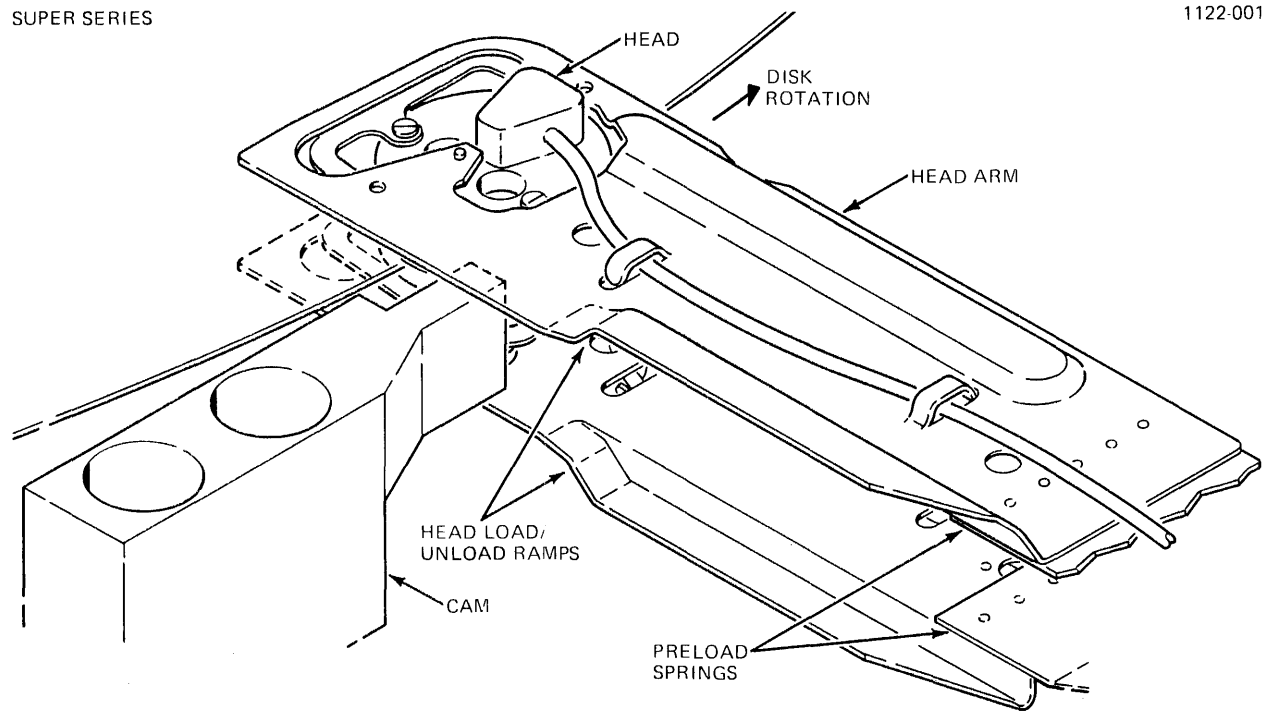


Figure 4-8. Head Unloading Mechanism

4.4 SYSTEM ELECTRONIC THEORY

4.4.1 FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

4.4.1.1 100 TPI and 200 TPI Similarities. Since the 100 TPI and 200 TPI Disk Drives are basically similar, the following theory discussion will apply to both types of Disk Drives. Operating principles are identical except for the track density achieved in the 200 TPI model by spacing of the concentric recording tracks. The 200 TPI unit also incorporates temperature compensation circuitry.

4.4.1.2 Introduction to Circuit Theory. Figures 4-9 and 4-10 are functional block diagrams of the Disk Drive showing interconnecting signals and the functions performed by the circuit boards contained in the unit. Figure 4-10 is for 4400 BPI machines only which use a Modified Frequency Modulation (MFM) board in place of the Data Interface Board (DIB). These block diagrams should be used as a reference when following circuit functions described; in addition, the basic block diagram of the Disk Drive can be referred to (see Figure 4-1). The mechanical operation theory also should be used as a reference.

4.4.1.3 Basic System Operation. When the POWER switch on the OCP is pressed, control circuits, registers, and counters are preset to a desired initial state. The applicable DC working voltages are generated, and the circuits which drive the DC spindle drive motor are enabled. Note that the Start, Stop, Run/Load mode selection, as well as activation of the Write protection circuits, are made by actuation of front-panel switches. Conversely, the Seek, Restore, Read and Write operations are initiated by the external Controller through data, control, timing and status signals transmitted through the I/O interconnecting cable.

Once the disk rotational speed has reached 1500 or 2400-rpm nominal value specified by the customer, the Read/Write heads are loaded automatically. At this time, the positioner carriage on which the heads are mounted is driven from its Home position to track 000. When the heads have settled over this track and READY INHIBIT has been disabled, a READY status signal is sent to the Controller.

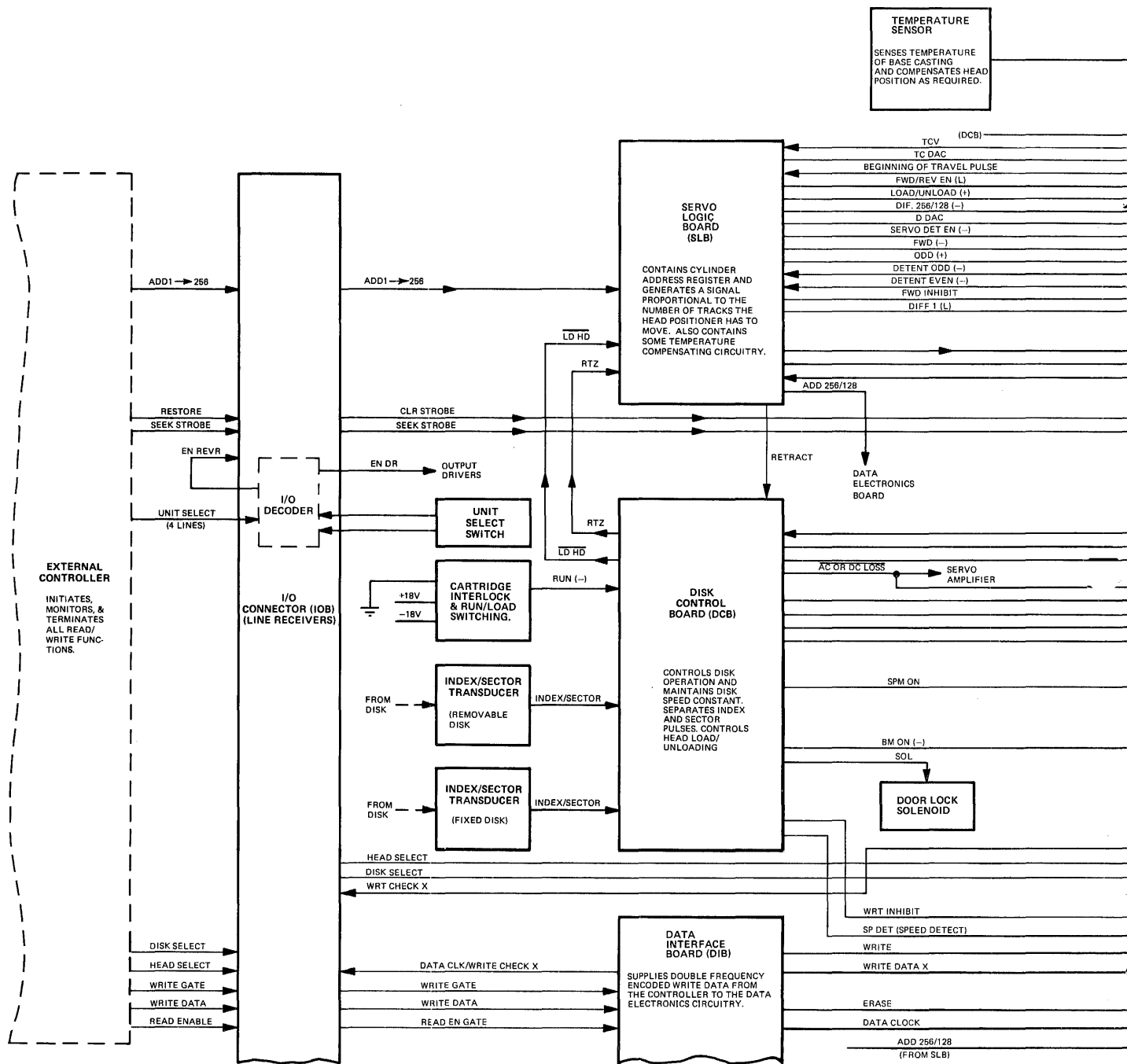


Figure 4-9. Block Diagram – Super Series (major signal lines) (sheet 1 of 2)

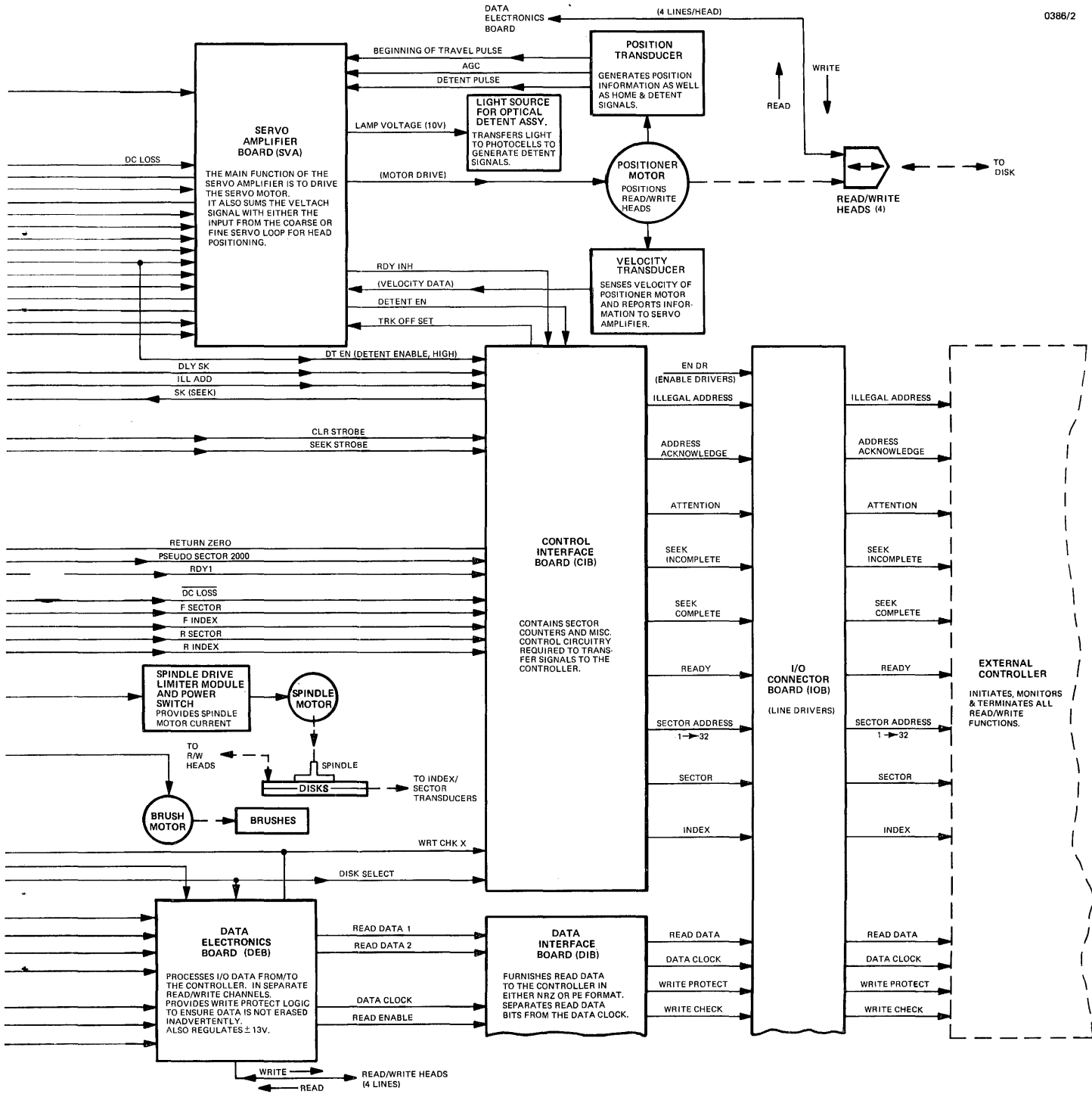


Figure 4-9. Block Diagram - Super Series (major signal lines) (sheet 2 of 2)

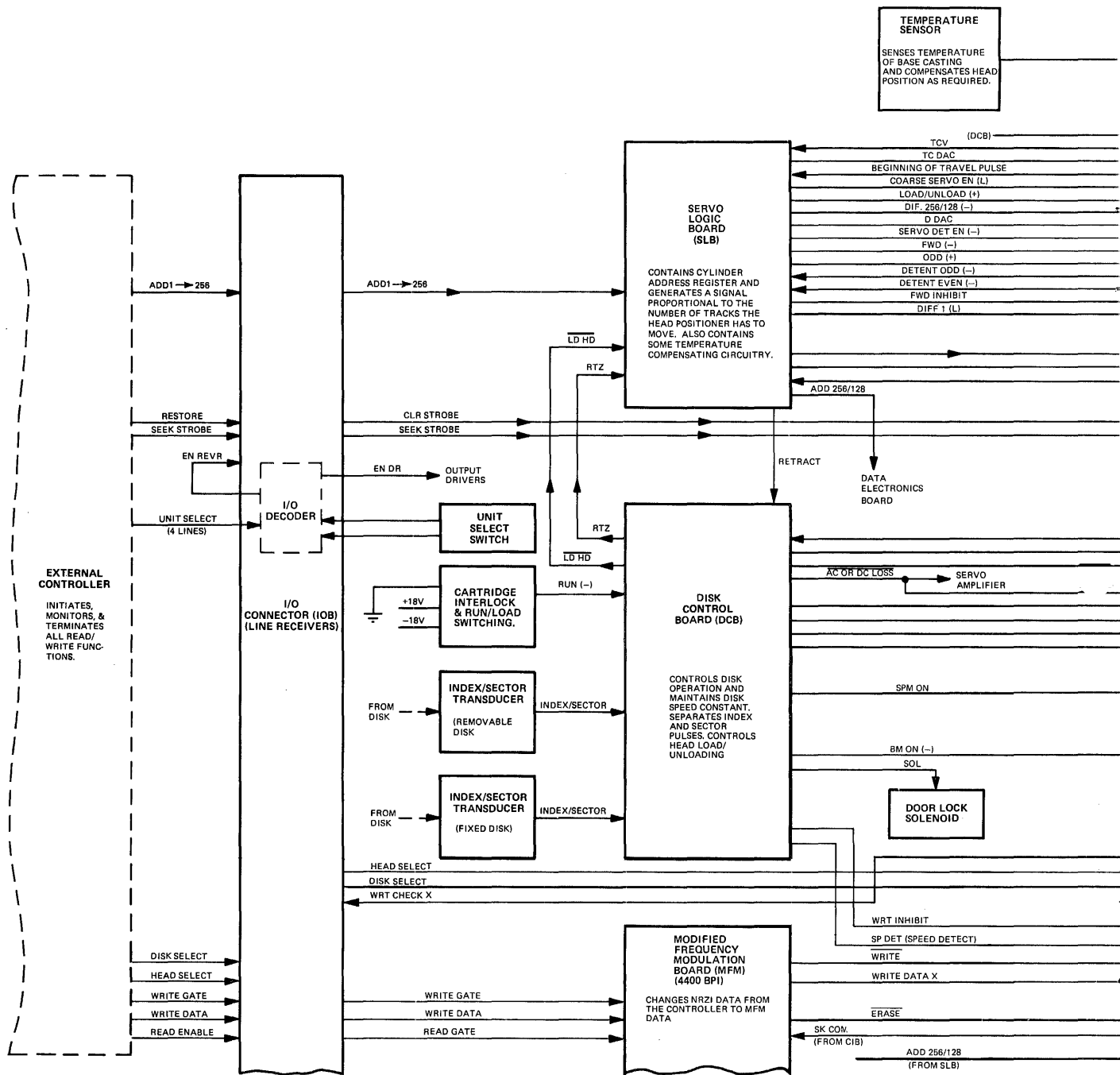


Figure 4-10. Block Diagram— Super Series (major signal lines) 4400 BPI Only (sheet 1 of 2)

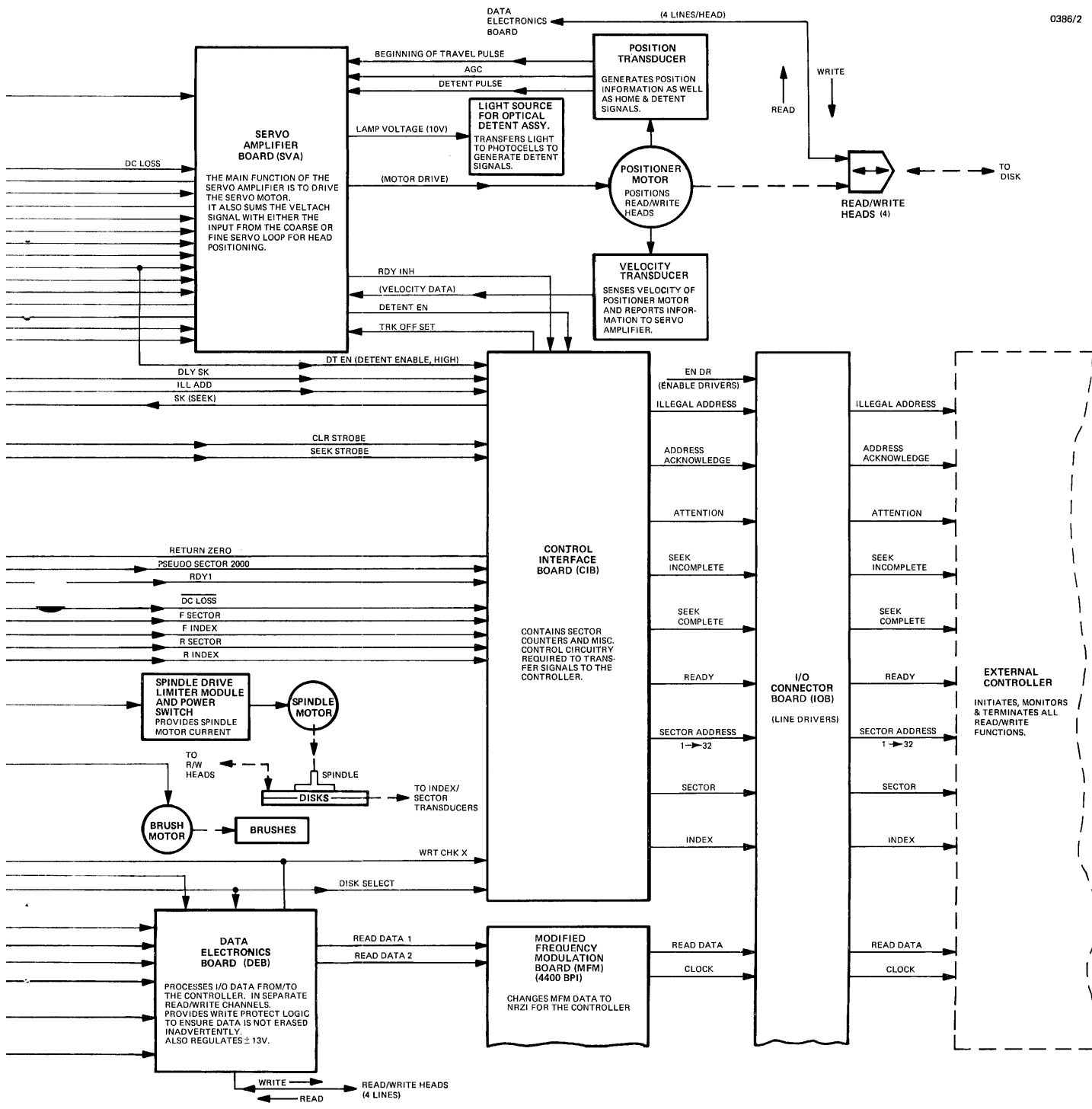


Figure 4-10. Block Diagram – Super Series (major signal lines) 4400 BPI Only (sheet 2 of 2)

The Controller may now initiate a Seek (SK) Command and load the cylinder address to which the carriage is to be moved. This information is routed to the Servo Logic Board where the cylinder (track) address is strobed into the New Address Register. This binary number then is compared to the value stored in the Current Address Register. This register consists of up/down binary counters containing the binary value representing the present positioner carriage location. These two values are compared, and a difference value is obtained which represents the difference between these two binary numbers. This difference value is applied to a D-A converter to provide an analog drive signal which is sent to the Servo Amplifier Board. A simplified block diagram of the head positioning system is shown in Figure 4-11.

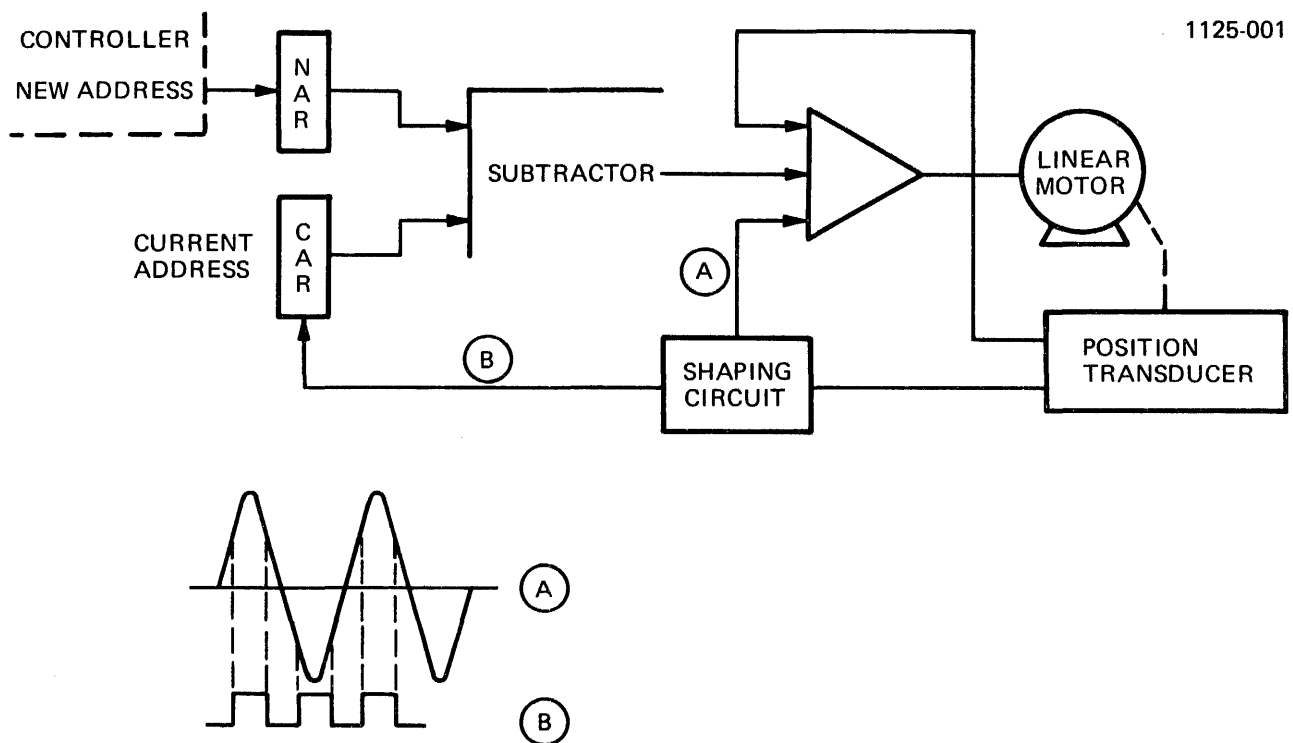


Figure 4-11. Functional Block Diagram – Head Positioning System

The circuits on the Servo Amplifier Board route the analog signal through the board to the linear DC positioning motor, and the carriage is moved toward the new address at a speed proportionate to the number of tracks to be crossed. The position transducer detects the crossing of each track as described in the discussion of mechanical operation of the head positioning system. The Current Address Counter is updated with the counter being incremented or decremented as required. Once the value in the Current Address Register is equal to that in the New Address Register, the Detent Enable (DET EN) signal is sent to the Control Interface Board (CIB). A status signal, SEEK COMP, is generated on this board and transmitted to the Controller signifying that the addressed track has been reached and that the Read/Write heads are settled over the desired track and locked or detented in place.

When the SEEK COMP signal is received by the Controller, a Read or Write operation may be initiated. A functional block diagram showing the logic circuits associated with Read and Write operations is shown in Figure 4-12. Head selection determines which surface, upper or lower, will be written on or read from. A decoding matrix on the Data Electronics Board (DEB) will determine whether the fixed or cartridge disk will be selected. Write data are routed from the Controller through the DIB or MFM to the DEB, and Read data is routed from the DEB to the DIB or MFM to the Controller. Circuitry on the Servo Amplifier Board (SVA) electronically keeps the carriage detented so the heads are positioned directly over the addressed track during either a Read or Write operation.

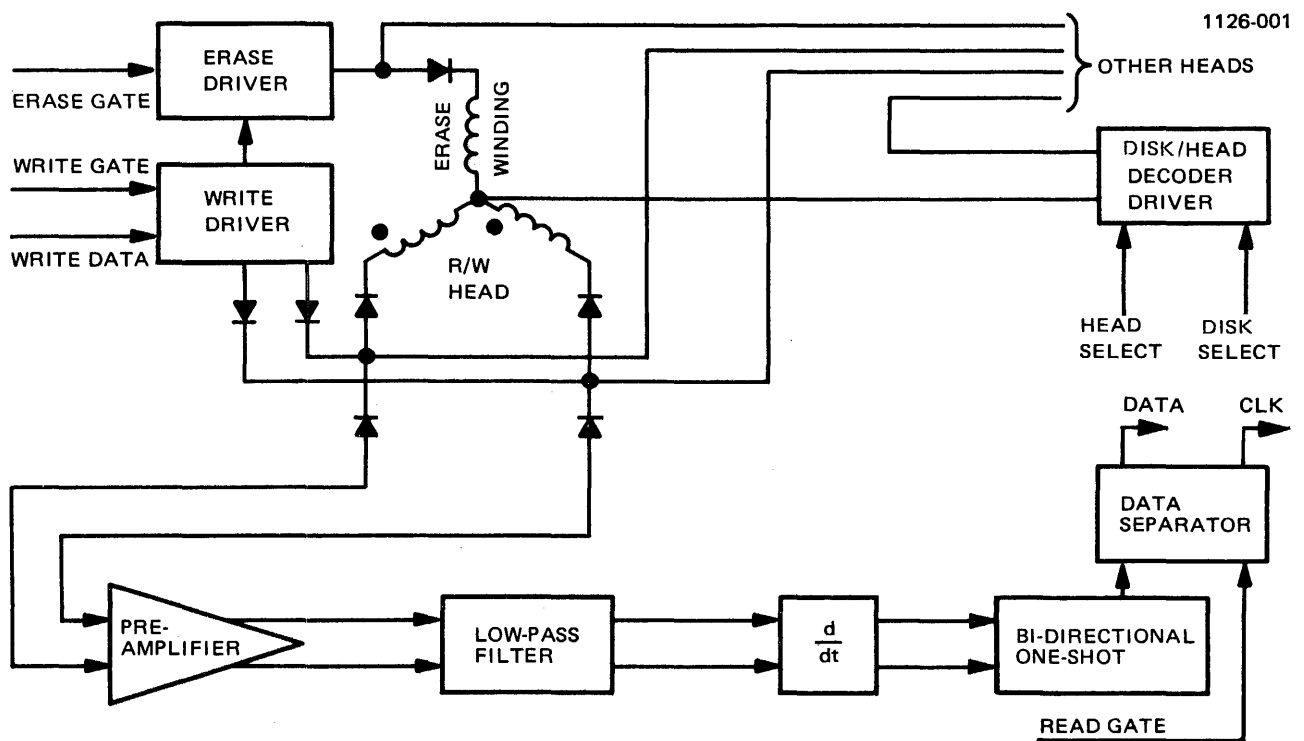


Figure 4-12. Functional Block Diagram – Read/Write Circuit

4.5 LOGIC BOARD CIRCUIT ANALYSIS

4.5.1 I/O CONNECTOR BOARD (IOB)

4.5.1.1 Board Functions. The main functions performed by the logic circuits on this board include:

- A. Line Receivers
- B. Line Drivers
- C. Daisy Chaining

4.5.1.2 Line Receivers. The command and data signal lines from the I/O cable enter the Disk Drive through connector J22 which is wired in parallel, pin-by-pin, with daisy-chain connector J23. Each input is connected to one input terminal of its associated line receiver. These lines are also connected to a terminating bias by a resistive network. The second input to each line receiver is a common enabling signal, EN RECV. A block diagram of this I/O Connector Board, showing the line receivers and drivers, is shown in Figure 4-13.

The input signals from the Controller are low-true signals; i.e., a logical "1" is defined as a level between 0 and 0.5 V. The inverting line receivers furnish high-true signals (logical "1" is represented by a level of approximately +4 VDC to the drive system). The receiver outputs are routed to the Electronics Interconnect Board (EIB) through connector J20 and the flexible interconnecting ribbon cable assembly.

4.5.1.3 Line Drivers. The status and data signals generated in the Disk Drive are routed to the IOB from J20 through the ribbon cable and connector J21. Each signal is routed to one input of the corresponding line driver. The second input to each line driver is a common enabling signal, ENDR. The low-true outputs from the line drivers are transmitted to the Controller through I/O connector J22 and the interconnecting cable.

4.5.1.4 Driver Enable Circuits. A control circuit on the IOB generates the enable signals for the line receivers and line drivers as a function of the UNIT SELECT. The logical address signal for selection of one of the four daisy-chained Disk Drives is received from the Controller via the I/O cable and connector J22. This signal is inverted and applied to a NAND gate. The second input to this gate is furnished by the SEL1/SEL2 decoder. The decoder is supplied by the four-position UNIT SELECT switch which is located on the control panel of the particular Disk Drive. The inputs on lines SEL1 and SEL2 are encoded by the UNIT SELECT switch mechanism.

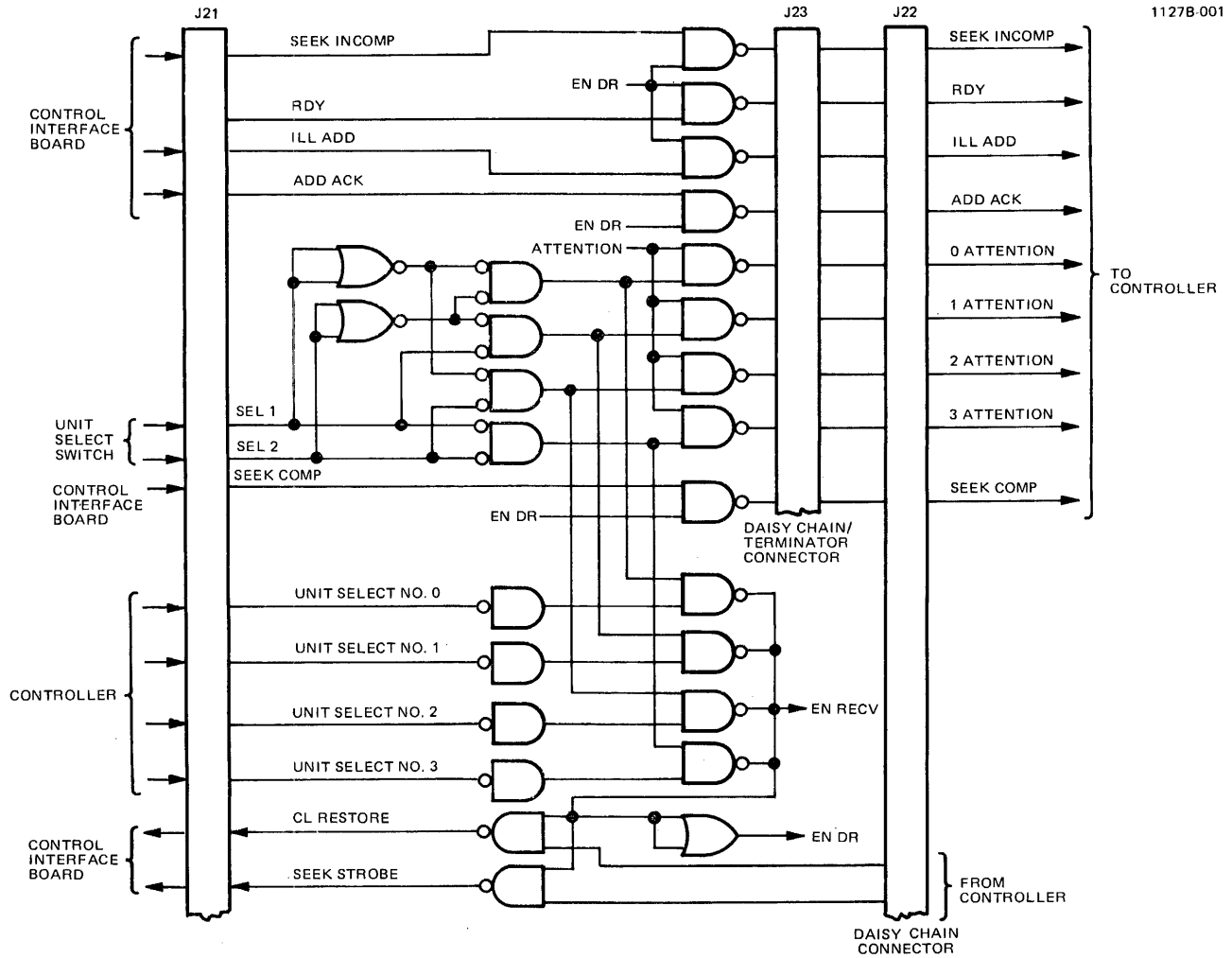


Figure 4-13. Block Diagram – I/O Board (Sheet 1 of 2)

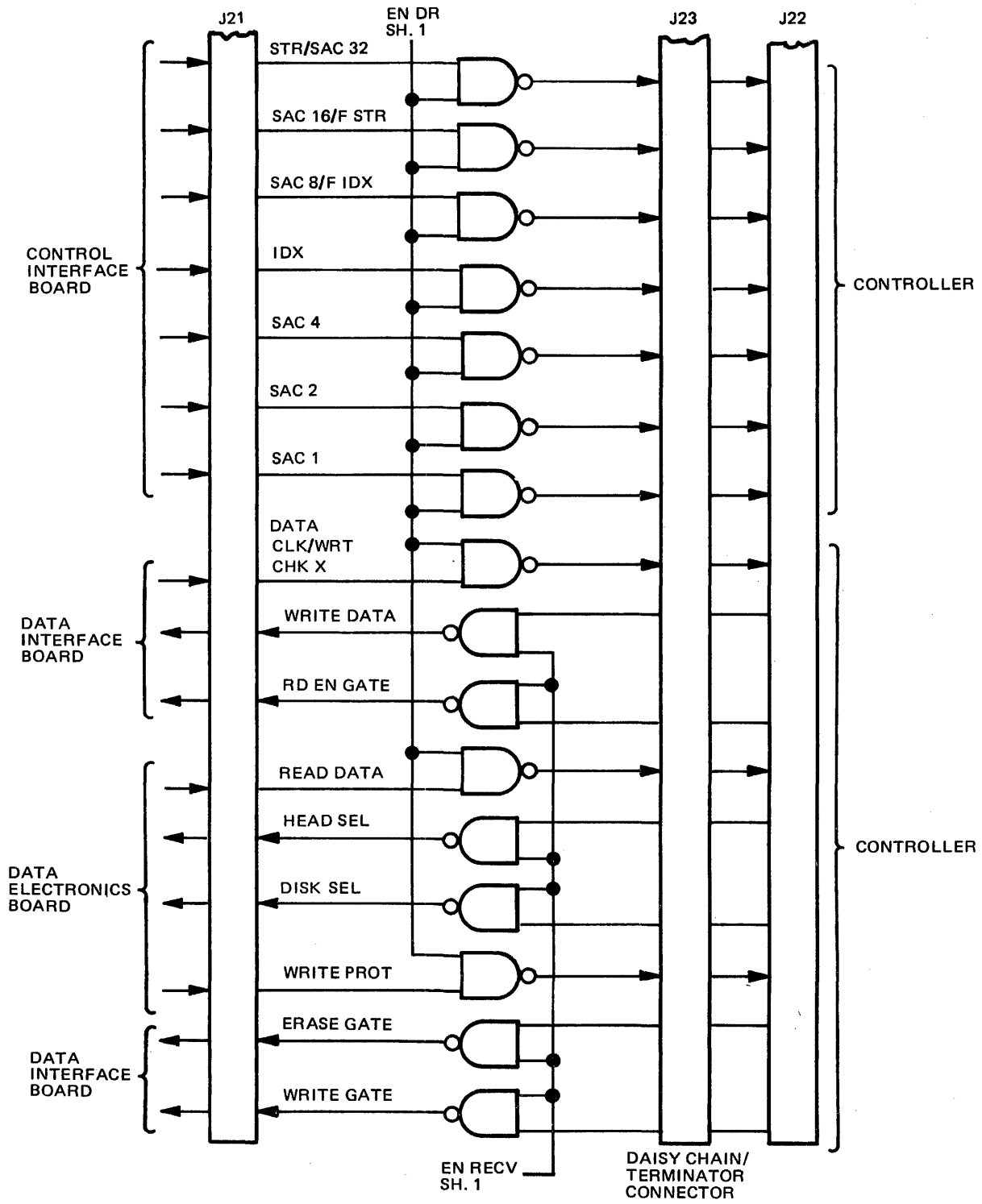


Figure 4-13. Block Diagram – I/O Board (Sheet 2 of 2)

When both inputs to any one of the gates are high, indicating matching selection (remote and local of the unit address), the output of that particular gate will be low: therefore, the EN REC signal is low. This low-level signal enables all line receivers. The EN REC signal is inverted to a high level and the resultant EN DR signal is used to enable all line drivers.

The decoder outputs are further used to generate the ATTENTION status signal. Depending on which gate is enabled by the high-level output of the decoder, a low level will be placed on the respective ATTENTION line when the internal ATTENTION signal is received.

4.5.1.5 Daisy Chaining. The daisy chaining provision is implemented with the two parallel-wired connectors J22 and J23. The I/O connector J22 (a male connector) mates with the interface I/O cable. The entire communications link between the DiskDrive and the Controller is established via this cable. The parallel (pin by corresponding pin) daisy chain connector, J23 (a female receptacle), mates with one end of a daisy-chain cable whose other end mates with I/O connector J22 of the second DiskDrive, etc. Up to four drives can be interconnected with the Controller in this manner. The daisy chain cable will be terminated in the end unit by inserting a terminator plug into J23. Circuitry is provided to disable Output Drivers when one of the Disk Drives in a daisy chain is powered up or down. Spurious 5 V. fluctuations are prevented from interfering with other drives in the chain by this means.

4.5.2 ELECTRONICS INTERCONNECT BOARD (EIB)

This is basically a mother board into which the other circuit boards are inserted. The interconnecting diagram for this circuit board is in the schematic drawings of Volume 2. Since this circuit board is used only to provide interconnecting signal paths, no further information is included.

4.5.3 DISK CONTROL BOARD (DCB)

4.5.3.1 Board Functions. The principle functions performed by the logic circuits on this board include:

- A. Spindle start-up and control
- B. Separation of Index and Sector pulses
- C. Generation of DiskDrive control signals

4.5.3.2 Spindle Start-Up and Control. The spindle motor speed detection and control circuitry is used to: (1) provide a clock signal of 2000 pulses for each revolution of the disk; (2) monitor the speed of the spindle motor, and (3) generate the Spindle Motor On (SPN MOTOR ON) signal. The block diagram for this circuitry is shown in Figure 4-14.

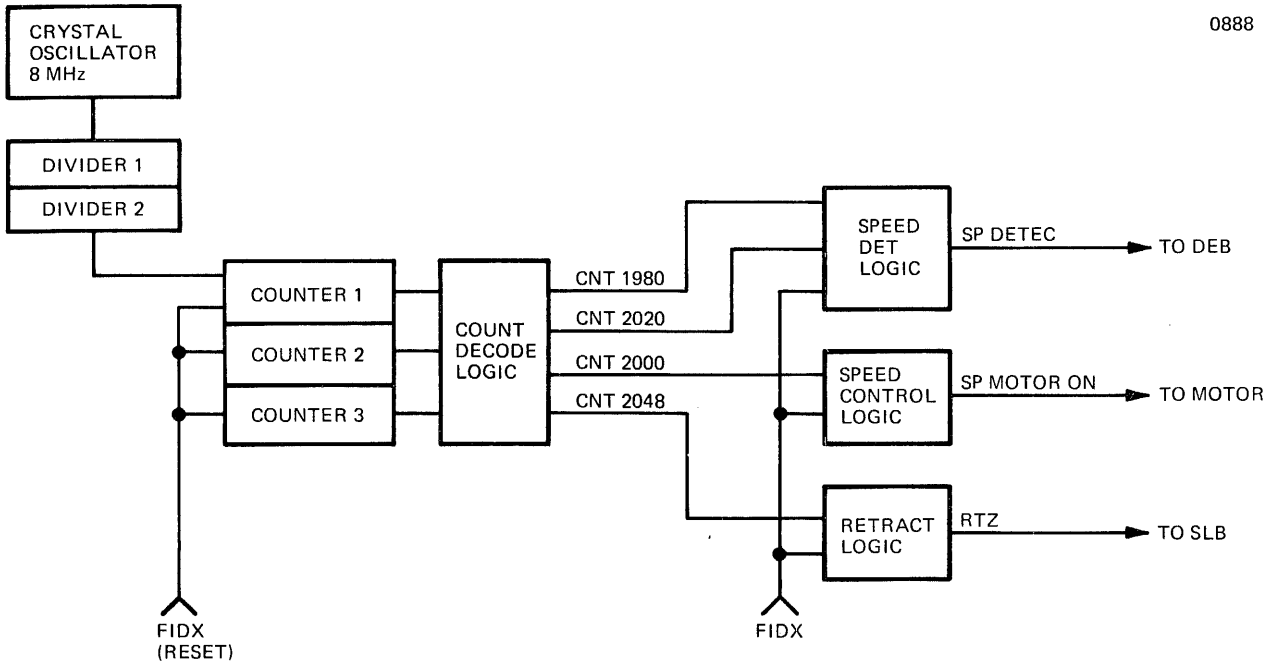


Figure 4-14. Spindle Motor Speed Detection and Control Functional Block Diagram

A simplified logic diagram and a timing diagram are provided in Figures 4-15 and 4-16 respectively. Two of the inputs to AND gate "A" (see Figure 4-15) are +5V and the output of the DC LOSS TIMER one-shot. During normal operation, these inputs will be high and the Spindle Motor Start (SPM START) one-shot will be triggered when the RUN/LOAD switch is set to RUN position.

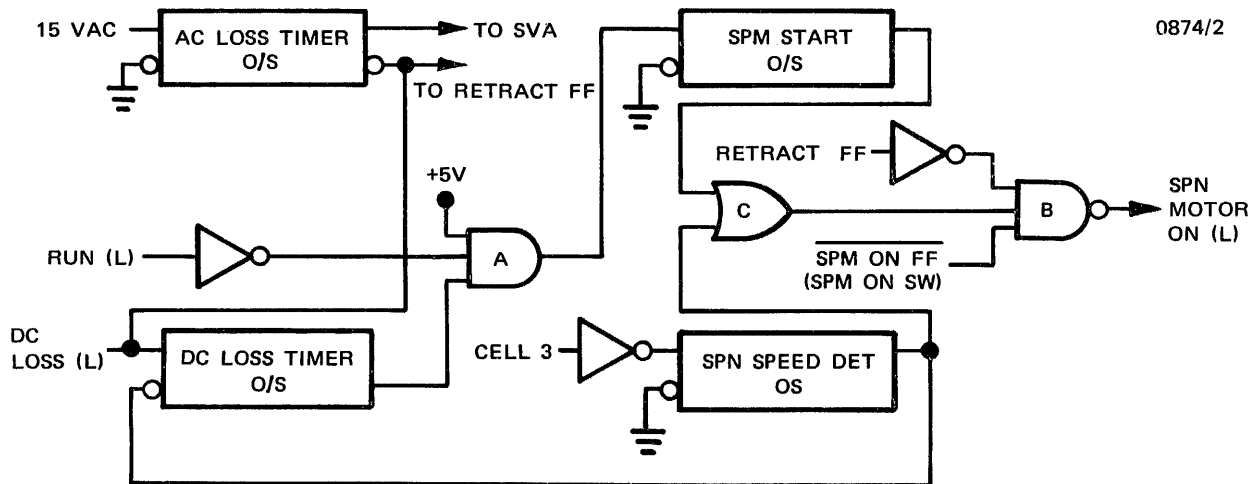


Figure 4-15. Spindle Motor Control Simplified Logic Diagram

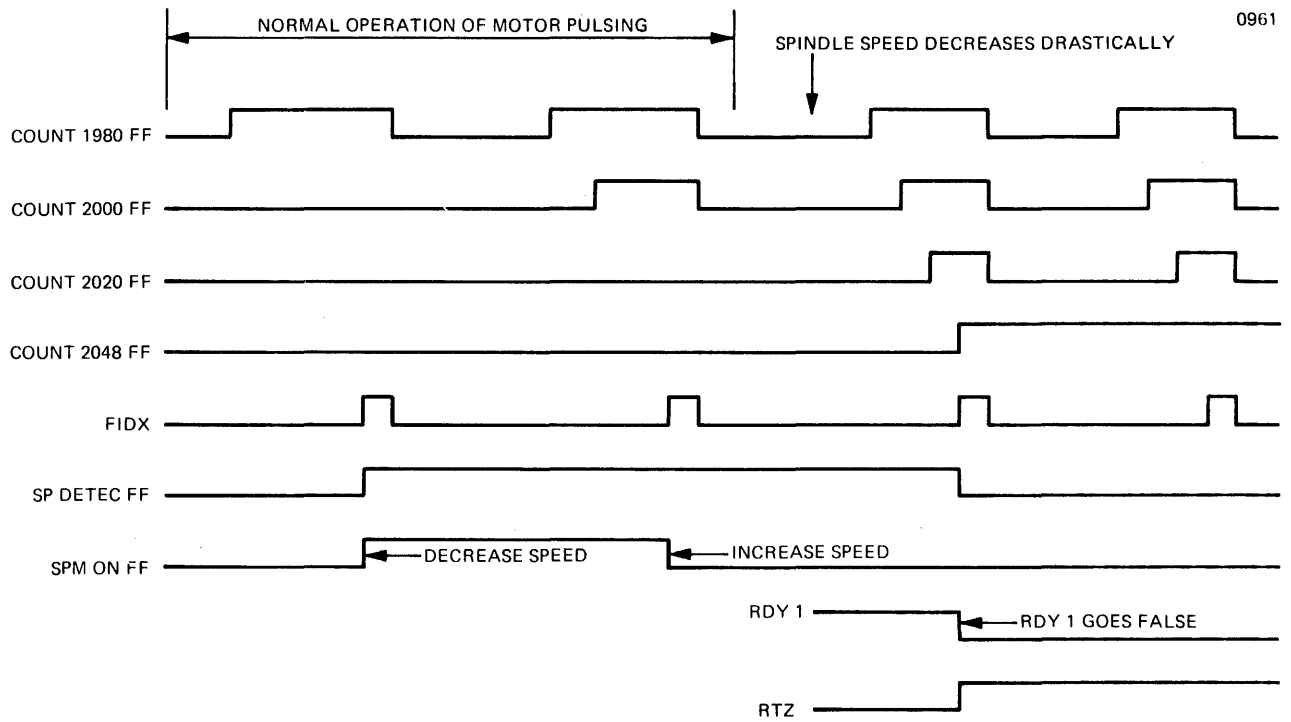


Figure 4-16. Motor Speed Control Timing Diagram

The output of the SPM START one-shot will be high for 3.36 seconds and will be one input to NAND gate B. The other two inputs will be high due to logic reset when power is turned on. The output of NAND gate B, SPN MOTOR ON (L), will allow the spindle drive motor to be turned on.

Once the spindle begins to turn, CELL signals will be generated by LED circuits on the COMMUTATOR board. It can be seen (see Figure 4-15) that the CELL 3 signal will trigger the Spindle Speed Detect (SPN SPEED DET) one-shot. CELL signals occur once every revolution of the spindle; therefore, CELL 3 will retrigger the SPN SPEED DET one-shot so often it will never have a chance to time out. This will provide a constant high through OR gate C to NAND gate B so when the SPM START one-shot times out, the SPN MOTOR ON (L) signal will be held constant.

The spindle motor will be turned on by SPN MOTOR ON (L) until it exceeds the designated rpm (1500 or 2400). Then through the timing relationship between the Counter decode outputs (see Figure 4-14) and the occurrence of Fixed Index (FIDX) pulses, the Spindle Motor On (SPM ON) f-f will be toggled periodically, and its \bar{Q} output (input to NAND gate B, see Figure 4-15) will either allow or inhibit spindle motor drive current. This pulsing of the spindle motor is the method employed to maintain spindle (disk) speed at a constant rpm ± 1 percent.

4.5.3.3 Index and Sector Pulse Separation. When the Sector pulse that precedes the Index pulse arrives, it will, after shaping, fire the IDX/DATA Timer. See Figures 4-17 and 4-18. The RIDX Pulse Widener will be fired by the trailing edge of the IDX/DATA Timer when it times out. The output of the pulse widener enables one input to two AND gates (1 and 2). Since the RIDX Separator is not firing yet, its bubble output is high and enables AND gate 1 so its output becomes the Removable Sector (RSTR) pulse. The next pulse to arrive at the input to the timer (pulse widener, etc.), will be the Removable Index (RIDX) pulse. This pulse will arrive at AND gate 2 while the RIDX Separator output to AND gate 2 is still high (because it was fired by the negative transition of the widener timing out and has not yet timed out). The output of AND gate 2 now becomes RIDX; therefore, RIDX and STR are now on separate lines. The operation of Fixed IDX/STR is basically the same except for the IDX/DATA timer which is only adjusted while using a CE Cartridge disk; therefore, it is unnecessary for the fixed disk circuitry.

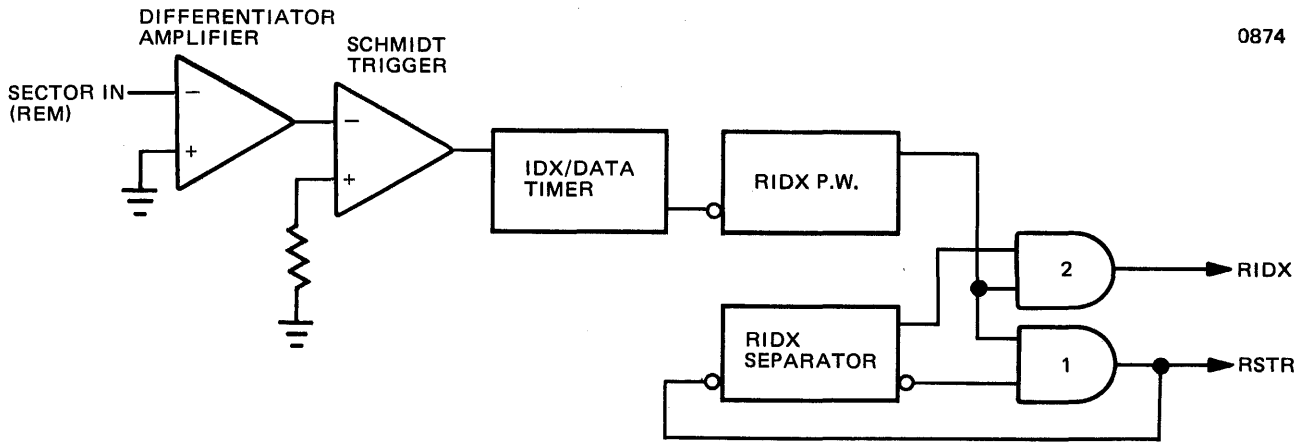
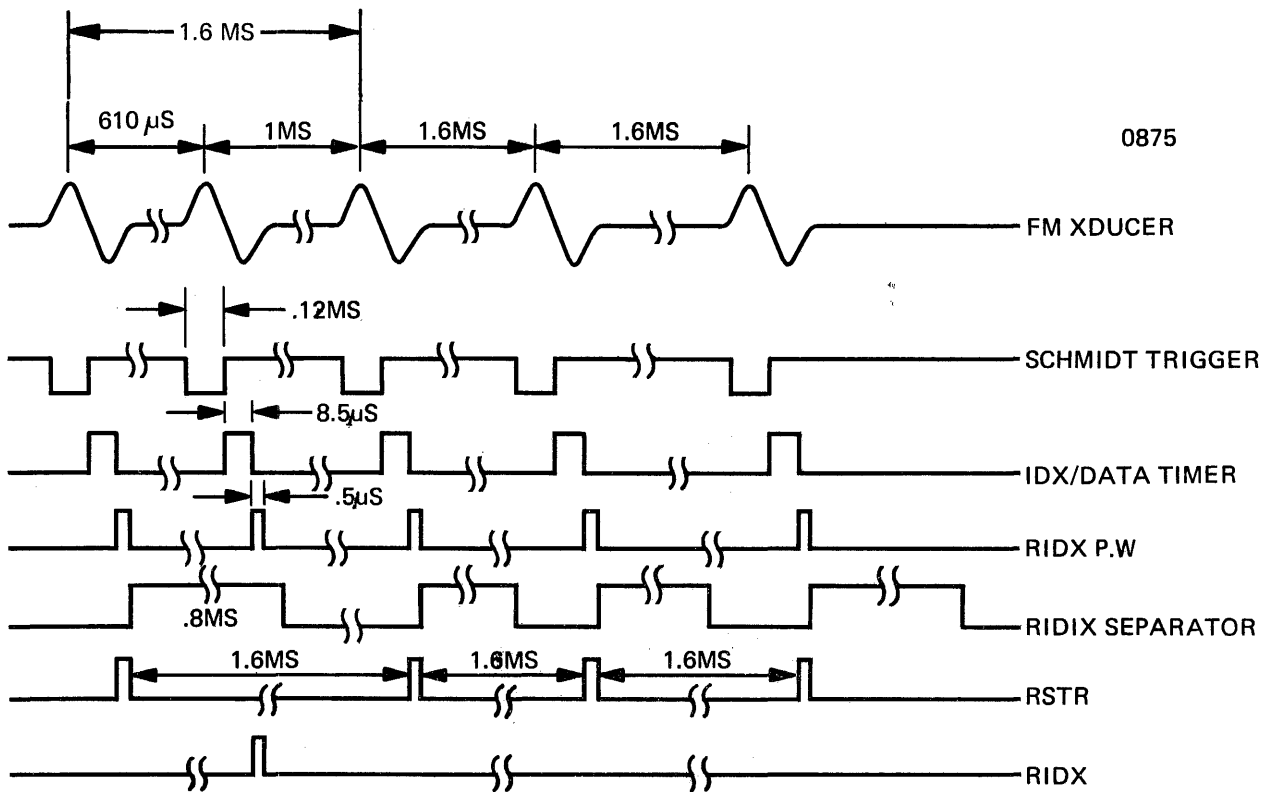


Figure 4-17. Removable Disk Index/Sector Separation



NOTE: 1500 RPM UNIT WITH 24 SECTOR RING
TIMING IS SAME FOR SF AND ST BUT OUTPUT
OF TRANSDUCER WILL BE DIFFERENT.

Figure 4-18. Removable IDX/STR Pulse Timing Diagram

4.5.3.4 Generation of Disk Drive Control Signals

4.5.3.4.1 RTZ. A return-to-zero carriage return signal is generated during the power-on sequence to ensure the carriage is retracted before the loading door can be opened. With the RUN/LOAD switch in LOAD position, the RUN (L) input to the DCB is high. This direct resets the RETRACT f-f sets the CNT 2048 f-f and causes the RDY DLY "A" f-f to be reset. See Figure 4-19. The Q output of this f-f generates the RTZ high signal to the SLB.

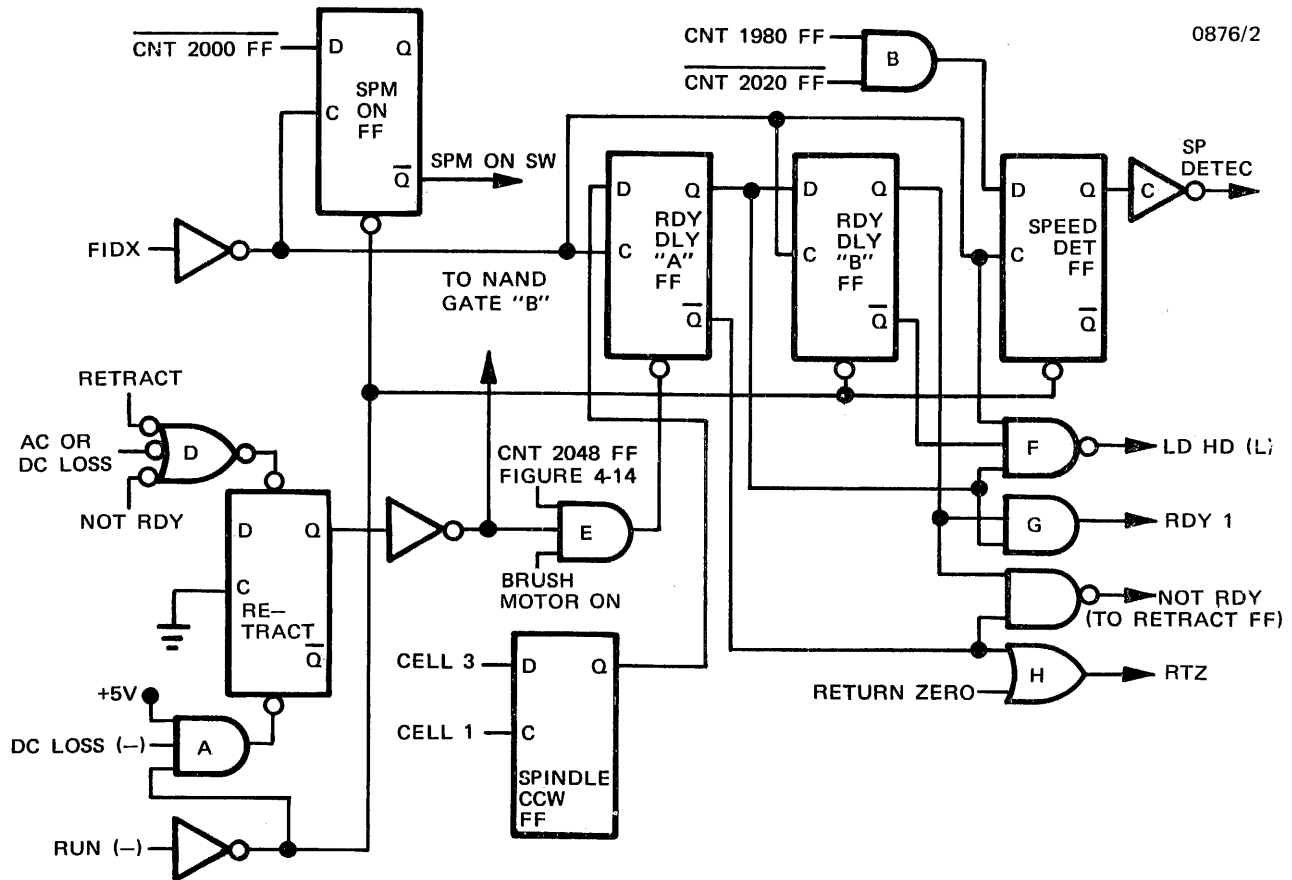


Figure 4-19. Disk Control Signals – Simplified Logic Diagram

When the RUN/LOAD switch is in RUN position, the spindle starts, and the CELL 1 and 3 signals (then generated) cause the spindle CCW f-f to set. This results in the RDY DLY "A" f-f getting set when the first FIDX pulse after the CNT 2048 f-f set arrives. This causes RTZ to go low. RTZ will remain low unless one of the following occurs:

- A. The RETURN ZERO command from the CIB is received
- B. The RETRACT signal from the SLB is received
- C. AC or DC Loss occurs (emergency retract)
- D. Excessive spindle speed loss (count of 2048)
- E. RUN/LOAD switch is placed in LOAD position

As a result of any of these conditions, signal RTZ will go high and the carriage will retract.

4.5.3.4.2 LD HD. The Load Head pulse is sent to the SLB where it starts the Initial Seek operation which includes loading the heads. When the disc is up to speed (see AND gate input to direct reset of RDY DLY "A" f-f in Figure 4-18), the RDY DLY "A" f-f will be set by FIDX and spindle CCW. The following FIDX pulse will set RDY DLY "B" f-f. The next FIDX pulse will gate LD HD to the SLB. At the same time, RDY 1 will be sent to the CIB for processing and eventual generation of READY to the Controller after the Initial Seek operation is finished.

4.5.3.4.3 SP DETEC. The Speed Detect signal, when low, allows Write operations. When it is high, it inhibits Write operations on the DEB. SP DETEC will be high if the counter decode at FIDX time is less than 1980 or more than 2020. If the FIDX pulse arrives before the count of 1980, the spindle is turning too fast; and if the FIDX pulse arrives after the count of 2020, spindle speed is too slow. Either condition would cause data to be written in an unacceptable Sector format (see Figures 4-19 and 4-16).

4.5.3.4.4 AC/DC Loss Recovery. The loss of either AC or DC will result in the RETRACT flip-flop being reset and triggering of the DC LOSS TIMER one-shot (see Figures 4-15 and 4-19). If the loss is short duration, as explained previously in the description of the Positioning assembly, the drive will automatically restart once the DC LOSS TIMER one-shot has timed out, and the setting of the POWER and RUN/LOAD switches remains unchanged.

Some other secondary control signals generated on the DCB are:

- A. Load indicator driver (light)
- B. Solenoid driver (locks or unlocks cartridge door)
- C. Power reset (initial circuit Reset pulse during power up)
- D. Brush Motor On (self explanatory)

4.5.4 SERVO LOGIC BOARD (SLB)

4.5.4.1 Circuit Functions. The principal functions performed by the logic circuits on this board include:

- A. Store new cylinder address
- B. Store current positioner address
- C. Compare and compute difference between NAR and CAR
- D. Decode illegal addresses
- E. Generate positioner control signals
- F. Provide temperature compensation (200 TPI units only)

4.5.4.2 New Address Register (NAR). The SLB contains the New Address Register into which the desired cylinder address is loaded at the start of any Seek operation. Prior to an initial Seek or Restore operation, this register will be reset by the Clear Counter (CL CNTR) signal. During a programmed Seek, the new cylinder address from the Controller will be routed to the SLB on input lines ADD 1 through ADD 256. These inputs are applied to the 100 and 200 TPI multiplexer whose outputs are then strobed into the NAR by the Seek Strobe (SK). Therefore, during continuous or alternate Seek operations, the NAR need not be reset prior to each Seek. A block diagram of the SLB is shown in Figure 4-20.

4.5.4.3 Current Address Register (CAR). The CAR is made up of three four-bit up/down counters and associated control gating circuitry. The count down and count up NAND gates are enabled by the \bar{Q} and Q outputs of the FWD flip-flop respectively. They are activated by the detent pulses (DT P) from the SVA. The output of the CAR will always reflect the current address of the cylinder over which the Read/Write heads are presently positioned. These counters are reset in the same manner (CL CNTR) as the NAR.

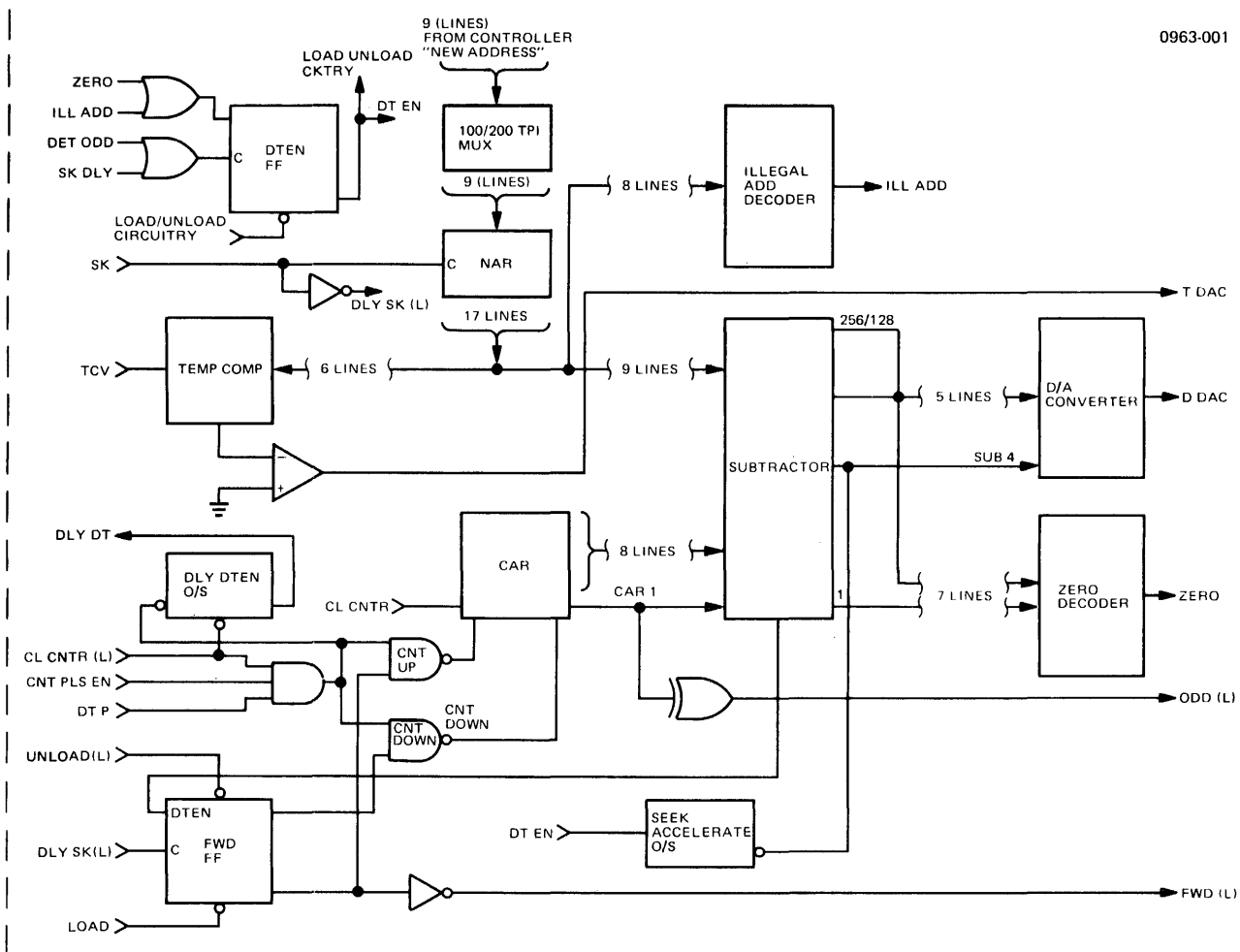


Figure 4-20. Block Diagram of Servo Logic Board (SLB)

4.5.4.4 Subtractor and Digital-to-Analog Converter. The inputs to the subtractor are the complimentary outputs of the NAR and the current address from the CAR. These inputs are applied to full adders which are configured through the use of exclusive OR gates as a binary subtractor using the 1's compliment to obtain the difference figure. This difference count is applied to a digital-to-analog converter whose output signal D DAC is routed to the SVA. The Subtractor LSB is decoded to generate the ZERO signal but is also routed to the SVA to generate the small amount of drive needed to advance the carriage the final distance to the selected track for detenting. This signal is called DIFF 1. See Figure 4-21.

4.5.4.5 Illegal Address Decoder (ILL AD). The Q outputs of the NAR flip-flops are applied to a decoder circuit. If the value of the binary number is greater than the valid number of tracks for the disc, an ILL ADD status signal is generated. The address is ignored by the Disk Drive and the carriage remains in its present position. Legal addresses are indicated for values less than octal 625 or 627 for 200 TPI Disk Drives and octal 312 or 313 for 100 TPI models. See Figure 4-22.

4.5.4.6 Beginning of Travel Pulse. The Beginning of Travel pulse is developed by the position transducer two tracks before the carriage reaches track 000 position. This negative-going pulse is developed on the SVA board and is routed to the SLB. There, the positive transition is used to clear the LOAD f-f and to set the DLY/BOT f-f. The Q output of the DLY/BOT f-f maintains the positive LOAD/UNLOAD signal to the SVA board and ensures that forward motion will be continued. The second detect pulse after the BOT pulse causes signal DETENT ODD to go low thus setting the DETENT f-f. The output of the DETENT f-f clears the DLY/BOT f-f thus removing the LOAD/UNLOAD signal, and the positioner is detented (locked) at track 000.

4.5.4.7 Detent Operation. Track 000 is defined as the position of the carriage (and heads) at which the first odd Detent pulse after BOT is detected. Detent takes place between the termination of the first odd Detent pulse and start of the even Detent pulse. At this point, the Detent pulse has a negative slope; e.g., it is positive and dropping toward zero. Therefore, the positioner slows down rapidly to approximately zero forward speed as it approaches the addressed concentric recording track. Because of the moving-mass inertia, some overshoot will occur, but the positioner is driven backward toward track 000 (the zero crossing of the detent signal) by the negative excursion of the Detent signal. When the carriage is locked over track 000, SEEK COMP signals will eventually be generated.

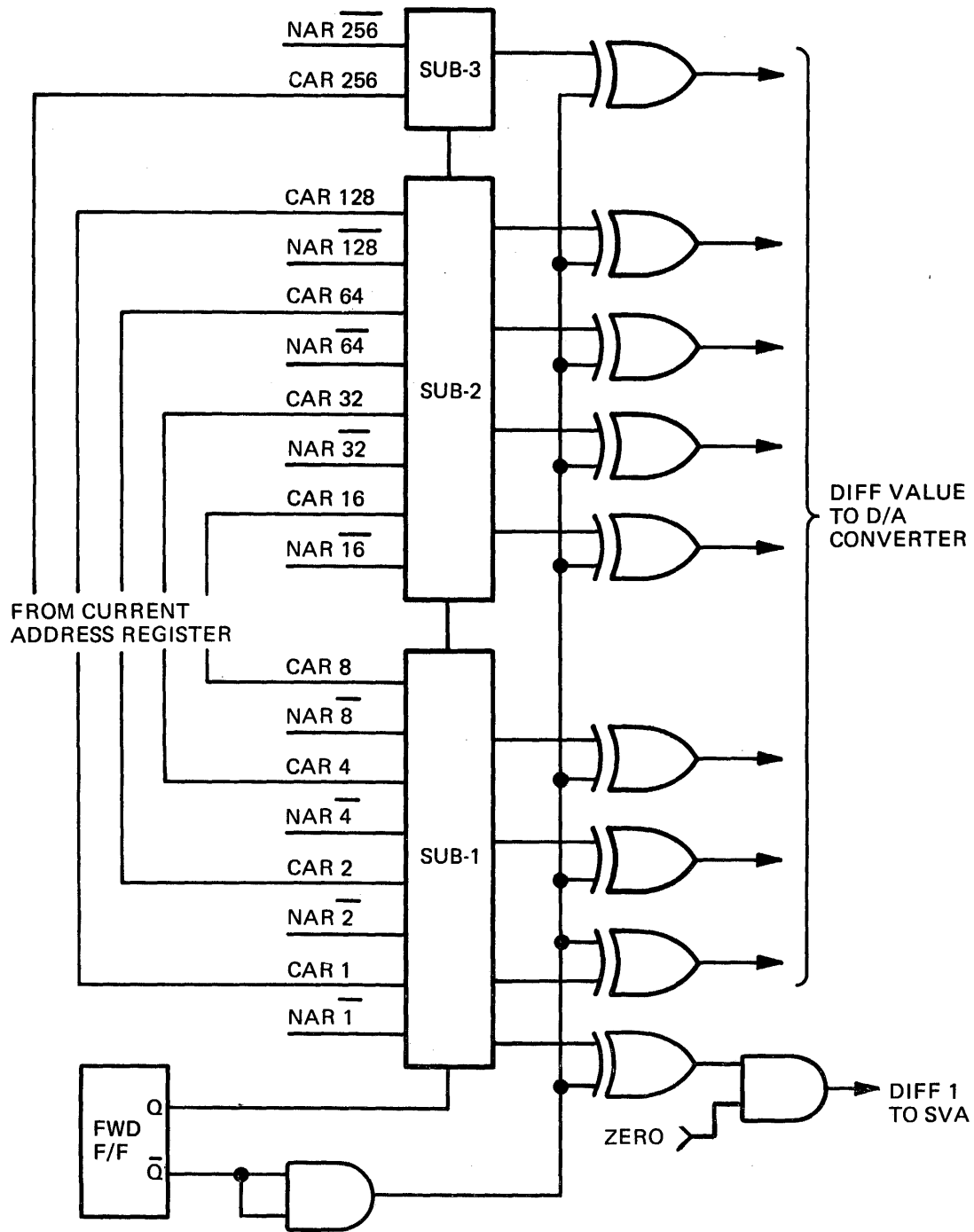
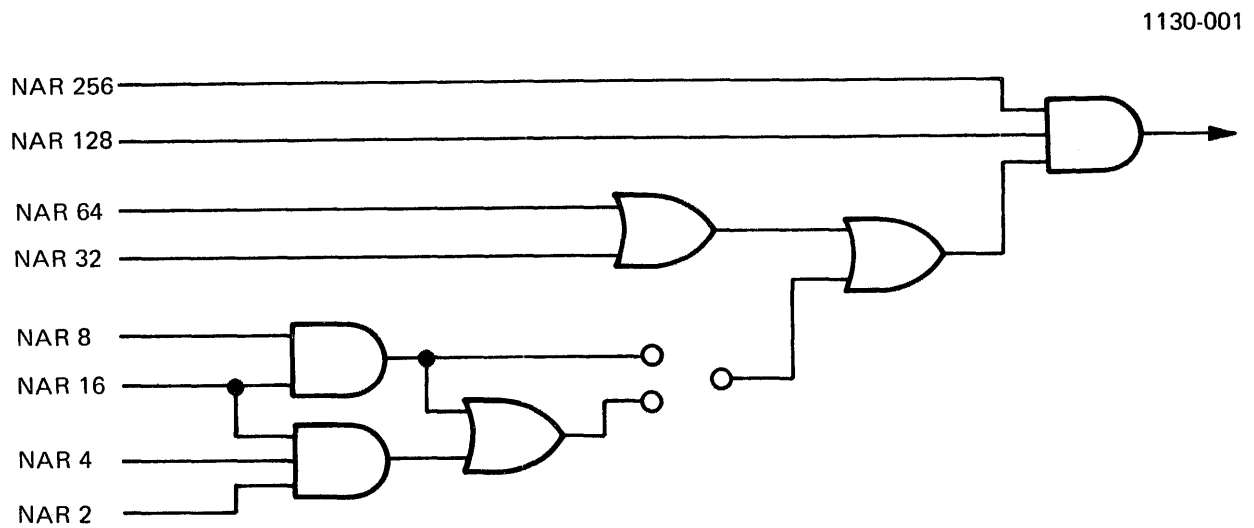
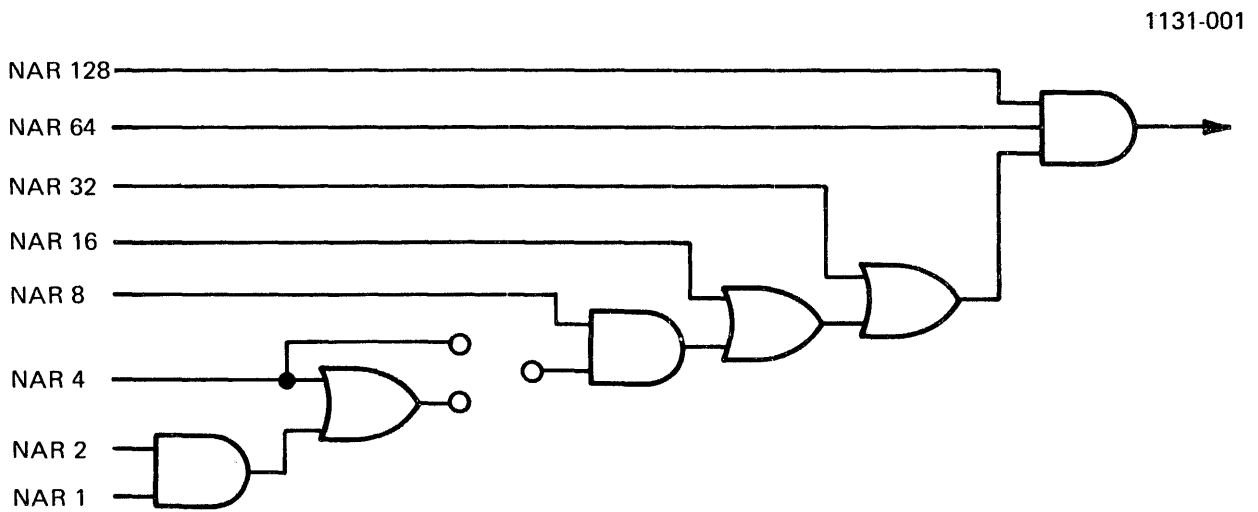


Figure 4-21. Subtractor Circuit – 200 TPI



a. ILL ADD Decoder – 200 TPI



b. ILL ADD Decoder – 100 TPI

Figure 4-22. Illegal Address Gating Circuits

4.5.4.8 Detent Pulses. As the carriage moves the Read/Write heads radially across the concentric recording tracks, the optical position transducer detents the track crossing as described in the mechanical description of the head positioning servo system. The position transducer transmits a series of modified sinewave signals to the SVA board (see Figure 4-11) through the Detent Amplifier board. There, the pulses are shaped and amplified; then, depending on the phase of the modified sinewave, the DET ODD or DET EVEN pulses are produced. These pulses are gated with the selected output of the FWD flip-flop to produce the signal required to increment or decrement the Current Address Register.

4.5.4.9 Zero Difference. The updated output from the CAR is constantly compared to the binary cylinder address stored in the NAR during a Seek operation by the SUBTRACTOR. When the SUBTRACTOR detects that the current value in the CAR equals that stored in the NAR, a ZERO signal is generated. This signal enables the set input of the Detent f-f, and this f-f will be clock-set when the Delay Detent one-shot times out.

4.5.4.10 Temperature Compensation Voltage (TCV). The TCV signal (used on the 200 TPI Disk Drive only) provides temperature compensation consisting of an analog signal proportional to the ambient temperature within the Disk Drive. This is accomplished by processing the output of a thermistor located on the base of the chassis. The analog signal is set at zero tolerance at the mid-point of the operating range. A procedure to be used in monitoring operation of the temperature compensation circuit is described in Section 5.

4.5.5 SERVO AMPLIFIER BOARD (SVA)

4.5.5.1 Board Functions. The main functions performed by the logic circuits on this circuit board include:

- A. Provide drive current to positioner motor
- B. Generate BOT and Detent pulses
- C. Energize Servo motor relay

A block diagram of the SVA circuit board, showing the principal signal paths and functional blocks, is shown in Figure 4-23.

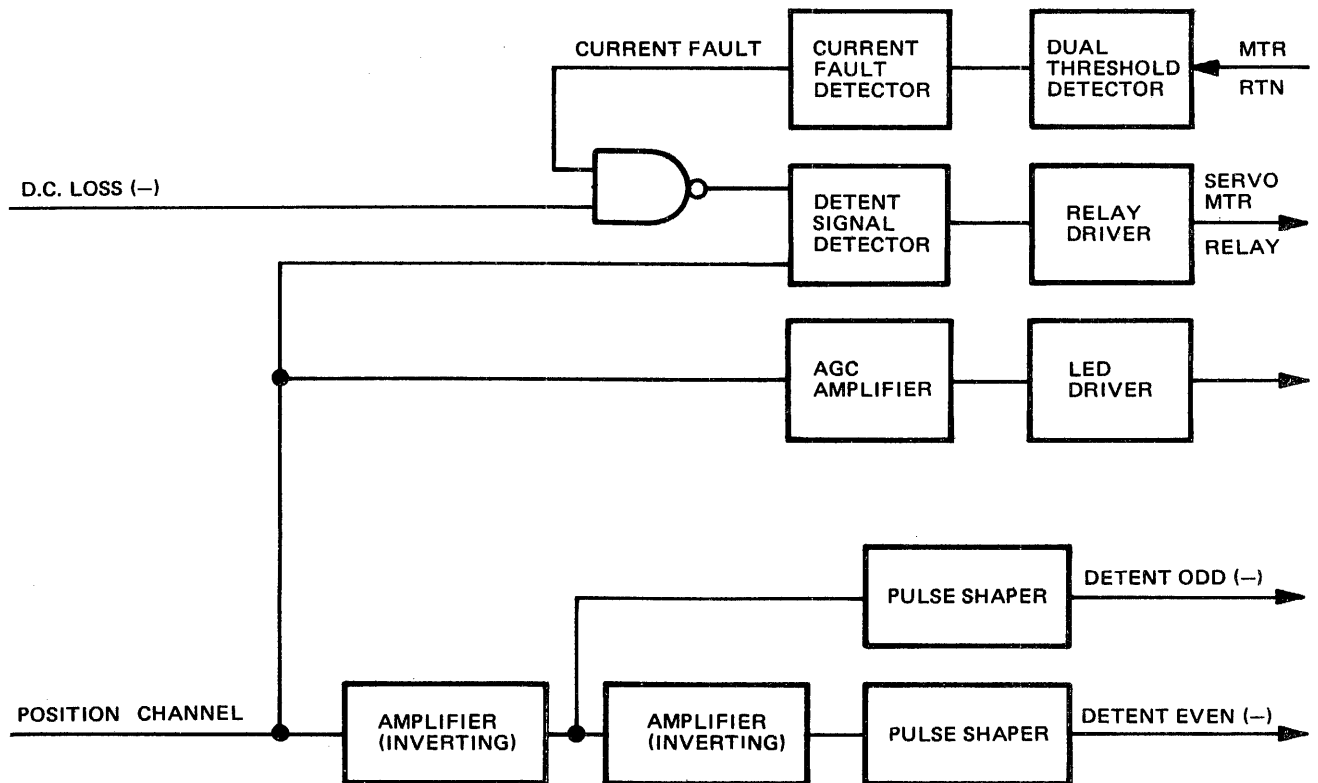
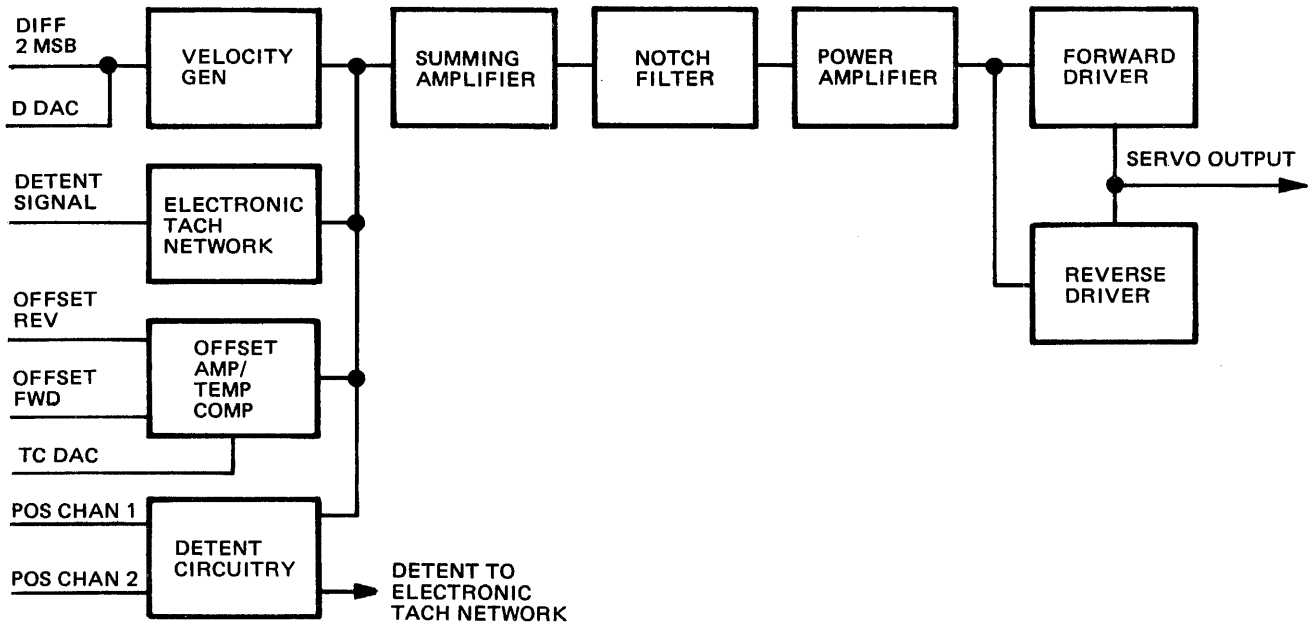


Figure 4-23. Block Diagram of Servo Amplifier Board (SVA)

4.5.5.2 D DAC Input. The SVA receives the output of the Digital-To-Analog Converter from the SLB. In the Velocity Ramp Generator it will appear as shown in Figure 4-24. The illustration represents the output of the D-to-A Converter as it converts the difference count from the subtractor. Note that when the difference count is maximum, the D DAC signal is maximum amplitude; and as the difference count reduces (value in the CAR approaches the value stored in the NAR), it will correspondingly decrease in amplitude. The output of the Velocity Ramp Generator and its inverted signal are applied simultaneously to two FET's.

During a LOAD or UNLOAD operation, the corresponding FET (LOAD or UNLOAD) will be activated by the state of the LOAD/UNLOAD signal and either the high \bar{Q} or low \bar{Q} output of the FWD f-f from the SLB to produce the Servo Velocity signal.

During a Programmed Seek operation, the corresponding FET (FWD or REV) will receive the Velocity Ramp Generator signal. The selection of one of these FET's is accomplished by the high or low \bar{Q} output of the FWD f-f which is enabled by the FWD/REV EN signal from the SLB. The Servo Velocity signal would then be applied to the Summing Amplifier and the FWD or REV Driver to develop the Servo Amplifier Output signal for carriage positioning.

4.5.5.3 Electronic Tachometer Network. This network monitors the Position Transducers POS CHANNEL signal. The network senses the carriage velocity and generates a voltage that is applied to the same two FET's as the Velocity Ramp Generator signal. A correction voltage will appear at the output of the Summing Amplifier to either speed up or slow down the carriage to its intended speed. The velocity signal is also applied to the LOAD/UNLOAD FET's and controls those velocities in the same manner.

4.5.5.4 Positioner Transducer Signals. These signals are routed to the SVA from the Positioner Transducer through the Detent Amplifier PWB. They are used on the SVA to produce the Electronic Tach signals, Detent ODD and EVEN pulses, Detent Fault Detection signal and for final DETENT operation. The signals are called POS CHANNEL 1 and 2. The DETENT signal is a composite signal derived from the outputs of the photo diodes in the Positioner Transducer POS CHAN 1 and POS CHAN 2. (Generation of electronic tach signals is explained in the preceding paragraph.)

Detent ODD and EVEN pulses are generated by shaping the DETENT signal into digital pulses which are used on the SLB.

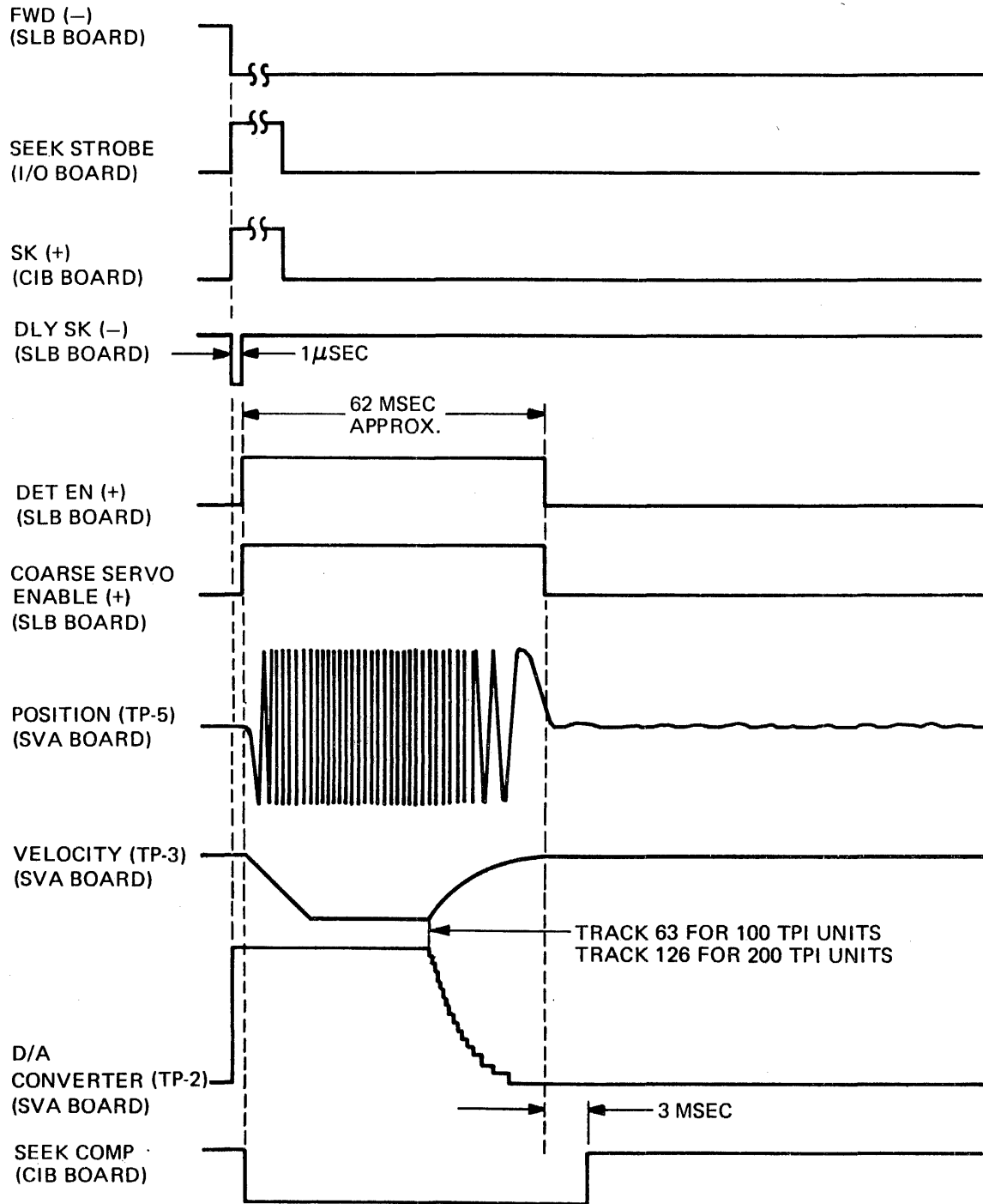


Figure 4-24. New Address Seek Operation Waveforms

The Servo Velocity signal is active until the Read/Write heads are within one-half track of the address stored in the NAR. At this time, the Detent Enable (DETENT EN) signal is generated, the Coarse Servo Loop is disabled, and the Fine Servo Loop is enabled. The servo detents (locks) the heads in place over the selected track. If the last track is even, detenting takes place on the negative slope of the DETENT signal. If the last address bit is odd, detenting takes place on the positive slope of the DETENT signal.

4.5.5.5 Track Offset. The Super Series Disk Drives have, as a customer option, the ability to retrieve marginal data. Two inputs from the controller allow the positioner to be moved a predetermined amount, approx. ½ mil, (0.0127 mm) in the desired direction (FWD or REV). These signals (TRK OFFSET FWD or TRK OFFSET REV) are used to recover marginal data during Read operations and must not be used when writing. Offsetting is accomplished by injecting a small current into the Detent circuitry.

4.5.5.6 Beginning Of Travel. The BOT pulse from the Positioner Transducer is amplified and shaped on this board before being routed to the SLB.

4.5.5.7 Positioning Servo System. Head positioning to a desired track is accomplished by means of the Positioner servo system. This system, a block diagram of which is shown in Figure 4-25, consists of a positioner actuator, a velocity servo loop, a position servo loop, a summing amplifier, and a servo amplifier. When the spindle motor comes up to speed, the IDX pulses set the RDY 1 f-f and cause LD HD signal to be generated and the LOAD/UNLOAD line goes high. The FWD signal is generated on the Servo Logic Board (SLB) when the LOAD f-f is set. The LOAD (L) signal goes low causing the FWD f-f to be reset. Then FWD (L) goes low and LOAD/UNLOAD goes high, and the Servo Amplifier is activated in the forward direction.

4.5.5.8 Ready Inhibit. This signal is generated only for 200 TPI disk drives. It is the output of the AMBIENT TEMP DETECTOR which is derived by comparison of the two temperature sensors (baseplate and air). When the two temperatures are equal, the RDY INHIBIT signal will be high allowing the READY signal to be sent to the Controller. This circuitry effectively inhibits controller READ or WRITE commands to the disk drive until proper temperature balance is achieved.

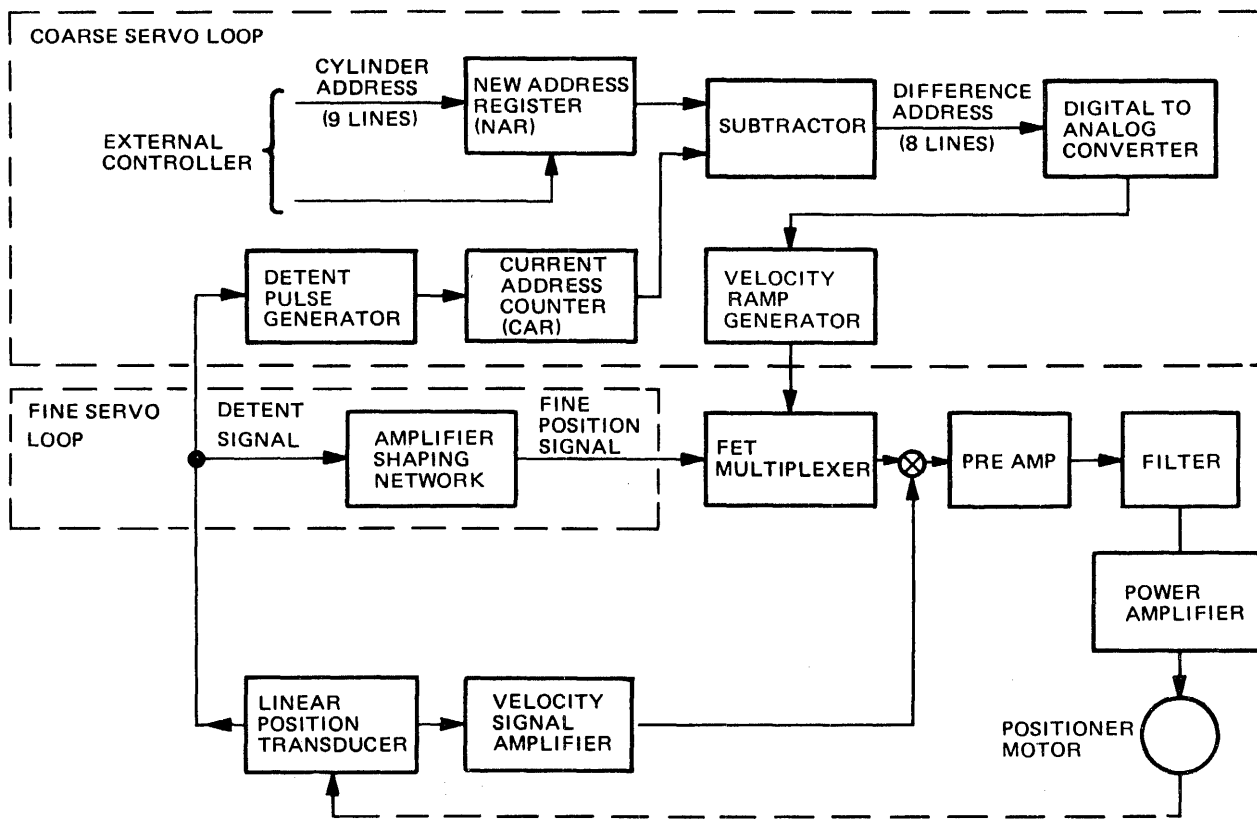


Figure 4-25. Positioner Servo

4.5.6 DATA ELECTRONICS BOARD (DEB)

4.5.6.1 Introduction. The Data Electronics Board contains the circuitry for processing I/O data to and from the external Controller on separate Read and Write channels and provides the necessary Write Protect logic to ensure that data are not erased. A block diagram of the DEB showing signal paths and circuit components is shown in Figure 4-26. Refer to the schematic of the Data Electronics board (in Volume 2) when following the circuit analysis.

4.5.6.2 Disk/Head Selection. The four cable assemblies from the Read/Write heads plug into receptacles mounted on this circuit board. The diodes shown next to the connectors on the schematic are selection diodes. The head activated is selected by decoding the HD SEL and DISK SEL inputs from the Controller. The NAND gates at the output of the decoder circuit are drivers used to ground the center point of the selected head. A logic diagram illustrating the decoding circuit is shown in Figure 4-27.

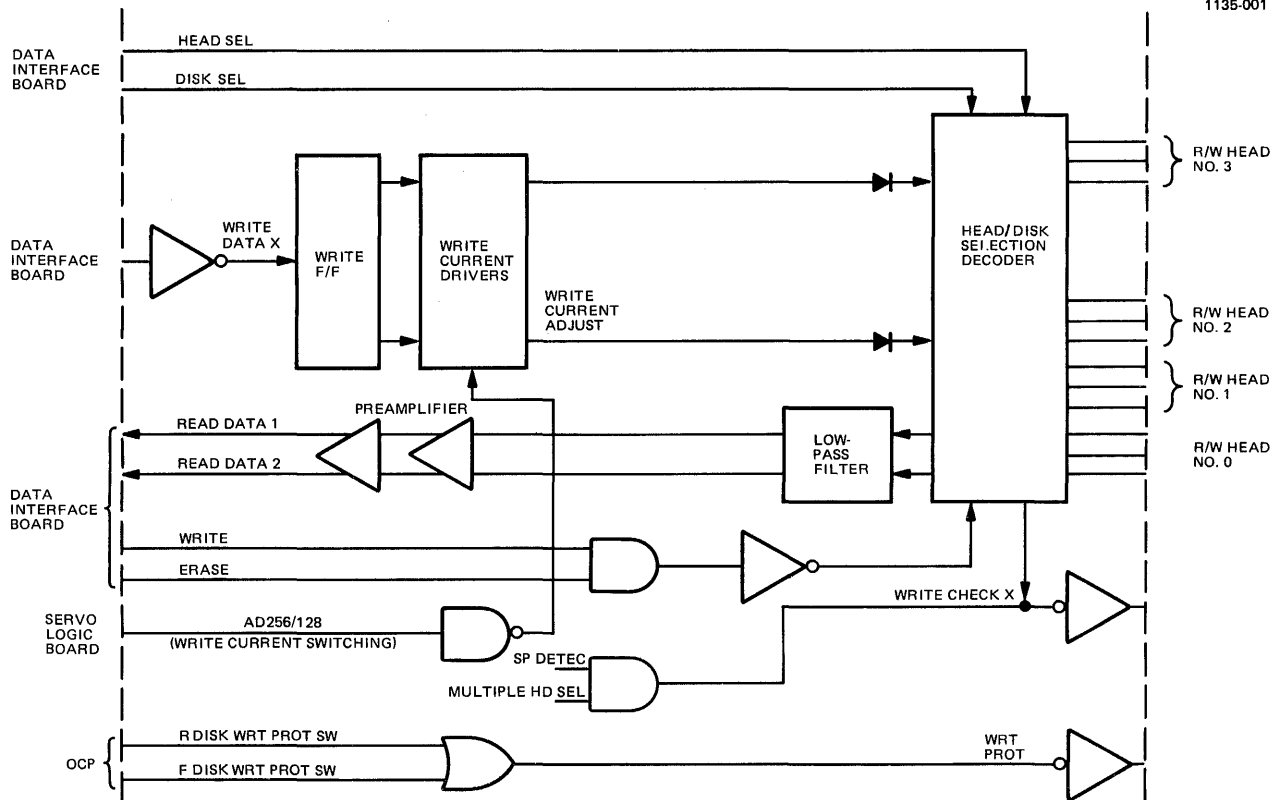


Figure 4-26. Block Diagram of Data Electronics Board (DEB)

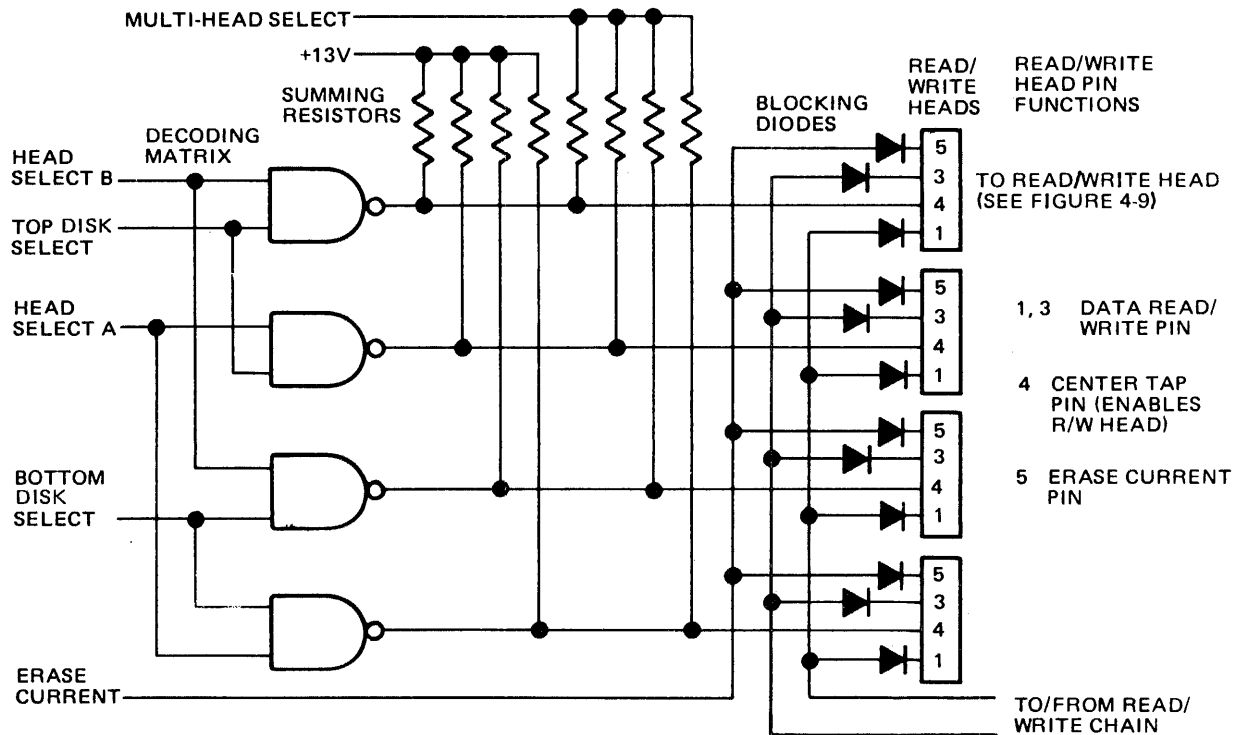


Figure 4-27. Disk/Head Selection Decoder

4.5.6.3 Read Operation. The sinusoidal output from the selected head is amplified and shaped by two differential amplifiers and a filter network. The outputs, READ DATA 1 and 2, are square wave pulses which are sent to the DIB for further processing.

4.5.6.4 Write Operation. The Write data are received from the external Controller on the WRITE DATA line. It is first processed by circuitry on the Data Interface Board then sent to the Write circuits on the Data Electronics Board (DEB). The WRITE DATA signal toggles the Write f-f; the true or false outputs of which are routed to the two Write current drivers. See Figure 4-28. The f-f is enabled or disabled by the output of an AND gate, and writing will be inhibited if either or both inputs to this gate are low. One input will be low if the WRITE signal (developed from the WRITE GATE) is low as determined by the Controller. The other input will be low under the following conditions:

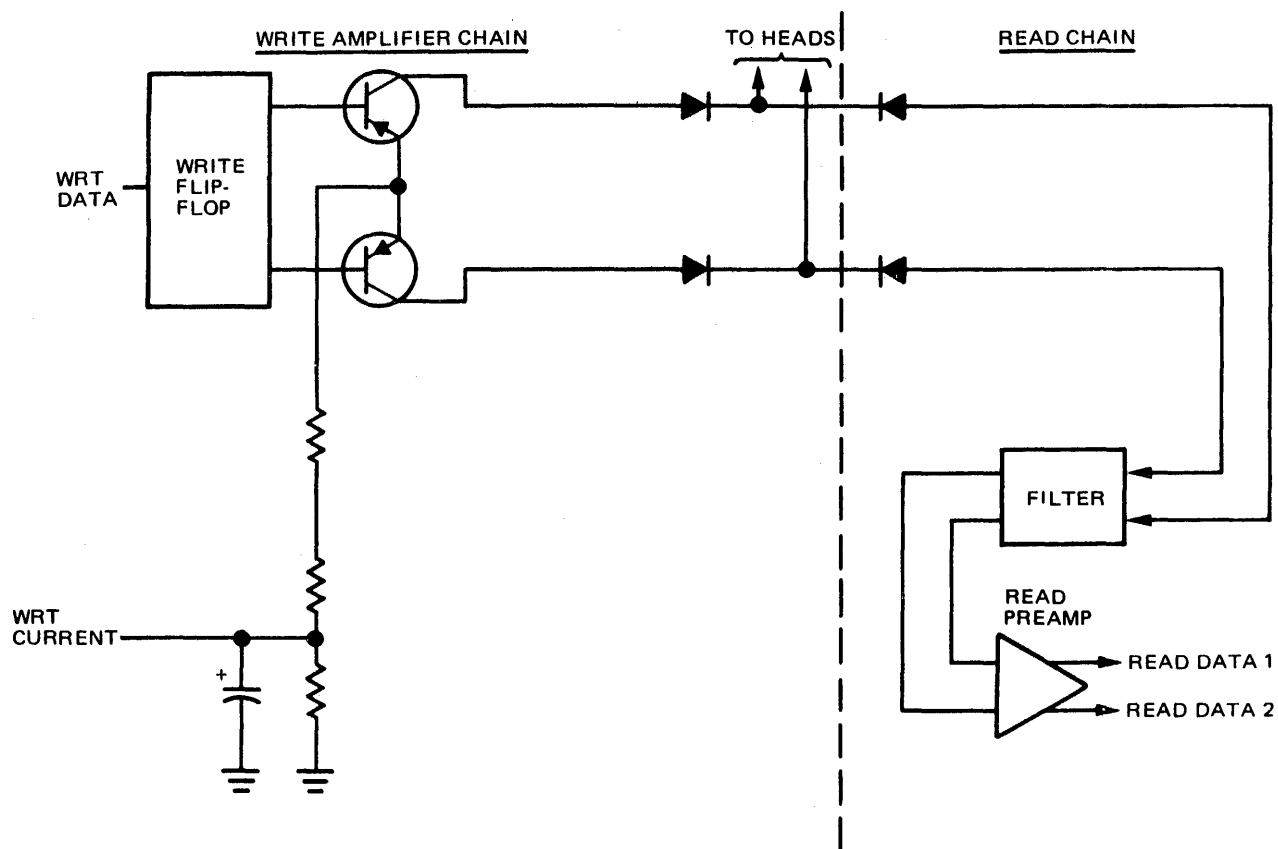


Figure 4-28. Block Diagram of Read/Write Amplifier

- A. The fixed disk PROT FIXED switch on the OCP is depressed and the fixed disk is selected.
- B. The removable cartridge PROT CART switch is depressed and the removable disk is selected.
- C. The SP DETEC input from the Disk Control Board (DCB) is high and/or two or more Read/Write heads are selected simultaneously.
- D. Write Inhibit from Control Interface Board (CIB) is low.

NOTE

Combinations of A, B, C or D can occur simultaneously except A and B (Both disks cannot be selected at the same time.)

If none of the inhibiting conditions exist, the Write f-f will be enabled. The f-f will change state for every Write data pulse and will supply base drive to one of the two transistors. Whichever transistor is gated on will deliver Write current to one of two diodes, and Write current will flow into the selected head. A timing diagram showing the relative waveshapes of Read and Write data is shown in Figure 4-29.

4.5.6.5 Erasing. Current for the erase coil is supplied by the Erase Drivers which are gated on automatically when the WRT signal is received or when the ERASE signal itself is received. The erase gap on each side of the data track is used to erase both edges of the written track to improve reliability of the written data. See Figure 4-30. The erase current also flows through the Erase Current Detector which monitors the erase current. If an erase current problem occurs, the Erase Current Detector will activate the WRT/ERASE Current Fault Detector. This would halt any Write or Erase operation in progress.

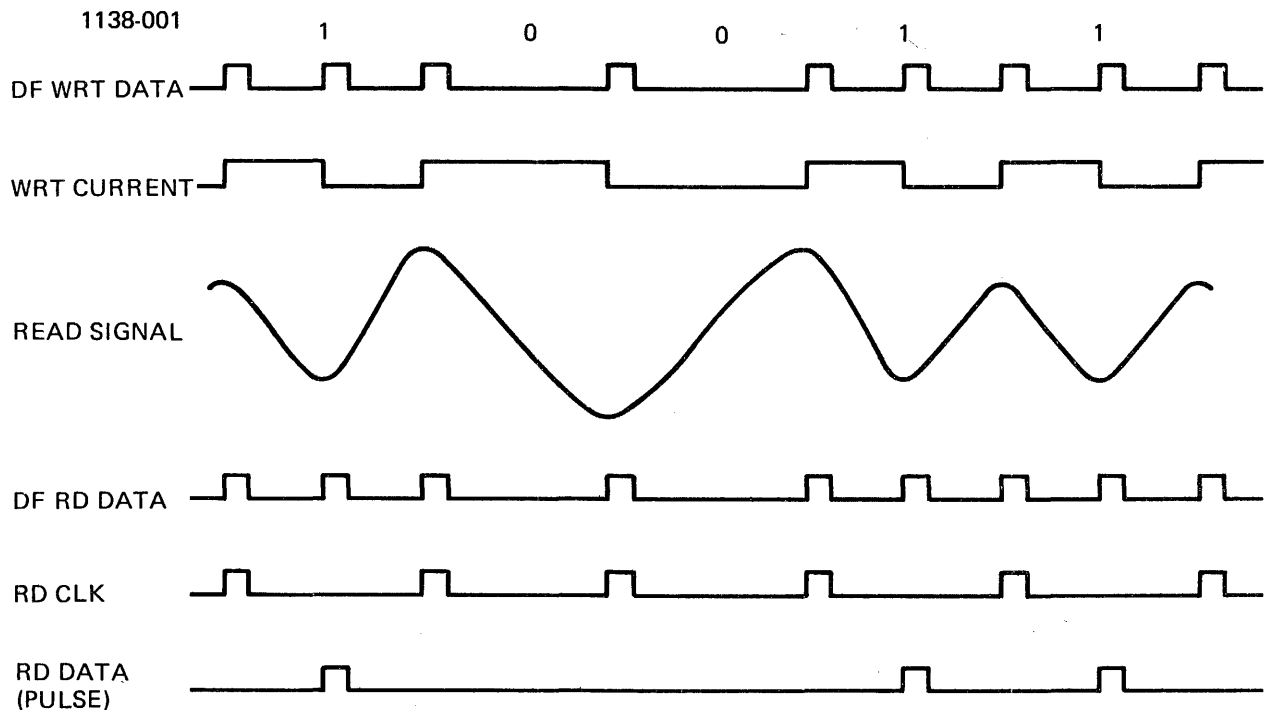


Figure 4-29. Read/Write Signals – Relative Timing

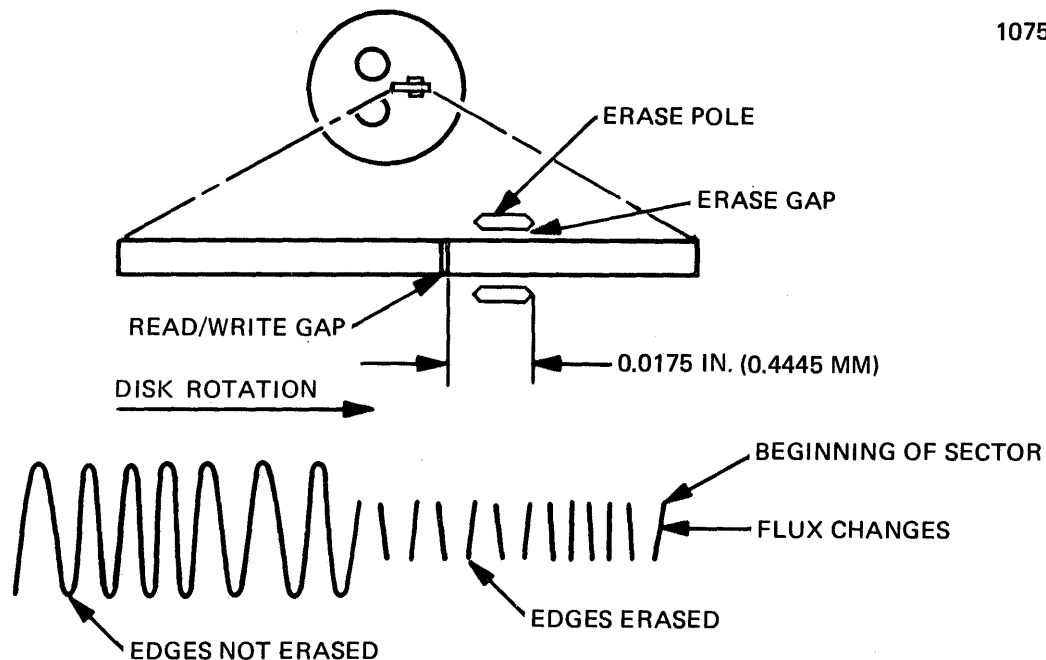


Figure 4-30. Edge Erasing

4.5.6.6 Write Current Switching. During a Write operation, the current to the write coil in the Read/Write head is decreased as the most significant output line from the Current Address Counter (CAR) goes high. This will be the AD256 line on 200 TPI Disk Drives or AD128 on 100 TPI units. Specifically, tracks 000 through 255 (127) are written with a higher current (approximately 35 milliamperes) than tracks 256 through 407 (128 through 203). The Write current on these tracks is decreased to approximately 30 milliamperes. Since recording density increases in proportion to the track number, improved bit resolution is obtained if the inside tracks are written with a lower level of Write current. The process is performed in the following manner: the most significant bit of the new cylinder address is routed to the Data Electronics Board (DEB). This signal goes high when the head changes from track 255 to track 256 (127 to 128). As a result, when signal AD256 goes high, less Write current is caused to flow into the emitters of the two Write amplifiers, and the remainder is shunted to ground.

Conversely, when the head position changes from track 256 to 255 (128 to 127), the output of the NAND gate goes high. Thus, the Write amplifier current drivers are switched back to the higher current level.

4.5.6.7 Write Protection. If writing is conditionally inhibited because of a spindle speed deviation of more than 1% or because of multiple head selection, a corresponding status signal, WRITE CHECK, is transmitted to the Controller. The internal signal, WRT CHK is developed at the output of the inverter. If writing is unconditionally inhibited by means of the PROT R or PROT F, a corresponding status signal, WRITE PROT, is transmitted to the external Controller. Also, if there is write current when not selected for a Write operation or no write current when selected for a Write operation.

4.5.6.8 DC Voltages. This board also contains circuitry for monitoring all power supply DC voltages. In the event of the loss of any DC voltage, the signal DC LOSS will be generated and sent to the CIB to reset the RDY f-f and to the DCB to reset the RETRACT f-f. Another function of this board is to regulate ± 13 VDC.

4.5.7 CONTROL INTERFACE BOARD (CIB)

4.5.7.1 Introduction. The Control Interface Board provides a means for transferring separated Index and Sector pulses to the external Controller. It also contains circuitry for controlling the signals described in the following paragraphs.

4.5.7.2 Seek Complete and Ready. When Detent Enable (DT EN), from the SLB goes high, it triggers the 3 msec Seek Complete Delay one-shot (SKC DLY O/S) and enables the D input to the Seek Complete (SKC) f-f. When the SKC DLY O/S times out, the negative transition will clock the SKC f-f set. The Q output enables the D input to the RDY f-f and one leg of an AND gate which is presently disabled by the Q output of the READY f-f. The next FIDX pulse after RDY INHIBIT goes high will clock the RDY f-f set which will generate both SEEK COMP and READY signals to be sent to the Controller. See Figure 4-31.

4.5.7.3 Seek Strobe. This pulse (approximately 400 nanosec) triggers the 200 msec Seek Incomplete Delay one-shot (SKINC DLY O/S). By the time the one-shot times out, either the Illegal Address (ILL ADD) or Seek Complete (SKC) f-f is set. If neither f-f is set, the Seek Incomplete (SKINC) f-f will reset and generate the SEEK INCOMPLETE status signal to the Controller.

4.5.7.4 Return-To-Zero. If a RESTORE command is received in the Controller, the RESTORE signal will go high and trigger the 12-usec RTZ O/S. This will generate the RETURN-TO-ZERO signal to the DCB, which in turn, will generate the RTZ signal to the SLB to start carriage retraction. It also triggers the SK DLY O/S whose Q output is used on the SLB in conjunction with the RTZ signal to ensure the carriage retracts to track 000.

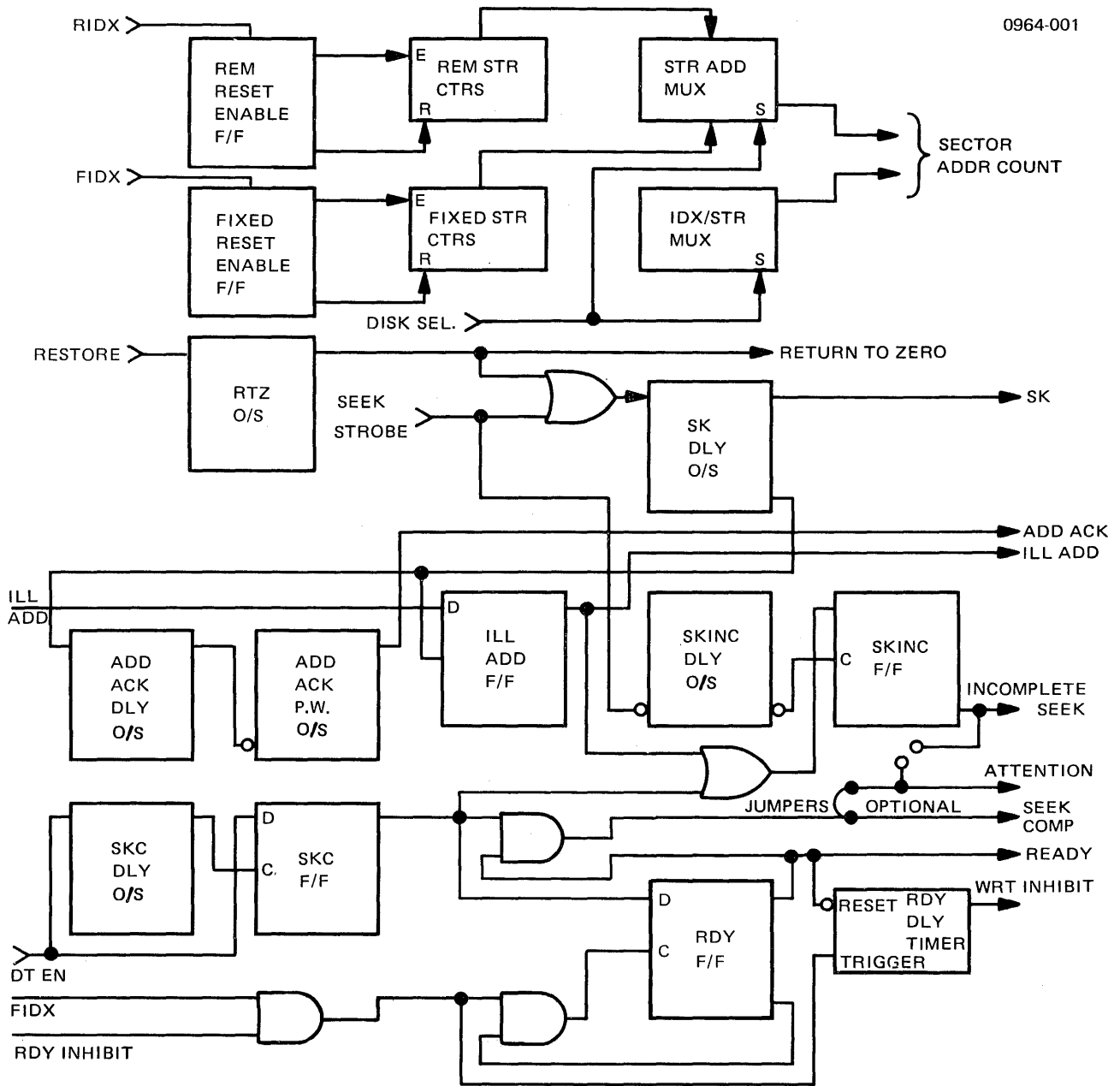


Figure 4-31. Block Diagram of CIB

4.5.7.5 Current Sector Identification. The Index pulse will cause its respective Sector Counters to be reset and enabled. From then on, Sector pulses will be counted during one full revolution of the disc. The counter outputs are input to multiplexers. There, the Disk Select signal will choose which multiplexer outputs (fixed or removable disk) are to be presented to the Controller. Thus, the Controller is made aware of what sector is passing under the Read/Write heads at any given time. See Figure 4-32. Customer option jumpering is available.

4.5.7.6 ATTENTION. This signal is jumper optional and can be generated in various ways.

4.5.7.7 WRT INHIBIT. This signal is generated each revolution by the FIDX pulse as long as the READY f-f is not set.

4.5.8 DATA INTERFACE BOARD VFO II (DIB)

4.5.8.1 Introduction. The Data Interface Board supplies double frequency-encoded Write data from the external Controller to the DEB. Other signals pass through this board coming from, or going to, the Controller. In addition, NRZ-coded data is converted to double frequency-encoded format for writing on the disk, or from double frequency-encoded data back to the original NRZ format after it is read from the disk. This function is performed by the Voltage Controlled Oscillator (VCO).

4.5.8.2 Edge Discriminator Operation. At the point where the Read data first enters the DIB, it is essentially a square-wave input. The first stage of the bidirectional one-shot is a differential amplifier which is used as a limiter. The second portion is used to form pulses on each edge of the input pulse as shown in Figure 4-33. Thus, a pulse is generated for each flux reversal recorded on the disk during a Write operation. In effect, the output from the edge discriminator is representative of the double frequency-encoded data written on the disk. The first clock pulse received from the edge discriminator after gating is enabled by RD ENABLE will set the RD SYNC A f-f. The second clock pulse then sets the second gating f-f RD SYNC B. The width of the output pulses from the edge discriminator is 150 to 160 nanoseconds for a 1500 rpm Disk Drive or 100 to 110 nanoseconds for a 2400 rpm Disk Drive.

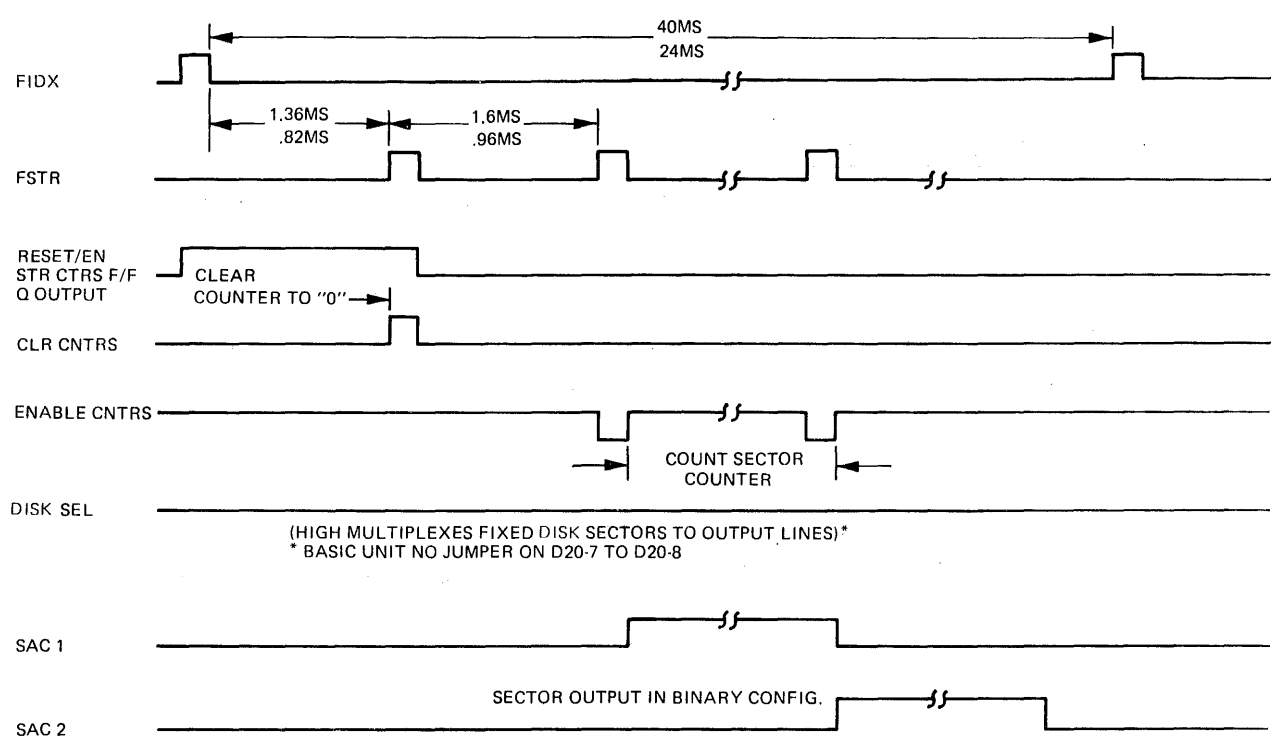


Figure 4-32. Current Sector Identification (CIB)

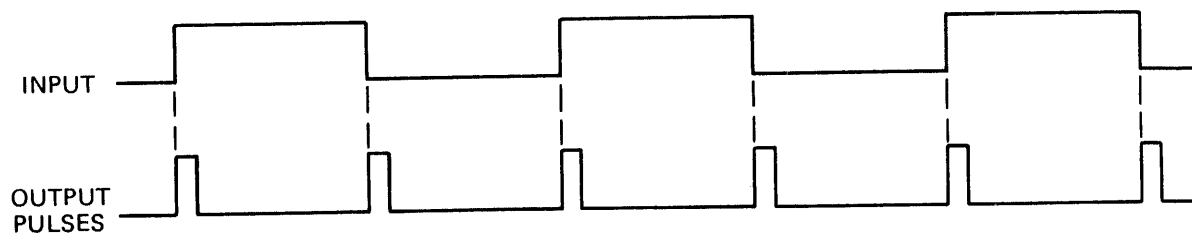


Figure 4-33. Output of Double-Edge Discriminator

4.5.8.3 Voltage Controlled Oscillator Operation. Signals RD DAT 1 and RD DAT 2 from the Data Electronics Board (DEB) are applied to the edge discriminator in order to form the pulse characteristics (see Figure 4-33). The output pulse of this unit will have the desired pulse width due to the external RC timing network. The value of the components comprising this network will be determined by the bit cell time. The output of the bidirectional one-shot constitutes raw data (clock signal intermixed with data) which will be used as the clock term for the RD SYNC A and RD SYNC B flip-flops.

During Standby or Write operations, the output of the local oscillator is ANDed with the Q output of the RD SYNC B f-f to provide a reference frequency to the phase detector. This input will be compared to the phase-lock loop made up of the voltage-controlled oscillator and frequency-divider circuit. Any phase difference will generate a correction voltage to the VCO.

When the RD GATE signal goes true, the enabling RD SYNC A f-f will be set on the next pulse from the bidirectional one-shot. The Q output of the RD SYNC A f-f will start the DATA 1 lock-out which will allow the output of the VCO to sync with the incoming data. After DATA 1 lock-out times out the next data pulse will set the DATA SYNC "A" f-f. Data and clocks will be generated. See Figure 4-34.

If a phase difference exists between the two inputs to the phase detector, a correction voltage is sent to the voltage-controlled oscillator (VCO). The output of the VCO will increase or decrease due to this correction voltage. The output of the VCO is inverted and used as the clock term for the VCO frequency divider. The false output of the frequency-divider network is ANDed with that of the VCO, and this term is used to provide a clock input for the RD DATA A and RD DATA B flip-flops.

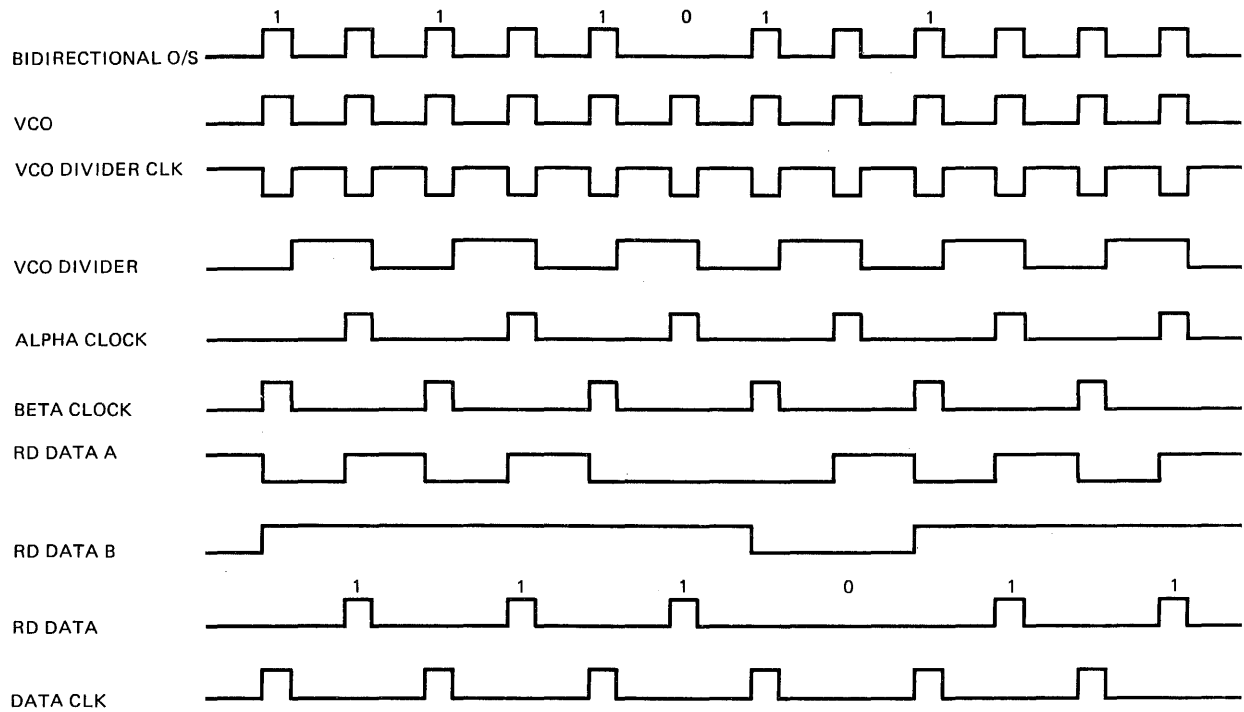


Figure 4-34. Data Interface and VCO. Timing Diagram

The true output of the RD DATA B f-f supplies data in NRZ format to the Controller when this option is selected. If DF (pulse) format is selected, the true output of the RD DATA B f-f is ANDed with the Alpha clock, and double-frequency-encoded data are sent to the Controller via the EIB and IOB logic circuits. As shown in Figure 4-35, a clock pulse initiates the writing or reading of each bit cell. If a digital "1" is to be recorded, a second pulse will occur in the center of the bit cell and a flux reversal will occur. If a digital "0" is to be recorded, no pulse will occur during the bit-cell time, and no flux reversal will occur until the clock pulse that initiates the next bit-cell period.

4.5.8.4 Read Operation Complete. When the Read operation has been completed, the Controller notifies the Disc Drive. The RD EN GATE line drops thus inhibiting further reading from the disk. At this time, the output of the free-running oscillator again will become the reference frequency for the phase detector.

1140-001

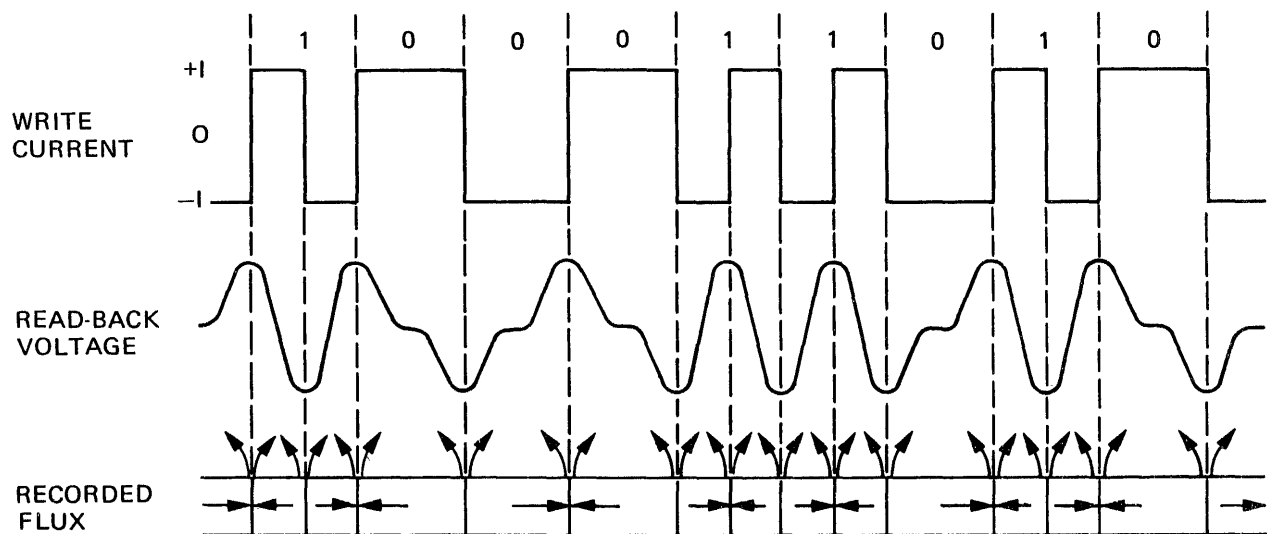


Figure 4-35. Double-Frequency-Modulated Waveshape

4.5.9 MODIFIED FREQUENCY MODULATION (MFM) BOARD

The MFM board is used in Disk Drives designed for 4400 BPI recording density. It replaces the DIB in J1 of the EIB and has two major functions. During a Read operation, it decodes MFM data into either NRZ or Pulse data; during a Write operation, it encodes NRZ into MFM data.

4.5.9.1 Read Operation. During Standby or Write operations, the Voltage Controlled Oscillator (VCO) will be kept locked to a 5 MHz clock signal from the Write circuitry as shown in Figure 4-36. NAND gate 1 will be enabled by the outputs of the READ SYNC and READ PHASE circuits. The 5 MHz clock will be routed to the PHASE DETECTOR circuit as a reference clock.

The outputs of the DATA SEPARATOR and VCO are disabled at this time, and WRT CLK from the Write circuits will be sent to the Controller through OR gate 4. When READ GATE goes high, indicating a Read operation is to take place, NAND gate 1 and WRT CLK will be disabled.

READ DATA is input to the Crossover Detection circuitry. NAND gate 2 is now enabled by the READ SYNC output and the READ PHASE O/S after it times out. The ENABLE input to the VCO will go active, and READ DATA will be routed to the DATA SEPARATOR and PHASE DETECTION circuits and cause the VCO to lock to the READ DATA.

Depending upon jumper option, either NRZ or Pulse data will be sent to the Controller; also, by jumper option, adjustment of clock timing within a bit cell time is available.

4.5.9.2 Write Operation. The Seek Complete (SEK COMP) signal, WRITE GATE, and ERASE GATE are the enabling terms for Write operations as shown in Figure 4-37. ERASE and WRITE are gated to the DEB, and WRT DATA is gated to the D input of the first stage of a 4-bit shift register (whenever the WRITE GATE signal is low, the 4-bit shift register is kept cleared). The 4-bit shift register is clocked by 5 MHz divider f-f Q output. Write Clock-To-Data timing adjustment is provided to compensate for variations in user Controller data strobe timing and I/O cable length.

The WRT DATA information contained in the B and C stages of the 4-bit shift register, and the combination of outputs from gates 4, 5, and 6 make up the NRZ to MFM encoder. The contents of the shift register and the multiplexer will enable one of the NAND gates (7 through 9 depending upon the incoming data pattern.) This accomplishes Write compensation of the MFM data.

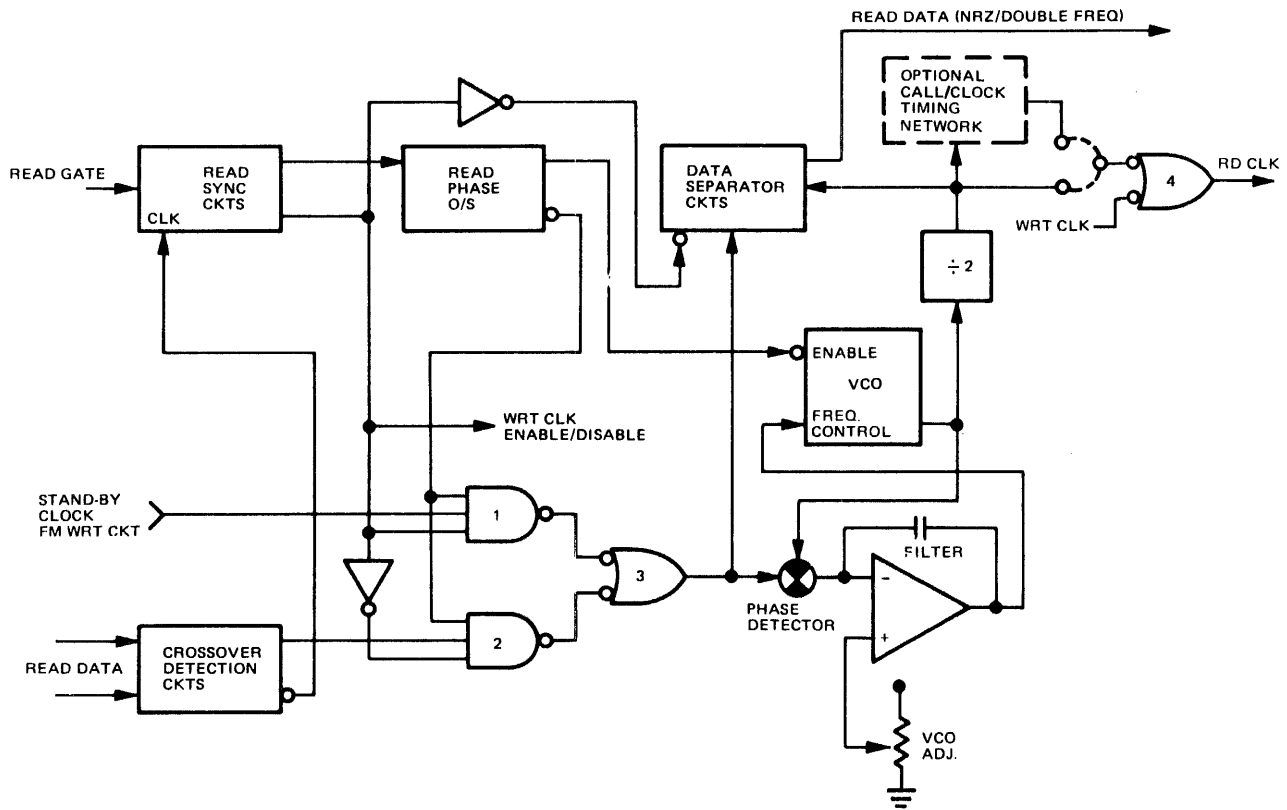


Figure 4-36. Simplified Logic Diagram – Read Circuitry

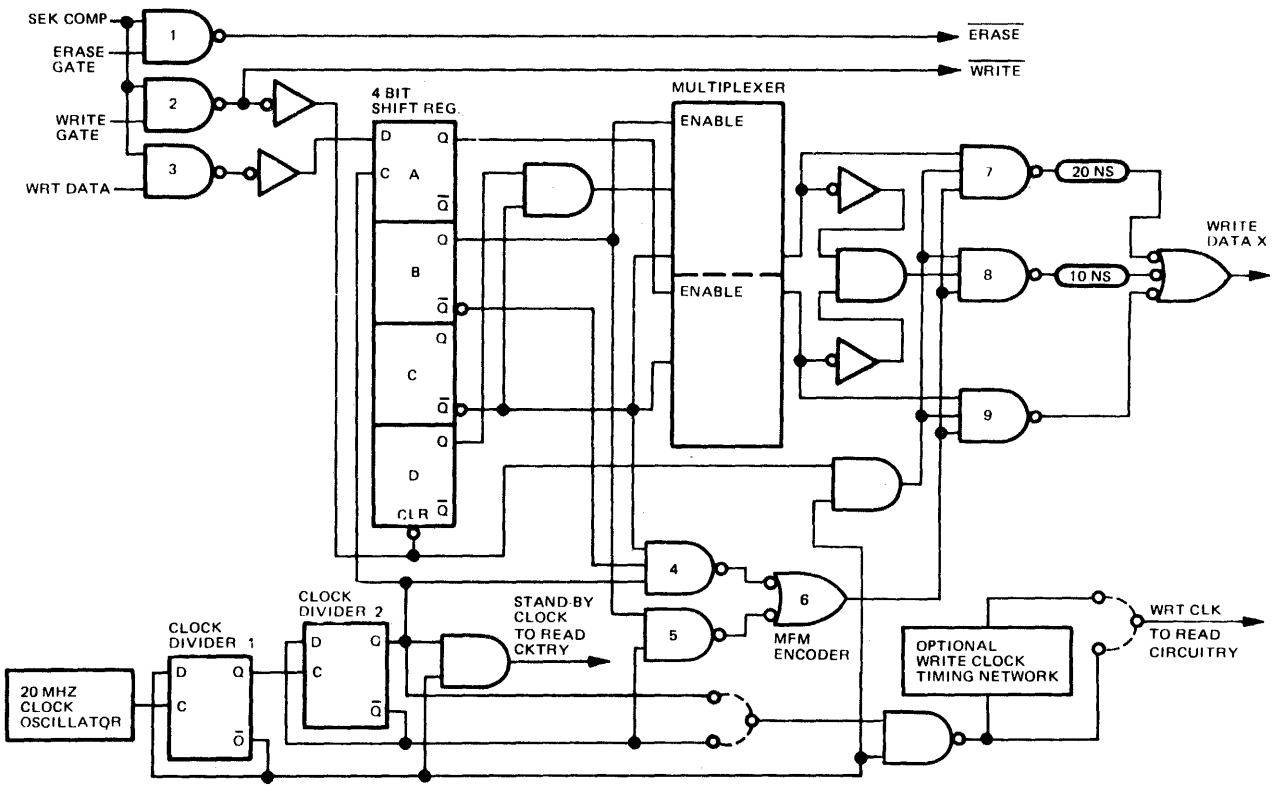


Figure 4-37. Simplified Logic Diagram – Write Circuitry

4.5.10 SPINDLE DRIVE LIMITER BOARD

This board, which is located in the plenum chamber next to the Motor Drive Power Switch Board, is a current limiter that provides motor current. A power transistor is connected as a current limiter (approximately 7 A). There is a resistor in parallel to provide more current during start and brake modes. Temperature sensing provides a means of turning off drive motor current in the event motor current is applied too long due to a circuit malfunction.

NOTE

These are two outputs, the current limiter output for the spindle motor, and +5V. The +5-volt output of a series regulator on this board provides the operating voltage for the TTL logic in the spindle drive and associated control circuits.

4.5.11 MOTOR DRIVE POWER SWITCH BOARD

4.5.11.1 Introduction. The Motor Drive Power Switch Board operates in conjunction with the Commutator Board to supply drive current to the spindle motor.

4.5.11.2 Board Operation. Refer to the schematic of the Commutator Board in Volume 2 when following the circuit analysis of spindle drive motor control.

The three CELL outputs from the Commutator Board are applied to the Motor Drive Power Switch Board at pins 4, 5, and 6. These inputs are routed to an auxiliary output which is required on some Disk Drives. These three signals are applied to a multiplexer.

When the Disk Drive is in the Run mode, the inputs are coupled directly through the multiplexer as shown in Figure 4-38; that is, from input pin 2 to output pin 4, from pin 5 to pin 7, and from pin 14 to pin 12. The three outputs from the multiplexer are then decoded in the decoder. Thus, one of the three motor phases is turned on according to which of the three CELL inputs is high, and the motor rotates. When the Disk Drive is operating in Brake mode, the three CELL inputs are decoded so that they are slightly out of phase with the motor phase requirements. Thus, the current inputs tend to brake the spindle motor.

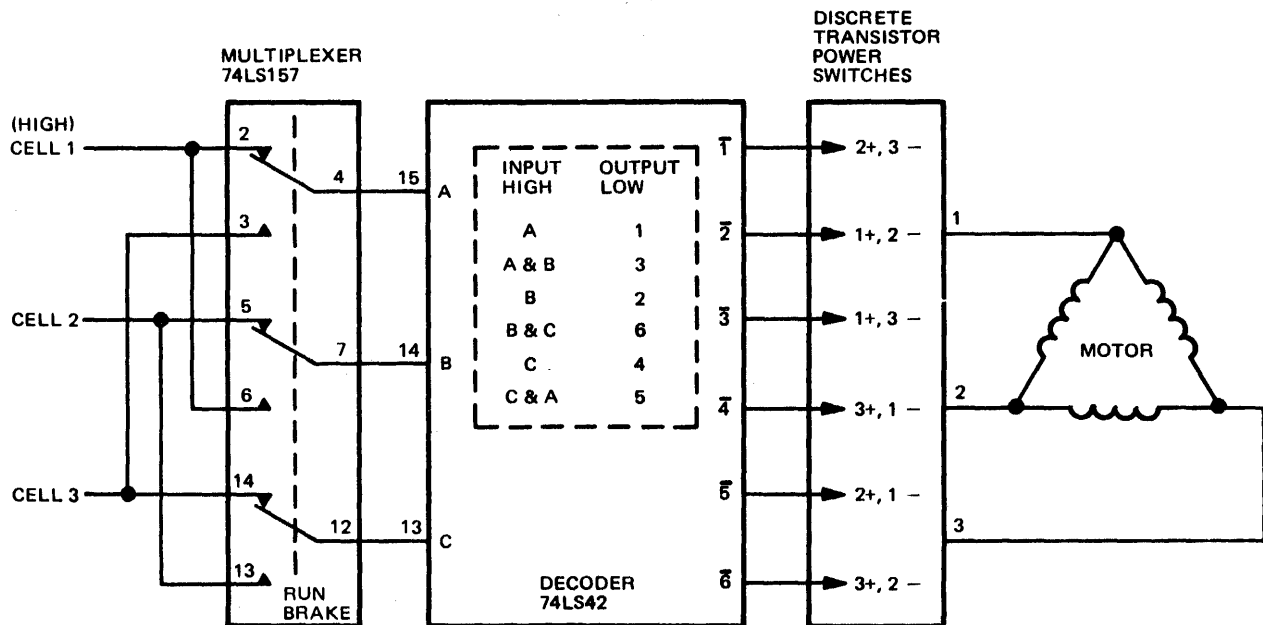


Figure 4-38. Simplified Diagram of Brushless Motor Circuit

4.5.12 COMMUTATOR BOARD

The Commutator Board is secured to the rear of the spindle drive motor assembly. The motor shaft protrudes through the hole in the center of the board. Three interruptor switches are mounted on the Commutator board. Each interruptor switch consists of a Light Emitting Diode (LED) on one side and a photo transistor on the other as shown on the schematic of the circuit board. A shutter is attached to the shaft of the spindle motor and rotates with it. As the shutter successively cuts off the light flow to two of the interruptor switches and allows the third switch to conduct, the three output lines labeled CELL 1, CELL 2, and CELL 3 are activated in turn. The output of the activated switch is routed through a comparator circuit to the Motor Drive Power Switch Board through connector P36 and turns on the applicable power phase. A constant 20mA. current source is provided to stabilize LED current, which adds to LED life expectancy.

Table 4-1 is an aid to trouble shooting the spindle drive motor. For example, if input lines CELL 1 and CELL 2 are high (cells seeing light while CELL 3 line remains inactive), the decoder will cause the No. 3 input to the three-phase motor to be low and lines 1 and 2 to be high. A simplified diagram of this circuit is shown in Figure 4-38.

Table 4-1. Normal Run Switching Sequence

	Cell High Seeing Light	Decoder		Motor Leads	
		In	Out (low)	+	-
180° Mechanical Rotation	1	A	1 (Pin 2)	2	3
	1 & 2	A & B	3 (Pin 4)	1	3
	2	B	2 (Pin 3)	1	2
	2 & 3	B & C	6 (Pin 7)	3	2
	3	C	4 (Pin 5)	3	1
	3 & 1	C & A	5 (Pin 6)	2	1
	Repeat				

4.5.13 EMERGENCY RETRACT BOARD

The Emergency Retract Circuit board is used to retract the carriage automatically in event of abnormal conditions. When the Disk Drive enters the Emergency Retract mode, the relay drops. This disconnects the Positioner motor from the SVA output and connects it to the Retract capacitor (located in the Power Supply). The Retract capacitor discharges through the Positioner motor. This results in the Positioner being driven in reverse, unloading the heads, and activating the Home Switch. The Home Switch turns off the current flow to the motor, and the Positioner remains in the fully retracted position.

A slightly modified version of this PWB is used in 20 megabyte Disk Drives (200 TPI, 4400 BPI). It provides the same functions, except it has a two-speed Retract.

Retract speed on 20 megabyte drives must be kept below 50 ips (127 cm/sec) during entire Retract or disk damage may occur as heads unload. Proper Retract speed is accomplished by a 100-Ohm resistor in series with Retract current. During Emergency Retract, as the carriage approaches track 025 (approximate; not critical), the reflective transducer senses the edge of the carriage mask and fires a transistor. This fires an SCR which shorts out the 100-Ohm resistor and applies full power to ensure heads unload.

4.6 SCHEMATIC DIAGRAM ANALYSIS

4.6.1 SCOPE OF ANALYSIS

The intent of this part of Section 4 is to provide the manual user with a sequential schedule of events as they would occur during an INITIAL SEEK, PROGRAMMED SEEK, RESTORE, or READ/WRITE operations. For the remainder of Section 4, all descriptions assume that power is ON and logic initialization has taken place.

4.6.2 INITIAL SEEK OPERATION

The Initial Seek discussion will be divided into four major functions:

- A. Spindle speed detection and control
- B. Head loading operation
- C. Initial seek to track 000 from home position
- D. Detent operation

4.6.2.1 Spindle Speed Detection and Control

This function can be further sub-divided into two operations:

- A. Initial start-up
- B. Speed detection and control

4.6.2.1.1 Initial Start-Up. When the RUN/LOAD switch is set to the RUN position, numerous events take place simultaneously. They will be discussed separately, but all occur in a very short period of time.

The first signal generated when the RUN/LOAD switch is activated is RUN (L) which is input to DCB as a constant low. It will trigger the 3.36-sec retriggerable SPM START O/S. The output of the one-shot will provide the gating input to the SPM MTR-ON NAND gate which will generate the SPN MOTOR ON (L) drive signal to start the spindle rotating. At the same time, it will turn on the brush motor, turn off the load indicator light, and de-energize the drawer/front panel lock solenoid.

As the brush motor turns, the brush tower will activate the BRUSH MOTOR SW signal (low) providing an auxiliary path to keep the brush motor turned on. This will be necessary because the counter circuits on DCB (activated by a free-running oscillator) will soon reach a count of 1024 which will clock the BRUSH MOTOR f-f set on DCB. Its \bar{Q} output will latch the f-f set and remove the enable term from the original brush motor drive path. When the brush cycle is finished (brushes return home) the BRUSH MOTOR SW will once again go high removing the drive to the Brush Motor.

4.6.2.1.2 Speed Detection and Control. The 3.36-sec SPM START O/S would eventually time out, so it is necessary to establish another means of maintaining the input to the SPN MOTOR ON NAND gate. On the Commutator board, CELL signals are periodically generated due to spindle rotation: the faster the spindle speed, the more frequently each CELL signal will be generated. Two of these CELL signals are put to use on DCB, CELL 3 and CELL 1. CELL 3 has two uses: (1) to repeatedly trigger the 3.36-sec retriggerable SPN SPEED DET O/S whose output will now maintain the generation of SPN MOTOR ON (L) whenever SPM ON SW is high; and (2) in conjunction with CELL 1, to detect improper spindle rotational direction. When the spindle is rotating in the proper direction (CCW), SPN CCW will be high and provide the D input to the RDY DLY "A" f-f on DCB.

As spindle speed increases, the frequency of Index pulse generation increases. In order to detect when spindle speed is fast enough to support head flight over the disk surface and to maintain or control that speed within $\pm 1\%$ of the designated operational speed, FIDX pulses and count decodes from the counter circuits on DCB are used.

While spindle speed is increasing, FIDX pulses are not arriving in time to keep the counters from reaching their maximum count (2048). This will inhibit Write operations (not necessary at this time but very useful later) and keep the carriage retracted. Carriage movement is inhibited by the RTZ signal generated by the \bar{Q} output of RDY DLY "A" f-f which is being held reset by the CNT 2048 f-f remaining set.

The CNT 2048 f-f will remain set until spindle speed is fast enough to allow a FIDX pulse to arrive before the count of 2048 is reached. When this happens, the positive transition of the FIDX pulse will reset the counters. Assuming the next FIDX arrives in time, the negative transition will clock the RDY DLY "A" f-f set (no longer held reset by the \bar{Q} output of the CNT 2048 f-f) which will allow RTZ to go low (Load operation can be initiated now). The present state combination of the two RDY DLY flip-flops also generates a LD HD (L) pulse exactly the width of an Index pulse (one of the gating terms). The next FIDX pulse (negative transition) will clock RDY DLY "B" set and generate RD1 which is used on CIB later to generate READY to controller at the proper time. Speed detection, to the point where it is safe to begin the Head Loading operation, is now accomplished.

However, before discussing the Head Loading operation, speed control (DCB) must be described (see Figure 4-14). Anytime the leading edge (positive transition) of an FIDX pulse arrives and the CNT 2000 f-f has been previously set by the counters, the SPM ON f-f will be reset and allow generation of the SPN MOTOR ON (L) (DCB) because the spindle speed is too slow. The trailing edge (negative transition) of the FIDX pulse resets the counters and the CNT 2000 f-f so that speed can again be tested on the next and succeeding disk revolutions.

If the CNT 2000 f-f is not set (count less than 2000) by the time the leading edge of an FIDX pulse arrives, the SPM ON f-f D input will be high and will set. This disables the SPN MTR-ON NAND gate and the spindle motor will slow down. This pulsing of the motor will maintain the speed within design tolerances.

In the event the motor should, for any reason, slow down so that the CNT 2048 f-f became set, its \bar{Q} output would reset the RDY DLY "A" f-f which in turn would initiate a retract operation (RTZ would go high). The reason for this is speed could diminish to the point that proper head flight would not be maintained, and severe damage to heads and disk surfaces could result.

4.6.2.2 Head Loading Operation. The major portion of this discussion will be in reference to SLB. Signals generated in the previous operation which pertain to this one will be discussed in order of their generation as though they were just occurring. See Figure 4-39.

The RTZ signal from DCB (held high until proper speed detection takes place) will set the UNLD f-f and reset the DLY UNLD, LD, and DLY BOT flip-flops. The Q output of the UNLD f-f is multipurposed: it resets the NAR and the CAR (CIB) which are not used during the Initial Seek Operation, it inhibits count pulses (DT P) to the CAR by keeping CL CNTR (L) low, it raises the COARSE SERVO EN (L) signal to a high, disabling the FWD/REV gates on SVA, and it makes LOAD/UNLOAD (L) a high signal enabling the LOAD/UNLOAD gates on SVA. The \bar{Q} output of the UNLD f-f direct resets the Detent (DTEN) f-f and direct sets the FWD f-f on SLB. It also causes the FWD INHIBIT signal on SLB to SVA to go high. This ensures no carriage motion until proper spindle speed is attained.

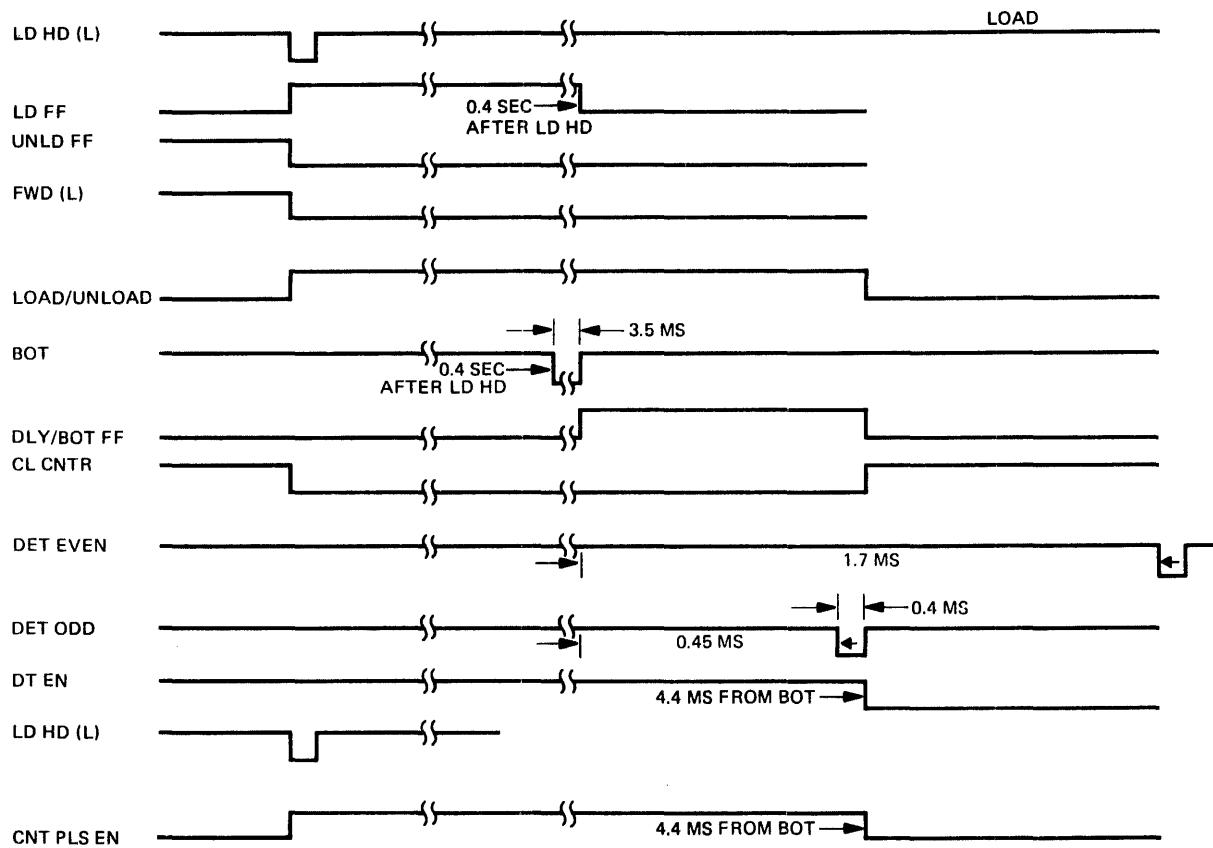


Figure 4-39. Head Load Timing Diagram

When spindle speed is detected as safe to load the heads (RDY DLY "A" f-f set, RDY DLY "B" f-f reset and a FIDX pulse) the LD HD (L) pulse, which is the same duration as a FIDX pulse, is generated on DCB and routed to SLB. This pulse has one job, to set the LD f-f. The outputs of this flip-flop will accomplish the same tasks as the UNLD f-f except they also reset the UNLD f-f. This drops the FWD INHIBIT signal low to SVA. The \bar{Q} output of the LD f-f direct resets the FWD f-f. This allows the carriage to be driven slowly forward by the SK ACCELERATE O/S (triggered by the DT EN (L) signal which went high when DETENT f-f was reset). The heads will now load (see Figure 4-39).

4.6.2.3 Initial Seek to Track 000 From the Home Position. Once the carriage started moving from the home position and loaded the heads, the Optical Transducer began detecting detent pulses (DT P) but they are not being used yet. Eventually the BOT will be encountered and generate a negative-going pulse whose negative transition will only be used to ensure that the UNLD and DLY UNLD flip-flops are still reset. The positive transition of this pulse will simultaneously reset the LD f-f and set the DLY/BOT f-f. The Q output of the DLY/BOT f-f will now maintain the signals necessary for carriage motion and keeping the CAR cleared.

The \bar{Q} output of the DLY/BOT f-f enables the Detent Odd (DET ODD) pulses to the clock input of the DTEN f-f on SLB. Since the ZERO signal (Subtractor difference value equals zero) to the D input of the DT EN f-f is high, the next DET ODD pulse will set it. The \bar{Q} output of this f-f resets the DLY/BOT f-f and generates the Detent Enable (DT EN) signal to CIB and the SERVO DET EN signal to SVA. The Detent Operation now begins (see Figure 4-39).

4.6.2.4 Detent Operation. The SERVO DET EN (L) enables both the ODD and EVEN NAND gates on SVA. When the next ODD detent pulse is detected by the position transducer, ODD (–) will be low and POS CHANNEL 1 from the Detent Amplifier Board will be a positive-going pulse. This will be the first odd detent pulse detected since the BOT. The ODD NAND gate will gate a low enable signal to the two ODD DTEN SW Field Effect Transistors (FET). The positive POS CHANNEL 1 pulse, after going through two Operational Amplifiers (OP AMP), will go through the DETENT AMP and STIFFENER. This output will be a negative signal that will slow the carriage to a stop. The negative-going slope of the POS 1 CHANNEL signal will have a slight over shoot and the heads will settle over Track 000. The ELECTRONIC TACH NETWORK (SVA) will keep the carriage from drifting off track by supplying a signal opposite in direction to the one the carriage might try to move in.

4.6.3 PROGRAMMED SEEK

When a SEEK command comes from the Controller, it will be accompanied by the Disc Drive Unit address, Disk Select signal (fixed or removable), Track Address, Sector Address and Head Select signal. After all of these have been decoded and processed, the Track (Cylinder) Address will be strobed into the New Address Register (NAR) on SLB by the 300 nanosec SK signal from CIB. If it is a legal address, the SK signal will generate the DLY SK (L) signal to SLB which will clock the FWD f-f to its desired state (FWD or REV depending on the state of the carry-out of the Subtractor). It will also clock the DT EN f-f reset.

The D DAC signal will be developed by the difference value from the Subtractor on SLB and sent to the Servo Amplifier on SVA and generate the SERVO VELOCITY signal. This will activate the carriage movement in the proper direction, the same as for an initial seek; except, now the CAR will be counted up or down until the difference value between the CAR value is equal to the NAR value. Detenting then takes place and SEEK COMPLETE status signals will be sent to the Controller signaling the drive is ready to perform a Read or Write operation. See Figure 4-40.

4.6.4 RESTORE OPERATION

When a Restore command is received on CIB, RTZ O/S fires and generates a 12 usec pulse (RETURN TO ZERO). This pulse is sent to SLB and sets the UNLD f-f. The UNLD f-f generates FWD INHIBIT high, UNLOAD (L) low, CL CNTR (L) low, and LOAD/UNLOAD high. It also resets the DT EN f-f which starts the carriage moving in the REV direction because the FWD f-f was set. When the BOT is detected, the BOT pulse resets UNLD f-f, sets DLY/UNLD f-f, forces UNLOAD (L) high, forces FWD INHIBIT low, and forces LOAD/UNLOAD low. The carriage continues moving until DET ODD (L) pulse occurs. This sets the CNT f-f triggering the 10 msec O/S causing SERVO DET EN (L) to go low and CNT PLS EN (L) to go low. When the 10 msec O/S times out, the 1 usec O/S fires thus setting LD f-f and resetting DLY/UNLD f-f. This resets the CNT f-f and causes DLY/UNLOAD (L) to go high. The carriage will now reverse direction (FWD), and detent takes place as it did during Initial Seek operation. See Figure 4-41.

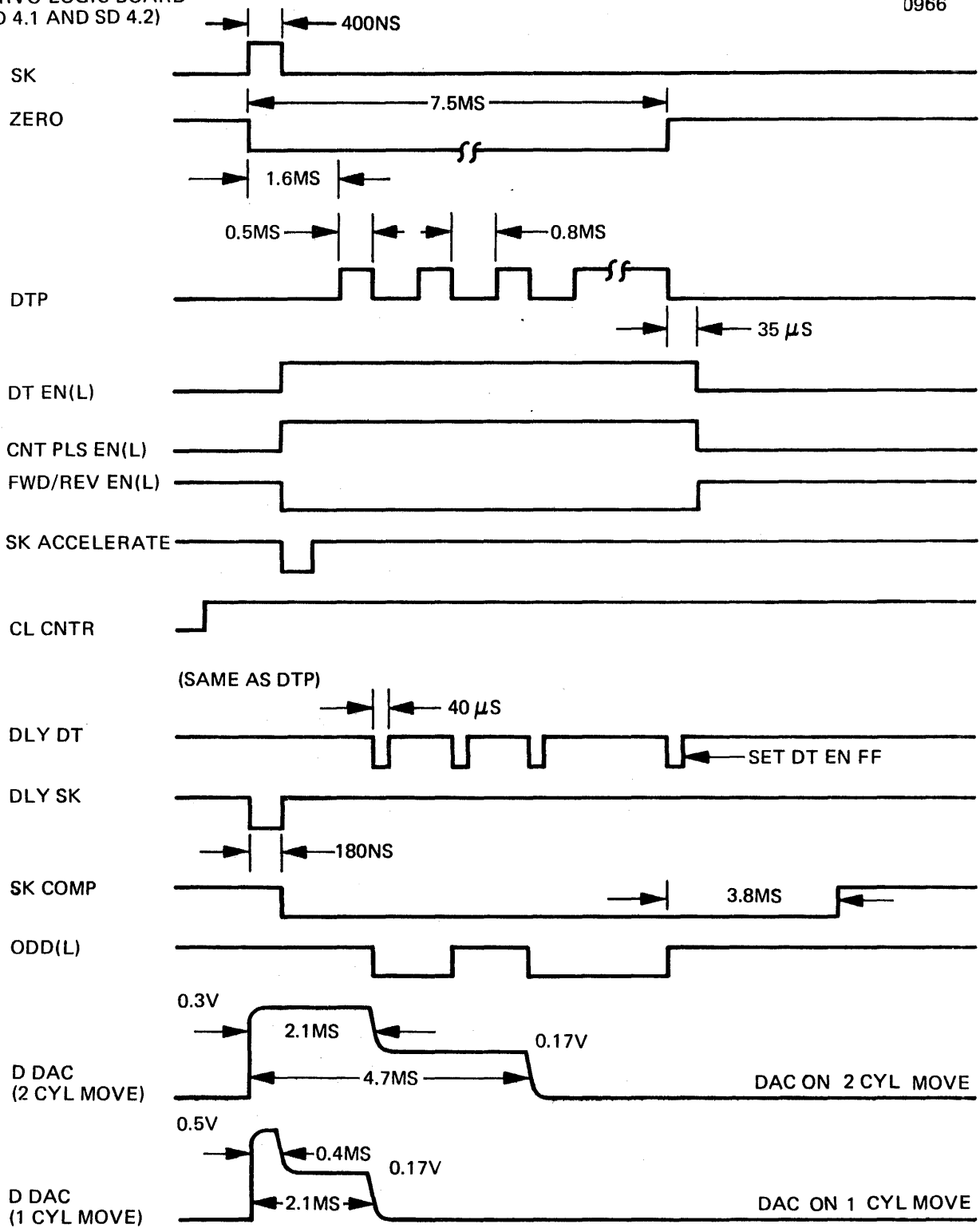


Figure 4-40. Programmed Seek (1 and 2 Cylinder Seeks)

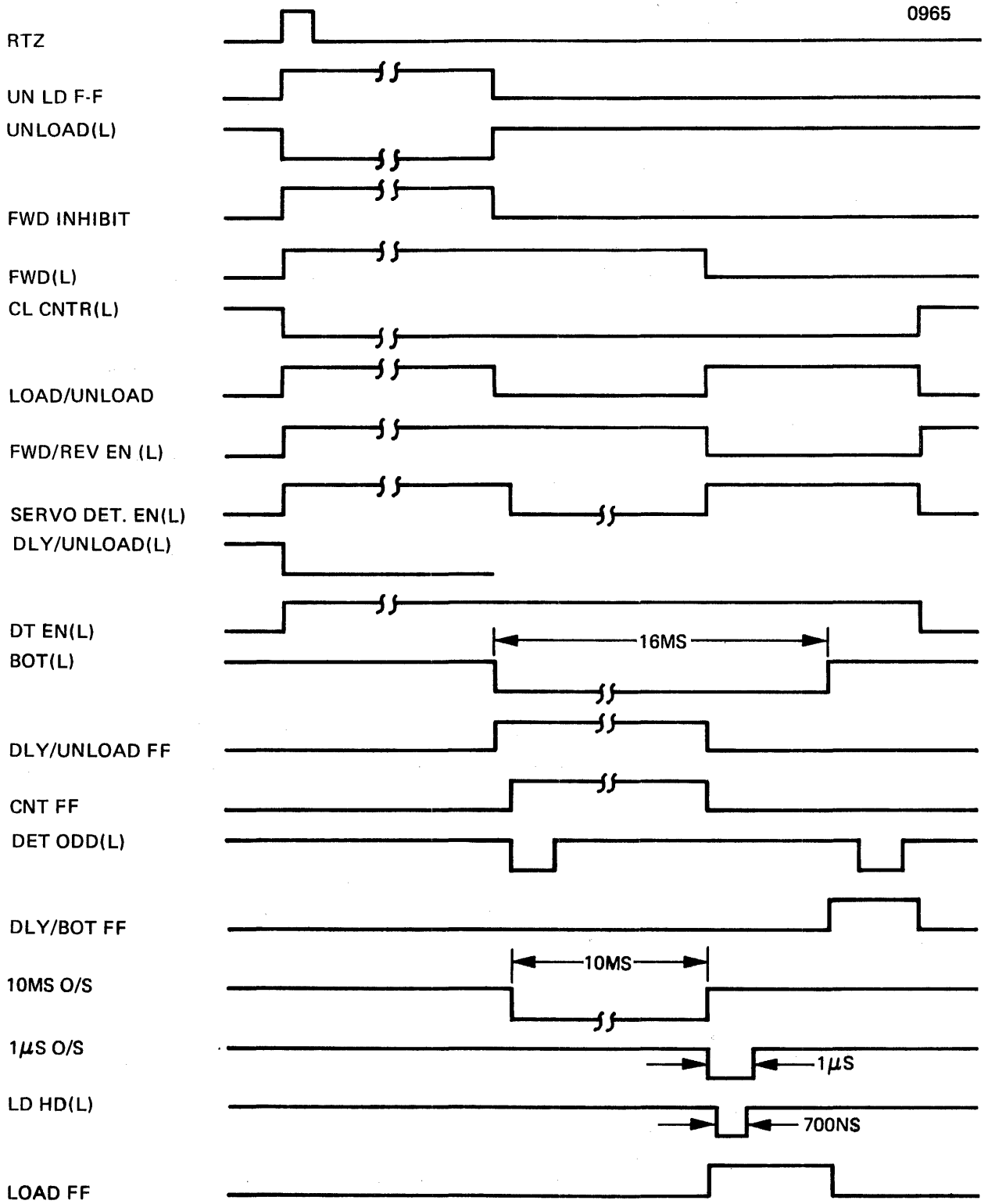


Figure 4-41. Timing Diagram of Restore Operation

4.6.5 READ/WRITE OPERATION

During Power-Up, LOGIC RESET sets the WRITE/ERASE CURRENT f-f. If this flip-flop ever gets reset, the unit must be powered down, then back up again in order to set it again. When it is reset, it will generate a constant WRITE CHECK to the Controller. This flip-flop can be set by either the WRITE CURRENT DETECTOR, ERASE CURRENT DETECTOR, or MULTIPLE HEAD SELECTED DECODER. If Erase or Write current is on and SPEED DETEC from DCB goes high, one or both of the current detectors will reset the WRITE/ERASE CURRENT f-f. This would also enable the +40V switch to shut off and disable Write and Erase circuits to prevent destruction of data.

SPEED DETEC from DCB is low whenever the counter decode on DCB is between 1980 and 2020 (CNT 1980 f-f set and CNT 2020 f-f reset) when the FIDX positive transition arrives. This allows Write operations to take place. The negative-going transition of FIDX resets both flip-flops. If the count decode was below 1980 (CNT 1980 and CNT 2020 flip-flops both reset) when the FIDX arrives, the SPEED DET f-f will be reset. This will generate SPEED DETEC high which will inhibit Write operations because the spindle speed is too fast, and data from one sector could be written into the next sector which could destroy previously written data in that sector. If both flip-flops are set when the FIDX pulse arrives, once again SPEED DETEC high will be generated to inhibit Write operations because the spindle speed is too slow and could not adhere to the correct sector data format. This would cause compatibility problems during Read operations.

If either or both of the PROT (FIXED or PROT CART) switches on the OCP are on, PROT F and/or PROT R will be false (low). When the DISK SEL is in the "0" state and the PROT CART switch is on, the WRITE PROT output will go high. If PROT FIXED is on and Disk Select is in the "1" state, WRITE PROT will be true.

HD SEL and DISK SEL constitute a decimal count of 4 (binary 0–3). With these combinations it is possible to select one of four Read/Write Head center taps. If, due to a malfunction, more than one center tap should get selected, it would be decoded as multiple head select by the MULTIPLE HEAD SELECTED DETECTOR and the ERASE/WRITE CURRENT f-f would be reset generating WRITE CHECK.

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

Perkin-Elmer Memory Products Division SF and ST Magnetic Disk Drives have been designed for exceptional serviceability. The clean, functional layout and interconnection of major assemblies, subassemblies, and associated components afford superior accessibility, and simplify preventive maintenance, replacement, and adjustment procedures. Advanced electronic and mechanical design and conservative component rating contribute to the high performance and reliability features in these units.

Field servicing of the Disk Drive will, in most instances, be confined to infrequent preventive maintenance measures and routine performance verification. Should replacement of a part or an assembly be required, removal and reinstallation of the respective item will present no difficulties because of the modular construction and good accessibility.

Alignment procedures are straightforward, and adjustment and test points are within easy reach when the top cover has been removed. Certain replacement procedures necessitate access to the bottom area of the Disk Drive. Since in most cases the chassis will be mounted on slides, such access is easily accomplished by pulling the unit out of the cabinet as far as required. The internal flexible I/O signal cable, which interconnects the stationary I/O connector panel to the slideable unit, allows the Disk Drive to be on-line even when the unit is partially removed from its mounting rack.

5.2 SCOPE OF MAINTENANCE

Servicing of the SF and ST Disk Drives can be broadly divided into preventive and corrective maintenance. The service work intended to preclude certain malfunctions is of a minor, periodic nature and is summarized in Table 5-1.

Corrective maintenance concerns itself mainly with service on the assembly level. That is, it will consist of the substitution, after appropriate diagnosis, of integral subassemblies such as plug-in boards, Read/Write heads, etc. It also will include follow-up calibration or adjustment where required.

Table 5-1. Preventive Maintenance Schedule

ITEM	INTERVAL	OPERATION
Detent Output Signal	6 months	Check and verify that the signal conforms with the specifications outlined in paragraph 5.5.5.
Disk Cleaning Brushes	6 months	Inspect condition (see Figure 5-18). Replace brushes if necessary.
Positioner Carriage Guide Rails	6 months	Clean with alcohol-saturated swab. Remove all cotton residue.
Read/Write Heads	6 months	Check retraction of positioner carriage. Inspect and if necessary clean as outlined in paragraph 5.3.3.
Spindle Chuck and Cone	6 months	Clean surfaces using alcohol-moistened kimwipes. Remove ferrous particles (if any) from chuck and magnet ring through application of masking tape.
Fixed Disk	6 months	Clean with an alcohol-saturated swab through access hole at the front of the unit (see Figure 5-1).
Adjustable DC Voltages	6 months	+5V, +13V, -13V
Air Filter:		
Prefilter	1 year	Replace prefilter (see Figure 5-15).
Main Filter	1 year	Inspect; replace if necessary.
Blower Ground Brush	1 year	Replace brush assembly.
Spindle Ground Brush	1 year	Replace brush assembly.
Blower Drive Belt	1 year	Replace belt (see CAUTION below).

CAUTION

WHEN REPLACING O-RING BELTS, PRE-STRETCHING BY HAND MUST BE AVOIDED. WHEN STRETCHED, BELTS "SET" AND BECOME LOOSE WHICH CAN AFFECT MACHINE PERFORMANCE AND SHORTEN BELT LIFE. INSTALL BELTS BY ROLLING THEM INTO PLACE WHILE SLOWLY ROTATING PULLEY.

CAUTION

WHEN REPLACING PWB's WITH MINIATURE DIP SWITCHES, CHECK LABEL BEHIND FRONT TRIM PANEL TO VERIFY PROPER SWITCH SETTING FOR THE CONFIGURATION.

In regard to individual (and possibly critical) parts, it is recommended that such work be done only after a careful study of the appropriate circuit description in Section 4. This theory study should be observed in conjunction with consultation with one of the factory field engineers in order to guarantee the continued integrity of the Disk Drive.

Problem diagnosis can be performed on-line and will be limited only by diagnostic program capabilities. Off-line diagnosis may be accomplished with a Field Exerciser card with positioning capabilities but with no data-interfacing capabilities. A self-contained bench-type exerciser unit, available from the Company, provides comprehensive test and diagnostic capabilities.

This section of the manual provides instructions for the removal and replacement of major assemblies and adjustment and calibration procedures that can be performed on-site.

5.3 PREVENTIVE MAINTENANCE

In Disk Drive installations, preventive maintenance is performed only at infrequent intervals, since all moving parts (including the recording medium) are normally enclosed, and are purged continuously by a clean-air system. However, some contamination of the system is inevitable, especially during changing of a removable cartridge. The cartridge itself is a potential source of some contamination unless it is maintained in a clean condition.

5.3.1 PREVENTIVE MAINTENANCE SCHEDULE

Note (see Table 5-1) that 1 year of operation is equivalent to 2,000 operating hours based on a single-shift day. This schedule should be modified to shorter intervals if one of the following situations prevails:

- A. Operation in excess of normal on-time
- B. Frequent cartridge exchange
- C. Adverse environment

5.3.1.1 Time Schedule. The time required to perform each cleaning, inspection, and re-
placement routine (see Table 5-1) is approximated below:

- A. Checking detent output signal – 15 minutes
- B. Inspecting disk cleaning brushes – 5 minutes
- C. Cleaning carriage and guide rails – 5 minutes
- D. Cleaning Read/Write Heads – 5 minutes
- E. Replacing Read/Write Head (if required) – 15 minutes
- F. Inspecting spindle chuck and cone – 1 minute
- G. Cleaning fixed disk – 2 minutes
- H. Adjusting DC Voltages – 15 minutes
- J. Replacing pre filter – 15 minutes
- K. Replacing main air filter – 15 minutes
- L. Replacing blower ground brush – 10 minutes
- M. Replacing spindle ground brush – 15 minutes

5.3.2 READ/WRITE HEAD INSPECTION AND CLEANING

Because of the very small clearance between head and disk surfaces, it is imperative that the heads (as well as the disk) be kept clean. When in the flying attitude, the heads are separated from the disk surface by only a few microns; and because of the high disk speed, even small particles adhering to the heads may cause damage to the heads or to the disk surface.

To inspect the head surfaces for accumulation of dust or oxide particles, remove the cartridge and illuminate the head area with a suitable light source. The upper heads may be viewed with the aid of a small dental-type mirror.



DO NOT TOUCH THE HEAD SURFACE OR
BRING THEM INTO CONTACT WITH ANY
OBJECT OTHER THAN THE CLEANING
APPLICATOR.

To clean the head surfaces, wipe them with an alcohol-saturated swab*. Use 91% isopropyl alcohol (IPA) only. Apply very light pressure to the head during this operation. The following cleaning aids should be used in cleaning the disks and Read/Write (R/W) heads:

* Foam Floss-tipped swabs leave no residue. Order PN TX700 (qty 50) or TX700B (qty 500) from Texwipe Co., 51 Prospect Pl., P.O. Box 278, Hillsdale, N.J. 07642.

- A. Cleaning fluid: 91% isopropyl alcohol (IPA) in solution with 9% distilled water. Do not use any other type of fluid.
- B. Applicator: Lint-free tissue or cotton swabs.

5.3.3 FIXED DISK CLEANING

To gain access to the fixed disk, snap out the trim panel at the front of the unit, and remove the two 4-40 screws securing the small access cover as shown in Figure 5-1. This cover is located above the air intake grate at the left-hand side of the center of the Disk Drive. Then lift out that cover.

Unplug connector P15 located near the top of the Servo Amplifier Board. This will inhibit the servo system and prevent loading of the R/W heads. Install a "scratch" cartridge to obtain disk speed control. If a test hub is used, the cartridge interlock switch must be manually activated in the following manner. For SF units, depress the button-type switch (protrudes from the base), and keep it depressed by placing masking tape over it. For ST units, install a matchbook cover between the pack sensor and switch actuator. See Figure 5-2.

Insert an alcohol-saturated swab through the access hole in the front of the Disk Drive (see Figure 5-1), and lightly move it across both the upper and lower surfaces of the disk. Repeat this operation, using a new swab each time, until the swab remains clean. Then secure the small panel over the access hole with the two 4-40 screws.



USE CARE TO AVOID ANY CONTACT BETWEEN THE DISK AND THE SWAB STICK. MAKE SURE THAT NO RESIDUE IS LEFT WITHIN THE DISK DRIVE AFTER CLEANING.

5.3.4 CARTRIDGE REMOVAL AND HANDLING

Review the procedure for cartridge loading and removal in Section 2. Load only cartridges that are known to be without defects. Keep the cartridge housing as clean as possible. When the cartridge is not installed, its air and head entry doors should remain closed at all times. The cover of the top-loading cartridge should remain in place.

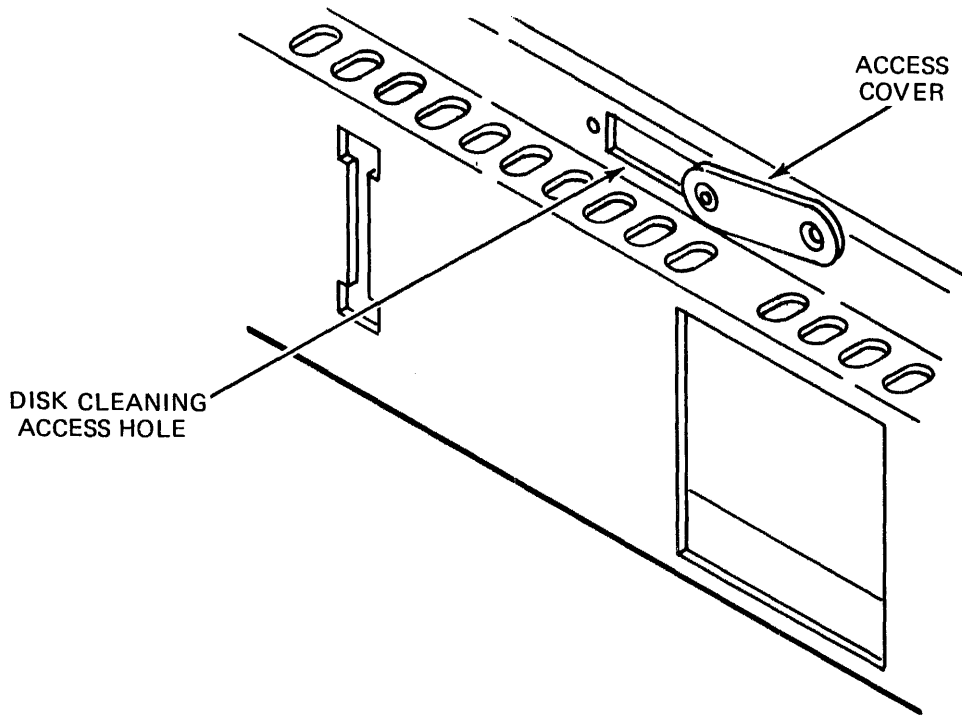


Figure 5-1. Fixed Disk Cleaning Hole Location

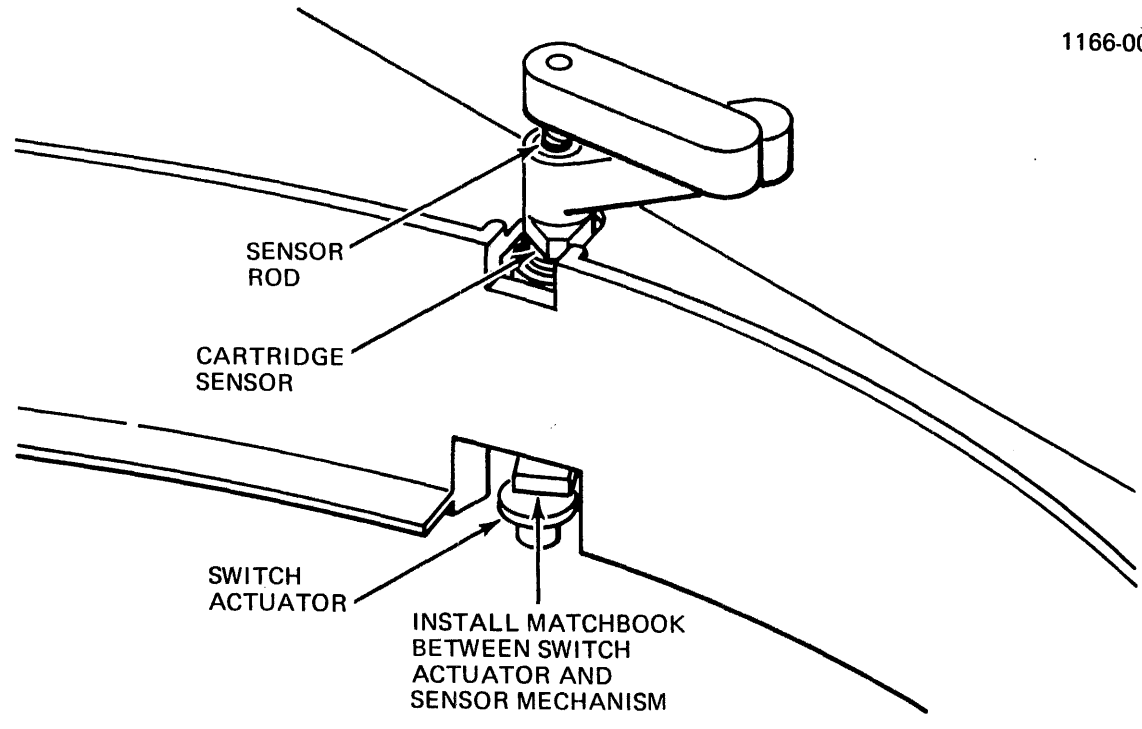


Figure 5-2. Cartridge Interlock Switch Actuation – ST

5.3.5 DISK DRIVE TOP COVER REMOVAL

5.3.5.1 Introduction. When carrying out the preventive maintenance work, the top cover of the Disk Drive must be removed in order to gain access to the various assemblies. The removal of this cover differs somewhat in the SF and ST Disk Drives.

5.3.5.2 Series F. To make the top cover fully accessible, open the loading door and pull the unit partially out of the cabinet. Refer to paragraph 5.4.1.1 for the procedures for releasing the door-locking mechanisms.

Remove the six screws on the top surface of the cover. Remove the three screws along the front lip of the cover. These screws secure this part of the cover to the filler panel between the end caps. The top cover can now be lifted off the Disk Drive.

5.3.5.3 Series T. To make the top cover fully accessible, refer to paragraph 5.4.1.2 and 5.4.2.2. Remove the four screws used to fasten the cover to the chassis and lift the cover from the Disk Drive.

5.4 CORRECTIVE MAINTENANCE

In this part of Section 5, the SF and ST Disk Drives are illustrated and described with emphasis on assembly configuration and location. The main mechanical differences between the two series of drives are identified. Procedures for the removal and replacement of assemblies and related components, and adjustment and calibration procedures, are presented.

5.4.1 GENERAL DESCRIPTION

The majority of assemblies and components in the SF and ST Disk Drives are interchangeable; the units differ essentially only in the cartridge-loading arrangement and the related electro-mechanical parts. The SF Disk Drive incorporates a cartridge receiver that is mechanically coupled to the loading door at the front of the unit. These mechanical differences are apparent in the photographic views of the two units in Figures 5-3 and 5-4.

Assemblies and components accessible from the bottom of the Disk Drive are mounted identically on both the SF and ST units. Figure 5-5 shows these components and assemblies with the major components and assemblies identified.

Figure 5-6 is a simplified front view of the SF Disk Drive. It identifies those components that either are not visible on the preceding figures or are contained only in the SF. Figure 5-7 is a similar simplified front view of ST Disk Drive.

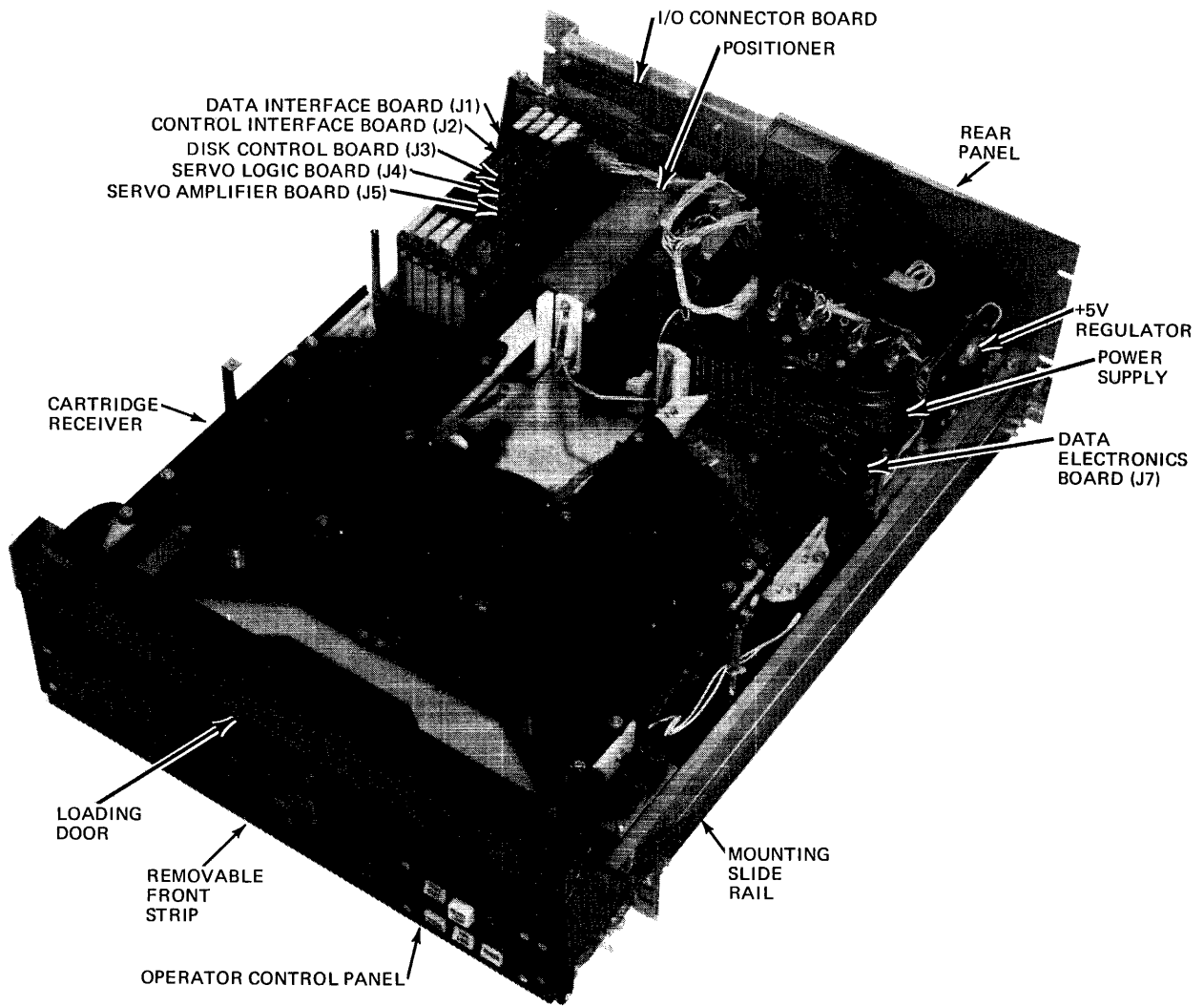


Figure 5-3. SF Disk Drive with Cover Removed

SUPER SERIES

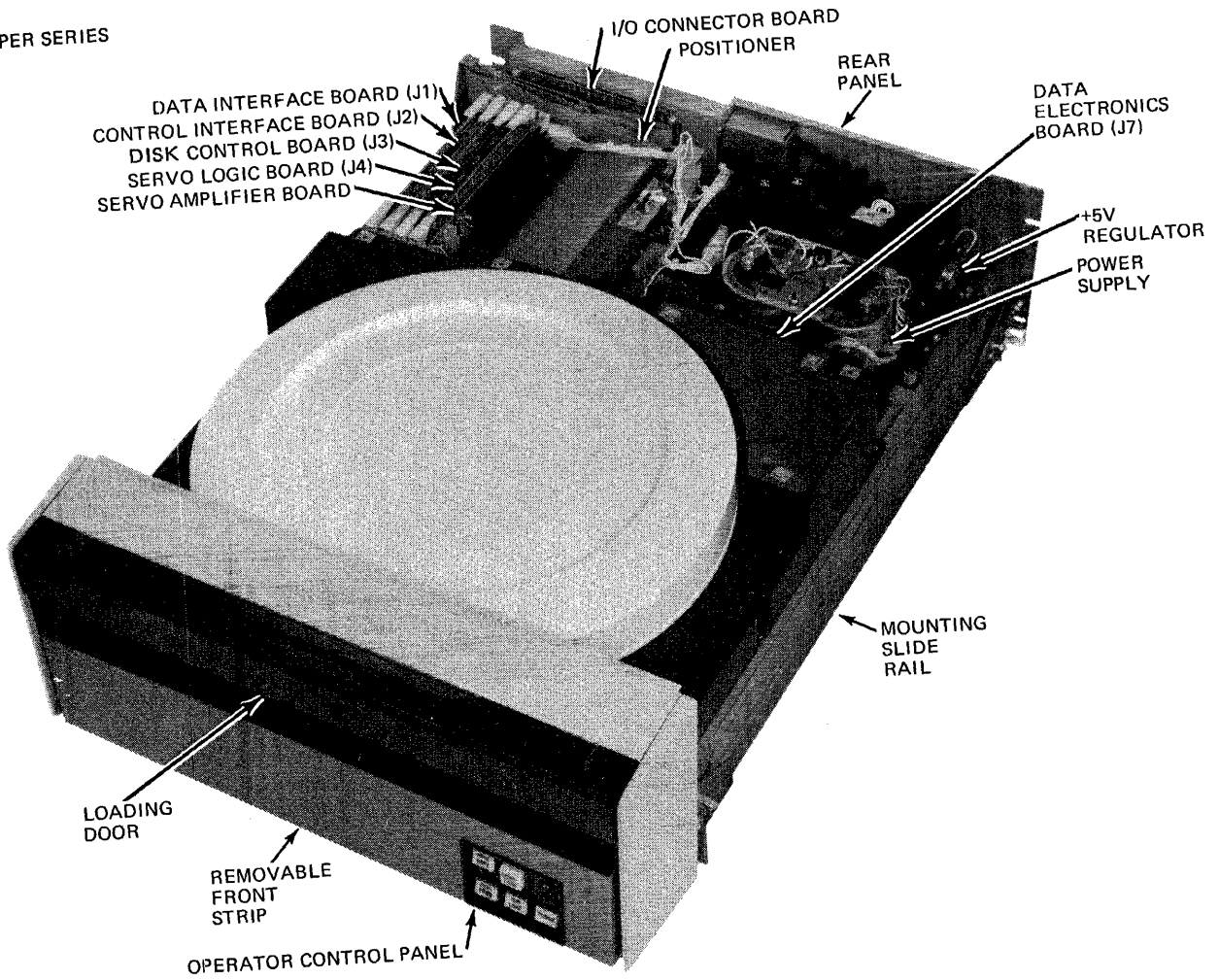


Figure 5-4. ST Disk Drive with Cover Removed

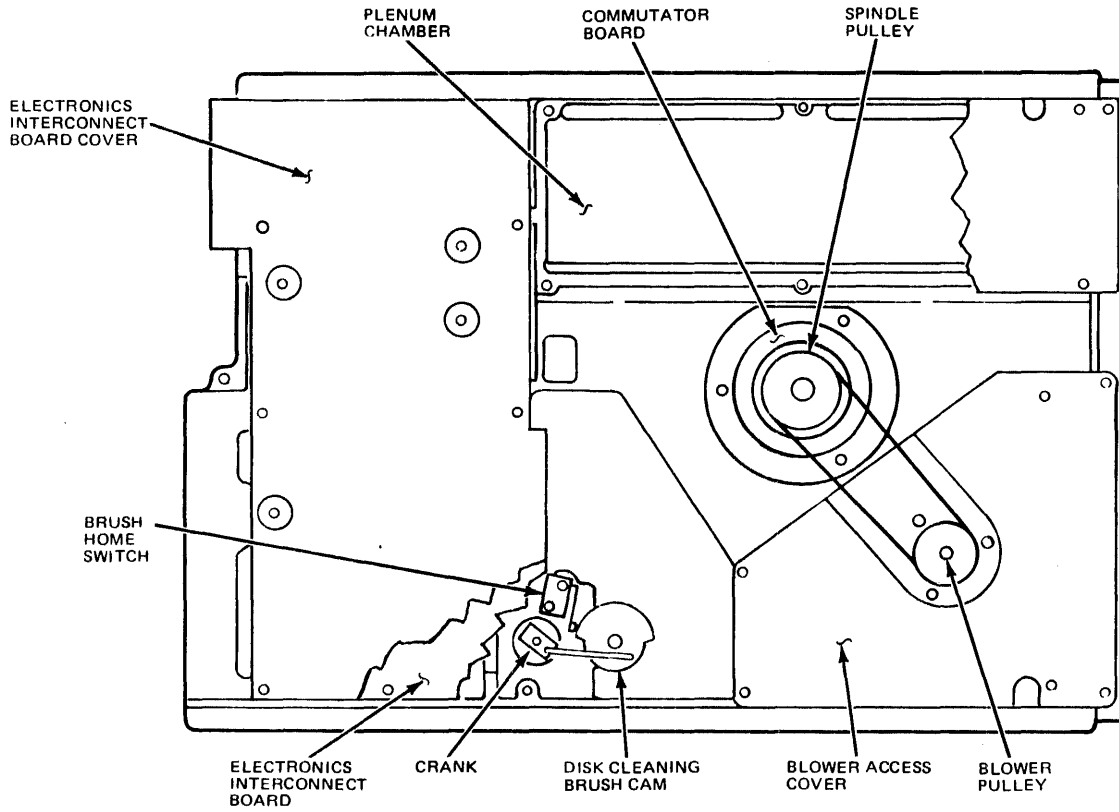


Figure 5-5. SF and ST Disk Drives, Assembly Identification – Bottom View

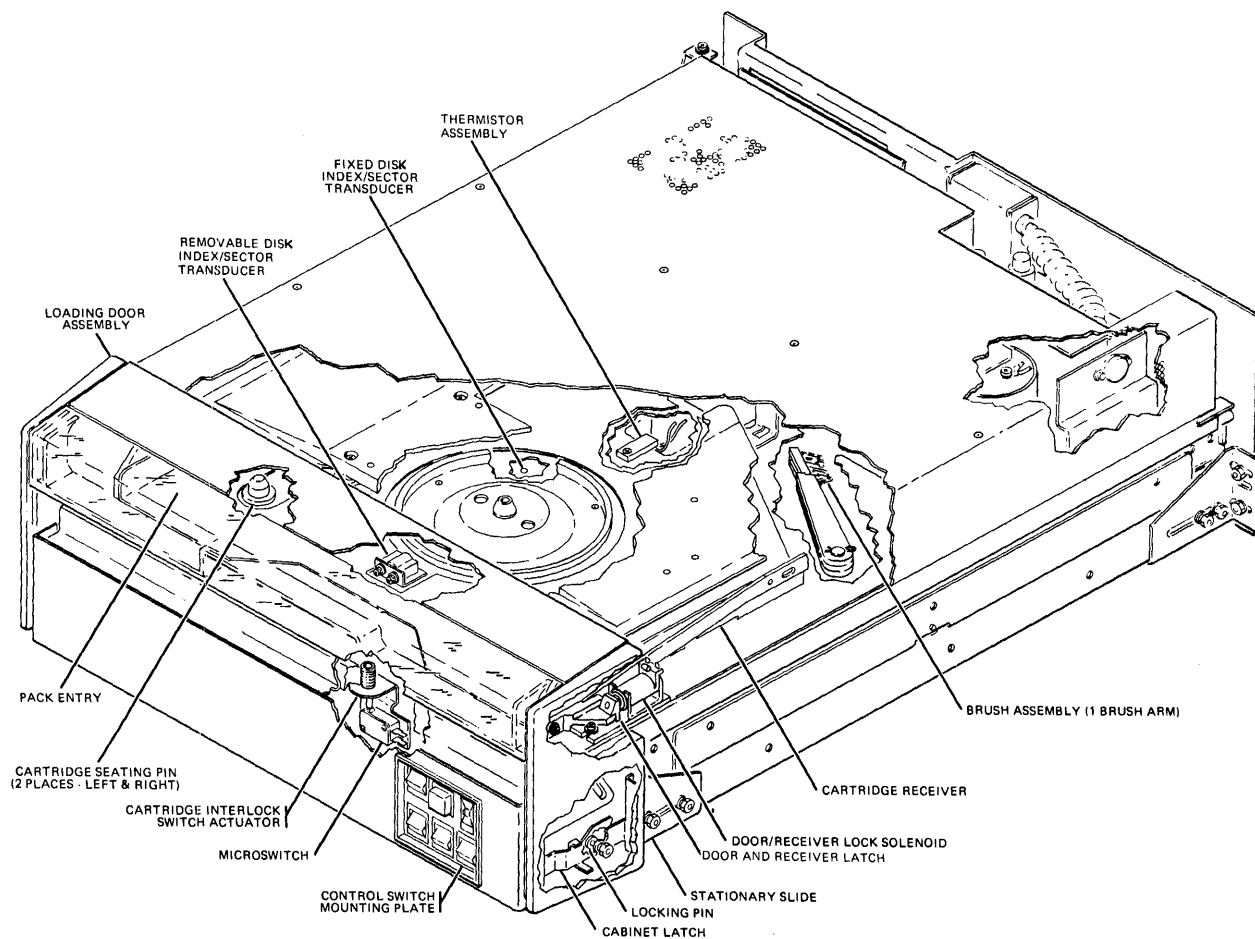


Figure 5-6. SF Disk Drive—Simplified Front View

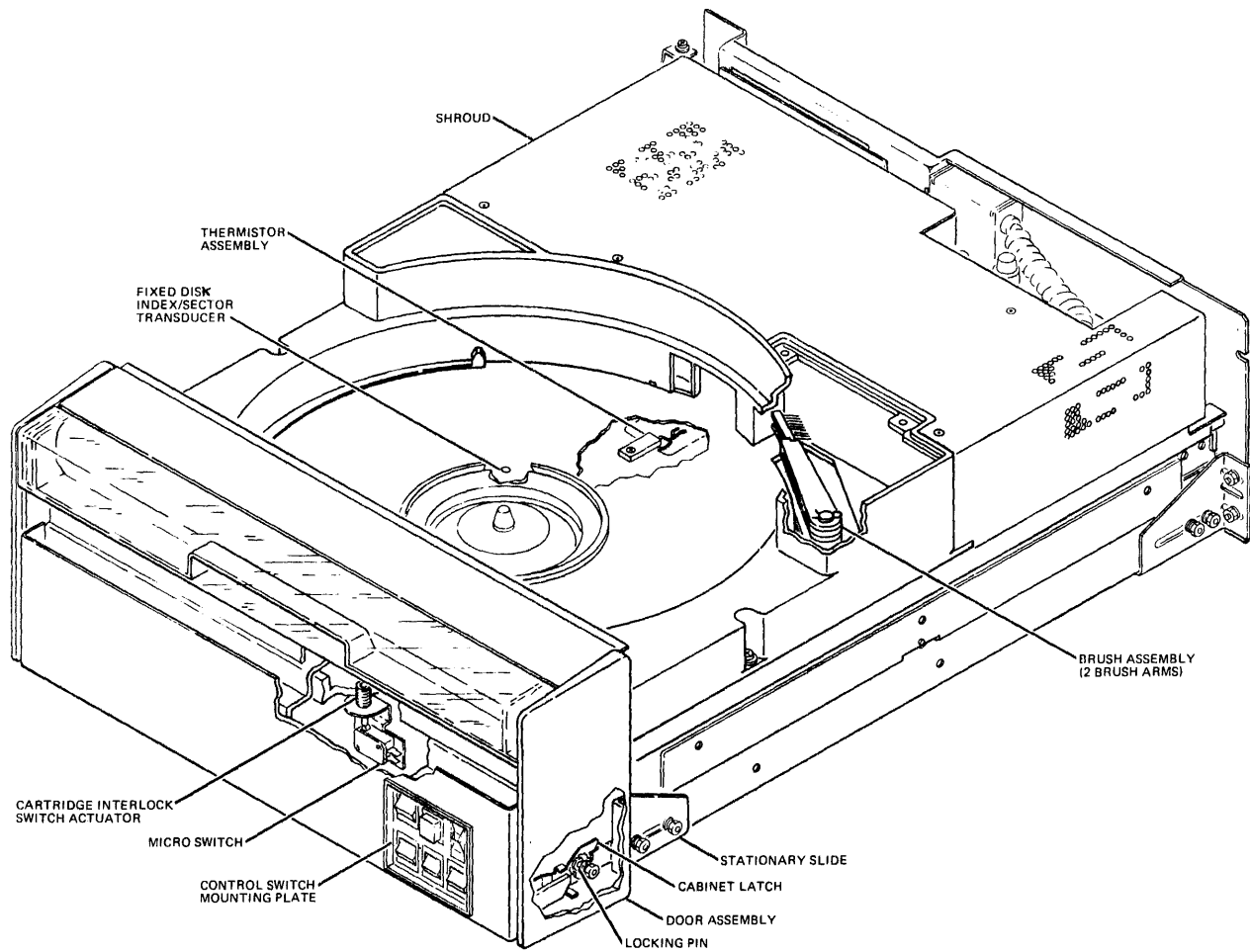


Figure 5-7. ST Disk Drive—Simplified Front View

5.4.1.1 Front Door and Cabinet Lock, Series F. The locking mechanism on the SF Disk Drive locks the loading door, also the cartridge receiver, in place when power is applied to the unit. This locking device also is activated in the event of power failure as explained in the discussion of this feature in Section 4.

The locking action (see Figure 5-6) is implemented by a locking solenoid mounted on the side of the loading door. The solenoid plunger carries a latch that engages a pawl when the solenoid is de-energized. The pawl is mounted on a rotatable plate which is connected to the door and cartridge receiver assemblies. When energized, the solenoid latch disengages the pawl, and the plate is free to rotate forward. This allows the cartridge loading door to be pulled open and down. Mechanical connections simultaneously elevate the cartridge receiver and move it forward.

The Disk Drive is locked into the cabinet by mechanical means. Opening the cartridge loading door will not release the unit from the cabinet. Two additional latches, one on each side of the door assembly, lock over pins on the stationary slide if the door is closed. To release these latches from their locking pins, they must be tripped manually; a slot is provided in each latch for this purpose. The painted front trim panel must be snapped out to gain access to the front part of the latch. The latch is depressed, and thus released, by applying a downward force on the slot in the latch.

5.4.1.2 Front Door and Cabinet Lock, Series T. The ST Disk Drive incorporates a locking mechanism similar to the Series F Disk Drive. Since the ST unit contains no receiver, the locking action involves only the door assembly and the cabinet slides.

The latching mechanism is partially illustrated (see Figure 5-7). When the door is closed and the Load mode is not established, the solenoid plungers engage pins mounted to the door assembly. Simultaneously with closure of the door, the latches slide over and engage the slide-mounted locking pins which lock the Disk Drive into the cabinet. Then the unit can not be pulled out of the cabinet until the solenoids are energized (releasing the pins on the door assembly).

5.4.1.3 Test Equipment. Test equipment and tools used in maintenance of the Disk Drive are listed in Table 5-2. The following equipment is required for use in alignment or calibration procedures and in diagnostic routines.

- A. Oscilloscope
- B. Current Probe
- C. Digital Voltmeter (suggested)

Table 5-2. Standard and Special Accessories and Service Aids

Description and Manufacturer	Model Usage	Part Number
Allen wrench, 1/16 in. Handi Hex Key	ALL	—
Allen wrench, 3/32 in. Handi Hex Key	ALL	—
Crescent wrench, adjustable, 4 in. Claude Michael	ALL	AC14
Screwdriver set, Xcellite	ALL	TS88
Potentiometer alignment tool, Walpo Electronics	ALL	2525
Screwdriver, torque, Utica Tool	ALL	TS30
Ball driver, 5/32 in. Bondhus	ALL	BS-5/32
Ball driver, 3/16 in. Bondhus	ALL	BS-3/16
Oscilloscope, dual trace, Tektronix	ALL	453 (or equivalent)
Probe (X10) Tektronix	ALL	P6065A
Probe, (X1) Tektronix	ALL	P6011
Probe, Current, Tektronix	ALL	P6021 (or equivalent)
Digital Voltmeter, Digitac (suggested)	ALL	016-0180-00
VOM, Triplett	ALL	800 (or equivalent)
Cable Extractor, 3M	ALL	3438
IC Extender, 14 pin, A.P. Inc. (suggested)	ALL	TC14
IC Extender, 16 pin, A.P. Inc. (suggested)	ALL	TC16
Disk Exerciser, Bench Type, (suggested)	ALL	300303
Torque wrench, head alignment	ALL	T00425
<u>Service Aids</u>		
Test Hub, XX = number of sectors	F, SF	101179-0XX
Test Hub, XX = number of sectors	T, ST	101180-0XX
Printed Wiring Board Extender	F, T, SF, ST	300034-001
Data Electronics Board Extender	F, T	300145-001
Power Regulator Board Extender	F, T	300403-001
Power Supply Extender Cable	F, T	300985-001
Power Supply Extender Cable, (replaces -001)	F, T, SF, ST	300985-002
Servo Amplifier Board Extender Cable,	F, T, SF, ST	300789-001
Head Extender Cable, (adapter for testing Write Current)	ALL	101183-001
Spindle Phasing Harness,	F, T, SF, ST	301396-001
Adapter, Spindle Phasing Harness, for use with Hi-Impedance Spindle P/N 301690	SF, ST	302010-001

Table 5-2. Standard and Special Accessories and Service Aids (continued)

Description and Manufacturer	Model Usage	Part Number
<u>Interface Cables</u>		
Daisy Chain cable, (standard twisted pair), XXX = length in inches	ALL	300118-XXX
Daisy chain cable kit, (flat 3M cable), XXX = length in inches	ALL	300917-XXX
I/O Adapter, (part of Daisy Chain Cable Kit), J22 standard to 3M cable	ALL	300915-001
I/O Adapter, (Part of Daisy Chain Cable Kit), J23 standard to 3M cable	ALL	300916-001
Cable, flat, 50 conductor (part of Daisy Chain Cable Kit), XXX = length in inches	ALL	300944-XXX
Interface Cable, (W to D-30 – male), XXX = length in inches	F, SF	300119-XXX
Interface Cable, (W to Caelus – 100 TPI)	F, T, SF, ST	300127-001
Interface Cable, (W to Caelus – 200 TPI)	F, T, SF, ST	300127-002
Interface Cable, (W to D-40), XXX = length in inches	F, T, SF, ST	300377-XXX
Interface Cable, (W to Data General) (Logicon), XXX = length in inches	F, T, SF, ST	300423-XXX
Interface Cable, (W to D-30 special), XXX = length in inches	F, T, SF, ST	300566-XXX
Interface Cable, (W to D-30 female)	F, T, SF, ST	300795-001
<u>Mounting Accessories</u>		
Filler Panel, 1 in. (fills gap above "T" in cabinet), XX = paint color	T, ST	300905-1XX
Shipping bracket, left (used if customer does not want cabinet slides)	F, T, SF, ST	300608-001
Shipping bracket, right (used if customer does not want cabinet slides)	F, T, SF, ST	300608-002
<u>Alignment Cartridges</u>		
C. E. Pack, 2200 BPI Tri-Bit Type	F, SF	301488-001
C. E. Pack, 2200 BPI Tri-Bit Type	T, ST	301488-002
C. E. Pack, 2200 BPI Cat-Eye Type (customer request only)	F, SF	300805-001
C. E. Pack, 2200 BPI Cat-Eye Type (customer request only) not for 4400 BPI	T, ST	300807-002
C. E. Pack, 4400 BPI MFM Type T-2422	ST	301488-006
<u>Unrecorded Cartridges</u>		
Cartridge, 2200 BPI, XX = number of sectors (.020 in. slots) (.508 mm) (Front Load)	F, SF	100442-0XX
Cartridge, 2200 BPI, XX = number of sectors (.020 in. slots) (.508 mm) (Top Load)	T, ST	100443-0XX
Cartridge, 4400 BPI, XX = number of sectors (.020 in. slots) (.508 mm) (Top Load)	ST	100444-0XX

- D. Volt-Ohmmeter
- E. Bench Exerciser (suggested)

5.4.2 REMOVAL AND REPLACEMENT OF MAJOR ASSEMBLIES

5.4.2.1 Introduction. In the following paragraphs, the procedures for removal of major assemblies for servicing or exchange are outlined in detail. The chart in Figure 5-8 summarizes the operations and their sequence. This chart indicates that where the disk is involved, the removal operations preceding the disk removal differ somewhat between the SF and ST Disk Drives.

5.4.2.2 Top Cover Replacement. In the procedures outlined in the removal and alignment paragraphs, it is assumed that the unit has been shut down and disconnected from the AC power source. If rack-mounted, the Disk Drive will have been pulled out of the rack on its slides. The cartridge will have been removed as well as the top cover. The removal of the top cover differs in the two series of Disk Drives as described in paragraph 5.3.6. To reinstall the top cover on the SF disk drive, insert all six screws loosely to permit slight shifting of the cover for hole alignment. Then tighten each of the six screws evenly.



TO PREVENT DAMAGE TO THE TOP COVER
ON THE ST DISK DRIVE, THE FOLLOWING
HOLE ALIGNMENT PROCEDURE SHOULD
BE FOLLOWED.

To reinstall the top cover on the ST Disk Drive, perform the following steps:

- A. Set the top cover in place, and insert the mounting screw in the access hole located toward the rear of the unit, as shown in Figure 5-9.
- B. Check alignment of the remaining holes in the top cover and if all holes align, insert and tighten all four mounting screws.
- C. If all three front holes are not aligned with the threaded standoffs, loosen the two screws through the horizontal fuse-mounting bracket on the power supply assembly (see Figure 5-9).
- D. Shift the chassis slightly to align all three front access holes, then insert the three mounting screws.
- E. Tighten all four mounting screws and the two screws securing the horizontal fuse-mounting bracket.

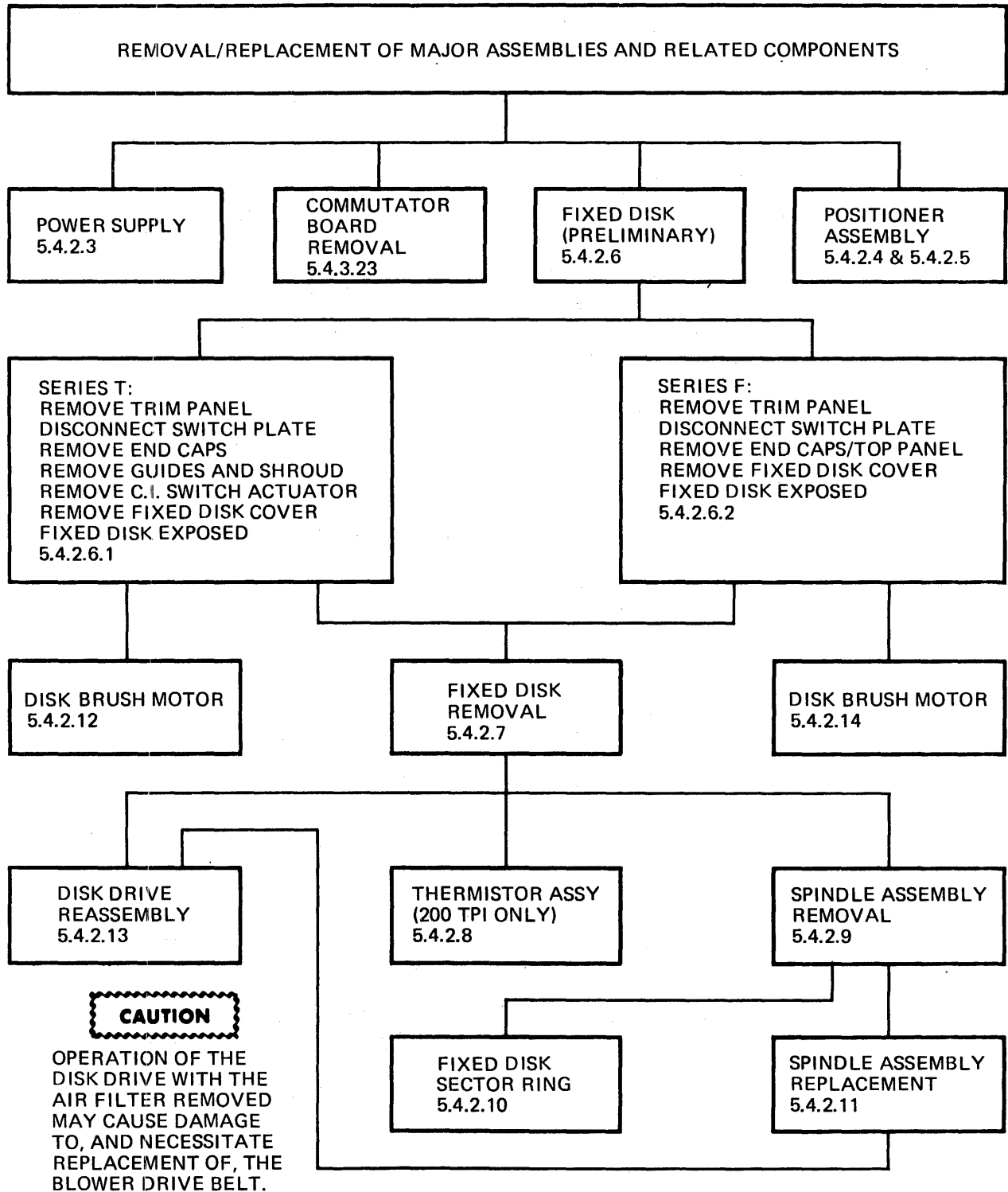


Figure 5-8. Removal/Replacement Guide – Major Assemblies

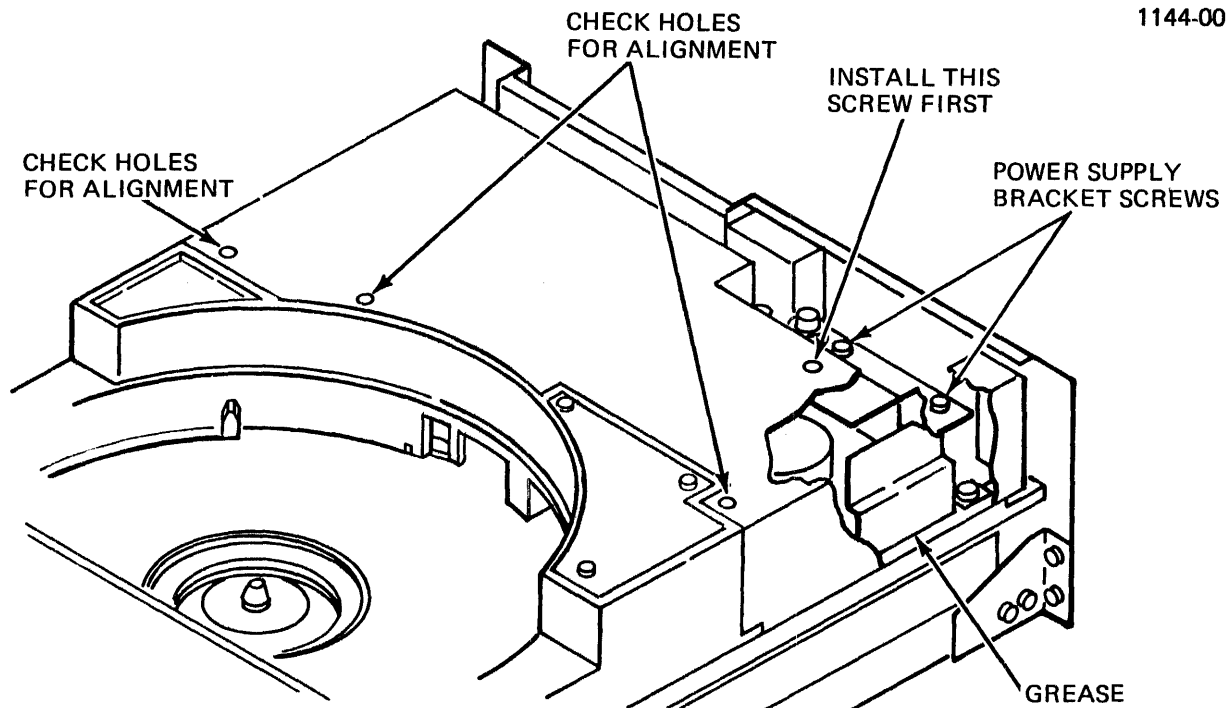


Figure 5-9. Top Cover Hole Alignment

5.4.2.3 Power Supply Removal and Replacement. To remove the power supply, refer to Figure 5-10 and perform the following steps:

- A. Disconnect connectors P10, P18, P9, and P16.
- B. Remove the two ¼-20 screws that fasten the power supply to the top edge of the casting.
- C. Remove the screw located at the base of the power supply. Access is through a hole in the EIB cover and EIB on the bottom of the drive. The power supply can now be lifted from the Disk Drive.
- D. To replace the power supply, install and tighten the screw at the base of the power supply and install the two ¼-20 screws to fasten the power supply to the top edge of the casting. (Apply silicone grease to the edge before fastening).
- E. Reconnect plugs P10, P18, P9, and P16.
- F. Apply power and perform the power supply check outlined in paragraph 5.5.2.

SUPER SERIES

1355-001

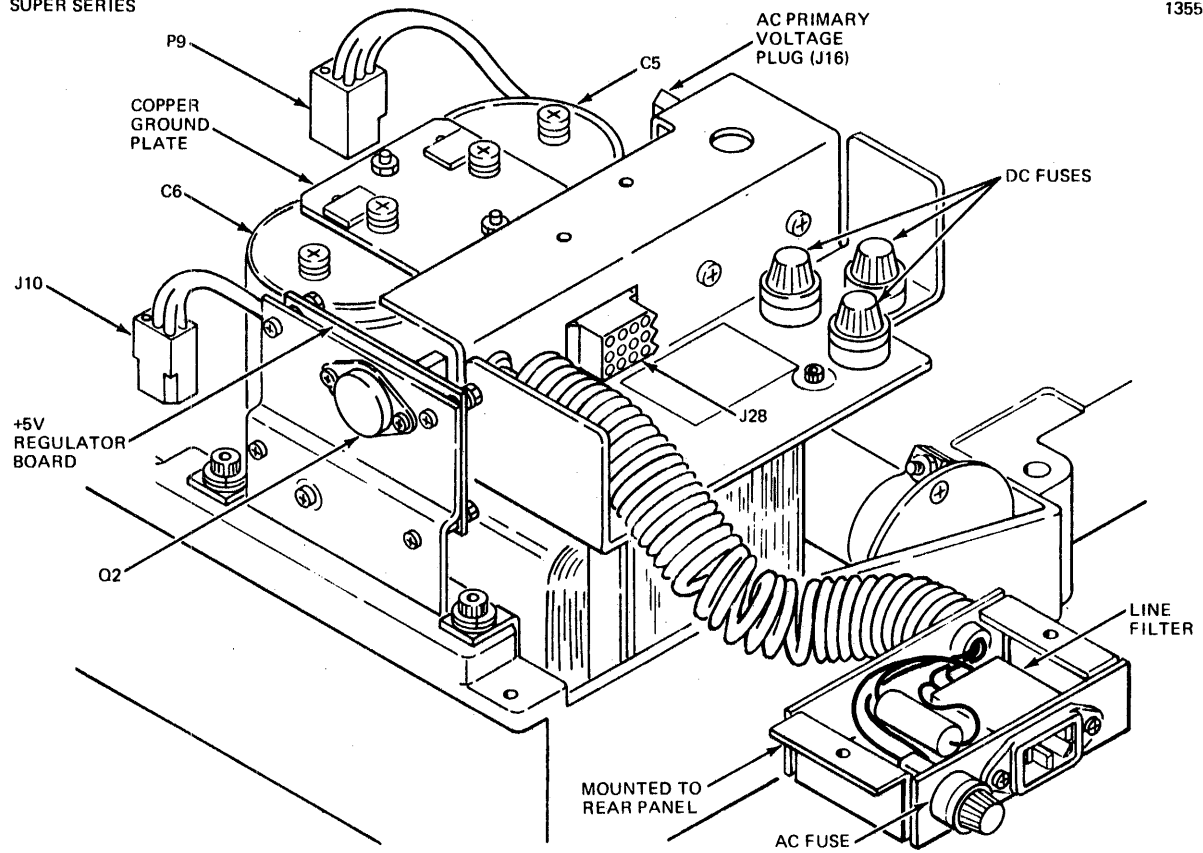


Figure 5-10. Power Supply Assembly

5.4.2.4 Positioner Assembly Removal. To remove the positioner assembly, see Figure 5-11 and perform the following steps:

- A. Install the shipping restraint (see Figure 2-2).
- B. Remove the power supply (see Figure 5-8).
- C. Disconnect Read/Write head connectors P24, P25, P26, and P27 from the DEB.
- D. Remove the DEB.
- E. Disconnect connectors P14, P15, P16, P17, and Temperature plug P40.
- F. Remove the three 10-32 cap screws used to fasten the positioner assembly to the casting. Access is from the bottom of the unit through the three access holes in the EIB cover.



DO NOT REMOVE THE HEAD LOAD CAMS OR HEAD MOUNTING BLOCK IN THE FIELD UNDER ANY CIRCUMSTANCES.



DURING REMOVAL OF THE POSITIONER, CONTACT BETWEEN THE CARRIAGE FRONT END STOP AND THE FIXED DISK MUST BE AVOIDED. DO NOT LIFT THE POSITIONER BY THE HEAD LOAD CAM. FOLLOW THE PROCEDURE BELOW.

- G. Lift the positioner slowly off the casting while constantly observing clearance between the carriage end stop and the fixed disk. Gradually slant the positioners rear end upward, and lift it from the unit toward the rear.

NOTE

Two guide pins, approximately 1/8-inch long, protrude from the base of the positioner into the casting.

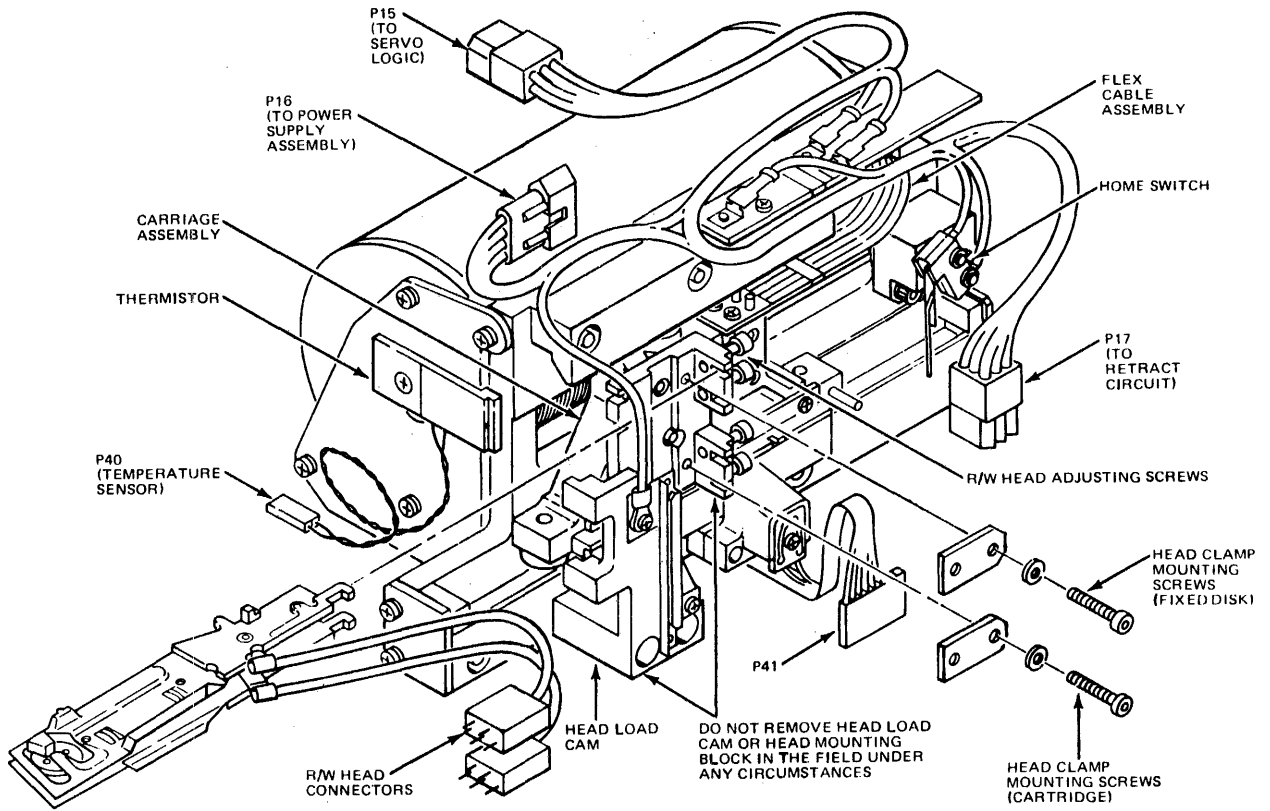


Figure 5-11. Positioner Assembly

5.4.2.5 Positioner Assembly Replacement. To replace the positioner assembly, perform the following steps:

- A. Install the Positioner Assembly, and secure it in place with the three 10-32 cap screws.
- B. Connect plugs P14, P15, P16, P17, and Temperature Plug P40.
- C. Install the DEB, and connect plugs P24, P25, P26, and P27.
- D. Install the Power Supply.
- E. Perform SVA Adjustments and Head Alignment procedures (see table of contents).

5.4.2.6 Fixed Disk Removal (Preliminary Operations). The fixed disk should be removed prior to removal of the spindle assembly.

NOTE

Data written on the fixed disk can not be recovered when the disk is removed from the spindle because the sector identity will be lost. If such data are to be retained, they should be transferred to a "scratch cartridge" prior to removal of the fixed disk. If the disk is to be reused, extreme care must be used to ensure that the disk remains clean and does not touch hard surfaces.

5.4.2.6.1 ST Disk Drive. The preliminary disassembly, leading to the exposure of the fixed disk, differs somewhat between the two series of Disk Drives. To remove the ST fixed disk assembly, perform the following steps:

- A. Remove the colored trim panel on the front of the unit.
- B. Remove the four 6-32 flat-head screws retaining the operator control switch plate, but leave the switch plate in place.
- C. Remove the single 6-32 screw (facing upward) inside the vertical end caps on each side of the bottom of the unit.
- D. Remove the two 6-32 screws at the top of each end cap used to fasten each end cap mounting to the shroud. The end caps and upper mounting brackets now can be removed from the Disk Drive.

- E. Disconnect the guides by removing the last mounting screw (one of three). The guides will be connected only to the door which can now be opened only part way.
- F. Remove the shroud as follows: remove the remaining screws around the perimeter of the shroud; disconnect the solenoid wires at the mating plug and jack receptacles inside the shroud, and lift the shroud off the Disk Drive.
- G. Remove the actuator for the cartridge interlock microswitch as follows: the vertical actuator, which engages the microswitch, is held in place by a retaining ring; remove the retaining ring, and lift out the actuator through the top of the fixed disk cover.
- H. Remove the fixed disk cover as follows: this black sheet metal piece, which covers the fixed disk, extends down the front and wraps underneath the casting. Remove two screws on top of the cover, as well as the three 6-32 flat-head screws on the bottom of the cover. Unplug connector P12 for the cartridge sector transducer, and remove the cover. The fixed disk in the ST Disk Drive is now exposed.

5.4.2.6.2 SF Disk Drive. Prior to removing the fixed disk assembly on the SF Disk Drive, perform the following steps:

- A. Remove the colored trim panel and the retaining screws on the operator control switch plate by the same procedure as in Step B of paragraph 5.4.2.6.1.
- B. Remove the two 6-32 screws (one for each end cap) directly below the end caps on the bottom of the unit. Remove the end caps and the top panel connecting the caps.
- C. Remove the screws and stand-offs around the perimeter of the fixed disk cover, as well as the three screws on the bottom front part of the cover. Unplug connector P12 for the cartridge sector transducer. Disconnect and tag the solenoid leads.
- D. Remove the front screw on the solenoid mounting plate. The fixed disk cover can be lifted off the unit, and the fixed disk in the SF Disk Drive is now exposed.

5.4.2.7 Fixed Disk Removal (Final Operations). When the preliminary steps have been performed, remove the fixed disk as follows:

- A. Remove the six 6-32 nuts and washers on the perimeter of the spindle. Remove the fixed disk clamp ring.

- B. Remove the disk from the spindle assembly.
- C. If removal of the spindle assembly, disk brush motor, fixed disk sector ring, or thermistor assembly is not required, disregard paragraphs 5.4.2.8 through 5.4.2.12 and proceed with the reassembly of the unit as outlined in paragraph 5.4.2.13.

5.4.2.8 Base Thermistor Assembly Removal. To remove the thermistor assembly, perform the following steps:

- A. Remove the 6-32 screw securing the assembly (see Figure 5-6).
- B. Disconnect plug P31, and remove the assembly.
- C. Reverse steps B and A for replacement. Apply silicone grease to the lower side of the assembly prior to its installation.
- D. After replacement, if no other assemblies are to be replaced, perform necessary adjustments.

5.4.2.9 Spindle Assembly Removal. To remove the spindle assembly, see Figure 5-12 and perform the following steps:

- A. Lift the belt off the two pulleys at the bottom of the Disk Drive.
- B. Remove the three 6-32 screws used to fasten the gasket cover to the spindle, and remove the gasket.
- C. Remove the air filter access cover, loosen the wedge-shaped filter clamps, and remove the air filter (see Figure 5-15).
- D. Disconnect the spindle motor plugs from the Power Switch Board located in the plenum chamber (see Figure 5-15).
- E. Remove the three ¼-20 cap screws used to fasten the spindle assembly to the casting. Access is through three corresponding holes in the casting. The spindle assembly can now be lifted from the Disk Drive.
- F. At this point, the fixed disk sector ring can be removed if it is to be replaced (to change the number of sectors). If removal of the sector ring is not required, disregard paragraph 5.4.2.10 and proceed to paragraph 5.4.2.11.
- G. If the disk brush motor or thermistor assembly is to be replaced, this should be done at this time. Otherwise, replace the new fixed disk sector ring and perform the required adjustments (see para. 5.5.1).

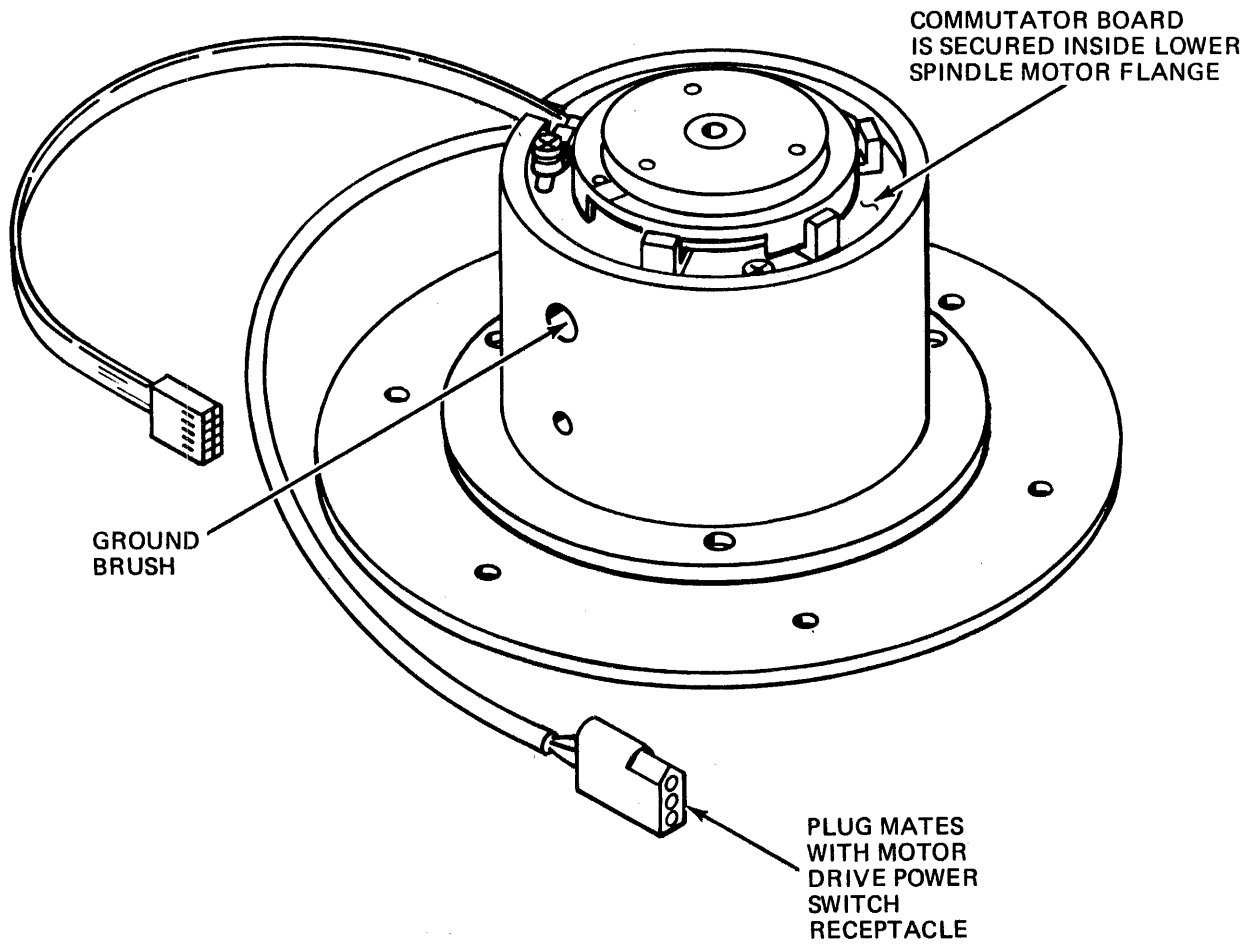


Figure 5-12. Spindle Assembly

5.4.2.10 Fixed Disk Sector Ring Removal. The sector ring is mounted to the bottom side of the fixed disk hub by means of the same six 6-32 screws that secure the fixed disk. Remove the six screws and lift off the sector ring. When the sector ring is replaced, install the six screws and install the fixed disk as outlined in paragraph 5.4.2.7.

5.4.2.11 Spindle Assembly Replacement. To replace the spindle assembly, perform the following steps:

- A. Seat the spindle assembly in the casting, and replace the three ¼-20 cap screws securing the assembly.

NOTE

The spindle assembly fits snugly into the casting hole. When installing the spindle assembly, make certain that it is inserted perfectly straight. No undue force should be used (or necessary) when performing this operation.

- B. Reconnect the spindle motor plugs.

5.4.2.12 Disk Brush Motor Replacement. To replace the disk brush motor, (see to Figure 5-13 and perform the following steps:

- A. Extract leads from plugs P11-6 and P11-1 or P11-4. An alternate method is to unsolder the two leads on the motor housing on top of the base plate.
- B. Loosen the 6-32 Allen head set screw located at one end of the plastic crank. Lift the crank off the motor shaft.
- C. Remove the two 4-40 screws used to secure the motor to the casting (top side of the base plate), and lift out the motor.

5.4.2.13 Reassembly of Disk Drive. To reassemble the Disk Drive, perform the following steps:

- A. Clean the casting cavity; a vacuum cleaner and suitable nozzle can be used for this purpose.

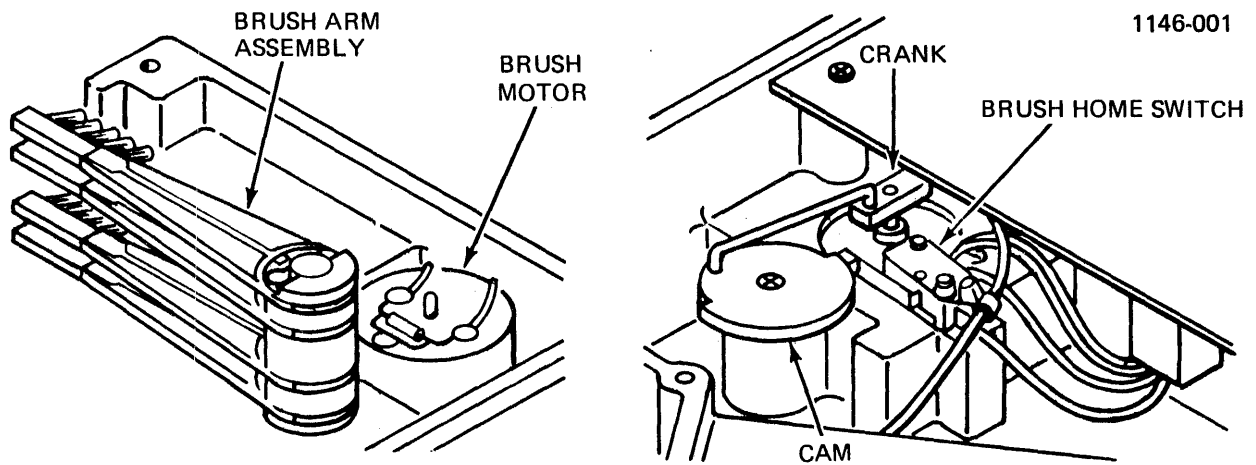
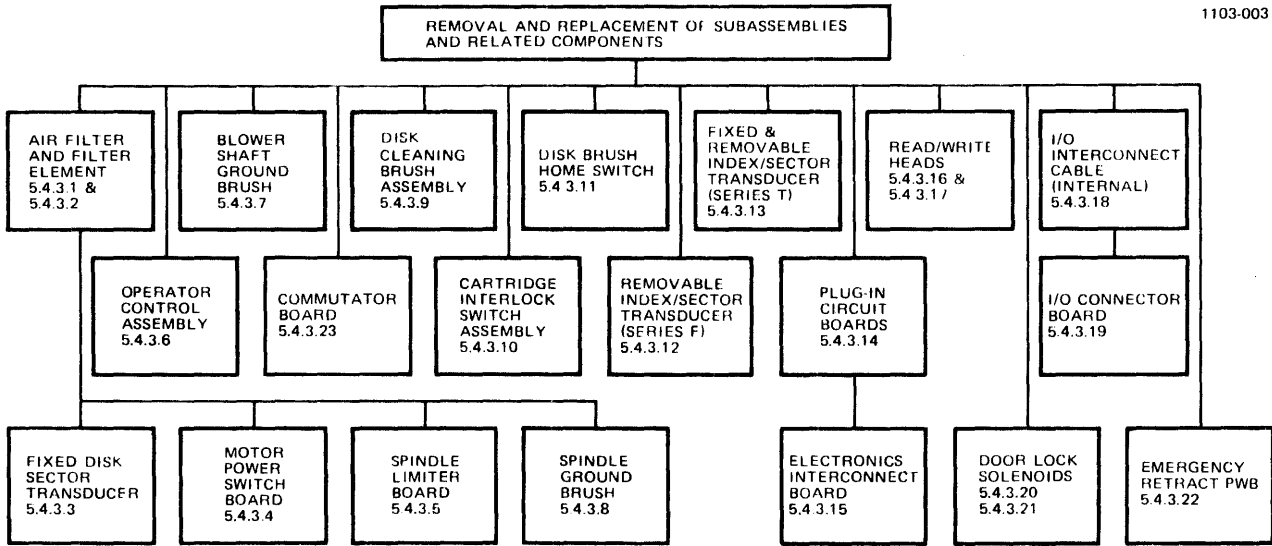


Figure 5-13. Disk Brush Drive Mechanism

- B. Install the fixed disk on the spindle hub; hold the disk by its edges. Make sure that the disk is perfectly clean (no dust or finger prints) and that any marking (serial number, etc.) on the inner uncoated area of the disk is facing up. The disk must be properly seated on the guide ridge of the spindle hub.
- C. Install the clamp ring, replace the six nylon washers with new washers, and install the 6-32 nuts. Tighten the nuts alternately in a criss-cross pattern, and tighten each nut to 8 inch-pounds (20.32cm/0.4536kg) with a torque wrench.
- D. Reassemble the Disk Drive in a reverse order of its disassembly as previously described. Verify that both transducer outputs align the index to data. (see Table 5-3 for a list of procedures for alignment and adjustment of the Disk Drive.)

5.4.3 REMOVAL AND REPLACEMENT OF SUBASSEMBLIES

In the following paragraphs, removal for servicing or replacement of subassemblies and associated components is described in detail. Figure 5-14 shows these operations.



CAUTION OPERATION OF THE DISK DRIVE WITH THE AIR FILTER REMOVED MAY CAUSE DAMAGE TO, AND NECESSITATE REPLACEMENT OF, THE BLOWER DRIVE BELT.

Figure 5-14. Removal/Replacement Guide – Subassemblies

5.4.3.1 Air Filter. The air filter, as shown in Figure 5-15, is located in the rectangular cavity in the bottom side of the base casting adjacent to the spindle assembly. It is retained by a sheet-metal cover. To remove this assembly, perform the following steps:

- A. Remove the seven 6-32 flat-head screws used to secure the air filter cover to the casting, and remove the air filter cover.
- B. Loosen the two wedge-shaped clamps on the filter, remove the filter element, and inspect or replace the filter element.
- C. If only the prefilter element is to be replaced, peel this part off the filter element and apply a new prefilter (on same side of main filter).
- D. To reinstall the filter element, perform these steps in the reverse order used for air filter removal.

5.4.3.2 Filter Element Replacement. When reinstalling the filter element, make sure that the arrow label (which indicates the direction of air flow) on the filter case points toward the outside wall of the casting. The prefilter will face the spindle assembly.

NOTE

If the following parts are to be replaced, this must be accomplished before reinstalling the filter element:

- 1. Fixed Disk Sector Transducer
- 2. Motor Drive Power Switch Circuit Board
- 3. Spindle Limiter Circuit Board
- 4. Spindle Ground Brush

5.4.3.3 Fixed Disk Sector Transducer. The Fixed Disk Sector Transducer is screwed into the casting in the plenum chamber and is accessible from the air filter cavity. If the air filter is in place, first remove that component. Then perform the following steps:



OPERATION OF THE DISK DRIVE WITH THE AIR FILTER REMOVED MAY CAUSE DAMAGE TO, AND NECESSITATE REPLACEMENT OF, THE BLOWER DRIVE BELT.

- A. To remove the sector transducer, unplug connector P13, loosen the jamb nut that locks the transducer body, and screw the transducer out of the casting.

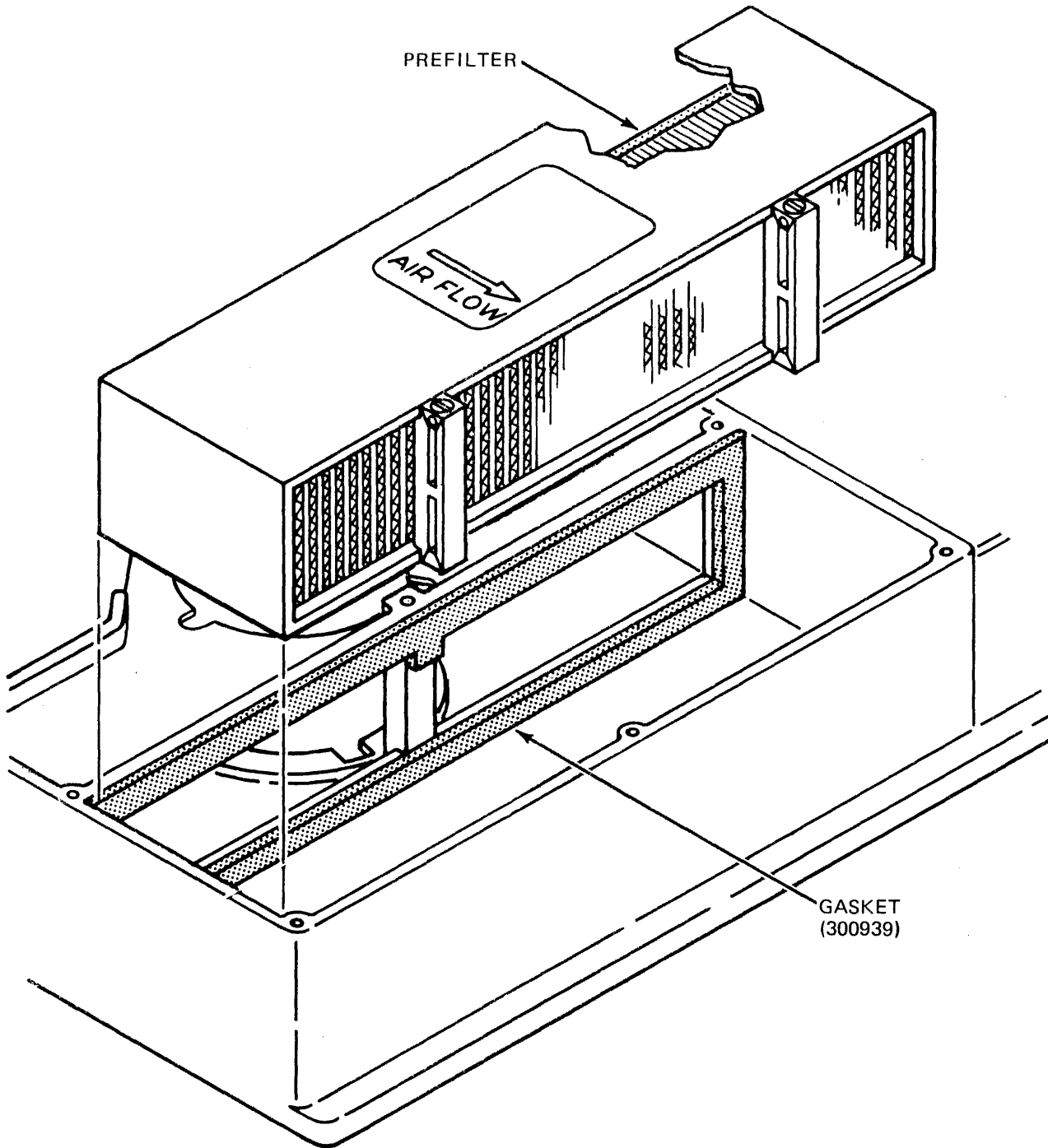


Figure 5-15. Air Filter Installation

- B. After the transducer has been replaced, its position relative to the fixed disk sector ring must be adjusted. To adjust the transducer position, place an 0.005-inch (0.127 mm) shim between the transducer tip and the sector ring. Screw the transducer toward the sector ring until the 0.005-inch (0.127 mm) clearance is obtained. Tighten the jam nut to secure the transducer to the casting, and remove the shim.

NOTE

This mechanical adjustment of the transducer can be performed only if the fixed disk has been removed. If it is in place, the alternate procedures outlined in steps C and D must be used, since it is not possible to insert the shim with the disk in place.

- C. Alternate Transducer Adjustment: Screw the transducer into the casting until it just touches the fixed disk sector ring. Then back off the transducer (counterclockwise) approximately one-quarter turn.
- D. Perform the fixed disk transducer adjustment procedure described in paragraph 5.5.4.2.

5.4.3.4 Motor Drive Power Switch Board. This circuit board is located in the plenum chamber, next to the spindle assembly, and is accessible from the air filter cavity. If the air filter is in place, first remove this component. To remove the Motor Drive Power Switch Board, unplug all electrical connectors from the board. Remove the two 6-32 screws which are available from below the base plate and which are used to mount the heatsink to the casting. The board then may be lifted out of the chamber.

5.4.3.5 Spindle Drive Limiter Board. This circuit board is located in the plenum chamber and is accessible from the air filter cavity. If the air filter is in place, first remove this component. To remove the circuit board, disconnect the electrical plug from the power switch board and take out the four 6-32 machine screws that mount the board to the casting.

5.4.3.6 Operator Control/Indicator Assembly. This assembly consists of a metal plate on which the control switches and indicators are mounted. The assembly is mounted to the vertical sheet metal panel (part of the fixed disk cover) across the front of the chassis with four 6-32 flat-head screws. The wire harness that connects the control assembly with the Electronics Interconnect Board is routed through the casting behind the blower access cover.

To remove the OCP (Operator Control Panel), perform the following steps:

- A. Remove the four 6-32 screws used to secure the control assembly plate to the Disk Drive chassis.
- B. Remove the two 6-32 set screws in the rim of the blower pulley; then slide the pulley off its shaft.
- C. Remove the nine 6-32 screws that fasten the blower access cover. These include the three screws around the pulley which are used to hold the bearing assembly to the cover. Remove the access cover.
- D. Unplug connector P8 (on the other end of the harness) from the Electronics Interconnect Board, and unplug connector P19. Remove the three wires from cartridge interlock switch S9. Then remove the harness and control assembly from the Disk Drive.
- E. To replace the control assembly, reverse the order of the procedure used for disassembly.

NOTE

If the blower shaft ground brush is to be replaced, this should be done prior to reinstalling the blower access cover and the blower pulley.

5.4.3.7 Blower Shaft Ground Brush. The blower shaft ground brush is mounted in the bearing housing of the blower. The brush is to be replaced if the resistance between the blower shaft and the casting exceeds 1.5 Ohms (with the shaft rotating). To replace the brush, remove the slotted screw at the back of the brush holder, remove the brush, and substitute a new brush. Figure 5-16 shows the configuration of the brush assembly mounting.

5.4.3.8 Spindle Ground Brush. The spindle ground brush is mounted on the side of the spindle motor. Brush replacement is indicated if the resistance between the spindle shaft and the casting exceeds 1.5 Ohms (with the shaft rotating). To remove the spindle ground brush, remove air filter and simply remove the screw securing the brush in the spindle assembly, as shown in Figure 5-17, and take out the brush. To replace the ground brush, reverse the procedure.

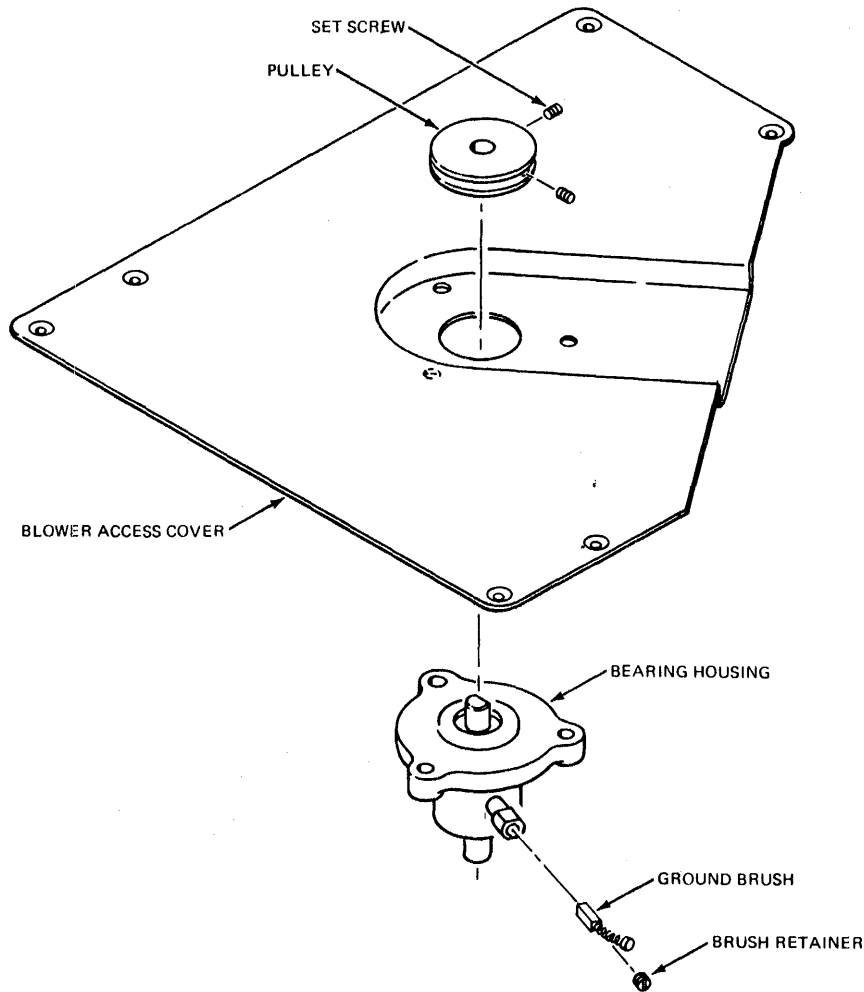


Figure 5-16. Blower Shaft Ground Brush – Mounting

5.4.3.9 Disk Cleaning Brush Assembly. The Disk Drive contains cleaning brushes that sweep the disk(s) once during the start operating cycle. The SF units contain a set of two brushes which are used to sweep the fixed disk surface. The ST units contain two sets, one set being used to sweep the fixed disk and one set for the cartridge disk. If the brushes are not in good condition (bristle tips are not touching), they must be replaced. See Figure 5-18 for correct mounting of the cleaning brushes.

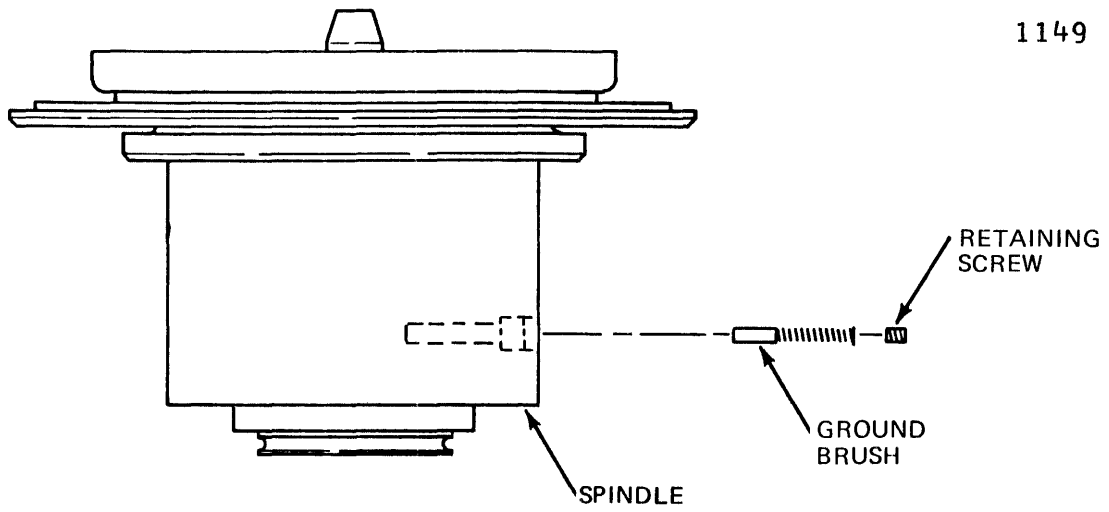


Figure 5-17. Spindle Shaft Ground Brush – Mounting

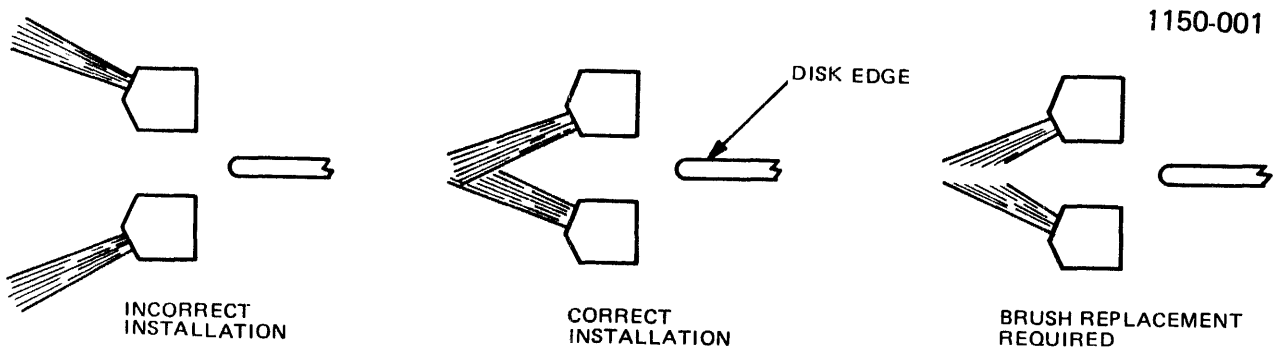


Figure 5-18. Disk Cleaning Brushes – Installation/Replacement Guide

Access to the brush assembly is through an opening on top of the fixed disk cover in the SF Disk Drive and through a similar opening on top of the shroud in the ST Disk Drive. These openings are normally closed by covers. To remove the cleaning brushes, perform the following steps:

- A. Remove the screws that secure the cover. Remove the cover.
- B. Remove the hair-pin shaped clip located on top of the brush arm assembly, and lift off the assembly.
- C. To replace the brushes, pull them (one at a time) from the brush arms. Observe proper keying of the brushes in the arm; there are two types of brushes, a right-hand brush and a left-hand brush.

NOTE

The brush may be installed only once, or its retention capabilities are greatly decreased.

5.4.3.10 Cartridge Interlock Switch. This mechanism consists of a microswitch and a plunger-type actuator on its upper end. When the disk cartridge housing is seated in the Disk Drive, the actuator is engaged. The switch is located at the left-hand side of the control/indicator mounting plate and is accessible when the trim panel at the front of the unit is removed. A photo of the cartridge interlock switch is shown in Figure 5-19.

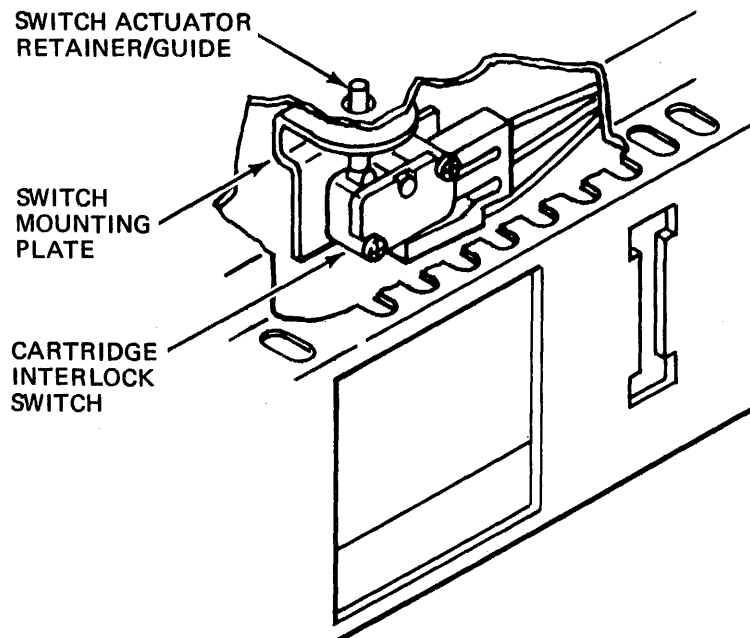


Figure 5-19. Cartridge Interlock Switch Assembly

To remove the cartridge interlock switch subassembly, perform the following steps:

- A. If the actuator is to be taken off, remove the retaining ring with which it is secured. Then lift the actuator through the top of the fixed disk cover.
- B. To remove the microswitch, unplug the leads from the switch terminals and remove the two 4-40 screws used to fasten the switch to its mounting plate.
- C. After the switch has been replaced, verify the proper operation of the switch/actuator. If necessary, the switch position should be adjusted.
- D. To adjust the microswitch position, slightly loosen the two switch-mounting screws. Install a disk cartridge and close the door. On the ST Drive, the bottom cover must be installed on the cartridge.
- E. Move the switch against the actuator until it clicks which indicates the switch has been actuated. Tighten the switch-mounting screws while holding the switch securely in the adjusted position.

NOTE

Some small travel should remain in the switch after it has been adjusted; i.e., the actuator plunger should not press the switch mechanism to its stop when the cartridge is seated.

5.4.3.11 Disk Brush Home Switch. This microswitch is located next to the cam of the disk brush drive mechanism below the base plate (see Figure 5-13). To remove the microswitch, perform the following steps:

- A. Unplug the two leads from the switch terminals, and remove the two 4-40 screws used to secure the switch to the panel.
- B. After the switch has been replaced, verify proper operation, and adjust switch position if necessary.
- C. To adjust the microswitch position, bend the actuator arm so that it actuates the switch as indicated by a click in the switch as the switch arm is halfway up the cam.

CAUTION

WHEN TESTING AND ADJUSTING THE SWITCH MECHANISM, DO NOT ROTATE THE CAM BY HAND UNLESS THE LINKAGE TO THE BRUSH MOTOR (SEE FIGURE 5-13) HAS BEEN DISCONNECTED. DAMAGE TO THE MOTOR HEAD WILL RESULT IF THE LINKAGE IS DRIVEN MANUALLY.

5.4.3.12 Removable Index/Sector Transducer, Series F. The index/sector transducer is a magnetic pickup device, as shown in Figure 5-20, that is mounted on the top side of the fixed disk cover.

To remove the transducer, perform the following steps:

- A. Remove the two 4-40 screws. Note or mark the position of the transducer on the bracket prior to removal. This will facilitate index alignment.
- B. When reinstalling the transducer, line it up to its original position mark as noted in Step A. After replacement, perform the removable disk Index/Sector transducer check and Index Alignment check (see para. 5.5.1).

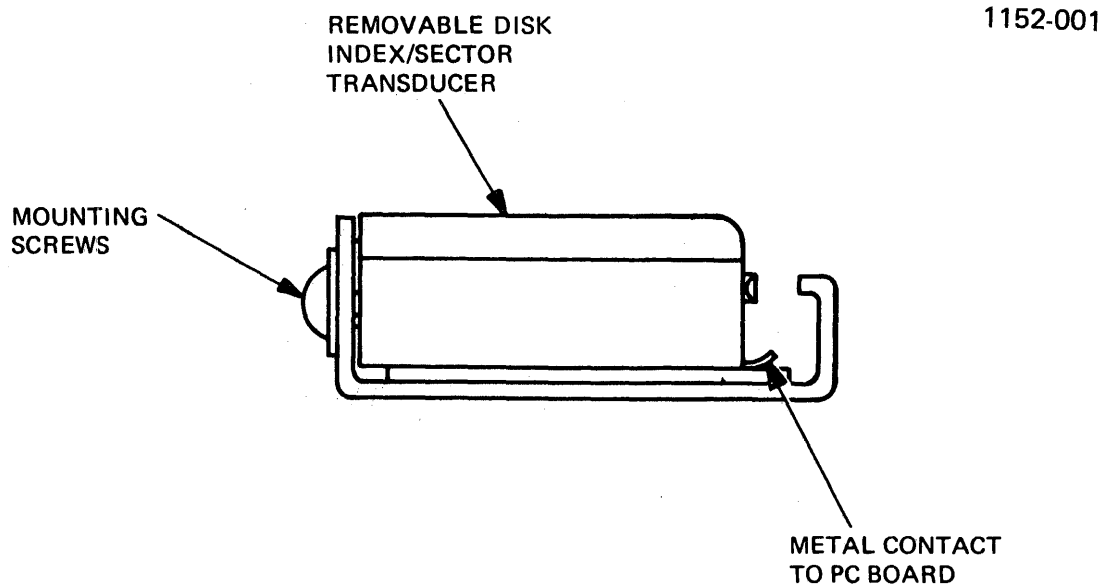


Figure 5-20. Removable Index/Sector Transducer – SF Only

5.4.3.13 Fixed and Removable Index/Sector Transducer, ST (Fixed Only for SF). The Index/sector transducer in the ST Drive is a magnetic pickup device mounted on top of the fixed disk cover near the spindle hub. See Figure 5-21.

To remove the transducer, perform the following steps:

- A. To check the transducer for continuity of its winding, disconnect connector P12 from the Electronics Interconnect Board and remove the disk cartridge. Using an ohmmeter, measure the resistance between the two contacts of P12. If this measurement indicates an open winding, the transducer must be replaced.
- B. To replace the transducer, loosen the 6-32 set screw in the side of the transducer mounting block. Remove the leads from the housing of connector P12. Turn the transducer counterclockwise until it is completely removed from the mounting block.
- C. Install a test hub on the spindle. Screw the replacement transducer into the mounting block (clockwise rotation) until it just touches the sector ring. Back off the transducer slightly, and with the aid of a shim, adjust the clearance between the transducer pole tip and the sector ring to 0.005-inch (0.127 mm) clearance. Reroute the transducer leads, insert the leads in the housing of connector P12, and reassemble P12 with its housing.
- D. Perform the Index/Transducer adjustment (see para. 5.5.4). Also perform the Index Alignment procedure.

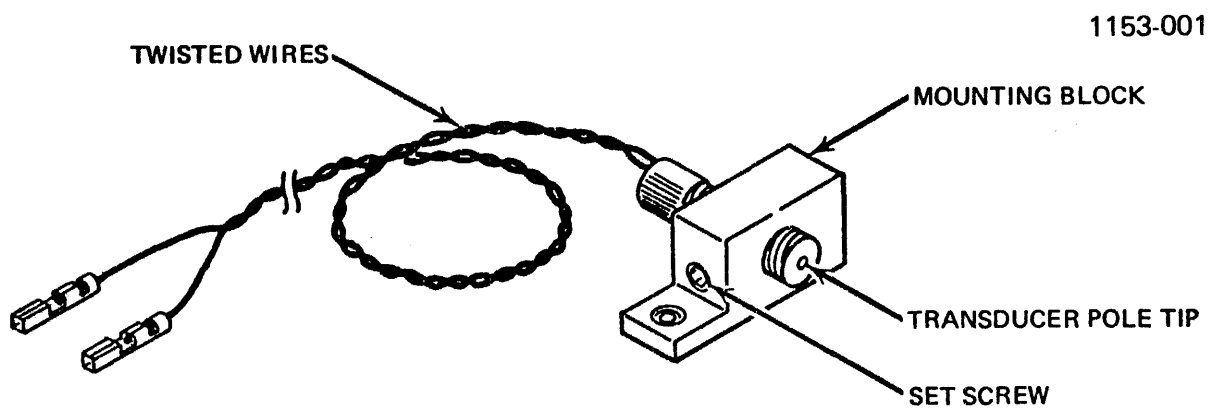


Figure 5-21. Fixed and Removable Index/Sector Transducer

5.4.3.14 Plug-In Circuit Boards. The Disk Drive contains six plug-in circuit boards (which are identified in Figures 5-3 and 5-4). To remove the plug-in circuit boards, perform the following steps:



TURN OFF THE POWER SWITCH ON THE OPERATOR CONTROL PANEL BEFORE REMOVING ANY OF THE CIRCUIT BOARDS.

- A. To remove any of the five boards in the card cage next to the positioner assembly, simultaneously lift up the two extractor levers on the top edge of the board being removed. The circuit board will be automatically extracted from its receptacle.
- B. Before the Servo Amplifier Board is removed, the harness connector (plug P15) must be disconnected.
- C. The logic board adjacent to the power supply is removed by pulling it straight up out of its connector. Prior to removing the Data Electronics Board, unplug the four Read/Write adapter cable connectors from the board.
- D. After replacement of the circuit boards, perform the applicable alignment, adjustment, or operational check (see para. 5.5.1).

5.4.3.15 Electronics Interconnect Board. This circuit board (mother board) incorporates the connecting receptacles of all six plug-in boards as well as connecting pins for various harness cable connectors (see Electronic Interconnect PWB Dwg., Volume 2). The Electronics Interconnect Board is located below the base plate (see Figure 5-5). To remove the Electronics Interconnect Board, perform the following steps:

- A. Remove the six plug-in circuit boards.
- B. Unplug all cable connectors including internal I/O connector. Use 3M extractor tool no. 3438 (Perkin-Elmer P/N 108200).
- C. Remove the three 6-32 screws that fasten each of the two brackets used to secure the card cage to the base casting. Disconnect the two brackets from the card cage but not from the casting.
- D. Remove all screws that fasten the Electronics Interconnect Board to the casting. The screws are accessible from the bottom of the Disk Drive (see Figure 5-5).

NOTE

The card cage should not be removed from the Electronics Interconnect Board under normal conditions.

5.4.3.16 Read/Write Head Assemblies. Each Read/Write head assembly consists of a circular ceramic pad that contains the Read/Write and Erase coils, a gimbal spring used to support the head pad on the head arm, and the head arm which is mounted to the positioner carriage. A highly flexible four-wire cable interconnects each head with the Data Electronics Board. Each of the four conductors carries a five-pin connector on its free-end which plugs into a corresponding receptacle on the Data Electronics Board. See Figure 5-22 for a line drawing of a Read/Write head assembly.

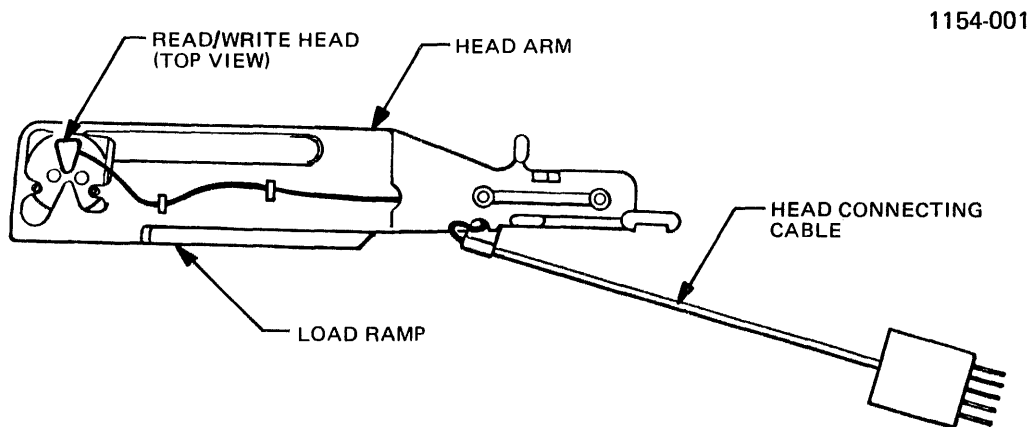


Figure 5-22. Read/Write Head Assembly

Replacement of the head assemblies is simplified if the power supply assembly is temporarily removed from the Disk Drive to obtain unrestricted access to the head area. However, it is possible to remove the Read/Write heads with the power supply in place.

CAUTION

WHEN REPLACING FIXED DISK HEADS, ENSURE THEY ARE OPPOSING EACH OTHER (SAME LOCATION IN MOUNTING SLOTS) AND STAGGERED APPROXIMATELY .075 (1.90mm) TO .100-IN. (2.54mm) FORE OR AFT OF CARTRIDGE DISK HEADS. THIS WILL ENSURE RELIABLE EMERGENCY RETRACT UNDER ALL CONDITIONS.

NOTE

Prior to removal of the heads associated with the fixed disk (the lower pair of heads), data written on the fixed disk should be transferred to a "scratch cartridge" since such data may not be recoverable after head replacement.

To remove the Read/Write heads, perform the following steps:

- A. Remove the power supply unit (see paragraph 5.4.2.3) after making sure that the line cord has been removed from the wall outlet.
- B. Unplug the head cable connectors from the Data Electronics Board.
- C. Remove the two 4-40 cap screws used to secure the head clamp for the upper head pair to the carriage, and remove the head clamp.
- D. Carefully lift the upper head arm off the ramp, and remove it from the carriage. Remove the lower head assembly in the same manner.
- E. Repeat the procedures performed in Steps C and D to remove the lower head pair.

CAUTION

DURING THE REPLACEMENT OF THE HEAD ASSEMBLIES, BE SURE TO AVOID CONTACT BETWEEN THE HEAD PADS AND ANY OTHER OBJECT. DO NOT BEND THE HEAD BEING REMOVED BEYOND THE CAM HEIGHT TO AVOID DAMAGE TO THE HEAD.

After replacement of a head assembly, perform the following procedures:

- F. Data Separator Check (see paragraph 5.5.12).
- G. Head Alignment (see paragraph 5.5.11).
- H. Index Alignment (see paragraph 5.5.9).

5.4.3.17 Use of Torque Wrench. An inexpensive torque wrench has been developed by the Company which will be useful in applying correct torque to the two mounting screws when replacing Read/Write heads. This tool, P/N T-00425, is available from the Company (see Table 5-2).

To use the torque wrench, refer to Figure 5-23 and perform the following steps:

- A. Install the disk head (1) to be replaced in the mounting block, using the head clamp (4).
- B. Insert the 4-40 x 3/4 socket-head screw (2), a No. 4 flat washer (3), and tighten the screw finger tight.
- C. Insert the torque wrench into the socket head of the mounting screw to be torqued.

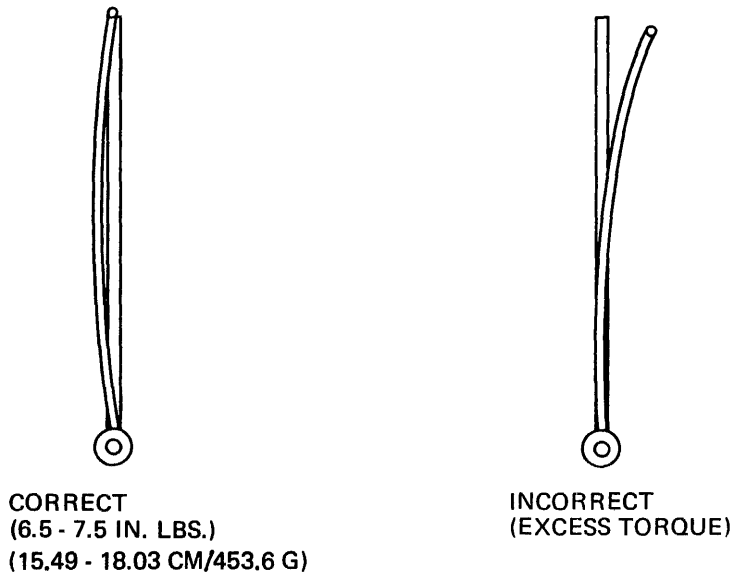
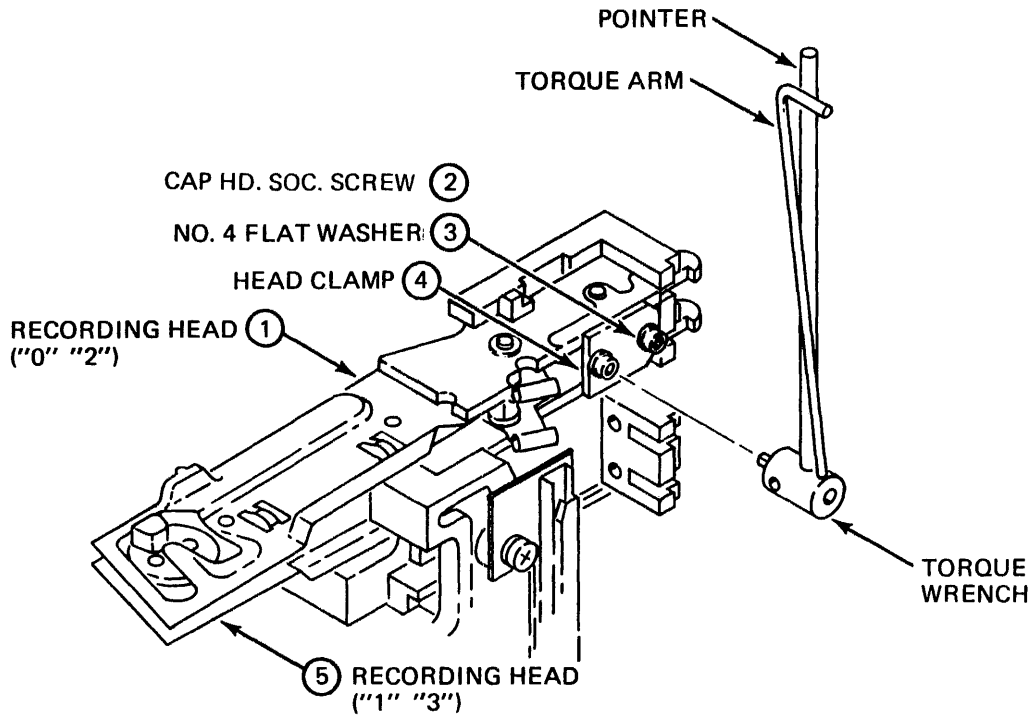


Figure 5-23. Torque Wrench No. T-00425 Application

- D. Press against the torque wrench arm, using finger pressure, until the tip of the arm is parallel with the pointer. The mounting screw is now tightened to the correct torque of 6.5 to 7.5 inch-pounds (15.49 - 18.03 cm/0.4536 kg).
- E. If the arm is pushed past the pointer, the correct torque will be exceeded (see Figure 5-23).

5.4.3.18 I/O Interconnect Cable. This flexible cable provides input/output signal connections between the I/O Connect Board (mounted on the rear panel of the Disk Drive) and the Electronics Interconnect Board (mother board). The cable is terminated with a 50-pin connector at each end; these connectors mate with pins on the Electronics Interconnect Board and the I/O Connector Board.

To remove the I/O interconnect cable, disconnect the two 50-pin connectors at each of the two circuit boards. Use the 3M extracting tool for this operation to facilitate removal of the two connectors. Remove the upper screw from the vertical rod in the cable-guide bracket; then, unsnap the cable clamps, tilt the rod, and slide out the I/O interconnect cable assembly.

5.4.3.19 I/O Connector Board. This circuit board is mounted on the rear panel of the Disk Drive. It incorporates the input/output line connectors and line drivers and receivers (see Figure 2-5).

To remove the I/O Connector Board, take out the four mounting screws (one at each corner) used to fasten the circuit board and its cover to the rear panel, then lift out the board and its cover. Unplug the I/O Interconnecting cable from the board and use a 3M cable extractor to facilitate disconnection without damage.

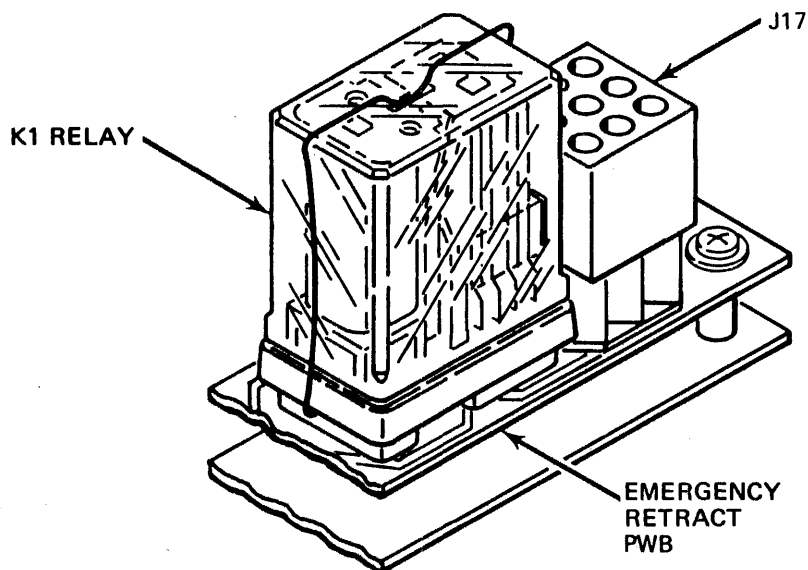
5.4.3.20 Door Lock Solenoid, Series F. This solenoid assembly is located near the right-hand edge of the base plate (see Figure 5-6) and is mounted on a small mounting plate that is bolted to the fixed disc cover. To remove the door lock solenoid, perform the following steps:

- A. Prior to disconnecting the leads from the solenoid, record and tag the polarity of the connections; one of the solenoid terminals is color-coded, and the leads must be reconnected in the same configuration.
- B. Unplug the two leads from the terminal tabs on the solenoid.
- C. Remove the two 6-32 screws used to secure the mounting plate to the fixed disk cover. The mounting plate and the solenoid can now be lifted off the fixed disk cover.

5.4.3.21 Door Lock Solenoid, Series T. These solenoids are located behind the door assembly (see Figure 5-7) and are mounted on two small mounting plates that are bolted under the top of the shroud. . To remove a door lock solenoid, remove shroud, perform the same steps used to remove the door lock solenoid for the SF in the preceding paragraph. Make sure that the attaching plug is disconnected. If only one solenoid is to be replaced, unsolder the leads and tag each lead to indicate its polarity as described in step A of paragraph 5.4.3.20.

5.4.3.22 Emergency Retract PWB Assembly. This PWB is located at the rear side of the Disk Drive, and is mounted next to the positioner assembly. To replace this circuit board, see Figure 5-24 and perform the following steps:

- A. Disconnect plug J17 and remove the four 4-40 screws used to secure the board. Remove the board assembly.
- B. To install the board assembly, reverse the steps used to remove the board.



1155-001

Figure 5-24. Emergency Retract PWB Assembly

5.4.3.23 Commutator Board Removal. This circuit board is mounted on the rear of the spindle motor assembly with the spindle motor shaft extending through the center of the doughnut-shaped Commutator Board. To replace this circuit board, perform the following steps:

- A. Slide the Disk Drive out of the rack, and remove the blower drive belt, spindle gasket cover, and the Allen-head screw in the center of the spindle motor drive pulley.
- B. When the pulley is removed, the three Phillips-head screws used to fasten the Commutator Board to the spindle assembly are accessible. Remove the three screws and the Commutator Board. Disconnect P36 from switch board.
- C. Replacement is done by reversing the steps used in removal.
- D. Since this board works in conjunction with the Drive Power Switch Board to control phasing of the spindle assembly, the procedure outlined in paragraph 5.5.3 must be performed when the replacement board has been installed.

5.5 ADJUSTMENT AND CALIBRATION PROCEDURES

On the following pages, procedures are described for all adjustments and calibrations that can be performed at the installation site. The procedures are listed in the sequential order to be followed if a complete calibration (covering every item described) should be intended.

All test equipment specified in the procedures is listed in subparagraph 5.4.1.3. It is recommended that the subparagraph 5.4.3.14, describing the removal of the circuit boards, be reviewed before carrying out the following procedures.

CAUTION

WHEN PERFORMING MAINTENANCE WITH P15 DISCONNECTED FROM THE SVA BOARD, THE SPINDLE WILL NOT MAINTAIN SPEED IF THE HEADS ARE MANUALLY LOADED UNLESS A JUMPER IS INSTALLED ON THE DCB FROM THE RETRACT TEST POINT TO F-2 (–) GROUND.

5.5.1 TABLE OF ADJUSTMENTS

Table 5-3 lists alignment and adjustment procedures for the SF and ST Disk Drives. The circuit board on which the adjustment is made or on which the output is monitored is noted in the first column; name of the procedure is in the second column, and the paragraph in which the procedure is described is listed in the third column. In some cases, the signal is only monitored, since no means of signal adjustment is incorporated on the board.

Table 5-3. Table of Adjustments

Board	Procedure	Paragraph
Power Supply and DEB	DC Voltage Check	5.5.2
Commutator	Spindle Phasing	5.5.3
DCB	Index/Sector Transducer Adjustment	5.5.4
SVA	SVA Adjustment Procedures	5.5.5
SVA	SVA Operational Checks	5.5.6
SVA	Temperature Compensation Check	5.5.7
SVA	Ready Inhibit Check	5.5.8
DCB & DEB	Index Alignment	5.5.9
DEB	Write Current Check	5.5.10
DEB	Read/Write Head Alignment	5.5.11
DIB (VFO)	Data Separator Operational Check	5.5.12
MFM	MFM Adjustments (4400 BPI Disk Drives only)	5.5.13

5.5.2 POWER SUPPLY ADJUSTMENT

To check DC operating voltages, perform the following steps:

- A. Place the POWER switch in OFF position.
- B. Remove the Data Electronics Board from location J7 and insert an extender board in its place. Insert the DEB in the extender board.
- C. Apply power and monitor the +5VDC at pin D of connector J7. Adjust R-10 on the 5V. regulator (see Figure 5-3) for exactly +5 volts on a DVM.
- D. Adjust potentiometer G26 on the DEB for $-13\text{VDC} \pm 2\%$ at pin B of connector J7.
- E. Adjust potentiometer G22 on the DEB for $+13\text{VDC} \pm 2\%$ at pin C of connector J7.
- F. Place the POWER in OFF position and remove the extender board from card cage location J7. Reinstall the DEB and remove test equipment.

5.5.3 SPINDLE PHASING

To adjust the spindle drive motor and commutator board phasing, perform the following steps:

- A. Replace the defective commutator board, and/or loosen the pulley of the interrupter cup. Remove air filter if not already removed.
- B. For drives with Low Impedance Spindle Drive Motors (PN 301217), disconnect P37 from the Spindle Switch board, and install the Phasing Harness (PN 301396) as shown in Figure 5-25 with harness jack J37 connected to P37 (spindle motor leads). For drives with High Impedance Spindle Drive Motors (PN 301690), the Spindle Phasing Harness Adapter (PN 302010) must be inserted between P37 (spindle motor leads) and J37 of the spindle phasing harness.
- C. Connect a jumper wire from the RETRACT test point and F-2 (–) ground on the DCB.
- D. Actuate the POWER switch on the Disk Drive, and touch the harness contact pin to the (+) side of capacitor C5. The spindle should rotate and lock in position.

CAUTION

DO NOT HOLD CONTACT PIN LONGER
THAN 3 SECONDS.

- E. Ensure that the spindle does not move while adjusting the interrupter cup as shown in Figure 5-26.
- F. Hold the interrupter cup with one hand, and tighten the pulley screws to 24-inch-pounds of torque.
- G. Rotate the spindle shaft approximately 45 degrees, and repeat step D. Ensure that the phasing is correct (see Figure 5-26).
- H. Place the POWER switch in OFF position, disconnect the phasing harness, and reconnect plug P37 to J37 on the Spindle Motor Power Switch Board.

5.5.4 INDEX/SECTOR TRANSDUCER ADJUSTMENT

5.5.4.1 Cartridge Disk Sector Transducer Adjustment (Series T). The ST cartridge disk transducer adjustment procedure is outlined in the following steps. The fixed disk transducer alignment procedure involves a sequence of similar steps (see paragraph 5.5.4.2). After mechanical adjustment of the transducer described in paragraph 5.4.3.13, perform the final positioning of the transducer as follows, and make certain power has been removed from the Disk Drive.

SUPER SERIES

1156B

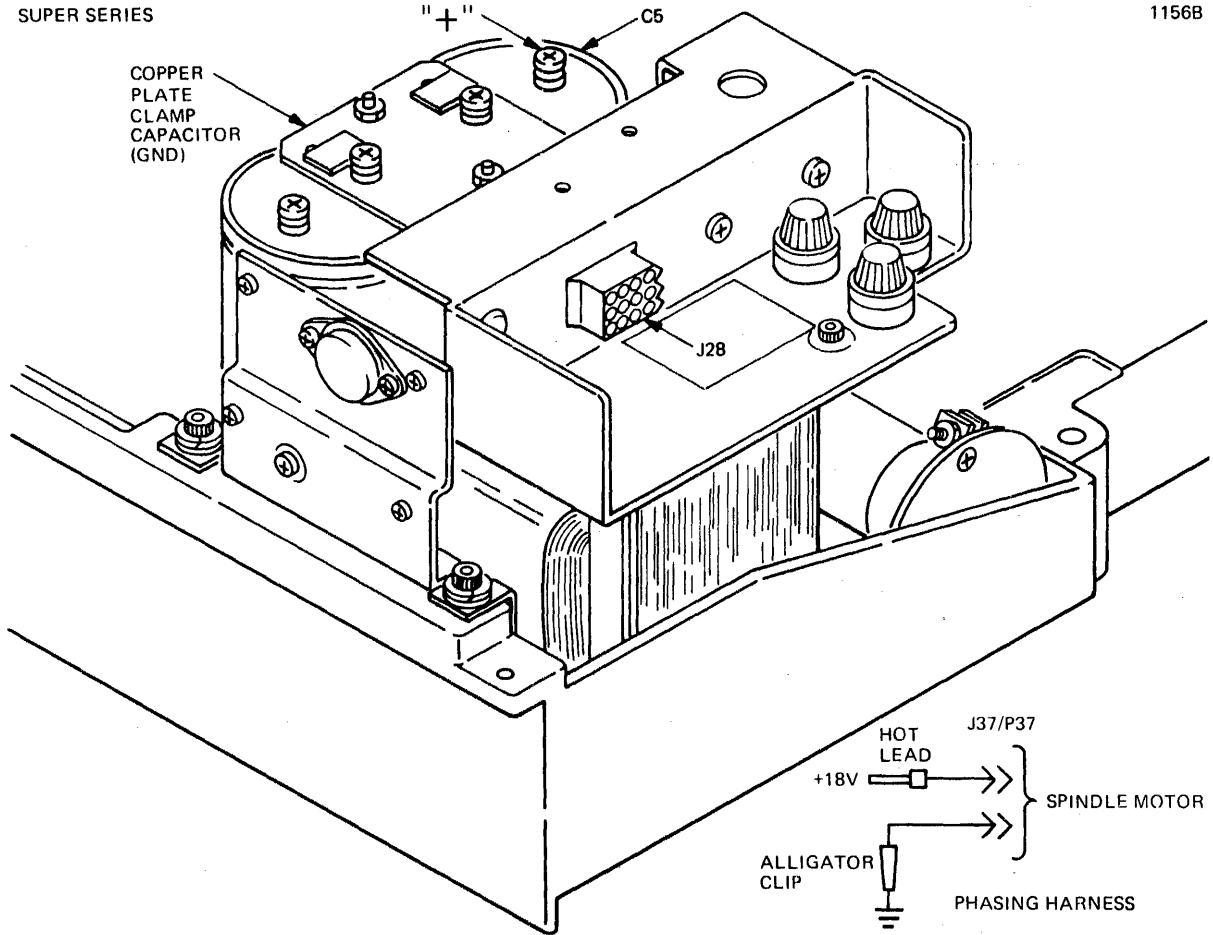


Figure 5-25. Power Supply Connections – Commutator Board Phasing Adjustment

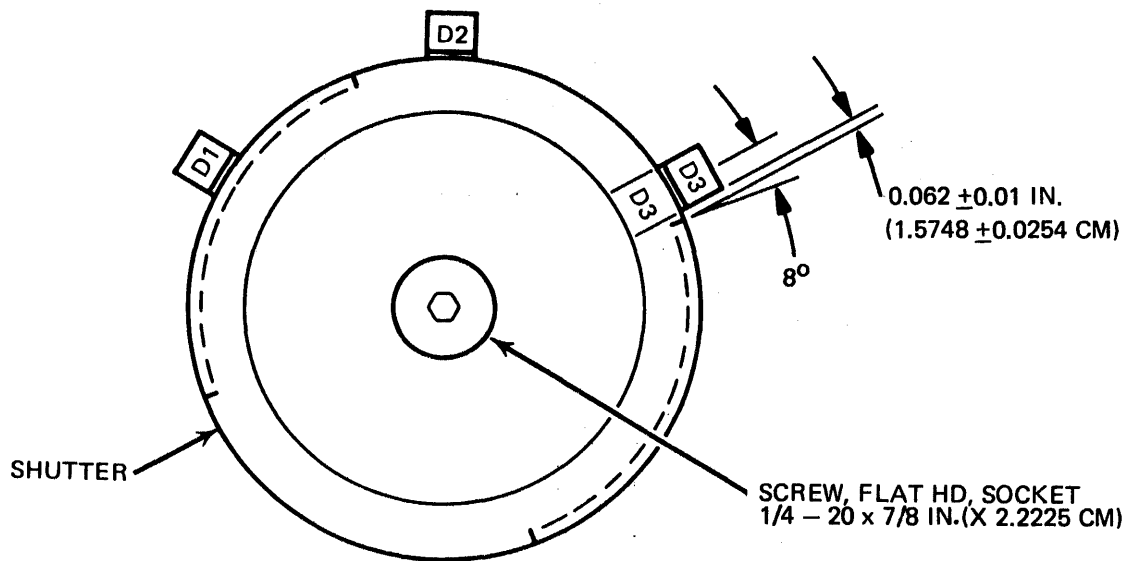


Figure 5-26. Shutter Adjustment – Commutator Board

- A. Remove the DCB from card cage location J3, insert an extender board, and place the DCB in the extender board.
- B. Connect the oscilloscope probe to pin \bar{M} of the extender board connector.
- C. If a cartridge disk is installed, remove it and install the test hub on the spindle chuck.
- D. Unplug connector P15, and manually rotate the spindle 360 degrees to ensure that the hub does not rub against the transducer pole tip. If rubbing occurs, see paragraph 5.4.3.13.
- E. Place the POWER switch to ON position.
- F. Manually actuate the cartridge interlock switch.
- G. Place the RUN/LOAD switch in RUN position and allow the spindle to reach operational speed.
- H. The waveform at pin \bar{M} of the extender card should have minimum output of 300 millivolts base-to-peak with a maximum overshoot (baseline noise) of 50 millivolts as shown in Figure 5-27.
- I. If an output having a minimum amplitude of 300 millivolts can not be attained, the transducer should be replaced. If overshoot is in excess of 50 millivolts, the transducer may be positioned further from the test hub by rotating it counter-clockwise. However, the minimum amplitude of the output signal must be maintained. If the output is acceptable, proceed to step X.

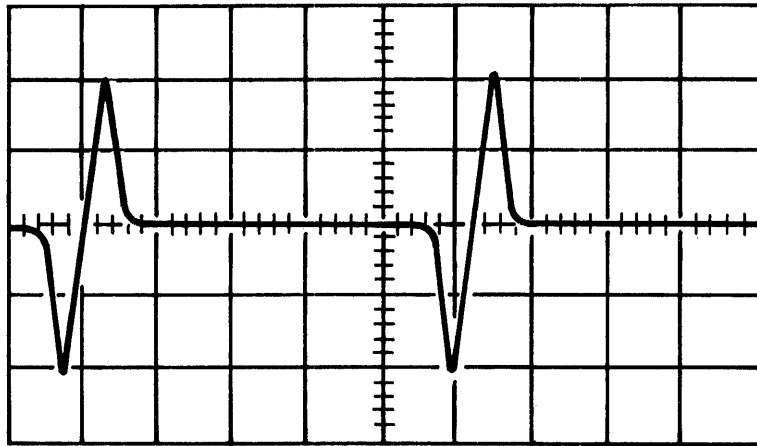


Figure 5-27. Cartridge Sector/Index Transducer Waveform

NOTE

These figures are for adjustment using narrow-slot, 0.020-inch wide, (0.508 mm) hubs only.

- J. If the waveform polarity does not agree with that shown in Figure 5-27, reverse the position of the two transducer leads on connector P12. The pulses should be negative going.
- K. When using 0.070-inch (1.778 mm) wide-slot hubs, the minimum output is 1-volt base-to-peak with a maximum overshoot of 50 millivolts. The same procedures as those previously described are used to obtain these outputs. At no time may the transducer be placed closer than 0.005-inch (0.127 mm) from the hub.
- L. Overshoot sometimes may be caused by a metal chip on the pole tip. A piece of masking tape can be used to remove the magnetized metal chip.
- M. The 1-volt minimum requirement for the wide-slot hub is necessary to ensure proper operation when using a narrow-slot disk cartridge.
- N. Place the POWER switch in OFF position.
- O. If the set screw used to lock the transducer in place has not been tightened, tighten enough that the transducer can not be rotated.

- P. If the transducer is moved closer to the hub, manually rotate the test hub and spindle assembly one complete revolution to ascertain that the transducer pole tip does not contact the sector ring at any time.
- Q. Place the POWER switch in ON position.
- R. Manually actuate the interlock switch (see Figure 5-2).
- S. Place the RUN/LOAD switch in RUN position and allow the spindle to reach normal operational speed.
- T. Observe the waveshape on the oscilloscope as described in step H to make sure the transducer did not move when tightening the set screw.
- U. After the final adjustment, place the POWER switch in OFF position and carefully tighten the jam nut on the transducer assembly.
- V. Repeat steps D, E, F, and G, in that order, to verify that tightening the set screw did not change the clearance between the transducer and the sector ring.
- W. Place the POWER switch in OFF position, remove the test equipment, replace the DCB in card cage location J3, and plug in connector P15.
- X. Perform the Index to data alignment outlined in paragraph 5.5.9.

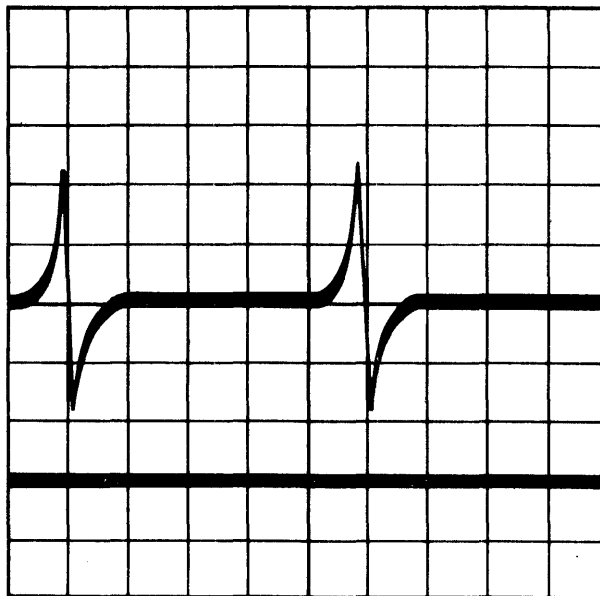
5.5.4.2 Fixed Disk Index/Sector Transducer Adjustment (SF and ST). In both series of Disk Drives, the index/sector transducer is mounted in the plenum chamber next to the air filter (see paragraph 5.4.3.3). If air filter has not been removed, remove it now. If this transducer has been replaced, its position relative to the fixed disk sector ring should be checked by one of the procedures in paragraph 5.4.3.3. To verify or adjust the final position of the transducer, perform the following steps:

CAUTION

OPERATION OF THE DISK DRIVE WITH THE AIR FILTER REMOVED MAY CAUSE DAMAGE TO, AND NECESSITATE REPLACEMENT OF, THE BLOWER DRIVE BELT.

- A. Place the POWER switch in OFF position.
- B. Remove the Disk Control Board (DCB) in card cage location J3, insert an extender card in its place, and insert the DCB in the extender card.
- C. Insert a cartridge disk as previously outlined.
- D. Disconnect P15 on the SVA board in card cage location J5.

- E. Connect the oscilloscope vertical input to pin \bar{P} of the extender board card-edge connector.
- F. Place the POWER switch in ON position.
- G. Place the RUN/LOAD switch in RUN position and allow the spindle to reach normal operational speed.
- H. After the spindle has come up to speed, verify that the waveform at pin \bar{P} is clean with a minimum amplitude of 800 millivolts base-to-peak. See Figure 5-28 for a picture of a normal oscilloscope display. The pulses should be positive-going. Use logic ground at the top of C7 and/or C14 for a reference.
- I. If the amplitude of the output waveform does not have the specified minimum value, turn the transducer clockwise very gradually while observing the display on the oscilloscope until the amplitude of the signal is within limits.
- J. Place the POWER switch in OFF position and carefully tighten the jamb nut on the transducer assembly. Verify that the position of the transducer has not changed during the tightening process. Use LOCTITE to hold the jamb nut in place.
- K. Remove the card extender and replace the DCB in card cage location J3. Remove the test equipment and connect P15 to the SVA board in card cage location J5.



1168

Figure 5-28. Fixed Disk Sector/Index Transducer Waveform

5.5.4.3 Cartridge Disk Index/Sector Adjustment, SF. If this transducer has been replaced as described in subparagraph 5.4.3.12, perform the following steps to check for a satisfactory output signal.

- A. Place the POWER switch in OFF position.
- B. Remove the DCB from card cage location J3, insert a card extender in the card cage connector, and insert the DCB in the card extender.
- C. Install a disc cartridge or a test hub on the spindle chuck.
- D. Disconnect plug P15 on the SVA Board.
- E. Manually actuate the cartridge interlock switch if a test hub is used.
- F. Press the POWER switch; then, press the RUN portion of the RUN/LOAD switch and allow the spindle to come up to operational speed.
- G. Place the oscilloscope vertical probe at the input to the differentiator circuit (pin \bar{M} of circuit board connector J3). The signal should appear as shown in Figure 5-29.
- H. If the waveform at the input to the differentiator circuit is not approximately as shown in Figure 5-29, check operation of the Sector/Index transducer.
- I. Verify that the input to the differentiator circuit is clean (see Figure 5-29). The signal amplitude should be 100 millivolts base-to-peak (minimum).
- J. Place the POWER switch in OFF position; remove the card extender, and insert the DCB in card cage location J3.

0062

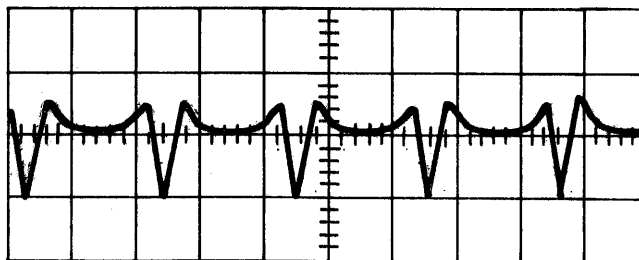


Figure 5-29. Input to Differentiator Board (SF)

- K. Remove test equipment and connect plug P15 to the SVA board.
- L. Perform the index alignment check outlined in subparagraph 5.5.9. If alignment can not be accomplished, the transducer may be moved slightly to the left – to advance the signal, or slightly to the right – to retard the signal. This can be done by loosening the 4-40 screws on the transducer mounting bracket and moving the transducer slightly in its mounting bracket.

5.5.5 SVA ADJUSTMENT PROCEDURES

NOTE

This procedure is only to be used for SVA boards with revision letter D or above.

CAUTION

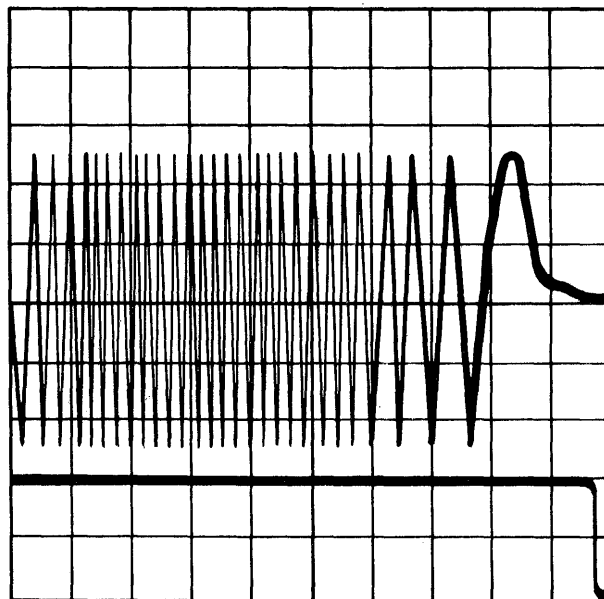
THESE PROCEDURES ARE DESIGNED TO BE ACCOMPLISHED IN SEQUENCE; HOWEVER, IF MAINTENANCE PERSONNEL DEEM IT NECESSARY TO PERFORM INDIVIDUAL CHECKS OR ADJUSTMENTS WITHIN THESE PROCEDURES, THE FOLLOWING MUST BE OBSERVED:

- A. Check initial procedure conditions i.e., POWER ON/OFF, JUMPERS installed/removed.
- B. Verify if P15 is connected or disconnected depending upon whether or not positioner is to be manually moved.
- C. Check for interaction between adjustments i.e., Detent Amplitude changes will affect access time.

5.5.5.1

Detent Amplitude and Balance Adjustment

- A. Place the POWER ON/OFF switch in OFF position; disconnect plug P15 and remove the SVA board from card cage location J5. Insert the SVA board in a card extender and place them in J5 leaving P15 disconnected.
- B. Check for presence of temperature and offset jumpers (A43 to A44, B40 to B44, C39 to C44). If any are present, remove them.
- C. Remove the DCB board from card cage location J3 and install a jumper from RETRACT test point (E5) to ground (F2), or ground pin 1 of E10. Place the CDB back into J3.
- D. Connect a scope probe to Detent signal test point (H63) on the SVA. Select internal sync and vertical sensitivity of 2V/cm, and install a cartridge or test hub.
- E. Place the POWER ON/OFF switch to ON and the RUN/LOAD switch to RUN.
- F. When the disc has reached full speed, manually load the heads.
- G. While manually moving the positioner carriage back and forth, adjust the AMPLITUDE potentiometer (H59) for 12 V. p-p as shown in Figure 5-30. During this and the following step, do not unload the heads.
- H. While manually moving the positioner carriage, adjust the BALANCE potentiometer (E-18) until the detent signal is equally balanced around ground to within $\pm 0.2V$.



1169

Figure 5-30. Detent Signal Output Waveform (manual)

5.5.5.2 Beginning Of Travel (BOT) Phasing and Detent Balance. The purpose of this procedure is to check and adjust, if necessary, the phasing between the BOT pulse and the Detent signal. Also to check and adjust, if necessary, the Detent Assembly balance.

- A. Place POWER ON/OFF Switch to ON and RUN/LOAD switch to RUN. Connect CHAN 1 probe of dual-trace scope to Detent TP H63 and connect CHAN 2 probe to BOT Analog TP B27 on SVA. Set scope to chopped mode. Refer to SVA assembly drawing in Appendix B for TP and component locations.
- B. Manually move carriage forward from its home position and observe phase relationship between BOT Analog and Detent signals. Positive peak of BOT Analog signal must line up within ± 33 degrees of positive peak of Detent signal as shown in Figure 5-31a.
- C. Loosen Detent assembly mounting screws shown in Figure 5-32 and rotate Reticle assembly until proper phasing is attained; then tighten mounting screws.

NOTE

Usually, Steps A-C are necessary only when replacing Detent assembly.

- D. Check amplitude of BOT Analog pulse. Amplitude must be at least +4.5V, including maximum offset voltage of 2.0V when Detent signal amplitude is 12V p-p.
- E. Check and adjust phasing between BOT Analog pulse and Detent signal. Move CHAN 2 scope probe from TP B27 to TP B15 and set scope to trigger on positive-going edge of BOT pulse at TP B15.
- F. Manually move carriage forward from its home position and observe phase relationship between positive-going edge of BOT signal and Detent signal.
- G. Positive-going edge of BOT signal should occur when Detent signal is between 0.0V negative-going slope point over to +3V point on positive-going slope. Preferred location of this coincidence is near 0.0V line on positive-going slope (see Figure 5-31b).
- H. If necessary to bring starting point below +3V point on positive-going slope of Detent signal, adjusting screw on LED housing can be adjusted to lower trigger point by turning screw inward (see Figure 5-31c).
- I. Check and adjust balance by manually returning carriage to its home position. There is a clear area of mask to help adjust DC balance. Differentially measure

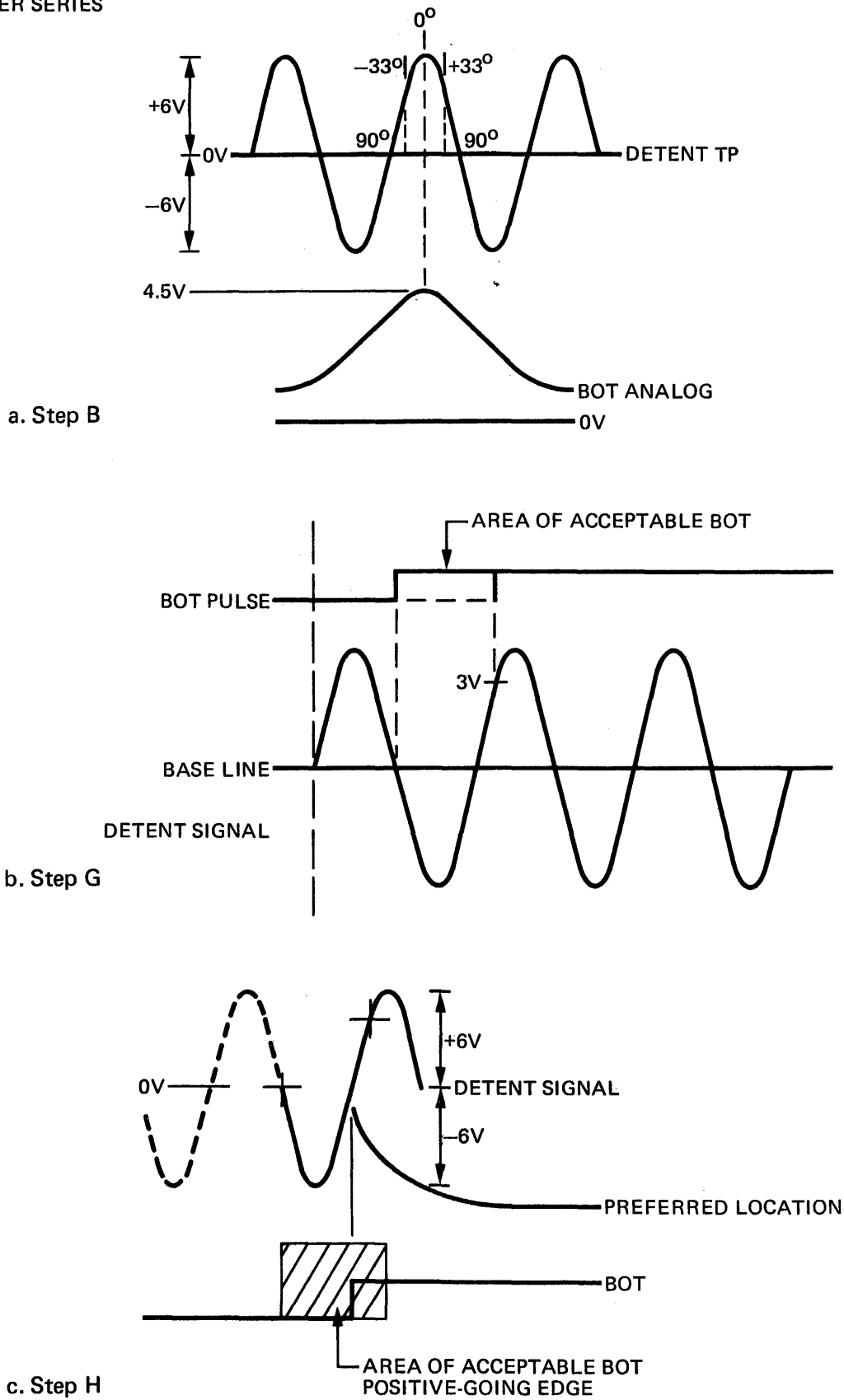


Figure 5-31. Phasing Adjustment Waveform

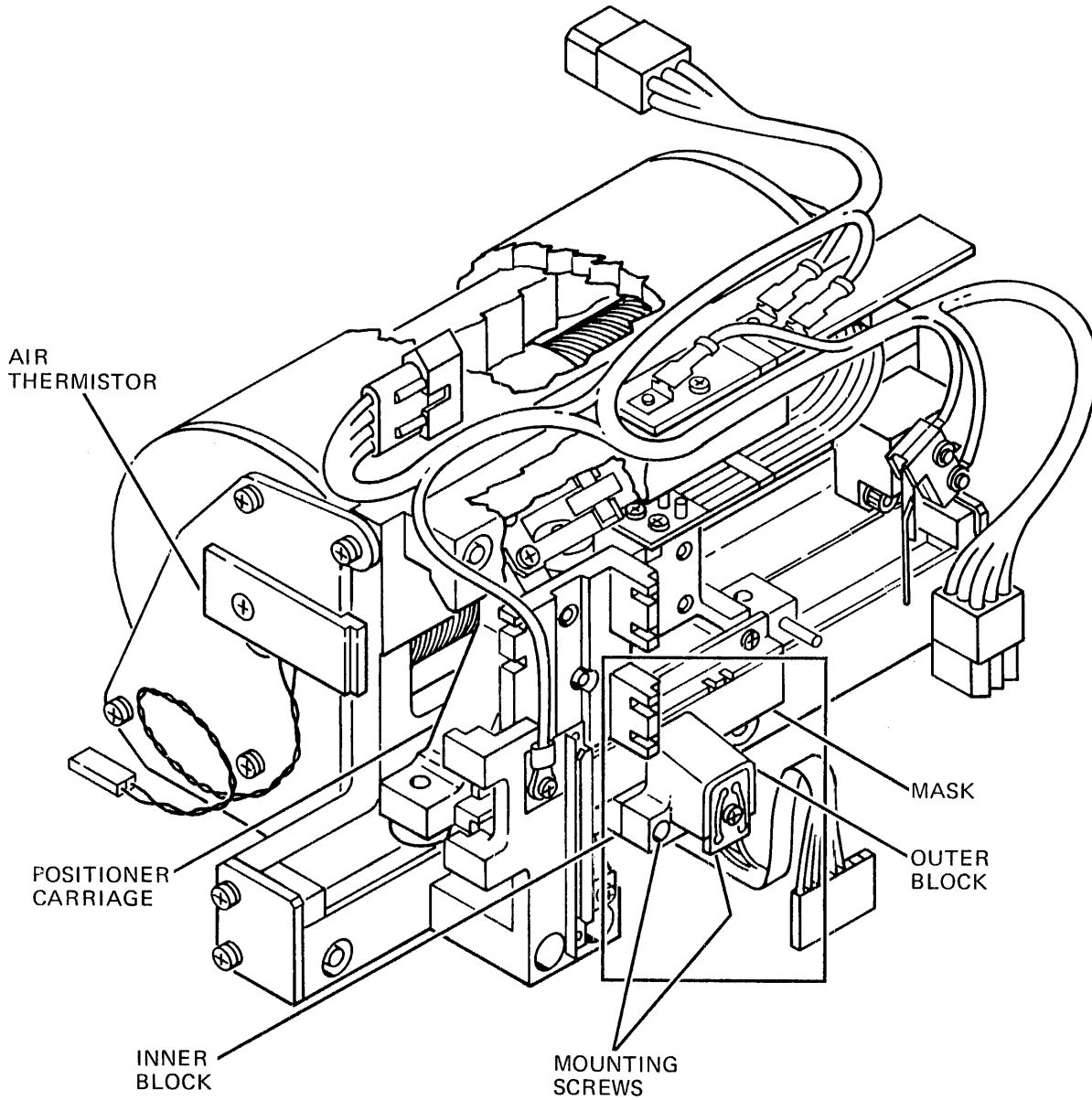


Figure 5-32. Optical Detent Assembly – Phasing Adjustment

voltages at pins W and 7 of connector P5. Difference between voltage measurements must be less than $\pm 60\text{mV}$. If adjustment is necessary, adjust balance screws on LED housing.

- J. Recheck the Detent signal for amplitude, balance, and phasing (see paragraph 5.5.5.1). Readjust as required.
- K. Manually unload the heads.
- L. Place the POWER ON/OFF switch to OFF and remove the jumper on the DCB.
- M. Perform Injection-Velocity and DC Offset adjustments described in the next paragraph.

5.5.5.3 Injection Velocity and DC Offset Adjustments. This procedure is written assuming an Exerciser will be used to initiate operations. To align the servo electronics, perform the following steps:

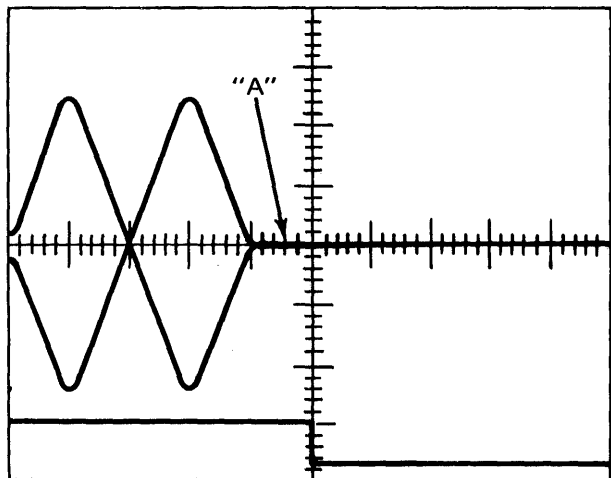
- A. Place the POWER ON/OFF switch to OFF.
- B. Disconnect plug P15 from the SVA board in card cage location J5; remove the SVA board; insert a card extender in its place, and insert the SVA in the card extender.
- C. Review paragraphs 5.5.5.1 and 5.5.5.2 and perform any adjustments needed. Remove any temperature compensation or offset jumpers as in step B of paragraph 5.5.5.1
- D. Place POWER ON/OFF switch to ON, measure the voltage at test point E61 (output of Velocity Ramp Generator). Adjust the Injection Velocity potentiometer (H61) until voltage is approximately -0.2V .
- E. Place POWER ON/OFF switch to OFF; connect plug P15 on the SVA using cable extender PN300789-001. Place POWER ON/OFF switch to ON and RUN/LOAD switch to RUN.

- F. Using the Exerciser, command a forward, incrementing, single track seek for 200 TPI drives. Command an alternating one-track seek between track 000 and 001 for 100 TPI drives. Observe the Detent signal at test point H63 with channel 1 of a dual track scope; then, trigger, with channel 2, on the seek complete signal at test point H65. Set sweep rate to 2 msec/cm. This should allow representation of the alternate tracks superimposed on the scope as shown in Figure 5-33 or Figure 5-34. One signal should be positive-going; the other negative for odd and even tracks.
- G. Adjust the Injection Velocity potentiometer (H61) slightly, if necessary, so that one-track seek time is 8.2 ± 0.3 msec for 200 TPI drives or 10 ± 0.5 msec for 100 TPI drives.
- H. Adjust DC OFFSET potentiometer (E19) until the overshoot (after seek complete, see CAUTION following step I) on adjacent odd and even tracks is symmetrical around 0V. (see Figure 5-33 and 5-34).
- I. Verify that the overshoot at or after seek complete is 0.3V. (max.). Careful adjustment of the Injection Velocity potentiometer (H61) from the setting arrived at in step G will modify the overshoot waveform. Before attempting any adjustment to modify overshoot characteristics, read the following CAUTION and study the waveforms.

CAUTION

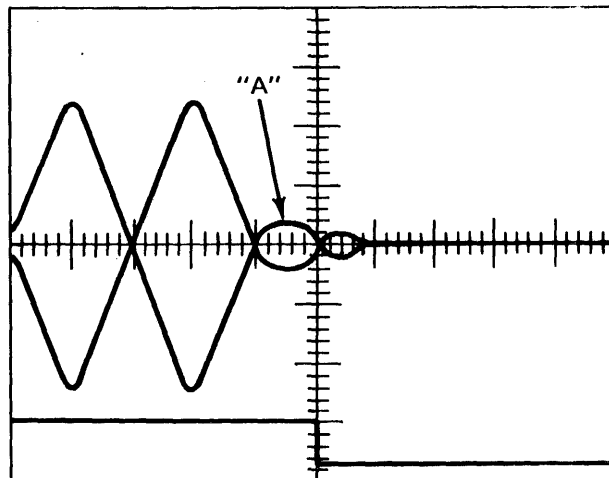
THE OVERSHOOT IS THE DETENT SIGNAL AFTER SEEK COMPLETE I.E., THE DETENT SIGNAL WHEN THE SCOPE IS TRIGGERED ON THE POSITIVE-GOING EDGE OF SKC ON TEST POINT H65 (NEGATIVE-GOING EDGE OF SKC IF USING EXERCISER TEST POINT).

REFER TO "A" IN FIGURE 5-33 OR 5-34. A SMALL UNSETTLED DETENT SIGNAL BEFORE SEEK COMPLETE IS NECESSARY. ELIMINATION OF THIS UNSETTLED DETENT SIGNAL BEFORE SEEK COMPLETE WILL RESULT IN OVERSTRESSING POWER TRANSISTORS.



CHAN 1 ON TPH63 – DETENT SIGNAL
 CHAN 2 ON TPH65 – SEEK COMPLETE (EXERCISER)

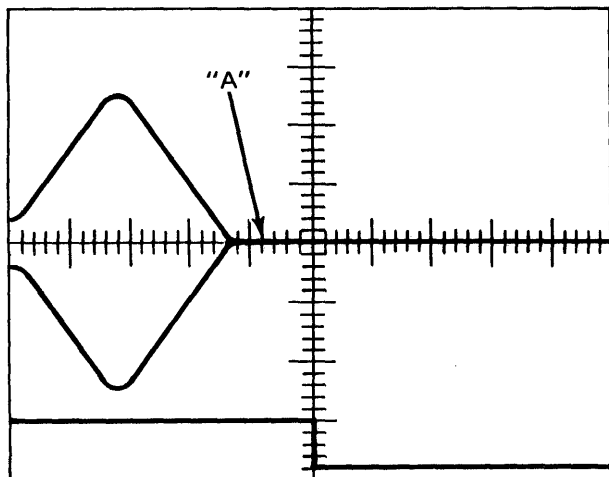
INCORRECT ADJUSTMENT – OVERDAMPED RESPONSE
 WILL CAUSE POWER AMP TO OVER HEAT.



CHAN 1 ON TPH63 – DETENT SIGNAL
 CHAN 2 ON TPH65 – SEEK COMPLETE (EXERCISER)

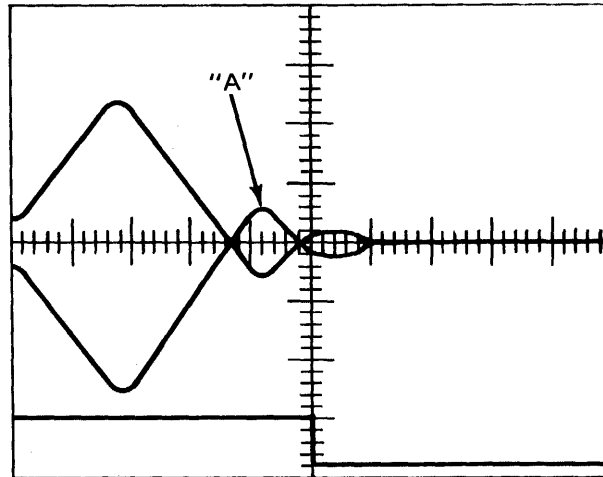
CORRECT ADJUSTMENT – SLIGHTLY UNDER-
 DAMPED RESPONSE MAXIMIZES RELIABILITY.

Figure 5-33. 100 TPI Drive – Detent Waveform – Alternate One Track Seek



CHAN 1 ON TPH63 – DETENT SIGNAL
 CHAN 2 ON TPH65 – SEEK COMPLETE (EXERCISER)

INCORRECT ADJUSTMENT – OVERDAMPED RESPONSE
 WILL CAUSE POWER AMP TO OVERHEAT.



CHAN 1 ON TPH63 – DETENT SIGNAL
 CHAN 2 ON TPH65 – SEEK COMPLETE (EXERCISER)

CORRECT ADJUSTMENT – SLIGHTLY UNDER-
 DAMPED RESPONSE MAXIMIZES RELIABILITY.

Figure 5-34. 200 TPI Drive – Detent Waveform – Incrementing One Track Seek

5.5.5.4 Fine Offset and Balance Adjustment

- A. Using the Exerciser, program the drives as outlined in paragraph 5.5.5.3 Step F.
- B. Adjust the FINE ADJ. potentiometer (H57) until the offset on adjacent odd and even tracks is minimized. A convenient place to check this is the point at the left of the trace where the seek begins. See Figure 5-36. Increase scope, vertical sensitivity as required to accomplish best adjustment. The potentiometer should be adjusted so each seek begins as close to the OV. line as possible.
- C. For fine balance and adjustment of 100 TPI drives, do single cylinder alternating seeks from cylinder zero. For fine balance adjustment of 200 TPI drives, do two cylinder alternating seeks from cylinder zero. Connect the Channel 1 probe to the Detent signal test point (H63) with a sweep rate of two (2) milliseconds per division and channel 2 probe on the Seek Complete test point (H65). Sync externally on Seek Complete at test point (H65). This will give a superimposed representation of the alternate forward and reverse detent signals.

Adjust the balance potentiometer (E18) to equalize the last positive and negative peaks to within 0.2V of each other. See Figure 5-35.

For 100 TPI drives, do single cylinder alternating seeks from the innermost cylinder. For 200 TPI drives, do two cylinder alternating seeks from the innermost cylinder.

Verify that the Balance criteria of the last positive and negative peaks are within 0.2V of each other. If greater than 0.2V, adjust the Balance potentiometer (E18). The intent is to ensure that Balance at both the innermost and outermost cylinders is less than 0.2V.

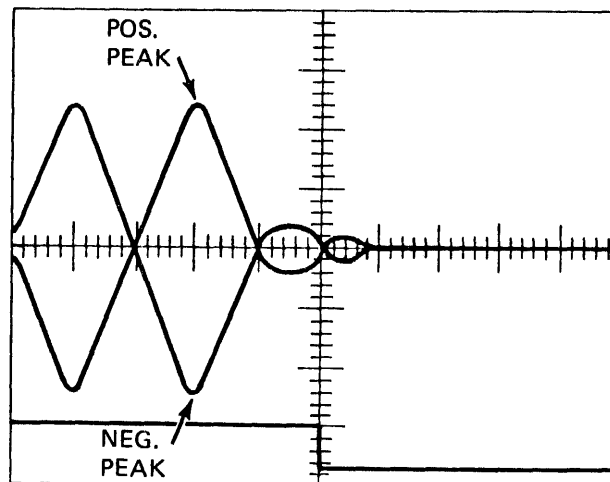


Figure 5-35. Fine Balance Adjustment

5.5.5.5

Access Time Adjustment. Perform the following steps:

- A. Use Exerciser and command a maximum-length, alternating, forward-reverse Seek. Adjust Seek time at TP H65 with potentiometer H59. Average forward-reverse Seek time should be set at 65 msec. Allowable variation from 65 msec is 2 msec; thus, the allowable difference between forward and reverse Seek times must be not more than 4 msec. For a maximum-length Seek, minimum Seek time must be 63 msec, and maximum Seek time must be 67 msec.
- B. Set scope horizontal sweep rate to 20 msec/div. so that detent waveforms can be observed on both forward and reverse maximum seeks. Over the entire envelope of both forward and reverse waveforms, verify that the variation and flatness of the detent waveform is within 0.6V as shown in Figure 5-37.
The waveforms (see Figure 5-37) represent some common optical detent assembly waveforms associated with scale flatness. Out-of-flat waveforms must meet the specified maximum variation of 0.6V on either or both sides.
- C. Repeat all steps of paragraphs 5.5.5.2, 5.5.5.3, and 5.5.5.4 until no further adjustment is necessary. Stop the Exerciser.
- D. This completes the SVA adjustments. To continue with SVA operational checks, proceed to the next paragraph. If not continuing, complete the remaining steps of this paragraph.
- E. Place the RUN/LOAD switch to LOAD and POWER ON/OFF switch to OFF.
- F. Reinstall temperature and offset jumpers (A43 to A44, B40 to B44 and C39 to C44) on SVA board.
- G. Remove jumpers (E5 to ground) on DCB board.
- H. Place DCB and SVA boards into card cage locations J3 and J5 respectively. Connect plug P15 to SVA board.

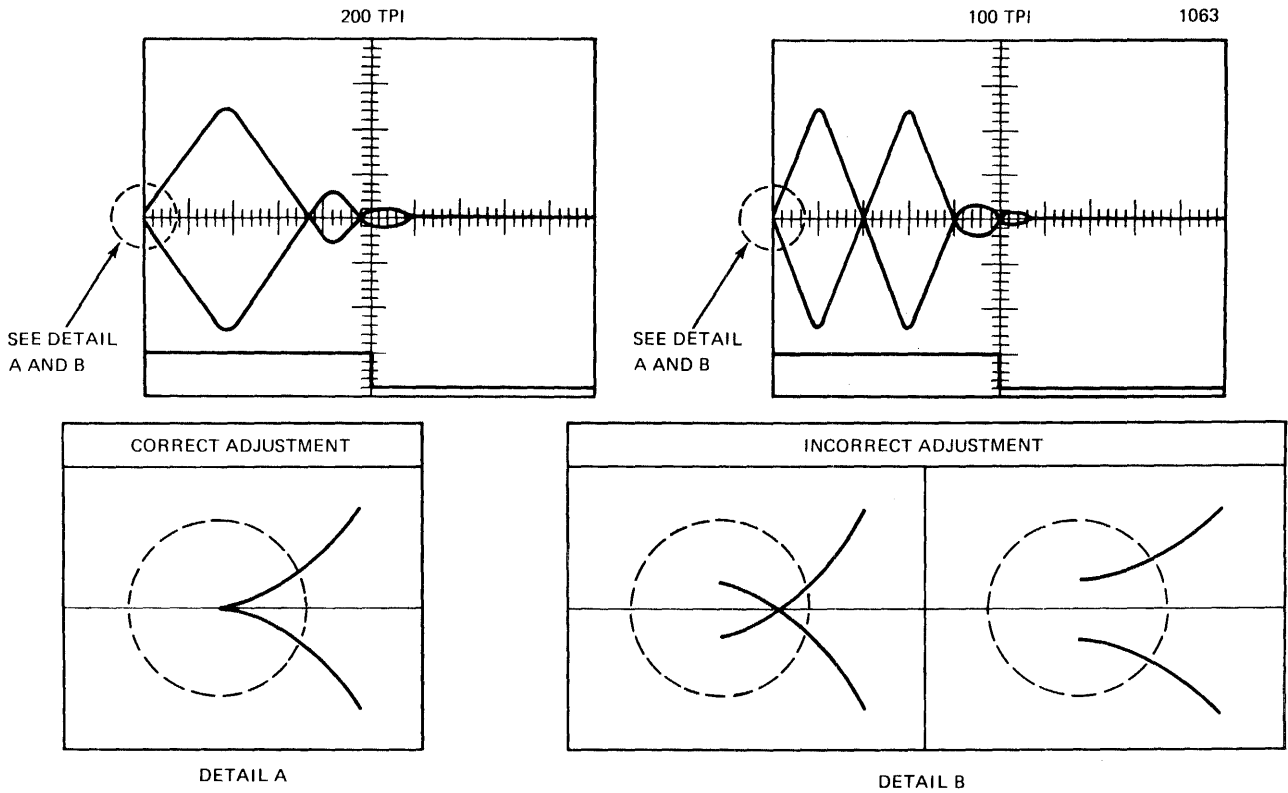


Figure 5-35. Fine Offset Adjustments

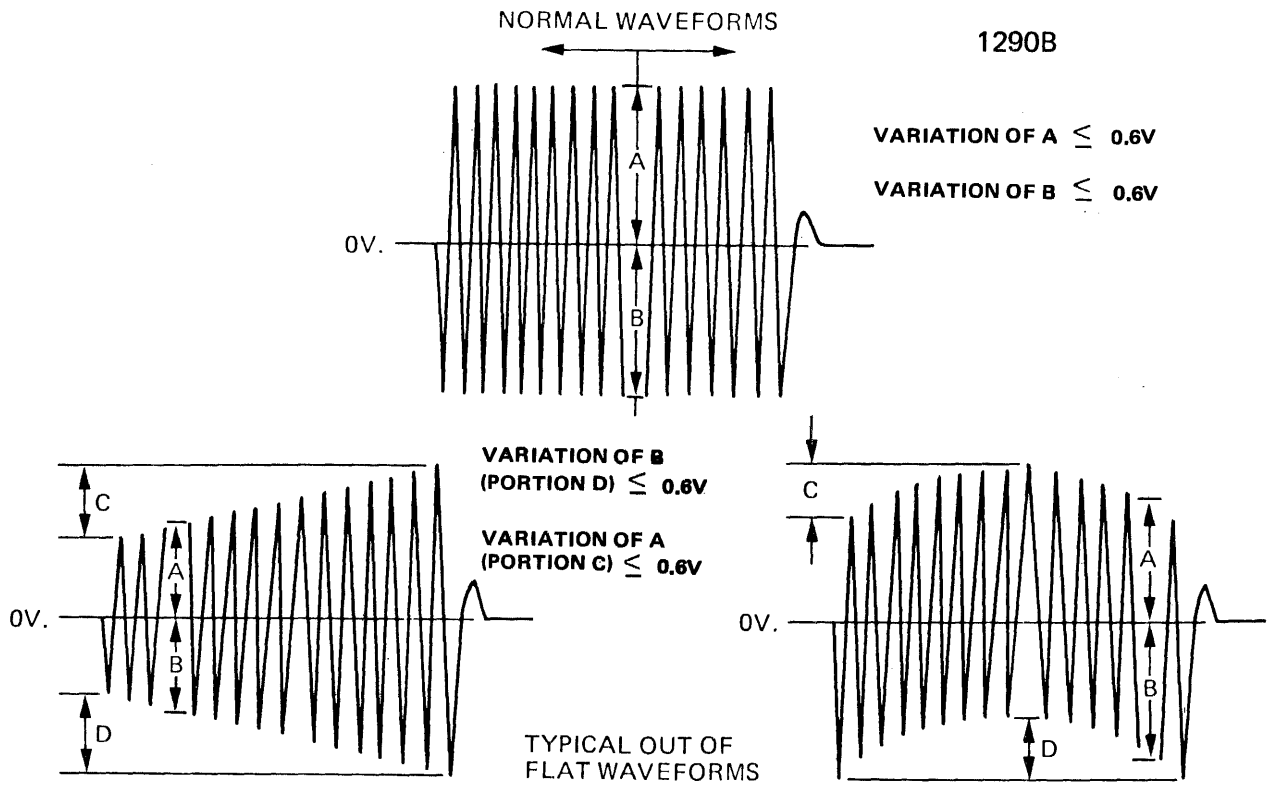


Figure 5-36. Detent Signal Output Waveforms

5.5.6 SVA OPERATIONAL CHECKS

5.5.6.1 LED Current. Use the following procedure:

- A. Place the POWER ON/OFF switch to OFF.
- B. Disconnect plug P15 from the SVA board in card cage location J5. Remove the SVA board; insert a card extender in its place, and insert the SVA in the card extender.
- C. Connect plug P15 on the SVA using cable extender PN 300789-001. Place POWER ON/OFF switch to ON and RUN/LOAD switch to RUN.
- D. After the heads load and the servo is in the Detent mode, measure the voltage at LED DRIVER test point (D17). It must be 4.0V. or less. This verifies that the LED current is 80 Ma or less.

5.5.6.2 Current Fault Circuit. Use the following procedure:

- A. To verify the operation of the Current Fault Detector, command a seek to approximately the middle of the disk.
- B. With the drive in Detent Mode, apply a smooth, firm pressure on the carriage in unload direction. After about one or two seconds, C8 will charge to 6.8 VDC and enable the SCR. The relay must de-energize and the carriage must retract.

NOTE

If this check is made, the drive must be powered down for a few seconds before continuing with the next paragraph.

5.5.6.3 Track Offset Option. Use the following procedure:

- A. Install a jumper from C39 to C44.
- B. Let the Drive load to track 000. Energize Track Offset lines on the IOB (J21 pins 40 and 41), one at a time, while observing the Detent signal (H63). The signal should be offset approximately equal to 1V. each time and should be of opposite polarity for Forward and Reverse.

5.5.6.4 AC Loss. Use the following procedure:

- A. Seek to track 000.
- B. Remove the AC power cord. The carriage should retract.
- C. Remove all test equipment, and restore drive to original operating conditions.

5.5.7 TEMPERATURE COMPENSATION CHECK

This procedure is used with 200 TPI Disk Drives only. To accomplish these checks, perform the following steps:

- A. Place the POWER ON/OFF switch to OFF.
- B. Disconnect plug P15 from the SVA board; remove the SVA board from card cage location J5; insert a card extender in its place, and insert the SVA board in the card extender. Remove temperature compensation jumpers (A43 to A44 and B40 to B44).
- C. Connect plug P15 to the SVA using the cable extender (PN 300789-001).
- D. Place the POWER ON/OFF switch to ON and LOAD/RUN switch to RUN. Allow spindle to reach operational speed.
- E. Temperature Compensation is checked by measuring the voltage at P5 pins 12 and 14. They should be between 5 and 8V. depending upon ambient temperature.
 - 1) Verify that the +13VDC on P5, pin C or 3, is $+13 \pm 0.25V$.
 - 2) Use the Exerciser to access track 400.
 - 3) Temperature Compensation is tested by measuring voltages with an accurate digital voltmeter and comparing with the formula. Measure all voltages quickly and write the values down. Calculate the formula.

Measure: Vp12, which is voltage at P5, pin 12
 Vp14, which is voltage at P5, pin 14
 V+13, which is voltage at P5, pin C or 3
 B25-1, which is voltage at IC B25, pin 1
 A14-1, which is voltage at IC A14, pin 1
 VpN, which is voltage at P5, pin N
 VpP, which is voltage at P5, pin P

All tolerances on formulas are $\pm 10\%$ or 100mV., whichever is greater.

Formula: 1 B25-1 = $-1(V_{p12})$
 2 A14-1 = $-1(V_{p14})$
 3 VpN = $2(V_{p12}) - 1.07(V+13)$
 4 VpP = $-2(V_{pN})$

- F. Access to track 000. Voltage on P5, pin P, should be 0V. $\pm 100\text{mV}$.
- G. Place RUN/LOAD switch to LOAD and POWER ON/OFF to OFF. Remove SVA, and install jumpers from A43 to A44 and B40 to B44.
- H. Replace SVA and power up the Drive.
- I. Command an incrementing one-track seek and observe with a scope the base line shift on Detent signal test point (H63). The voltage level shift at track 400 should be equal in amplitude and opposite in polarity from track 000.
- J. Adjacent even and odd tracks should have essentially equal amplitudes and opposite polarities. The base line can shift as much as $\pm 0.5\text{V}$. at extreme temperatures.
- K. This completes the Temperature Compensation check. A listing of Thermistor characteristics is provided in Table 5-4 for general information or troubleshooting if needed.
- L. Stop Exerciser. If Ready Inhibit check is to be made, skip to step D of paragraph 5.5.8. If Ready Inhibit check is not to be made, power down the Drive and restore to operating configuration.

Table 5-4. Temperature Compensation Voltage.

DEG. C	DEG. F	OHMS	DEG. C	DEG. F	OHMS	DEG. C	DEG. F	OHMS
0	32.0	32,650	18	64.4	13,680	36	96.8	6,267
1	33.8	31,030	19	66.2	13,070	37	98.6	6,017
2	35.6	29,500	20	68.0	12,490	38	100.4	5,747
3	37.4	28,050	21	69.8	11,940	39	102.2	5,547
4	39.2	26,690	22	71.6	11,420	40	104.0	5,327
5	41.0	25,390	23	73.4	10,920	41	105.8	5,117
6	42.8	24,170	24	75.2	10,450	42	107.6	4,917
7	44.6	23,010	25	77.0	10,000	43	109.4	4,727
8	46.4	21,920	26	78.8	9,573	44	111.2	4,543
9	48.2	20,880	27	80.6	9,167	45	113.0	4,370
10	50.0	19,900	28	82.4	8,777	46	114.8	4,200
11	51.8	18,970	29	84.2	8,407	47	116.6	4,040
12	53.6	18,090	30	86.0	8,057	48	118.4	3,890
13	55.4	17,250	31	87.8	7,723	49	120.2	3,743
14	57.2	16,460	32	89.6	7,403	NOTE THIS DATA PERTAINS TO THERMISTOR PART NO. 101193.		
15	59.0	15,710	33	91.4	7,097			
16	60.8	15,000	34	93.2	6,807			
17	62.6	14,320	35	95.0	6,530			

5.5.8 READY INHIBIT CHECK

To check Ready Inhibit, use the following procedure:

- A. Place POWER ON/OFF switch to OFF. Remove P15 from SVA board; remove SVA board from card cage location J5; insert a card extender into J5, and place SVA in extender. Connect P15 to SVA using cable extender (PN 300789-001).
- B. Attach a scope probe to B14, pin 7, on SVA.
- C. Place POWER ON/OFF switch to ON and RUN/LOAD switch to RUN.
- D. After the drive becomes READY, look at the signal on B14, pin 7. Normally, it should be a high logic level 4 to 5 V.
- E. Moisten a cotton-tipped swab with Isopropyl alcohol and gently swab the AIR THERMISTOR at the front of the carriage (see Figure 5-32). The signal at B14, pin 7, should immediately go to a logic low state then return high as the alcohol dries.
- F. Power down the Drive. Remove all test equipment, and restore Drive to original operating condition.

5.5.9 INDEX ALIGNMENT

NOTE

On ST Drives, if a disk cartridge having only an index slot is used, set switches on DCB for "index only", per switch setting chart shown on DCB schematic.

To perform the index alignment, conduct the following steps:

- A. Place the POWER switch in OFF position.
- B. Connect the external (+) sync input to the REM IDX test point (B94) on the DCB.
- C. Select a time base of 5 microseconds/division.
- D. Place the CART PROT switch in up (ON) position.
- E. Insert the CE cartridge. The cartridge must have been in the same ambient conditions as the Disc Drive for at least 2 hours.
- F. Press the POWER switch; then place the RUN/LOAD switch in RUN position, and allow the unit to run for 5 minutes.
- G. Access the carriage to the appropriate track; i.e., to track 100 for the SF or to track 005 for the ST (100 TPI drives); 190 on SF and 010 on ST for 200 TPI drives.
- H. Adjust the INDEX ALIGN potentiometer (B95) on the DCB in card cage location J3 to obtain the specified time relationship for the appropriate waveform as shown in Figure 5-38. Ensure that the oscilloscope is begin triggered on the leading edge of the Index pulse.
- I. Select the other Read/Write (R/W) head and verify that the oscilloscope display of both heads is within ± 10 μ sec of each other for 1500 rpm or ± 6 μ sec for 2400 rpm.
- J. Adjust the delay by turning the INDEX ALIGN potentiometer (B95) so that the single pulses (upper and lower heads) are equally spaced to the left and right sides of the 30 μ sec line for 1500 rpm or the 19 μ sec line for 2400 rpm.
- K. If the specifications noted in step J can not be attained, the R/W heads should be replaced. If replacement of heads known to be functioning normally will not produce satisfactory operation, replacement of the Positioner is indicated.

NOTE

In SF Disk Drives, additional adjustment may be attained by shifting the transducer block (see paragraph 5.5.4.1).

- L. If both heads can not be adjusted to the correct position with respect to the Index pulse, either the transducer or the DCB components should be investigated.
- M. After completion of the index alignment, remove power from the Disk Drive and take out the CE Cartridge.
- N. On ST Drives, reset switches on DCB to original position if they were changed (see label on front of drive behind trim panel).

1170

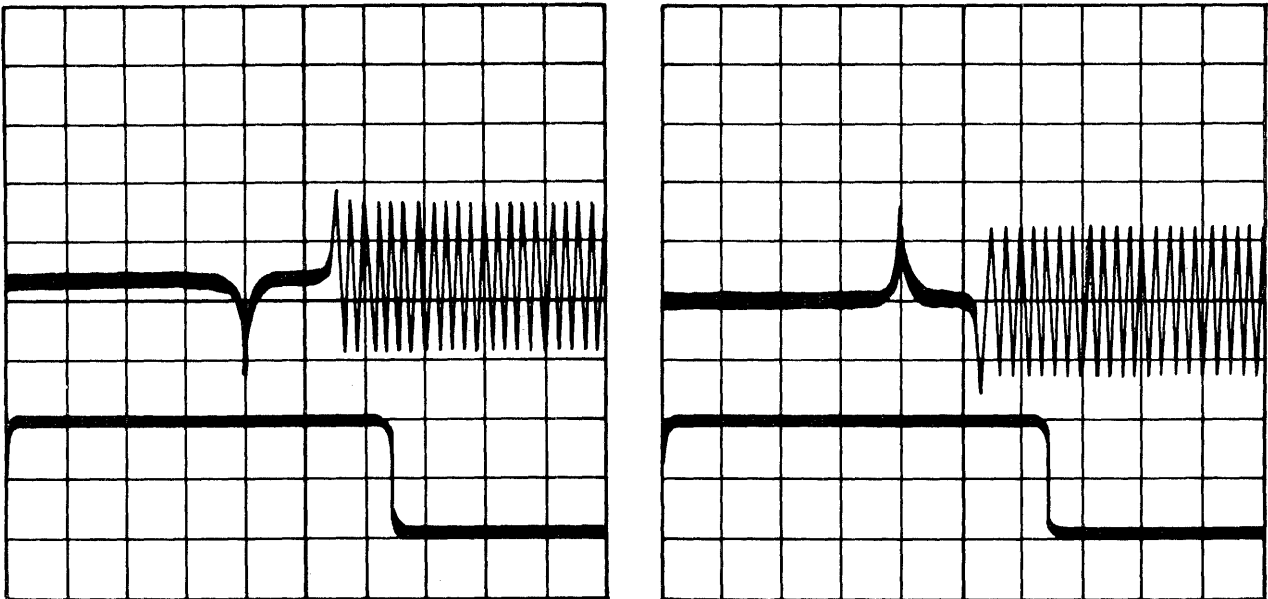
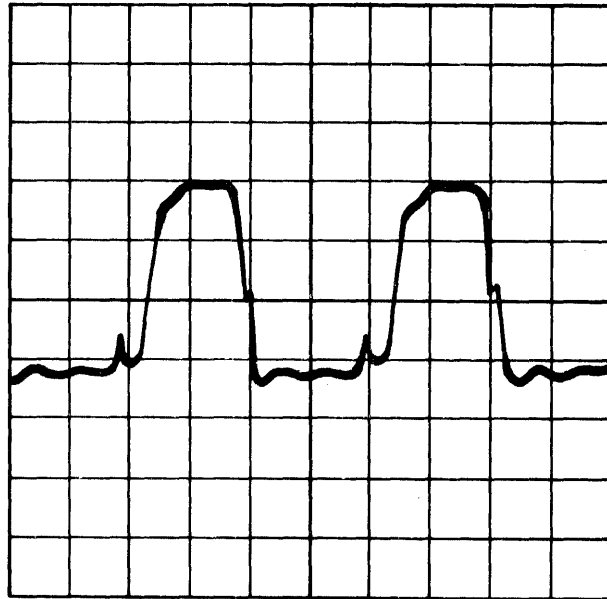


Figure 5-38. Index-to-Data Alignment (2400 rpm shown)

5.5.10 WRITE CURRENT CHECK

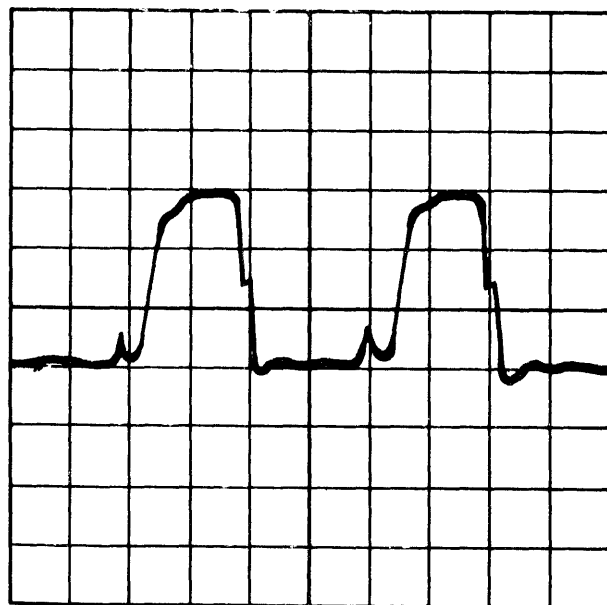
To check write current, perform the following steps:

- A. Place the unit On-Line and use a Write Diagnostic program. If a bench-type Disk Exerciser is to be used, connect this unit to the Disk Drive as a substitute for the Write Diagnostic program procedure.
- B. Install a scratch cartridge as described in Section 2.
- C. Press the POWER switch; then place the RUN/LOAD switch in RUN position, and allow the spindle to come up to normal operational speed.
- D. Select the upper head of the removable (scratch) cartridge.
- E. Write an all zeros pattern at track 000.
- F. Place the POWER switch in OFF position.
- G. Remove the R/W head cable from receptacle J24 on the Data Electronics Board (DEB) and connect the Write Current Adapter (PN 101183) to J24.
- H. Connect the head cable to the Write Current Adapter.
- I. Connect the oscilloscope channel 1 input probe from channel 1 to the wire loop on the Write Current Adapter.
- J. Press the POWER switch; then place the RUN/LOAD switch in RUN position, and allow the spindle to come up to normal operational speed.
- K. Check for a peak-to-peak waveform of 34 to 36 mA while writing all zeros to disk as shown in Figure 5-38.
- L. Access to the innermost track and verify that peak-to-peak waveform current is between 29 and 31 mA. The waveform should appear as shown in Figure 5-40.
- M. Access to track 000 and verify that the Write current is between 34 and 36 mA.
- N. Place the RUN/LOAD switch in LOAD position.
- O. Place the POWER switch in OFF position and remove the Write Current Adapter. Reconnect the head cable to receptacle J24 when the Write Cable Adapter is removed.



1171

Figure 5-39. Write Current Waveform – Track 000



1172

Figure 5-40. Write Current Waveform – Innermost Track

5.5.11 READ/WRITE HEAD ALIGNMENT

5.5.11.1 Introduction. R/W head alignment involves adjusting the position of the head arms relative to the carriage after it has been accessed to a specific alignment track.

The procedures outlined in the following paragraphs describe the alignment of both removable (cartridge) and fixed disk heads. The power supply must be in place to perform the procedures correctly.

5.5.11.2 Customer Engineer (CE) Alignment Cartridge Types. Either of two types of CE alignment cartridges may be used. The two types are:

- A. Cats Eye – The output waveform of this CE cartridge is two loops resembling cats eyes which must be adjusted until both loops are equal in length. See Figure 5-41a.
- B. Tribit – This CE cartridge uses a technique which records two adjacent tracks with opposite polarity bits. Correct head alignment is (between these two tracks) when the adjacent bits are of equal amplitude (see Figure 5-41b).

5.5.11.3 Removable Disk Head Alignment Using Cat's Eye CE Cartridge. If only verification of head alignment is intended, perform steps E through J, and select first the lower head of the pair, then the upper while observing waveforms; then, perform steps P and Q. For head alignment, perform entire procedure.

- A. Place POWER switch to OFF position. For ST drives, see DCB switch setting chart on front of drive behind trim panel. If cartridge has only one notch on sector ring, set for INDEX ONLY.
- B. Slightly loosen the two cap screws used to secure the upper head pair clamp; the clamp itself should not be loose.
- C. Slide the upper (cartridge) pair of head arms fully to the rear of the mounting block slots of the carriage (away from the spindle).
- D. Ensure head arm adjustment screws are not touching the head arms. If they are, back them away (CCW), and repeat step C.
- E. Connect both the SYNC input and CHAN 1 scope probes to REMIDX test point (B94) on the DCB. Use 50 or 100 mV/cm with AC coupling.

CAUTION

PLACE THE PROT CART SWITCH TO ON POSITION TO PRECLUDE THE POSSIBILITY OF ACCIDENTAL ERASURE OF DATA ON THE CE CARTRIDGE.

- F. Place POWER switch to ON, and RUN/LOAD switch to LOAD. Load the Cat's Eye-type CE cartridge.
- G. Place RUN/LOAD switch to RUN, and allow Disk Drive to run for 15 minutes.

(ALIGNMENT PACK)

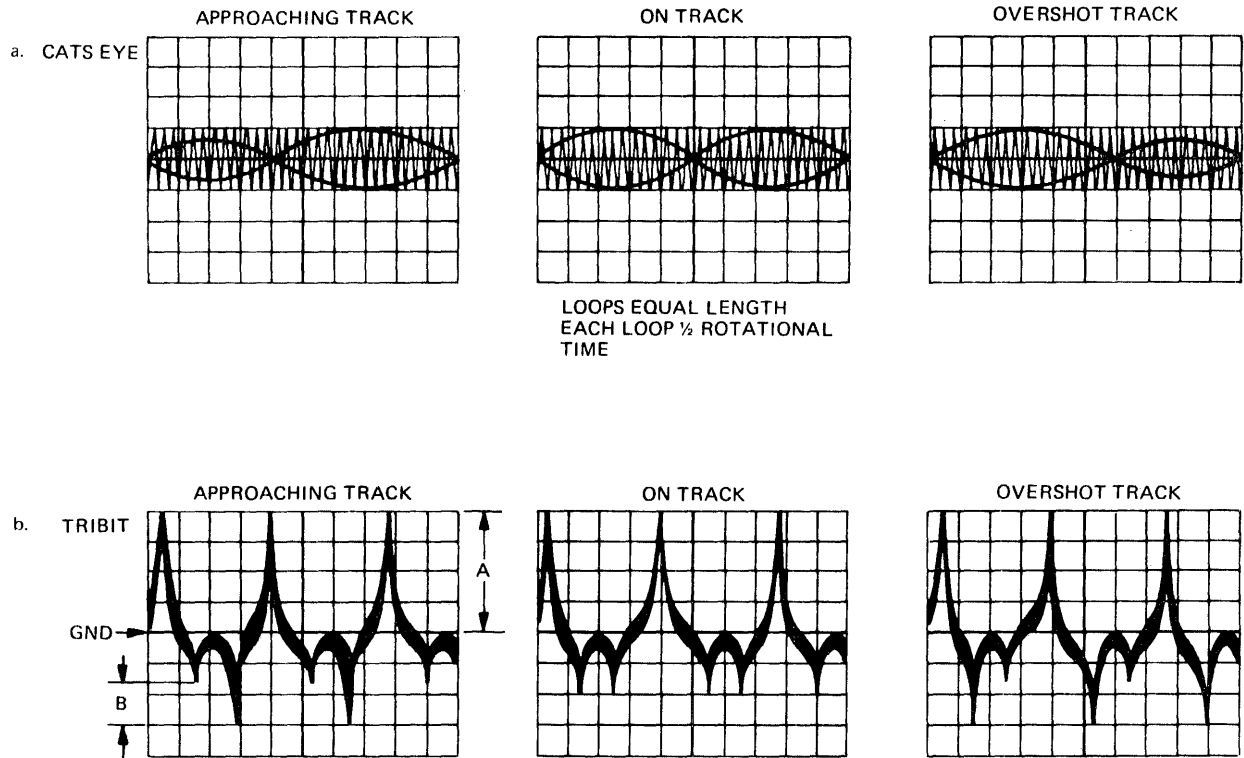


Figure 5-41. Read/Write Head Alignment Waveforms (Removable Disk)

NOTE

The CE cartridge must have been in the same environment as the Disk Drive for at least 2 hours prior to use.

- H. Uncalibrate the scope, and adjust the display to show only two Index pulses 10 cm apart (full screen).
- I. Move the CHAN 1 probe to R/W head test point C30 or B27 on the DEB in location J7.
- J. Using an Exerciser or Controller, seek to appropriate alignment track listed in Table 5-5.

Table 5-5. CE Cartridge Head Alignment Tracks

CE Cartridge Type	Disc Drive Series	Alignment Track		Alternate* Alignment Track	
		100TPI	200TPI	100TPI	200TPI
Cat's Eye	SF	105	200	110	210
Cat's Eye	ST	73	146	—	—
Tri Bit	SF	105	200	110	210
Tri Bit	ST	73	146	2	4

* on some packs

- K. Select the lower R/W head of the cartridge disk pair. Check whether or not Head and/or Disk Select inverted options have been incorporated. If so, this should be taken into consideration when checking output waveforms.
- L. Turn the adjustment screw for the lower R/W head clockwise until the correct waveform is obtained (see Figure 5-41a).
- M. Select the upper R/W head of the cartridge disk pair, and turn the adjustment screw clockwise until the correct waveform is obtained (see Figure 5-41a).
- N. Use torque wrench (PN T-00425) to tighten the head clamp screws to 6 in.-lb. (15.24 cm/0.5436 kg).
- O. Access track 000, then once again, access the alignment track. Verify that head alignment has not changed during tightening of clamp screws. If necessary, repeat the alignment procedure.
- P. Place RUN/LOAD switch to LOAD, POWER switch to OFF, and reset DCB switch on ST drives if moved.
- Q. Remove CE cartridge and disconnect test equipment.

5.5.11.4 Removable Disk Head Alignment Using Tribit CE Cartridge. The procedure for head alignment with the Tribit CE cartridge is the same as for Cat's Eye-type except for scope use and the use of a formula for figuring misalignment measurement. Use the following scope setup and formula to determine head misalignment.

CAUTION

WHEN REPLACING FIXED DISK HEADS, ENSURE THEY ARE OPPOSING EACH OTHER (SAME LOCATION IN MOUNTING SLOTS) AND STAGGERED APPROXIMATELY .075 (1.90mm) TO .100-IN. (2.54mm) FORE OR AFT OF CARTRIDGE DISK HEADS. THIS WILL ENSURE RELIABLE EMERGENCY RETRACT UNDER ALL CONDITIONS.

- A. Trigger the scope internal (source channel 1).

CAUTION

TRIGGER MUST NOT BE ON INDEX, OR ONLY ONE SEGMENT OF THE TRACK WILL BE ALIGNED.

- B. Set vertical sensitivity to 50 mV/cm, and sweep to 2 μsec/cm.
- C. Place CHAN 1 scope probe on R/W head test point C30 or B27 on the DEB, and adjust heads per paragraph 5.5.11.3 excluding scope setting instructions. Adjust for minimum difference in length between adjacent peaks (see Figure 5-41b).

The following equation may be used to determine head misalignment (see Figure 5-41b):

$$\frac{BY}{2A} \times 1000 = \text{microinches (misalignment)}$$

Y = 4 for 200 TPI Drives.

Y = 7 for 100 TPI Drives.

Example for 200 TPI Drive:

A = 300 mV.

B = 10 mV.

$$\frac{10 \times 4}{2 \times 300} \times 1000 =$$

$$\frac{40}{600} \times 1000 =$$

$$.066 \times 1000 = 66 \text{ microinches (0.0016764 mm).}$$

To convert microinches to millimeters multiply by 0.0000254.

5.5.11.5 Fixed Disk Head Alignment. If this alignment is to be accomplished independently (not preceded by alignment of the cartridge disk heads), and if data on the disk is not to be recovered, perform steps A through E of the following procedure. If data previously written on the fixed disk is to be recovered, perform the entire procedure.

- A. Place POWER switch in OFF position.
- B. Loosen the two cap screws used to secure the head clamp of the fixed disk R/W head pair just enough so heads can be moved.
- C. Slide the two lower head arms fully back (away from the spindle) into the head mounting block slots. Ensure that the head arm adjustment screws do not touch the head arms.
- D. Slowly turn each screw clockwise until it just touches the head arm; then turn each screw clockwise one-half turn.
- E. If the remainder of the procedure is not to be performed, use the torque wrench (PN T-00425) to tighten the head clamp screws to 6 in.-lb. (15.24 cm/0.4536 kg).
- F. If data on the fixed disk is to be recovered, the head position will be changed as described in the following steps until data on the fixed disk can be read accurately. This procedure may be performed On-Line.
- G. If Controller is not to be used, install an Exerciser.
- H. Place POWER switch to ON position. Install a scratch cartridge. Place RUN/LOAD switch to RUN.
- I. Connect CHAN 1 scope probe to R/W head test point C30 or B27 on the DEB. Sync at the REMIDX test point (B94) on the DCB.
- J. Select the upper head of the pair, and turn the adjustment screw clockwise until the R/W signal (C30 or B27) is maximum amplitude.
- K. Alternately position the heads further in or out with the adjustment screw to obtain minimum Read errors. If track 000 data does not verify, or is not what it should be, the head may have been adjusted off track or to an adjacent track. Repeat adjustment until data verifies and no errors occur during Read operation.
- L. Select the lower head and repeat the adjustment procedure using the lower head adjustment screw.
- M. Tighten the head clamp screws to 6 in.-lb. (15.24 cm/0.4536 kg).
- N. Disconnect all test equipment.
- O. With the Disk Drive On-Line, check data recovery characteristics on all tracks.

NOTE

It is recommended that the fixed disk data be rewritten after the fixed disk alignment has been completed by transferring it to a "scratch cartridge" and then recording it back onto the fixed disk. Any head-to-track irregularities will be eliminated by this procedure.

5.5.12 DATA SEPARATOR OPERATIONAL CHECK

To make the Data Separator Check, perform the following steps:

- A. Place the POWER switch in OFF position.
- B. Remove the DIB from card cage location J1 and insert an extender board in its place. Insert the DIB in the extender board.
- C. Connect an Exerciser to the Disk Drive, or place the Disk Drive on-line and use a Write Diagnostic program.
- D. Press the POWER switch and the LOAD portion of the RUN/LOAD switch.
- E. Insert a "scratch" cartridge for this check. Press the RUN/LOAD switch to
- F. Select the upper head on the removable cartridge and write an all-zeros pattern at track 000.
- G. Connect Channel 1 of the oscilloscope to pin 5 of the IC at location C25 and Channel 2 to pin 4. Sync internal positive from Channel 1.
- H. Set the leading edge at the Channel 1 signal on the zero time-base reference line.
- I. Monitor the time interval from the leading edge of the signal on Channel 1 to the leading edge of Channel 2. The waveform should appear as shown in Figure 5-42, and the difference should be between 490 and 530 nanosec for 1500-rpm units or between 320 and 360 nanosec for 2400-rpm units.
- J. Place the POWER switch in OFF position; remove the extender board from card cage location J1, and insert the DIB in its place.
- K. Disconnect all test equipment. The alignment and calibration procedures are complete; and if all indications are normal, the Disk Drive can be assumed to be in proper working order.

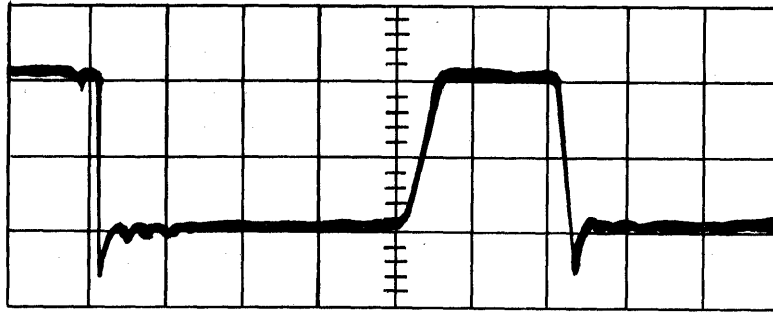


Figure 5-42. Data Separator Output Waveform

5.5.13 MFM ADJUSTMENTS (4400 BPI Disk Drives Only)

Preliminary adjustments on the MFM are performed at the Company, and need only be accomplished if the original board is replaced due to failure. The Data Separator adjustment should be checked if excessive Read data errors occur.

Preliminary adjustments are made with the MFM mounted in an extender board. Data Separator adjustment can be accomplished with the MFM board in place.

5.5.13.1 Preliminary MFM Adjustments. To make these adjustments, use the following procedure:

- a. Remove power from disk drive. Install extender card in connector J1 of card cage and mount MFM in this extender card.
- b. Load a "scratch" removable disk cartridge in disk drive.
- c. Connect disk exerciser to disk drive, then power up disk drive.
- d. Write an all-zeros pattern on track 405, then stop disk exerciser.
- e. Use internal sync on oscilloscope, connect channel 1 oscilloscope probe to CLK DIVIDER 2 test point (zone C54), and calibrate oscilloscope to 5 megahertz signal from this test point.
- f. Set up disk exerciser for continuous reading of track 405.
- g. Move channel 1 oscilloscope probe to VCO output at jumper point A42, and adjust VCO ADJ potentiometer (zone D34) to obtain 10.0 megahertz output signal from VCO.

NOTE

This frequency is not continuously variable.

- h. Move oscilloscope probe to right side of resistor (zone C30) or pin 10 of inverter (zone C24). Connect channel 2 oscilloscope probe to test point at zone C34.
- i. Stop disk exerciser.
- j. Continue adjusting VCO ADJ potentiometer (zone D34) to align trailing edges of VCO signal until both positive and negative-going edges cross at mid-point, as shown in Figure 5-43A. The positive-going edge is monitored at zone C30. The negative-going edge is monitored at zone C34.
- k. Start reading track 405. Sync negative with sync probe on test point (zone B57).
- l. Turn RD PHASE ADJ potentiometer (zone D44) fully counterclockwise, then adjust this potentiometer until first pulse width monitored at zone C30 switches from maximum to minimum. Continue adjustment clockwise until trailing (positive-going) edge of pulse monitored at zone C30 is aligned with trailing (negative-going) edge of pulse monitored at zone C34 test point, as shown in Figure 5-43B. After this adjustment, the RD PHASE one-shot should time out between 100 and 180 nanoseconds, as shown in Figure 5-43C.
- m. Connect one oscilloscope probe to DATA SEPARATOR one-shot test point (zone B55) and connect other oscilloscope probe to VCO: RD DATA flip-flop test point (zone B56). Sync positive with sync probe on test point at zone B56 and observe three cycles.
- n. Adjust DATA SEPARATOR ADJ potentiometer (zone D58) for timing and phase relationship as shown in Figure 5-43D; i.e.; positive-going transitions, monitored at test point in zone B55, should be centered in the negative pedestals monitored at zone B56 testpoint. Negative pulse widths, monitored at test point in zone B55, should never exceed 160 nanoseconds.
- o. Power down disk drive, remove all test equipment, and install MFM in connector J1 of EIB.

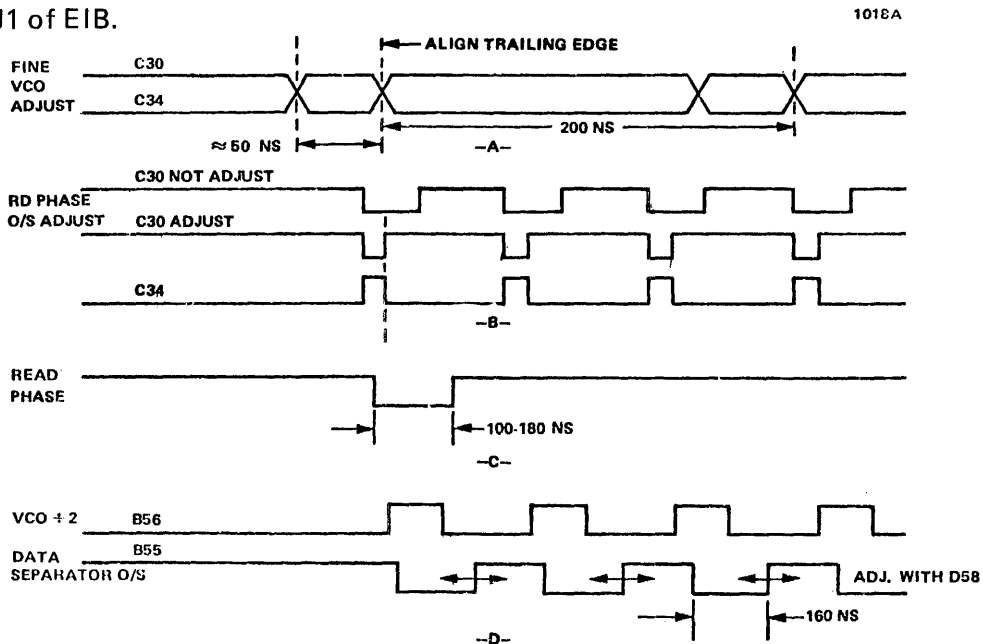


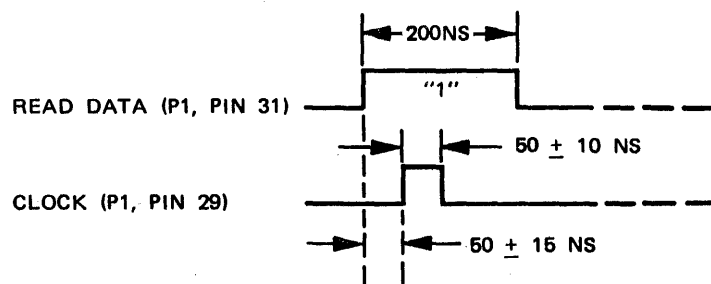
Figure 5-43. MFM Timing Relationships Diagram

5.5.13.2 Data Separator Check and Adjustment. To make this check, perform the following steps:

- A. Power down the Disk Drive and connect an Exerciser.
- B. Power up the Disk Drive and install a "scratch" cartridge.
- C. Write a random or incrementing data pattern on track 405.
- D. Place Channel 1 input scope probe on B55 (Data Separator O/S) and sync internally.
- E. While Reading from track 405, adjust D58 (Data Separator adj.) so the positive transitions occur in the center of its operating range.
- F. Place Channel 2 scope probe on B56 (VCO \div 2). The positive transitions of B55 should be occurring in the center of a positive pedestal of B56 for a logic 1 and in the center of a negative pedestal of B56 for a logic zero.
- G. Power down the Disk Drive and disconnect all test equipment. The adjustment and alignment procedures are complete.

NOTE

To accomplish error checking with an Exerciser it is necessary to have the optional Cell/Clk Timing Network installed. The DATA/CLK ADJ potentiometer (C53) must be adjusted as shown in Figure 5-44.

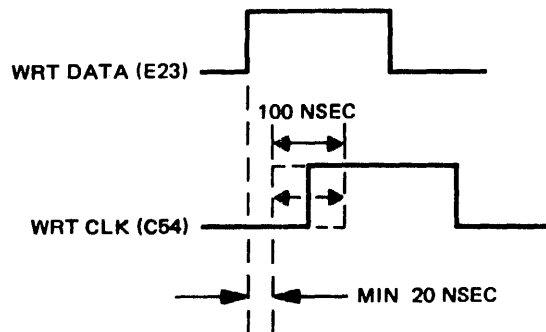


1028

Figure 5-44. Timing Relationship Between MFM DATA and CLOCK for Error Checking with an Exerciser

5.5.13.3 Write Clock to Data Timing Adjustment. To make this adjustment, perform the following steps:

- A. Power down the Disk Drive, and connect one scope probe to C54 (WRT CLK); the other to E23 (WRT DATA). Power up the Disk Drive.
- B. From the Controller, write an alternating 1's and 0's pattern.
- C. The positive transitions of the WRT CLK should occur no less than 20 nano-sec after the positive transitions of the WRT DATA as shown in Figure 5-45.
- D. WRT CLK is adjustable over a 100 nanosec range by potentiometer E50, and if necessary, may be inverted by connecting jumper at F33 or F34 the opposite way.
- E. Power down the Disk Drive and disconnect all test equipment. Adjustment and Alignment procedures are complete.



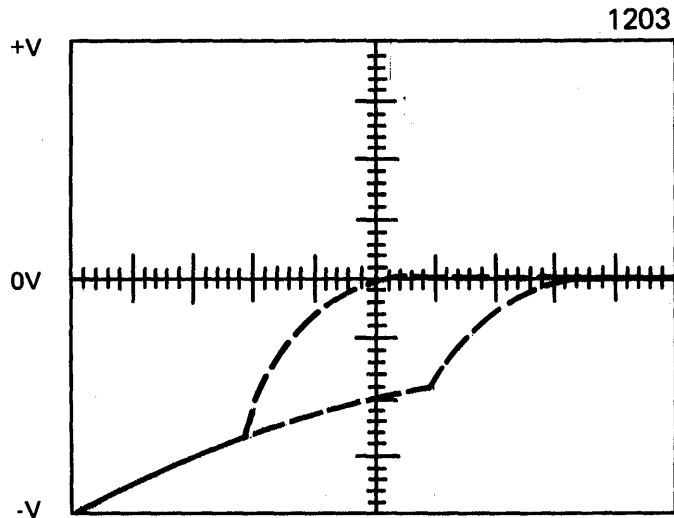
1051

Figure 5-45. Write Clock to Data Timing Adjustment

5.5.13.4 20 Megabyte Emergency Retract Check. To make this check, perform the following steps:

- A. Position heads to track 400.
- B. Trigger scope on Retract f-f (DCB, E50-5)
- C. Place chan 1 probe on J17-7 or black leads of optical device of Emergency Retract Assembly.
- D. Set sweep rate for 100 msec/div.
- E. Place POWER ON/OFF to OFF position

The scope should show a slow discharge of the capacitor until the heads approach track 025, then as heads unload, it should show rapid discharge. See Figure 5-46. Failure of discharge to show rate change indicates a faulty Emergency Retract Assembly.



NOTE: TIMING NOT CRITICAL

Figure 5-46. Two-speed Emergency Retract

5.5.14 CIB ADJUSTMENT

Perform the following steps to adjust the Seek Complete Delay (SKC DLY) one-shot:

- A. Power down drive and connect an Exerciser.
- B. Mount the CIB in a card extender placed in J2 of card cage.
- C. Power up drive and set Exerciser for incremental seeks.
- D. Place scope probe on D50 pin 5 (SKC DLY O/S) and adjust potentiometer C31 for 4 msec \pm 5%.
- E. Power down drive, reinstall CIB, and disconnect scope. This completes adjustment of CIB.

5.6 TROUBLESHOOTING

Use the fault isolation chart in Table 5-6 as an aid in identifying, locating, and correcting possible malfunctions of the more common type. The last (remedy) column specifies the applicable component or circuit to be checked for the probable cause of the symptom.

Replacement electronic components are listed in the Master Spares List, Volume 2.

Table 5-6. Fault Isolation Chart

Item	Symptom	Probable Cause	Remedy
1	POWER indicator lamp does not light when switch is pressed	Line cord disconnected Line fuse open Line filter open +18V. DC fuse open POWER switch and/or indicator lamp defective Bad connection at Data Electronics Board, or at P10 from power supply	Plug in line cord Replace line fuse F4 Replace line filter on rear panel Replace +18V. DC fuse F1 Replace power switch and/or indicator lamp Reseat connector P7, or connection P10/J10 from power supply
2	LOAD indicator does not light when POWER switch is turned on	LOAD indicator bad Cable from EIB loose. +5V. DC absent +13V, -13V inputs absent Defective component on Disk Control Board Brush switch S6 defective	Replace indicator lamp Reseat connector P8 Check +5V. DC fuse F3 Replace regulator chips G40, G30 on DEB. Replace Disk Control Board Replace brush switch S6
3	Handle does not unlock when unit is powered up	Solenoid plunger caught on latch Defective component on Disk Control Board Solenoid open	Readjust door latch mechanism Replace Disk Control Board Replace solenoid
4	LOAD indicator lamp does not go out and handle does not lock when RUN portion of RUN/LOAD switch is pressed	RUN/LOAD switch defective, or poor connection at plug P8 Cartridge interlock switch misadjusted	Replace switch S2 or reseat plug P8 on cable from EIB Adjust or replace S9 or replace DCB

Table 5-6. Fault Isolation Chart (continued)

Item	Symptom	Probable Cause	Remedy
5	Disk does not start to turn when RUN portion of switch is pressed	<p>–18V. DC absent</p> <p>Poor connection in harnesses</p> <p>Defective spindle drive circuit boards</p> <p>Defective spindle motor</p>	<p>Check –18V. DC fuse F2</p> <p>Check P8/J8, P10/J10, P19/J19 and P28/J28</p> <p>Check connections to, or replace Motor Drive Power Switch Board, Spindle Drive Limiter Board, or Commutator Board on spindle</p> <p>Replace spindle assembly</p>
6	<p>READY indicator does not light after completion of initial cycle</p> <p>NOTE: Ready light will not illuminate until cartridge temperature is stabilized on 200 TPI units.</p>	<p>If heads do not load, brush cycle may not have been completed</p> <p>Belt may be broken</p> <p>If heads do not load, spindle may not have come up to speed</p> <p>Lack of input to Disk Control Board</p> <p>If heads do not load, but brush cycle and spindle speed are o.k., may have poor connection in positioner harness</p> <p>If heads do not load, but other symptoms are normal, may have defective Servo Logic Board</p> <p>If heads do not load, other indications are normal and replacement of Servo Logic Board does not correct trouble, Servo Amplifier Board may be defective</p>	<p>Check operation of brush motor, driver chip E26 on DCB, brush motor S6 and brush motor cam linkage</p> <p>Replace OH Ring belt</p> <p>Check +13V. DC and –13V. DC outputs on DEB</p> <p>Verify that transducer is plugged into connector P12 on Electronics Interconnect Board and that output is normal. If so check for loose or broken OH Ring belt. If o.k., replace DCB</p> <p>Verify that P16 is plugged in at power supply</p> <p>Replace SLB</p> <p>Replace SVA Board</p>

Table 5-6. Fault Isolation Chart (continued)

Item	Symptom	Probable Cause	Remedy
6 (con't.)		<p>If heads load, READY lamp may be defective</p> <p>If heads load, READY lamp driver defective</p> <p>If heads load, defective IC on Control Interface Board</p>	<p>Replace READY indicator lamp</p> <p>Replace driver chip E26 on DCB</p> <p>Replace CIB</p>
7	<p>READY indicator goes out after completion of initial cycle and successful operation of unit</p>	<p>Defective lamp</p> <p>Defective lamp driver</p> <p>Belt broken</p> <p>Defective IC on Control Interface Board</p> <p>If heads also retract, READY indicator may be following a valid or invalid indication such as:</p> <ol style="list-style-type: none"> 1) Low spindle speed 2) Current sense 3) AC loss 4) DC loss 	<p>Replace indicator lamp</p> <p>Replace or check chip E26 on DCB</p> <p>Replace "O" ring belt</p> <p>Replace CIB</p> <p>Fault indications may be isolated by observing the characteristics of these signals and the generated outputs on DCB. If abnormal, replace DCB</p>
8	<p>Disk Drive will not respond to external position commands</p>	<p>Interface cable or line terminator may be loose at the I/O Connector Board</p> <p>UNIT SELECT switch in wrong position</p> <p>Defective receiver(s) on I/O Connector Board</p> <p>Interconnect cable from I/O board to EIB may be loose or damaged</p> <p>Defective IC on Control Interface Board</p> <p>Defective component on Servo Amplifier Board</p>	<p>Reseat connector or terminator assembly on I/O Connector Board</p> <p>Reset switch S3</p> <p>Replace I/O Connector Board</p> <p>Reinsert cable connectors or replace cable</p> <p>Replace CIB</p> <p>Replace SVA Board. Check signals</p>

Table 5-6 Fault Isolation Chart (continued)

Item	Symptom	Probable Cause	Remedy
9	Previously recorded data can not be read out	<p>Heads dirty or head connectors not properly seated</p> <p>READ ENABLE line inoperative</p> <p>HEAD SELECT or DISK SELECT line inoperative</p> <p>READ DATA or READ CLOCK line inoperative</p> <p>Head alignment off Index to data off Data Timing inaccurate</p> <p>Fixed disk transducer mis-adjusted or defective (if errors on fixed disk only)</p> <p>Defective component in analog read data chain</p> <p>Defective component in digital read data chain</p>	<p>Clean R/W heads or reseal heads in DEB</p> <p>Check for high signal on DIB. If present, replace DIB</p> <p>Check for high inputs on DEB. If present, replace DEB</p> <p>Perform the data separator check. If no READ DATA input, replace DIB</p> <p>Realign Realign Replace DIB</p> <p>Perform fixed disk index/sector transducer adjustment or replace transducer</p> <p>Replace DEB. Check Write current</p> <p>Replace DEB and perform data separation check</p>
10	Data error rate too high	<p>Cartridge, heads, or fixed disk dirty</p> <p>Dirty or damaged air filter</p> <p>Write current misadjusted</p> <p>Data separator timing out of limits</p>	<p>Replace cartridge, clean heads and fixed disk</p> <p>Check and replace air filter</p> <p>Perform Write current check</p> <p>Perform data separation check</p>

Table 5-6. Fault Isolation Chart (continued)

Item	Symptom	Probable Cause	Remedy
10 (con't)		<p>Bad spindle or blower grounding brushes</p> <p>Servo not settling properly</p> <p>Defective component in read data chain</p> <p>Defective component in digital read chain</p>	<p>Replace grounding brushes</p> <p>Perform detent signal adjustment</p> <p>Replace DEB and perform Write current check</p> <p>Replace DEB and perform data separation check</p>
11	Positioner will not retract upon pressing the LOAD portion of RUN/LOAD	<p>If READY indicator does not go out, RUN/LOAD switch defective or Disk Control Board is defective</p> <p>If READY indicator goes out home switch (S7) is defective or misadjusted</p> <p>If READY indicator goes out, bad DCB, SLB, or SVA board</p>	<p>Check operation of, or replace RUN/LOAD switch and replace DCB</p> <p>Bend switch arm to allow it to swing freely, or replace switch S7</p> <p>Replace DCB, SLB, or SVA</p>
12	LOAD indicator will not light and/or will not release after completion of stop cycle	<p>Defective component on Disk Control Board or DEB (probably driver)</p> <p>Defective lamp</p> <p>Defective solenoid</p> <p>Solenoid plunger caught on latch</p>	<p>Replace DCB or DEB</p> <p>Replace indicator lamp</p> <p>Replace solenoid</p> <p>Readjust solenoid latch mechanism</p>