CRAY RESEARCH, INC.

THIS IS A PRELIMINARY DRAFT COPY

CRAY® COMPUTER SYSTEMS

(PRE- DC/DD-40 ~~M~~AINTENANCE MANUAL

CMM1103000

RECORD OF REVISION

PUBLICATION NUMBER CMM1103000

Each time this manual is revised and reprinted, all changes issued against the previous version are incorporated into the new version and the new version is assigned an alphabetic level.

Every page changed by a reprint with revision has the revision level in the lower righthand corner. Changes to part of a page are noted by a change bar in the margin directly opposite the change. A change bar in the margin opposite the page number indicates that the entire page is new. If the manual is rewritten, the revision level changes but the manual does not contain change bars.

Requests for copies of Cray Research, Inc. publications should be directed to Logistics and comments about these publications should be directed to:

CRAY RESEARCH, INC.
ATTENTION: Publications
890 Industrial Blvd.
Technical Operations Building
Chippewa Falls, WI 54729

Revision	Description

THIS IS A PRELIMINARY DRAFT COPY

This manual is intended to help Cray Research, Inc. (CRI) field engineers (FEs) maintain the DC-40 disk controller and the DD-40 disk storage device. The DC-40 has been designed and manufactured by CRI to control the DD-40, which consists of XMD spindles. This is a CRI company private document and should not leave the site.

This manual consists of seven sections. The following is a description of each section:

Section	Description
1	Overview - introduces the DC-40 and DD-40
2	DD-40 Drives - describes the XMD-III drives of the DD-40
3	Cabling - describes the cabling for the DC-40 and DD-40
4	Theory of Operations - describes the DC-40 modules
5	DC-40 Cooling System - describes the cooling system of the DC-40
6	DC-40 Maintenance - describes how to maintain the DC-40
7	Trouble shooting - provides trouble shooting procedures for the DC-40 and the DD-40

The following publications are relevant to this manual:

- HR - 0077 Disk Systems Hardware Reference Manual
- HR - 0080 Cray Peripheral Equipment Site Planning Reference Manual

Complete details of the DD-40 are contained in the following vendor manuals:

- CDC Publication Volume 1 - 83325090 (CRI Publication Number xxxxxxxxxx)
- CDC Publication Volume 2 - 83325100 (CRI Publication Number xxxxxxxxxx)
- CDC Publication Volume 3 - 83325110 (CRI Publication Number xxxxxxxxxx)

CONTENTS

FIGURES

TABLES

TABLES (continued)

1. OVERVIEW

The following devices are components of the I/O Subsystem (IOS) of a Cray computer system:

- I/O Processor (IOP)
- Disk Controller Unit-5 (DCU-5)
- DC-40 disk controller (DC-40)
- DD-40 disk storage device (DD-40)

The DD-40 stores information from a Cray computer system. The DC-40 is the interface between the DCU-5 and the DD-40. The DCU-5 is the interface between the IOP and the DC-40.

When the IOP executes a write request, the DC-40 receives the data from the channel, buffers it, and passes it to the DD-40. On a read request, the DC-40 retrieves the data requested from the DD-40, buffers it, and passes it to the channel. The DC-40 does error checking on the data that is read or written and relays status messages to the IOP.

//

WARNING

This device operates in accordance with FCC Part 15, Subpart J Rules.

//

1.1 COMPONENTS OF THE DC-40

The DC-40 is designed and manufactured by CRI. It occupies a separate cabinet and consists of the following components:

- Four controllers
- Four power supplies
- One cooling system

Each controller is functionally independent and can control up to two DD-40's. When there are two DD-40's on a controller, one is called the primary DD-40 and the other the shadow DD-40. Each DD-40 consists of four XMD spindles. Because a controller in the DC-40 can control two DD-40's, it can control eight spindles. A DC-40, consisting of four controllers, can control 32 spindles.

Each controller in the DC-40 consists of the following five types of modules:

- 2EI channel interface module
- 2EM disk multiplexer module
- 2EB full-track buffer module
- 2EK disk-data and error-correction module
- 2EJ disk controller module (four per controller)

There are four 2EJ disk controller modules and one of each of the other modules in each controller in the DC-40. Each 2EJ module controls read and write exchanges for a single spindle in the DD-40. The 2EJ module has a single cold plate; all the other modules have a double cold plate.

Figure 1-1 shows the interrelationship of the modules of the DC-40. This figure shows the modules of a single controller of the DC-40.

The DC-40 is cooled by a vapor compression type of cooling system. This system consists of a compressor, a condenser, two evaporators, an accumulator, valves, filters, piping, guages, and controls. The refrigerant used in the cooling system is R-22. Heat is absorbed by the liquid refrigerant from the modules and passed from the refrigerant to a water supply.

1.2 IOS CONFIGURATION

Figure 1-2 shows an IOS with a single DC-40 and a primary and a shadow DD-40 connected to DC-40 controller 0. There are four controllers in the DC-40 and each of these can control a primary and a shadow DD-40. Each DD-40 has four spindles (A, B, C, and D).

One IOP can control up to four DCU-5's. Each DCU-5 can control up to four controllers in the DC-40. Thus one IOP can control up to 16 controllers (that is, up to four DC-40's). A full IOS configuration is as shown in figure 1-3. A single controller in the DC-40 can control up to 8 spindles, a DC-40 can control up to 32 spindles, and an IOP can control up to 128 spindles.

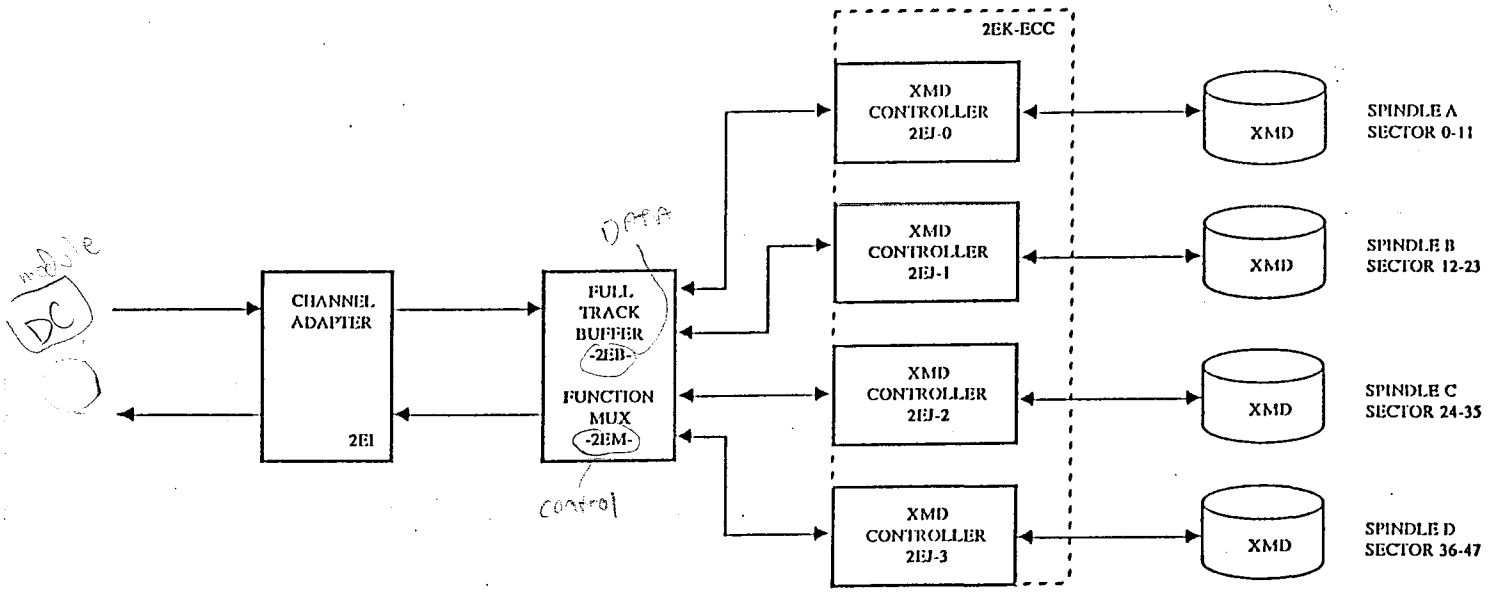


Figure 1-1. DC-40/DD-40 Block Diagram

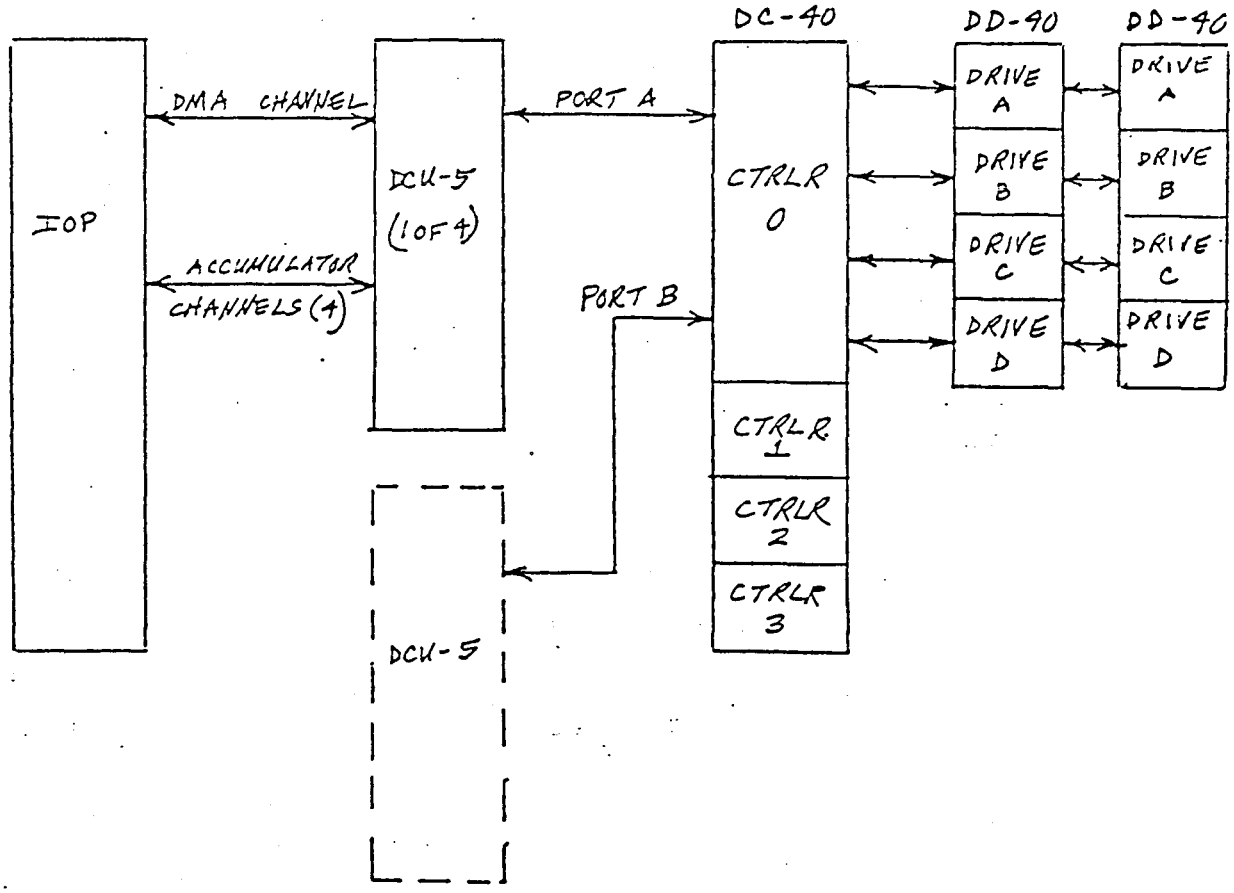


Figure 1-2. IOS Configuration

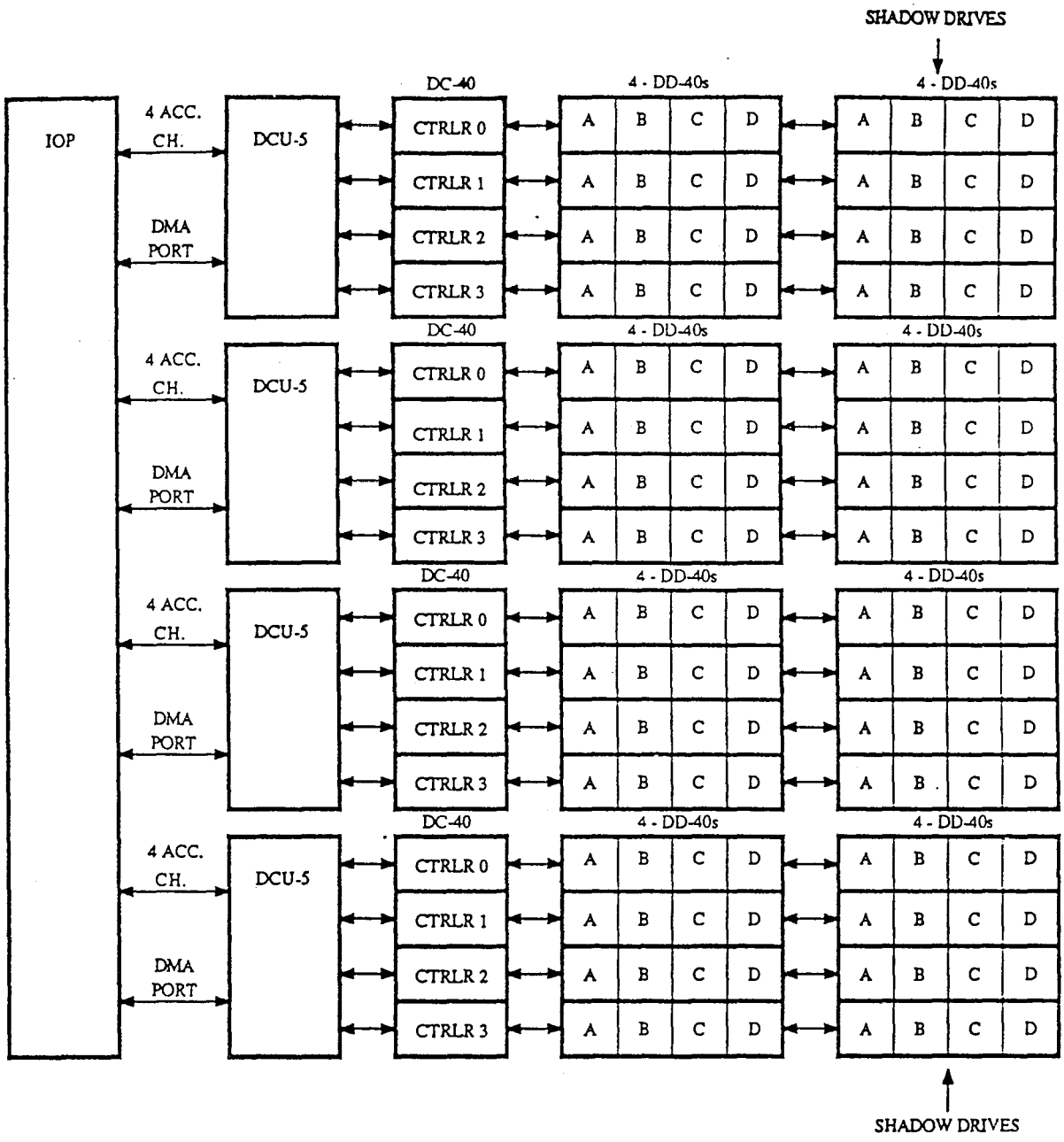


Figure 1-3. Maximum IOS Configuration

1.3 DC-40/DD-40 SPECIFICATIONS

This section discusses the following specifications of the DC-40 and DD-40:

- Floor loading
- Heat rejection
- Power requirements
- DD-40 XMD spindle specifications

1.3.1 FLOOR LOADING

The DC-40 cabinet weighs 1100 lbs (500 Kg) and takes up 7.3 sq ft (.68 sq m) of floor space. The DC-40 average floor loading is 150 lbs per sq ft (735 Kg per sq m). Figure 1-4 shows the DC-40 cabinet.

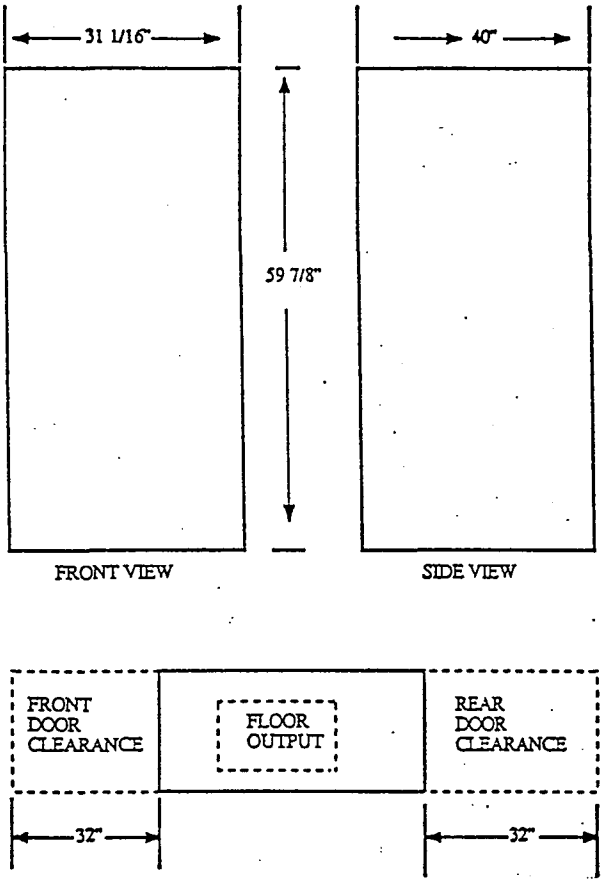


Figure 1-4. Dimensions of the DC-40 Cabinet

The DD-40 cabinet weighs 800 lbs (364 Kg) and takes up 8.7 sq ft (.81 sq m) of floor space. The DD-40 average floor loading is 92 lbs per sq ft (449 Kg per sq m). Figure 1-5 shows the DD-40 cabinet.

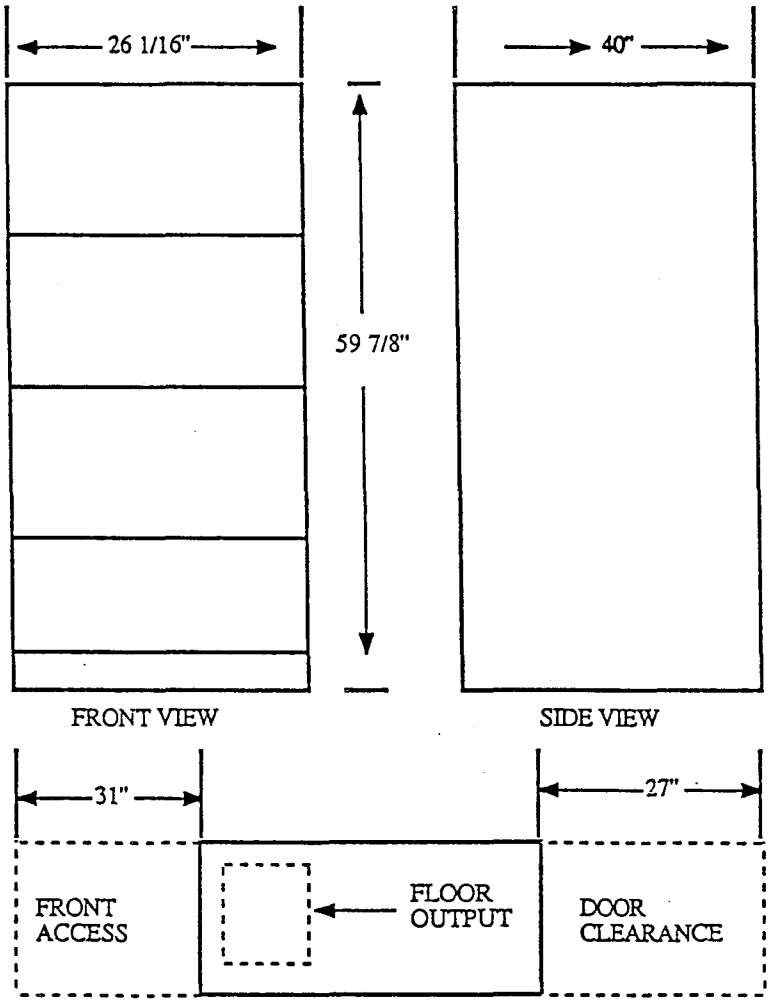


Figure 1-5. Dimensions of the DD-40 Cabinet

1.3.2 HEAT REJECTION

The DC-40 generates approximately 28,000 BTUs per hour. It is freon-cooled by a self-contained refrigeration unit. The refrigeration condenser unit is cooled by an external water supply.

The DD-40 generates approximately 8,000 BTUs per hour. The heat generated by the DD-40 must be handled by the equipment room air conditioning.

1.3.3 DC-40/DD-40 POWER REQUIREMENTS

The following are the electrical power requirements for the DC-40 and the DD-40:

DC-40:

40A/phase, 120/208, 3 phase Y, 5-pin power plug: IEC 309

DD-40:

208 VAC, 3 phase, 5-pin power plug: NEMA L21 through 20P

The nominal operating current for the DD-40 is:

Phase A-B 2.8A
Phase B-C 2.8A
Phase C-A 5.6A

The nominal startup current for the DD-40 is:

21.4 A/phase for 3.5 seconds

Spindles A, B, and C start simultaneously, presenting a balanced load to the 3-phase line. Spindle D is started after spindles A, B, and C are up to speed.

1.3.4 DD-40 XMD SPINDLE SPECIFICATIONS

Table 1-1 lists the specifications for the XMD spindles of the DD-40.

Table 1-1. Specifications for the XMD Spindles

Characteristic	Specification
Number of spindles per DD-40	4
Cylinders per spindle	1418 + 2 maintenance 2611_8 12
Cylinders per DD-40	1418 + 2 maintenance
Data heads per spindle	19
Buffer capacity	48 sectors
Sectors per track	48
Sectors per cylinder	912
Data bytes per sector	4096
Bytes per spindle, formatted	1,324 Mbytes
Bytes per DD-40, formatted	5,297 Mbytes
Transfer rate	86 Mbits/s
Ports per DD-40	1
Drives active at one time	4
Minimum number of operational drives required per cabinet	4

1.4 DC-40 CONTROLS AND INDICATORS

This section describes the controls and indicators for the DC-40.

Figure 1-6 identifies the controls and indicators of the power supply and refrigeration system control panel. Table 1-2 describes the function of the controls and indicators.

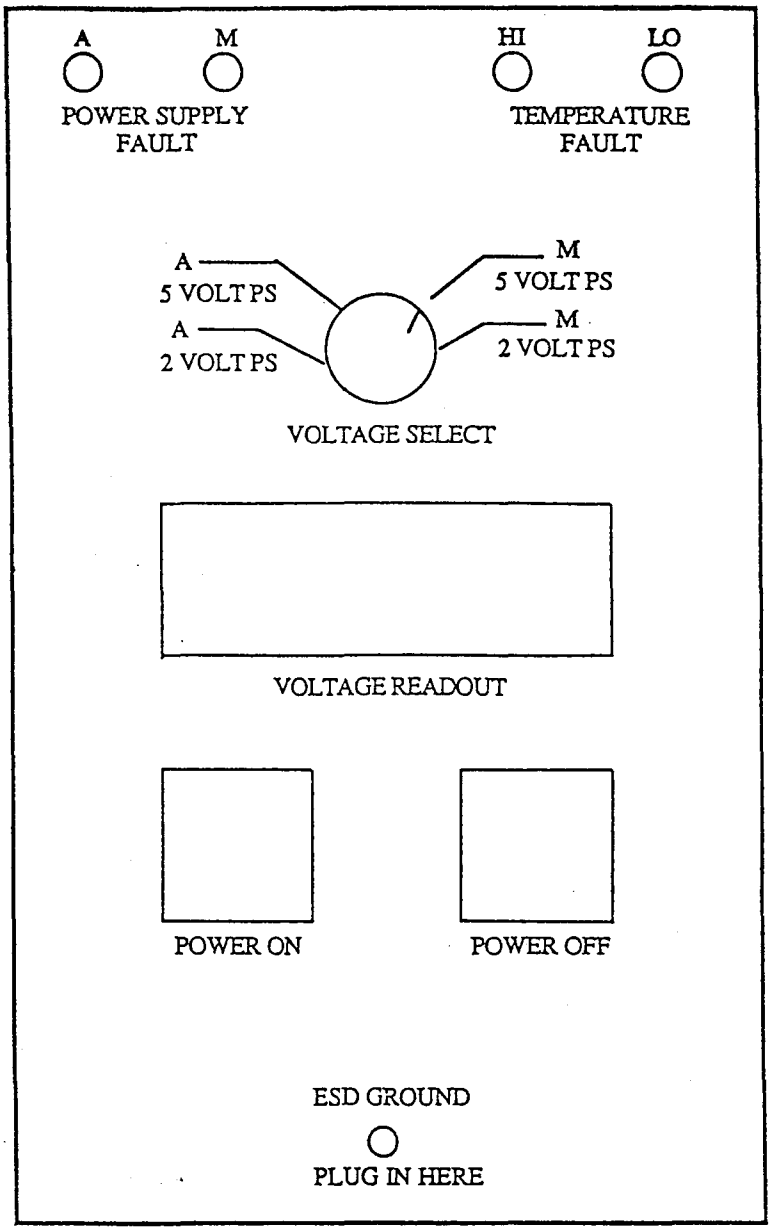


Figure 1-6. Power Supplies and Refrigeration System Control Panel

Table 1-2. Power Supplies and Refrigeration System Control Panel Functions

Name	Function
POWER SUPPLY FAULT A,M indicator	Indicate out-of-range fault in power supplies A and M. A is the lower power supply. M is the upper power supply.
TEMPERATURE FAULT, HI, LO indicator	Indicate out-of-range temperatures within the DC-40.
VOLTAGE SELECT switch	Selects one of four power supply outputs to be displayed at the VOLTAGE READOUT METER.
VOLTAGE READOUT meter	Indicates the value of the selected power supply on the digital voltmeter.
POWER ON switch	Enables power supplies to provide power to the modules and opens the cooling system solenoid.
POWER OFF switch	Disconnects the power supplies from modules and puts the refrigeration system into the pump-down cycle. After about three seconds of pump-down, the compressor is automatically shut off.
ESD GROUND receptacle	Provides ground connection for draining off electrostatic discharge (ESD).

Figure 1-7 identifies the controls and indicators of the control panel for a single DC-40 controller. Table 1-3 describes the function of the controls and indicators. The controls and indicators shown for controller 0 are the same for controllers 1, 2, and 3.

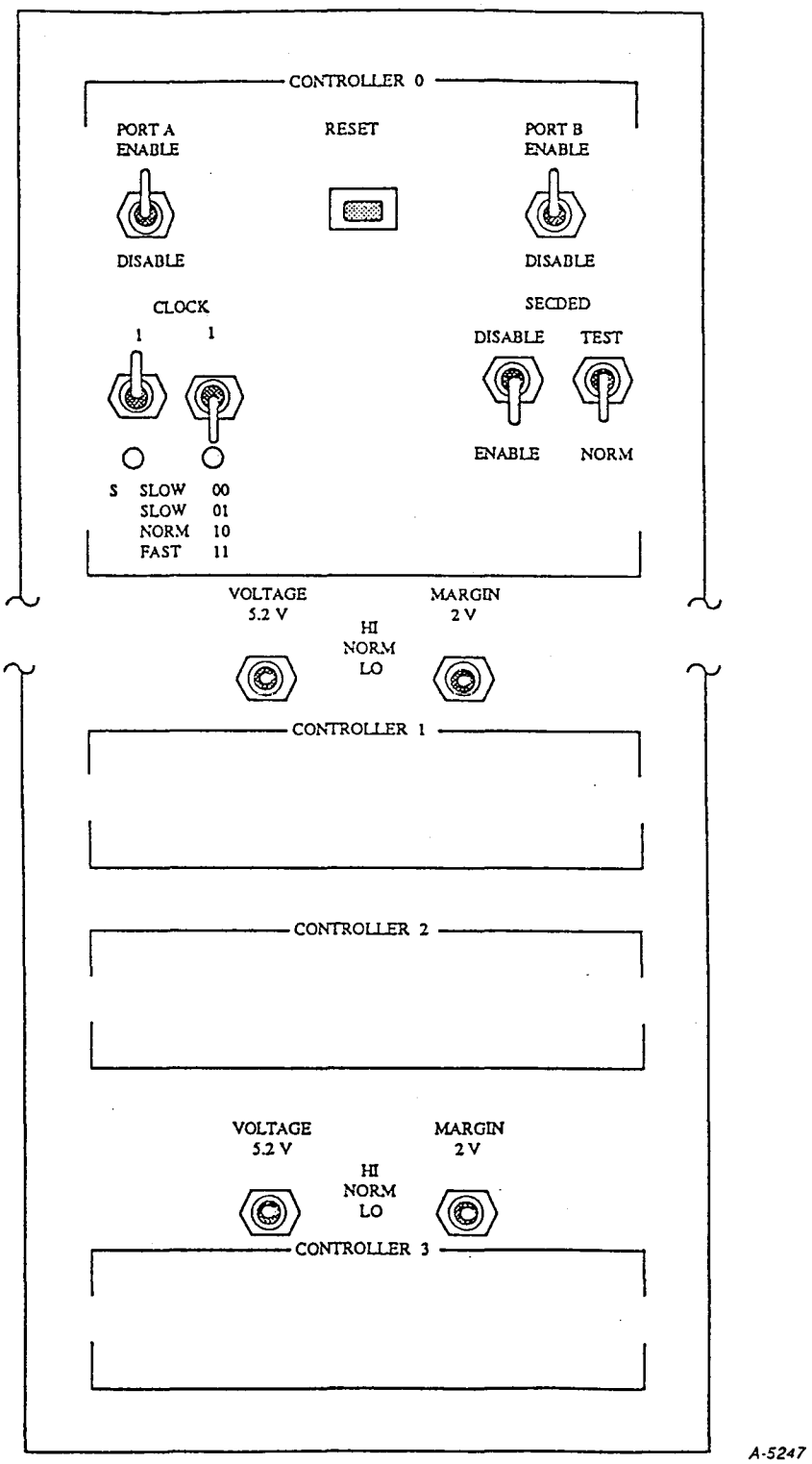


Figure 1-7. DC-40 Control Panel

Table 1-3. DC-40 Control Panel Functions

Name	Function
Port A Enable/ Disable switch	Allows port A to use the DC-40 when in the ENABLE position. Prevents port A from using the DC-40 when in the DISABLE position.
Port B Enable/ Disable switch	Allows port B to use the DC-40 when when in the ENABLE position. Prevents port B from using the DC-40 when in the DISABLE position. Both port A and port B may be enabled at the same time.
Clock 1,0 switch	Selects the logic clock speed.
Margin -5.2V -2.0V switch	Selects the voltage levels of the logic power supply outputs.
SECDED Enable/ Disable switch	Activates single error correction double error detection (SECDED) when in the ENABLE position. Inactivates SECDED when in the DISABLE position.
SECDED Test/ Norm switch	Allows testing of SECDED by forcing 0's to be written into check bits.

Figure 1-8 identifies the controls of the DC-40 power panel. Table 1-4 describes the function of the controls. (This panel is located inside the rear of the DC-40 cabinet.)

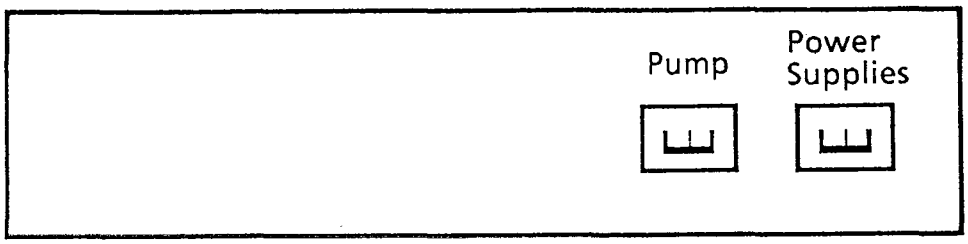


Figure 1-8. DC-40 Power Panel

Table 1-4. DC-40 Power Panel Functions

Name	Function
COMPRESSOR circuit breaker	Applies primary power to the compressor and control circuitry.
POWER SUPPLIES circuit breaker	Applies primary power to the power supplies. Observe the warning below.

//

WARNING

When powering off the DC-40, before turning off the COMPRESSOR and POWER SUPPLY circuit breakers on the DC-40 power panel, you must first press the POWER OFF switch on the power supply and refrigeration system control panel. The refrigeration system must be allowed to power down (about 3 seconds) before removing all power in order to prevent damage to the compressor at start up.

//

DD-40 DISK DRIVE

DD-40 DISK DRIVE

Hardware Training Aid

HTA-0859

This document cannot be sent outside the United states without a Validated Export License.

RECORD OF REVISION

PUBLICATION NUMBER
HTA-0859

Each time this manual is revised and reprinted, all changes issued against the previous version are incorporated into the new version.

Comments about Cray Research, Inc. Training Volumes should be directed to:

Hardware Training Department
Cray Research, Inc.
890 Industrial Boulevard
Chippewa Falls, WI 54729
(715) 723-2206

Revision	Description
	August 1988 - Original printing.
A	September 1988. Page 7 added.

This device is exempt from the technical requirements of the FCC's Part 15 Subpart J Rules pursuant to Section 15.801(c).

OBJECTIVES - Overview

Upon completion of this section, the student will be able to:

- Describe each disk channel with respect to DCU-5 modules, DC-40 modules, and DD-40 drives
- Give specifications on the DC/DD-40 configuration
- Briefly describe each of the DC/DD-40 commands and functions

OBJECTIVES - DD-40

Upon completion of this section, the student will be able to:

- Describe the functions of the DD-40, (seek, load, RTZ, write and read)
- Follow the flow charts and diagrams and know which part of the drive is involved with each step
- Explain errors that can occur with each of the drive functions
- Interpret the drive's selected status. (Refer to troubleshooting section)
- Explain the purpose of each part of the Sector Format
- Demonstrate the switch settings for the sector count and I/O Board switch settings

DC4004W103M

OBJECTIVES - Cabling

Upon completion of this section, the student will be able to:

- Correctly cable the DCU-5, DC-40 and DD-40 together
- Identify and describe each signal on the A and B cables between the DC-40 and DD-40
- Locate the part numbers that identify different cables for the DC-40 and DD-40
- Re-cable DD-40 spindles for fault isolation

OBJECTIVES - DC-40

Upon completion of this section, the student will be able to:

- With the aid of the Boolean and diagrams, describe the major functions of the modules
- Follow the read and write paths through the DC-40 and give a description of what each module does during a read and write
- Determine the bad buffer chip, given the syndrome bits
- Interpret the error bits that are in General Status and Buffer Status and know the module where the bits originate
- Explain the function of each of the fields in the PROM sequencer
- Follow a sequence through the PROM Micro Code
- Explain how defect detection works

OBJECTIVES - Lab

Upon completion of this section, the student will be able to:

- Load and run the DC-40 diagnostics and give an explanation of what each test section does
- Set up diagnostics to check out a given number of cylinders and heads
- Execute diagnostic tests from the Fault Display panel
- Use the micro tester to write test and execute diagnostics to the DC-40 and DD-40
- Take refrigeration readings and know how to make adjustments
- Demonstrate adding a flaw to the user flaw table with a defect and moving a defect pad
- Demonstrate writing and reading the O.S. flaw table

DS-40 Commands

A REGISTER		B REGISTER		DESCRIPTION
1DD000	Int. Addr.	000000	00000U	Release
1DD001	Int. Addr.	000000	00000U	Release Opposite and Select
1DD010	Int. Addr.	000000	00000U	Reserve
1DD020	Int. Addr.	000000	000000	Clear Faults
1DD021	Int. Addr.	000000	000000	Reset
1DD030	Int. Addr.	000000	000000	Return to Zero
1DD040	Int. Addr.	000000	Status	Select Status
1DD050	Int. Addr.	000000	000000	General Status
1DD070	Int. Addr.	000000	Diag. mode	Diagnostic Select
1DD100	Int. Addr.	000000	Offsets Cyl. Addr.	Select Cylinder
1DD101	Int. Addr.	000000	Head Addr.	Select Head
	READ			
1DD200	Int. Addr.	000000	RRRRRR	Read disk data (with Read Ahead Enabled)
1DD201	Int. Addr.	000000	RRRRRR	Read ID
1DD202	Int. Addr.	000000	RRRRRR	Read Absolute
1DD203	Int. Addr.	000000	RRRRRR	Read Buffer (16 parcels)
1DD204	Int. Addr.	000000	RRRRRR	Read Syndrome Block
1DD205	Int. Addr.	000000	RRRRRR	Compute Correction Vector
1DD206	Int. Addr.	000000	RRRRRR	Track Header
1DD210	Int. Addr.	000000	RRRRRR	Read disk data (with Read Ahead Enabled
1DD212	Int. Addr.	000000	RRRRRR	Read Buffer (2048 parcels)
	WRITE			
1DD300	Int. Addr.	000000	WWWWWW	Write disk data (Write Behind Enabled)
1DD301	Int. Addr.	000000	WWWWWW	Write ID
1DD302	Int. Addr.	000000	WWWWWW	Write Defective ID
1DD303	Int. Addr.	000000	WWWWWW	Write Buffer (16 parcels)
1DD304	Int. Addr.	000000	WWWWWW	Write Zero ECC
1DD310	Int. Addr.	000000	WWWWWW	Write disk data (Write Behind Disabled)
1DD314	Int. Addr.	000000	WWWWWW	Write Buffer (2048 parcels)
1DD370	Int. Addr.	000000	PPPPPP	Echo Parameter

DC4004/117

DD-40 COMMANDS

		ACCUMULATOR BITS	FUNCTION
*	DIA:1	Drive Control Functions	
		01000U	Unit select
		010007	Port select
		04hh00	Head select
		07SSSS	Status select (5 status words available)
		100000	General status
		11000d	Diagnostic select (2 options available to perfom Bus-In Parity errors and Status Parity errors)
		130000	Reset drive
		140000	Clear faults on drive
		150000	Return to zero
		16000U	Release opposite and select
		17000U	Release
*	DIA:2	Read	
		00xxxx	Read data record with read ahead
		01xxxx	Read ID
		02xxxx	Read absolute
		03xxxx	Read track buffer (16 parcels)
		04xxxx	Read ECC parameter block
		05xxxx	Compute and transfer correction vectors
		06xxxx	Read track header
		10xxxx	Read data record with no read ahead
		12xxxx	Read track buffer (1 sector)
*	DIA:3	Write	
		00xxxx	Write data record with write behind
		01xxxx	Write ID
		02xxxx	Write defective ID
		03xxxx	Write track buffer (16 parcels)
		04xxxx	Write data with zero ECC
		10xxxx	Write data record with no write behind
		14xxxx	Write track buffer (1 sector)
*	DIA:4	Diagnostic Echo/Enter Defect Parameter	
		xxxxxx	Echoes xxxxxx out to the 2EI and back, and enters Defect Parameter into latches on the 2EK
*	DIA:5	Select Cylinder (Seek)	

* Accumulator value accompanies these commands and must be set up before issuing the command.

Hardware Trng.
DC4004/116 S.J.M.

Bit

$2^0 - 2^3$ **Sector #**

$2^4 - 2^5$ **Drive #**

2^6 **Command Error** - Command Error will set if a new FNX is received with a FNX in progress. Also if a FNX 12 is decoded, since a FNX 12 is not used in the DC40.

2^7 **Channel Diagnostic Mode** - This bit is set when only the port is selected. The port is selected without selecting a drive when a Unit Select FNX is issued with the lower three bits set. This condition is held until a Unit Select is sent to select the drive, a Reset or a Release Opposite and Select will also clear the bit.

2^8 **Unit Ready** - Unit Ready indicates that the drive is up to speed, that the first seek was successful, and that no fault condition exists.

2^9 **On Cylinder** - This signal indicates that the servo head is positioned at a track. This line goes inactive if the positioner drifts off cylinder.

2^{10} **Seek Error** - This signal indicates that the drive took too long to complete a seek, that the positioner has moved outside the recording field, or that the drive was commanded to seek beyond cylinder 1063. The seek error can be cleared by an RTZ command.

2^{11} **Fault** - When this line is active, it indicates that one or more of the following faults exists:

- Read and Write Fault
- Write or Read attempted while Off Cylinder
- First Seek Fault
- Write Fault
- Write and Write Protected Fault
- Head Select Fault
- Voltage Fault

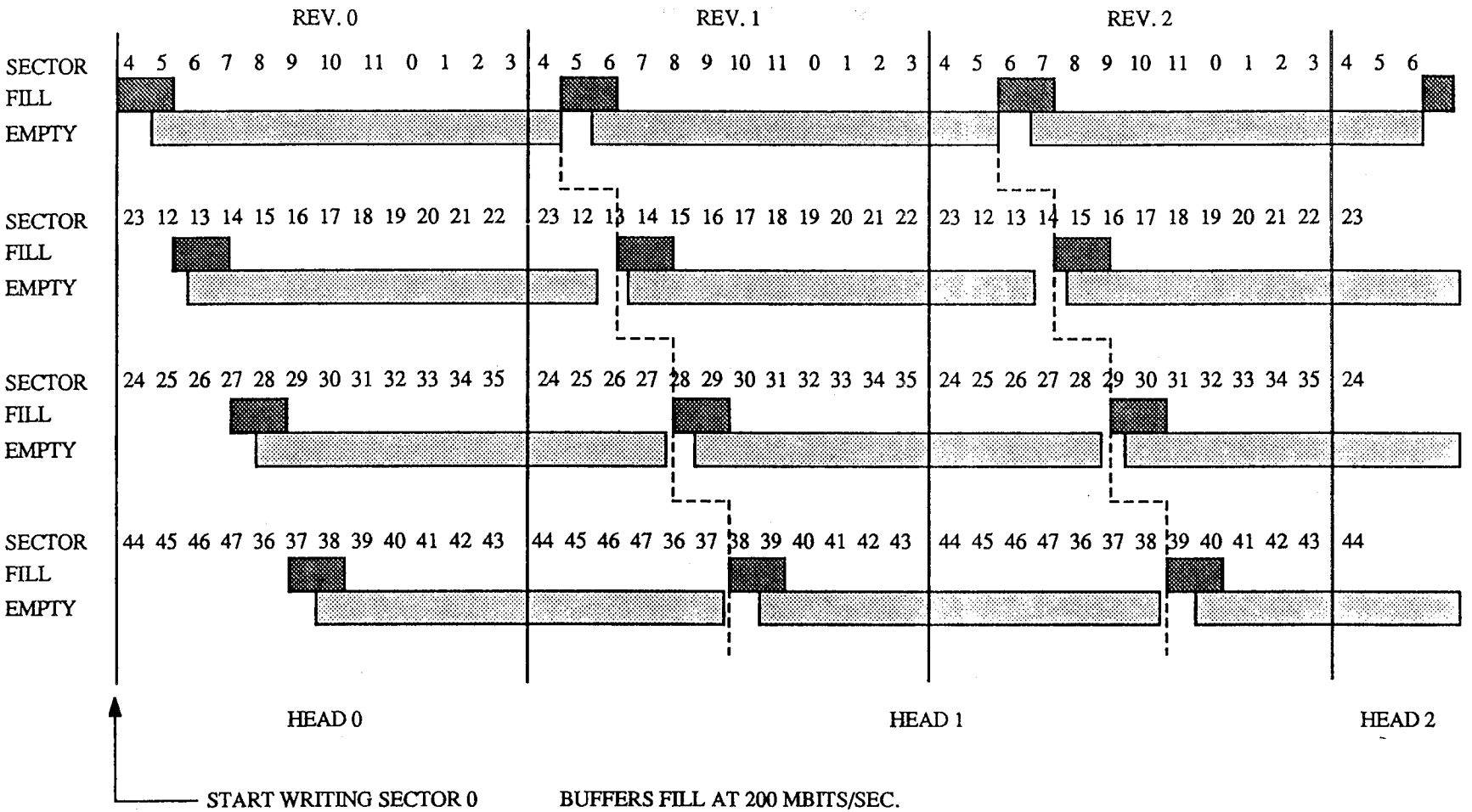
2^{12} **Write Protect** - This signal indicates that the drive write circuits are disabled. The write protect mode is enabled by a jumper plug on the control board, by a switch on the operator panel, by a fault condition, or by a loss of motor speed. Attempting to write while the write protect mode is active results in a fault condition.

2^{13} **Address Mark** - When an address mark has been found during an address mark search operation, this line goes high (refer to Tag 3 description).

2^{14} **Index Mark** - This signal is derived from the servo tracks. It occurs once per revolution of the disk, and its leading edge is the leading edge of sector zero. Note: This signal may be disabled by a switch selection on the I/O board.

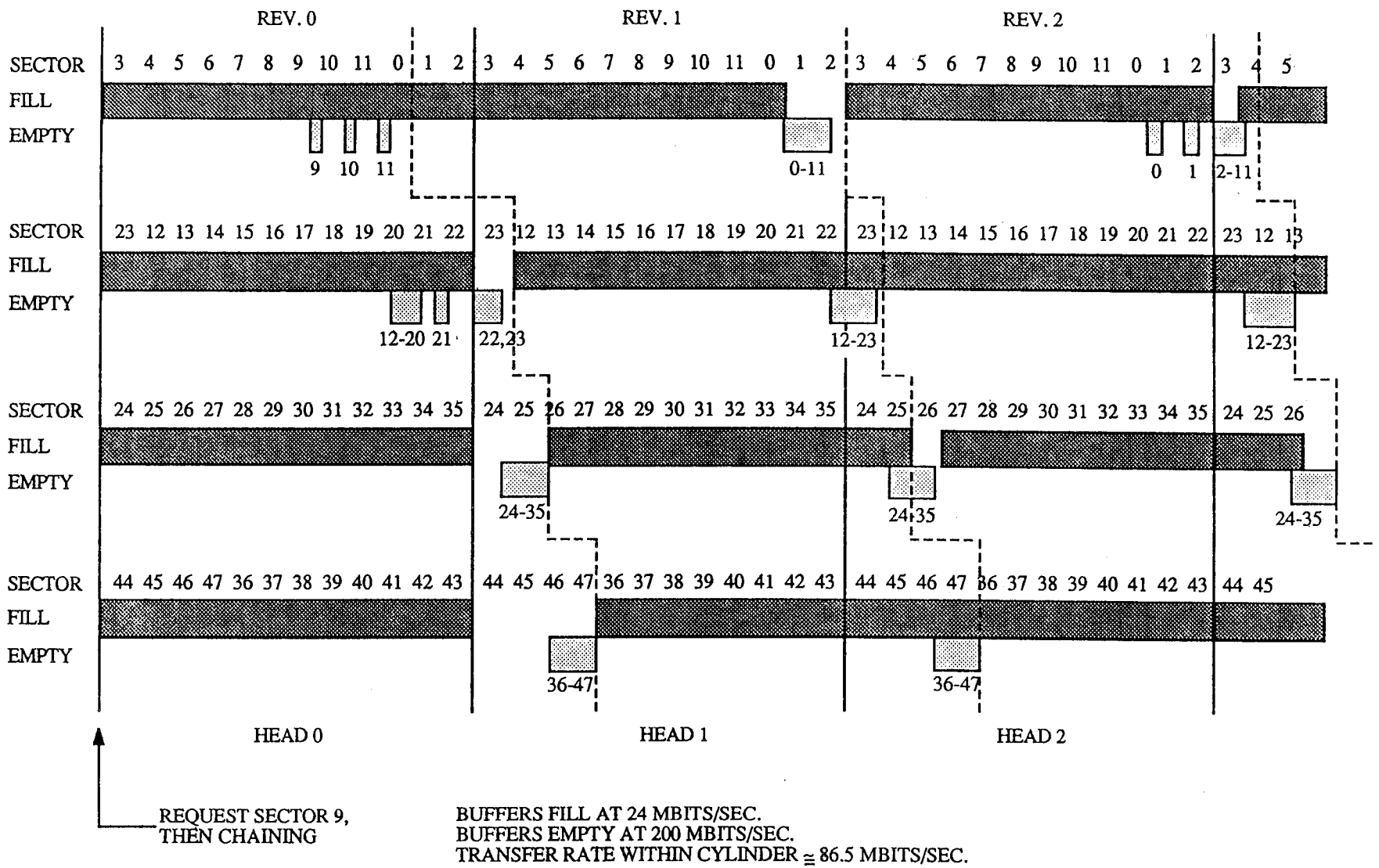
2^{15} **Sector Mark** - This signal is derived from the servo tracks. The number of sector signals that occur for each revolution of the disk is selected by switches on the control board. Note: This signal may be disabled by a switch selection on the I/O board.

DC4004W107M



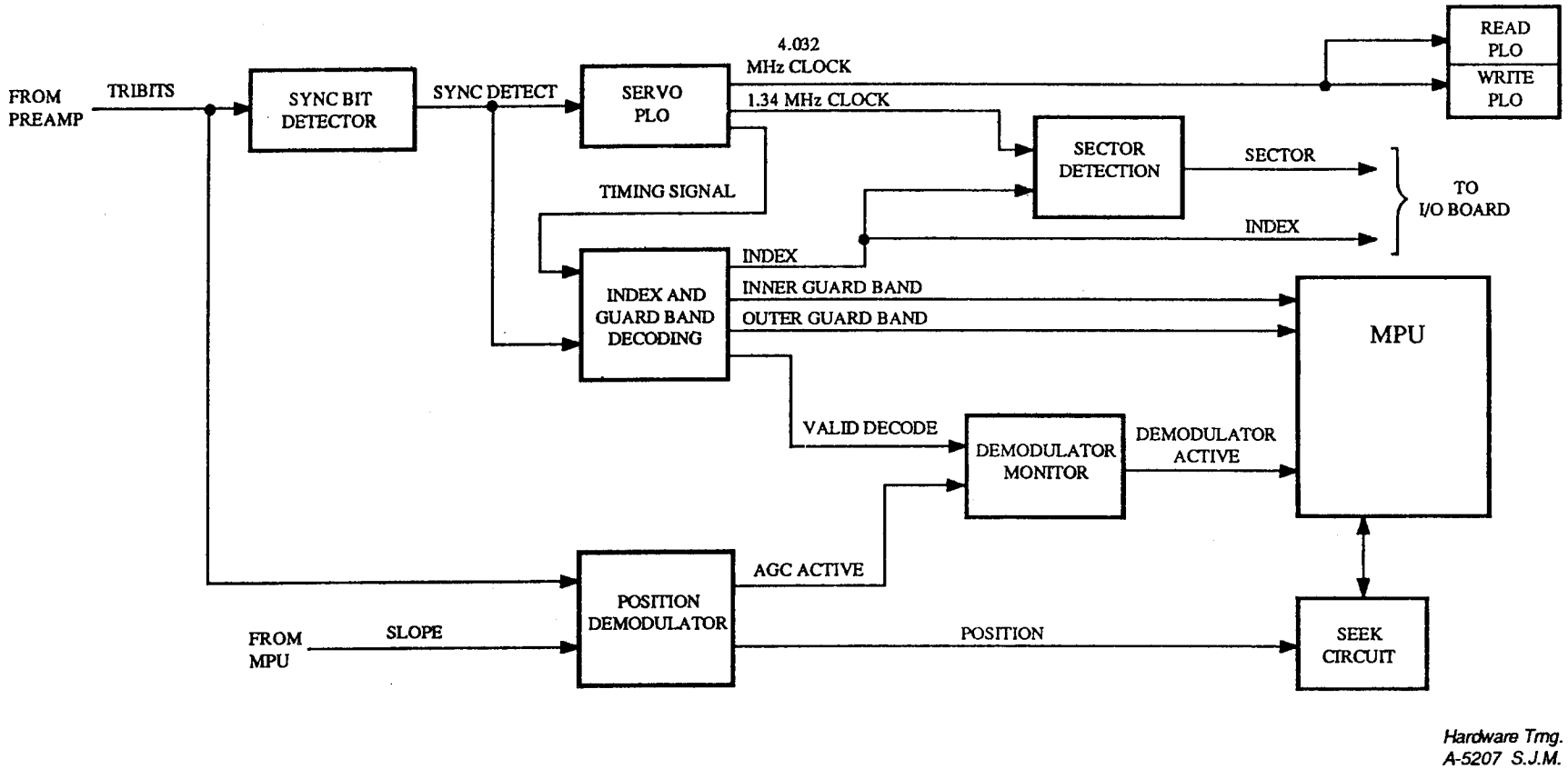
Hardware Trng.
A-5199A S.J.M.

DD40 - WRITE TRANSFER

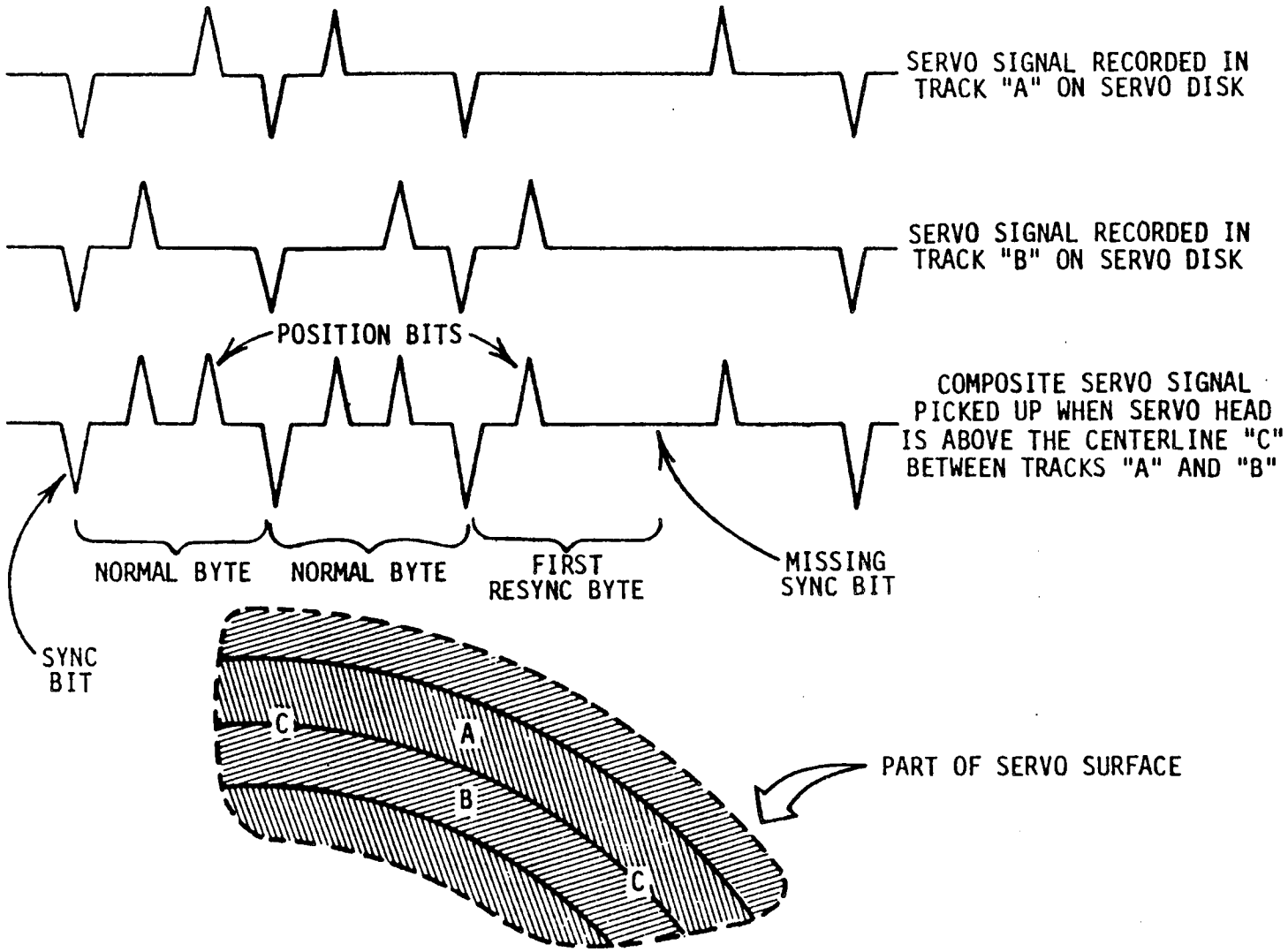


Hardware Trng.
A-5200A S.J.M.

DD40 - READ TRANSFER



DD40 SERVO CIRCUIT



ibit Pattern

CALCULATING DEFECT PARAMETER FROM CORRECTION VECTOR

The offset and mask obtained from the CRAYLOG after an ECC error on a DD-40 can be used to calculate a defect pad. The drive can then be reformatted to hide this defect. This should be done only for errors which are corrected in error recovery and repeat after being rewritten. The following algorithm should be used:

$$\text{DEFPAD} + R = \frac{100040_8 - \text{OFFSET}}{200_8}$$

if $R \geq 170_8$, the defect is unhideable

Example:

OFFSET = 75366
MASK = 003400

$$\frac{100040_8 - 75366_8}{200_8} = \frac{2452_8}{200_8} = 12 + R\ 52$$

The defect pad entered in the diagnostic flaw table would be 12. The flaw should be added using format mode 2.

Hardware Trng.
DC4004/122 S.J.M.

DD-40 EXTRACT ERROR REPORT 1

17:46:06.3159 Disk error packet Error type: Read Final Status: Corrected
Reason recovery invoked: DN and BZ both set
IOP/Chan: 1/27 Device type: DD-40 Unit: 00 Retry count: 3
Expected cylinder: 000567 Expected head group: 000004 Expected sector: 000006
Controller status: 003211 Drive general status: 011406 Function: Read
Buffer status: 011406 Drive status: 001406 Final buffer status: 001406 Final drive status: 001406
Offset: Disabled
Correction mask: 003400 Offset: 051312 Previous correction mask: 003400 Previous offset: 051312

17:46:06.3467 * Corrected data error Read IOP device: 40-1-27A Local dataset: DD-40 JSQ/Job name: 8/40127
Cylinder: 0567 Head: 0004 Sector: 0000

$$\frac{(\#\text{Data bits}_8 + \text{ECC bits}_8) - \text{Offset}_8}{\text{bits in a defect pad}}$$

$$\frac{100040_8 - 51312_8}{200_8} = \frac{26526_8}{200_8} = 132 \quad R126_8 = 86_{10}$$

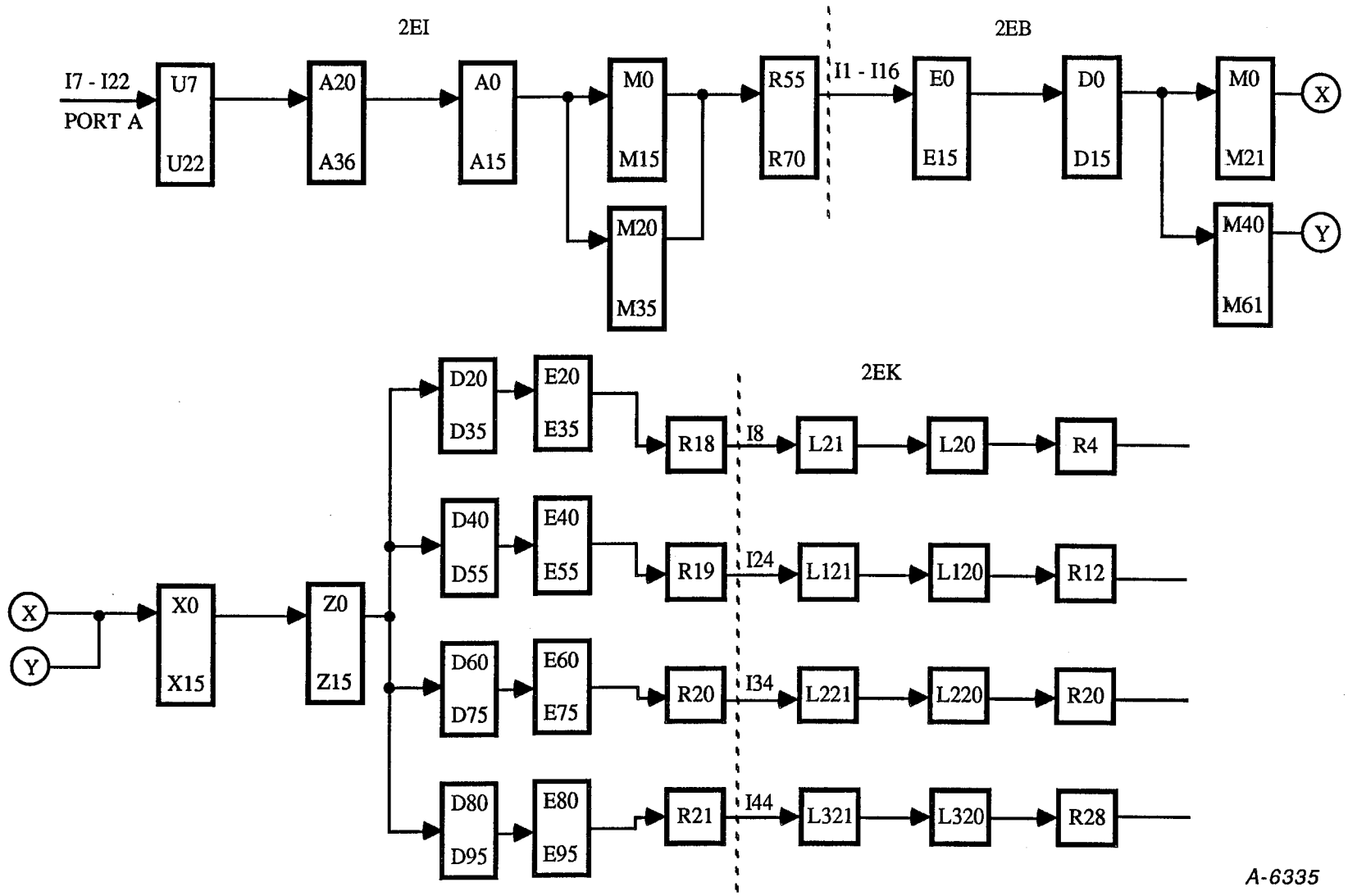
DD-40 EXTRACT ERROR REPORT 2

17:59:21.1634 Disk error packet Error type: Read Final Status: Corrected
Reason recovery invoked: DN and BZ both set
IOP/Chan: 1/25 Device type: DD-40 Unit: 00 Retry count: 3
Expected cylinder: 000004 Expected head group: 000013 Expected sector: 000024
Controller status: 114211 Drive general status: 011430 Function: Read
Buffer status: 011430 Drive status: 001430 Final buffer status: 001430 Final drive status: 001430
Offset: Disabled
Correction mask: 001400 Offset: 074674 Previous correction mask: 001400 Previous offset: 074674

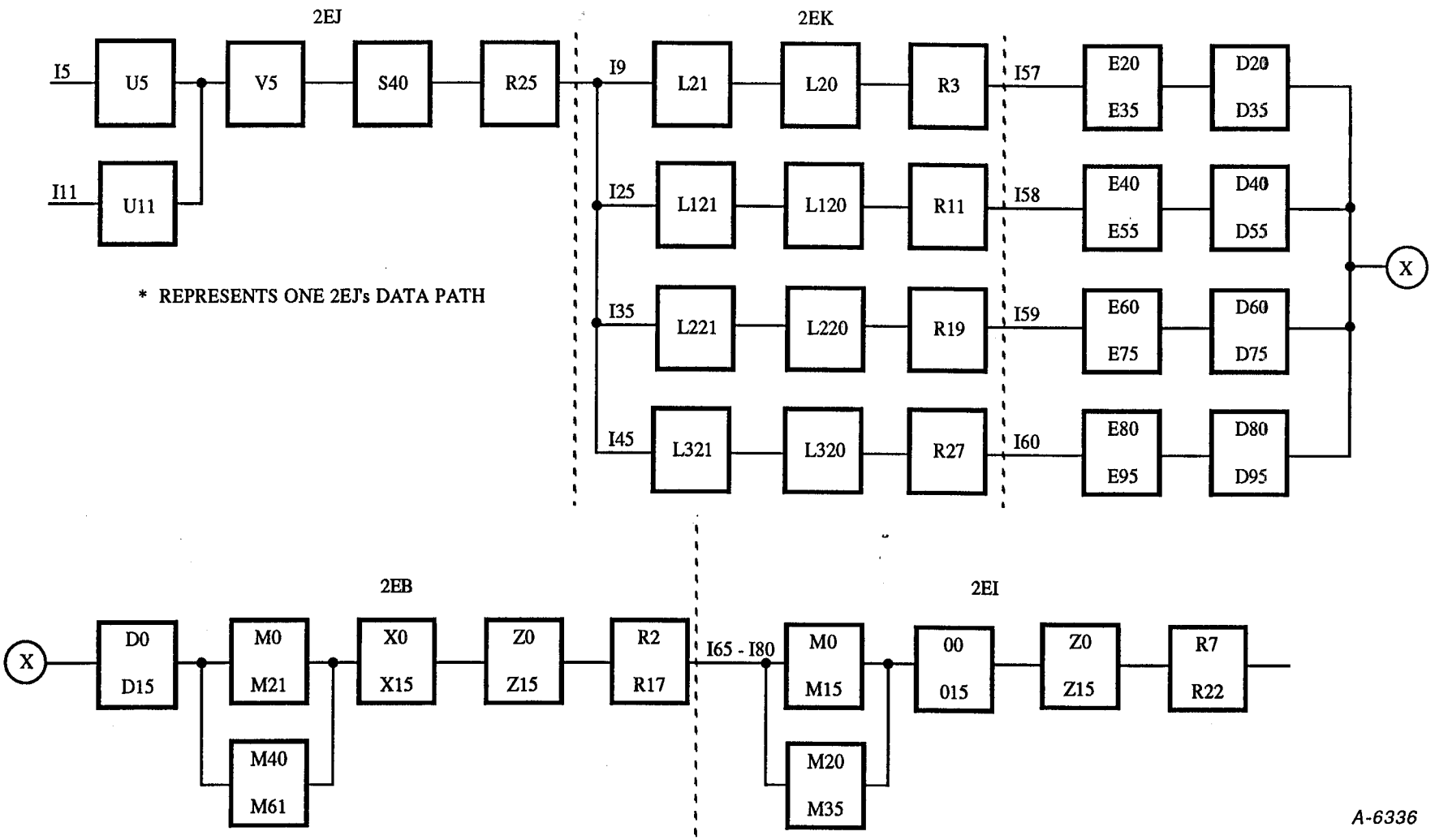
17:59:21.1898 * Corrected data error Read IOP device: 40-1-25A Local dataset: ZZZ25A JSQ/Job name: 6/DD125A
Cylinder: 0004 Head: 0013 Sector: 0000

$$\frac{\text{(\#Data bits + ECC bits) - Offset}}{\text{bits in a defect pad}}$$

$$\frac{100040_8 - 74674}{200} = \frac{3144}{200} = 14 \quad R = 144_8 \text{ or } 100_{10}$$



DATA PATH WRITE MODE 0



DATA PATH READ MODE 0

COMMAND LIST

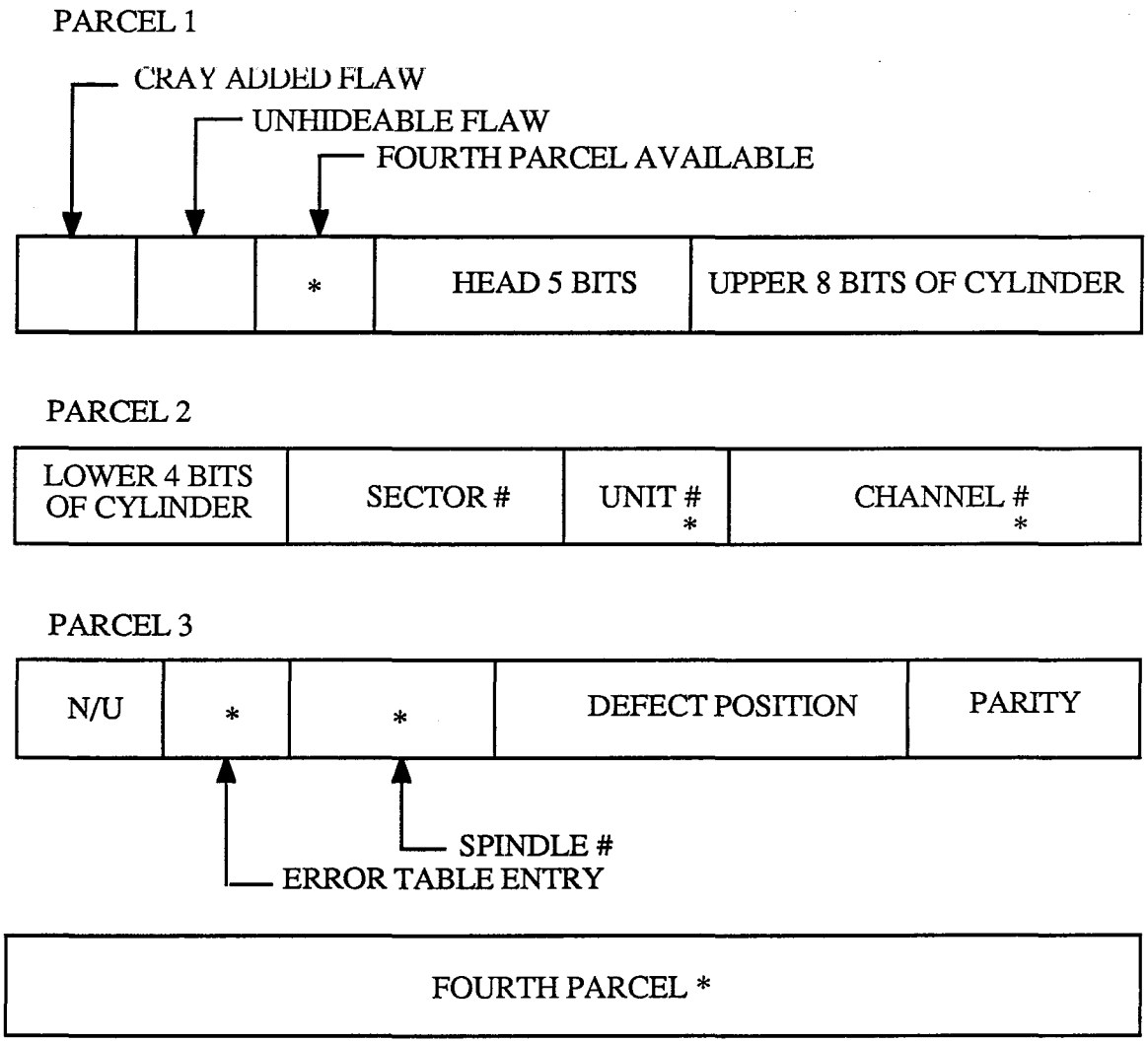
COMMAND	DESCRIPTION
DS	(Diagnostic start ; Run the selected diagnostics)
EX	(Exit ; Prepare spindles for power down)
MC	(Master clear ; Software reset)
RC	(Reset all selected disk controllers)
RD	(Reset all selected disk cabinets)
RG X	(Display the contents of an operand register) X = Register number to display
D XXXX	(Display memory) XXXX = Memory Address
DL XXX	(Display memory left) XXXX = Memory Address
DR XXX	(Display memory right) XXXX = Memory Address
DF	(Display Forward)
DE	(Display the error table)
DC	(Display counts for flaw tables) (First load the tables)
S XXXX YYYY	(Store a value to memory)
S+XXXX YYYY	(Store consecutive memory locations) XXXX = Memory Address YYYY = Value to be stored
ST ZZ Y X	(Save a flaw table on the expander disk)
RT ZZ Y X	(Restore a flaw table from the expander disk)
VF ZZ Y X	(Display a active flaw table)
LF ZZ Y X	(Load an active flaw table from a DC40 disk)
CF ZZ Y X	(Clear an active flaw table) ZZ = Channel number of DD40 cabinet Y = Unit number X = Spindle number
CFA	(Clear all active flaw tables)

AF ZZ Y X WWWW VV UU TTT S R (Add a flaw to the active flaw table)
RF ZZ Y X WWWW VV UU TTT S R (Remove a flaw to the active flaw table)

ZZ = Channel number of the DD40 cabinet
Y = Unit number
X = Spindle number
WWWW = Cylinder
VV = Head number
UU = Sector number
TTT = Defect position
S = CRI added
R = Unhidable defect

DC4003C26M

DD-40 FLAW TABLE FORMAT UNDER XMD



The fourth parcel will be either the logical difference if a data error or Status register 1 if the error was other than a data error.

* This information is only available in Local Memory.

PARAMETERS

220 = Section selects (Lower)

1 -	Section 0	2EI data echo through save bus out
2 -	Section 1	Force a parity error
4 -	Section 2	Full track buffer data bus
10 -	Section 3	Full track buffer drive secded
20 -	Section 4	Full track buffer spindle addressing
30 -	Section 5	Full track buffer sector addressing
100 -	Section 6	Track buffer memory
200 -	Section 7	Header Reads - Seek Timing - Head Address
400 -	Section 10	Correction vector analysis
1000 -	Section 11	Disk data bus - scratch cylinder
2000 -	Section 12	Disk spindle addressing - scratch cylinder
4000 -	Section 13	Disk sector addressing - scratch cylinder
10000 -	Section 14	Defect pad writeability
20000 -	Section 15	Chaining - write ahead / read ahead
40000 -	Section 16	Disk system exerciser
100000 -	Section 17	Seek distance / data verification

221 = Section selects (Upper)

1 -	Section 21	Flaw table generation from factory headers
2 -	Section 22	Disk formatting
4 -	Section 23	Write the O.S. flaw table on O.S. cylinder
10 -	Section 24	Surface analysis

222 = Number of passes to run - 177777 means infinite
223 = Type of disk to test
0 = DD40
1 = DD10
226 = Flaw table reference enable
0 = Disable
1 = Enable (default)
230 = Spindle number to test (starting)
231 = Spindle number to test (ending)
232 = Head number to test (starting)
233 = Head number to test (ending)
234 = Cylinder number to test (starting)
235 = Cylinder number to test (ending)

240 = IOP channel number for the display
241 = IOP channel number for the keyboard
242 = Timeout delay used in wait for done (lower)
243 = Timeout delay used in wait for done (upper)
244 = Number of sectors in each track buffer drive (148 normally)
245 = Number of cylinders in one spindle
246 = Number of heads in one spindle

250 = Retry count (used in formatting)
251 = Scratch cylinder address
252 = Flaw table cylinder address
253 = Flaw table head number
254 = O.S. flaw table sector number
255 = O.S. flaw table drive number
256 = O.S. flaw table head number
257 = O.S. flaw table track number
260 = Channel number and unit number for the drive under test. Example:

LOC.	ENTRY	MEANING
260	000025	Chan 25, unit 0
261	100026	Chan 26, unit 1
262	177777	No more
263	177777	
264	177777	
265	177777	
266	177777	
267	177777	

NOTE: These entries must be in ascending order by channel number.

ERROR INFORMATION

12 = Current test section
13 = Current test condition
14 = Error code

1 - Timeout - channel never got done (done = 0 after delay)
2 - Channel error (busy = 1, done = 1)
3 - Channel took longer to finish than expected
4 - Hardware error - check status registers
5 - Unexpected interrupt
6 - Channel not busy too soon
7 - Channel done too soon
10 - Status registers error
11 - Data compare error
12 - Software error - contact Engineering
13 - Exit stack under run
14 - Track header defect position past end of track
15 - Could'nt find any UD's
16 - Unexpected interrupt on DC40 channel
17 - Chaining broken
20 - Hardware error during chaining - check status registers
21 - Did'nt get an expected ECC error
22 - Timeout on waiting for a DC40 interrupt
23 - Did'nt get an expected sync time out
24 - Got an ECC error but data compare did'nt fail
25 - No writeable sectors, found only defective sectors
26 - O.S. flaw table buffer overflow
27 - Out of memory for the active flaw table buffer
30 - Could'nt find the end of the flaw table
31 - Incorrect flaw table on the current spindle

32 - Could'nt find the flaw table in active memory
33 - Out of temporary buffer space
34 - Could'nt find the flaw table entry
35 - Flaw table is too big; it won't fit in buffer memory image
36 - Incomplete flaw table (missing hideables or unhideables)
37 - Empty disk flaw table
40 - The real-time clock is defective
41 - Not enough space on the current spindle trace
42 - Could'nt find a clean track on the selected cylinder
43 - Seek distance exceeded the last entry of the seek time chart

20 = Logical difference
21 = Actual data
22 = Expected data
23 = Error count
24 = Pass count
25 = Location in listing where error occurred (E)
26 = Stop on error flag
0 - continue after error and update error count
1 - stop on error

STATUS INFORMATION

320 = STAT0 (Status register 0)
Bit 0 = Drive ready
Bit 1 = Drive Status available
Bit 2 = Drive Busy/invalid drive command
Bit 3 = Drive error
Bit 4 = Status parity error
Bit 5 = Bus-in parity error
Bit 6 = Read data parity error
Bit 7 = Error flag
Bit 8-15 = Parameter register

321 = STAT1 (General status)
Bit 0-3 = Sector number of last error
Bit 4-5 = Drive number of last error
Bit 6 = Channel error
Bit 7 = Buffer error
Bit 8 = Unit ready (all four spindles)
Bit 9 = On cylinder (all four spindles)
Bit 10 = Seek error (on any of the four spindles)
Bit 11 = Drive fault (on any of the four spindles)
Bit 12 = ECC error (sector status of last error)
Bit 13 = ID not found (sector status of last error)
Bit 14 = Sync time out (sector status of last error)
Bit 15 = Defect parity error (sector status of last error)

322 = STAT2 (Track buffer status)
Bit 0-3 = Sector number
Bit 4-5 = Drive number
Bit 6 = Uncorrectable buffer error
Bit 7 = Buffer error
Bit 8 = Unit ready (on specified drive)
Bit 9 = On cylinder (on specified drive)
Bit 10 = Seek error (on specified drive)
Bit 11 = Drive fault (on specified drive)
Bit 12 = ECC error (on specified sector)
Bit 13 = ID not found (on specified sector)
Bit 14 = Sync time out (on specified sector)
Bit 15 = Defect field parity error (on specified sector)

323 = STAT3 (Drive status)
Bit 0-3 = Sector number
Bit 4-5 = Drive number
Bit 6 = Command error
Bit 7 = Drive in channel diagnostic mode
Bit 8-15 = SMD disk bus in bits specified by tags 4 and 5 and SMD disk bus bits 0-2

DEFINE SPECIAL ERROR LOCATIONS

300	177777	ERRPRC	177777	• Sector address the error occurred in
301	000000	CHERCT	0	• Channel error count
302	000000		0	
303	000000		0	
304	000000	ERROR1	0	• General purpose error location
305	000000	ERROR2	0	• General purpose error location
306	000000	ERROR3	0	• General purpose error location
307	000000	ERROR4	0	• General purpose error location
310	000000	ERRCH	0	• Current channel number after error
311	000000	ERRCI	0	• Current cylinder number after error
312	000000	ERRHN	0	• Current head number after error
313	000000	ERRSP	0	• Current spindle number after error
314	000000	ERRSN	0	• Current sector number after error
315	000000	LSTCI	0	• Last cylinder number
316	000000	ERLNXT	0	• Next previous error location (E - 1)
317	000000	ERLNX2	0	• Next previous error location (E - 2)
320	000000	STAT0	0	• Status register 0
321	000000	STAT1	0	• Status register 1 (general - reg. 1)
322	000000	STAT2	0	• Status register 2 (track buffer - reg. 1)
323	000000	STAT3	0	• Status register 3 (spindle - reg. 1)
324	000000	ADREG0	0	• Local Memory Address register 0
325	000000	ADREG1	0	• Local Memory Address register 1
326	000000		0	
327	000000		0	

USER TEST MODES UNIQUE TO TEST SECTIONS
(See the individual test sections for more detail)

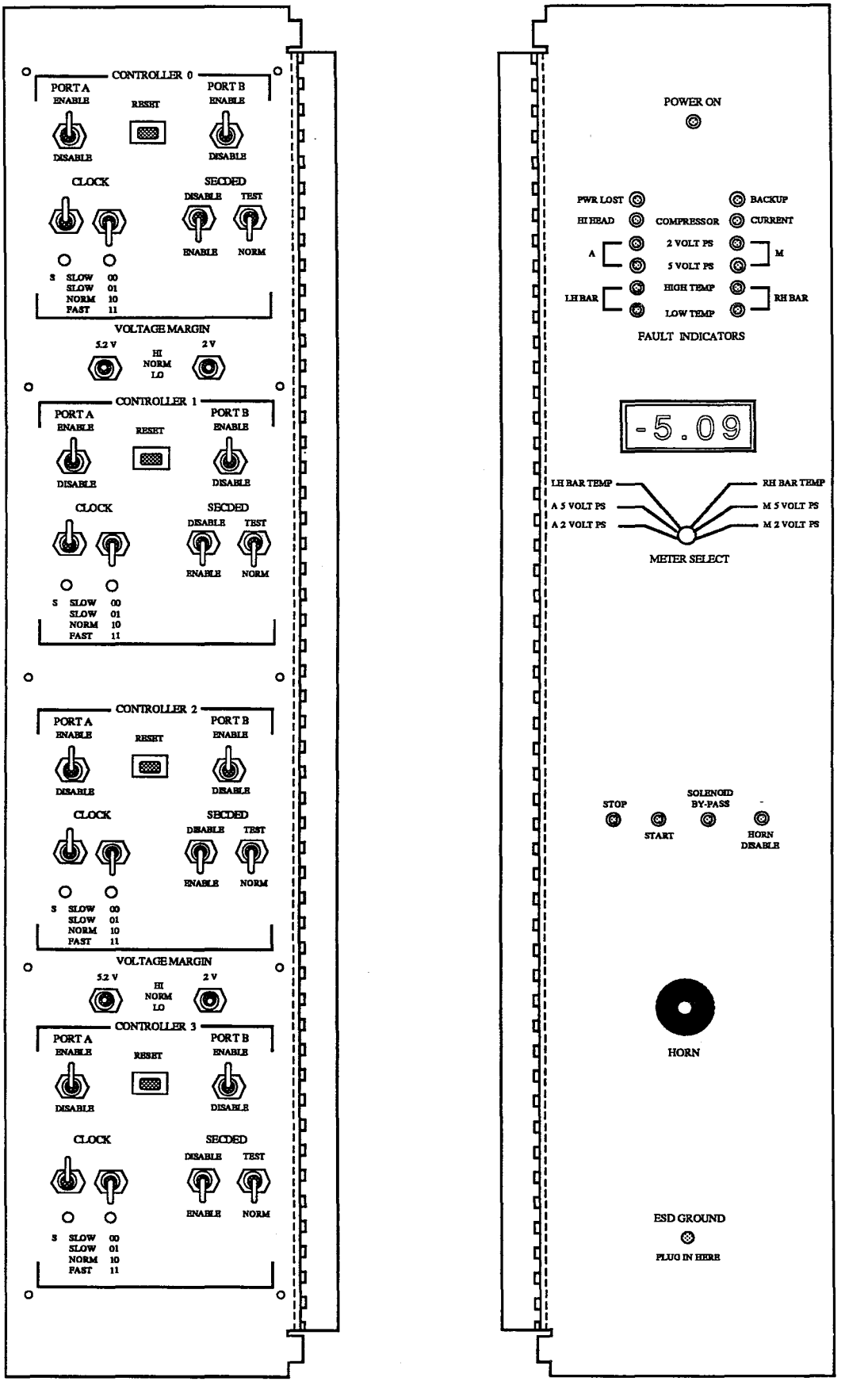
		* ******	SECTION 6	(Track Buffer Memory)
330	125252	BFPT1	125252	• Test data pattern
331	052525	BFPT2	52525	• Test data pattern
		* ******	SECTION 7	(Header reads - seek timing - head address)
332	000044	CDSL7	44	• Condition selector starting / ending
333	000001	FACCRA	1	• Factory track headers or Cray formatted sector IDS • 0 - Factory track headers • 1 - Cray formatted sector IDS (default) • 2 - Seek timing only (no reads)
334	000400	BSCIST	400	• Base cylinder number step
335	002000	RDCT7	2000	• Number of random seeks in condition 4
336	000000	DSPTRA	0	• Display cylinder number
		* ******	SECTION 10	(Connection vector analysis)
337	000044	CDSL10	44	• Condition selector starting / ending
340	000001	WLKINT	1	• Walking one interval (1/16)

DCUS101/82

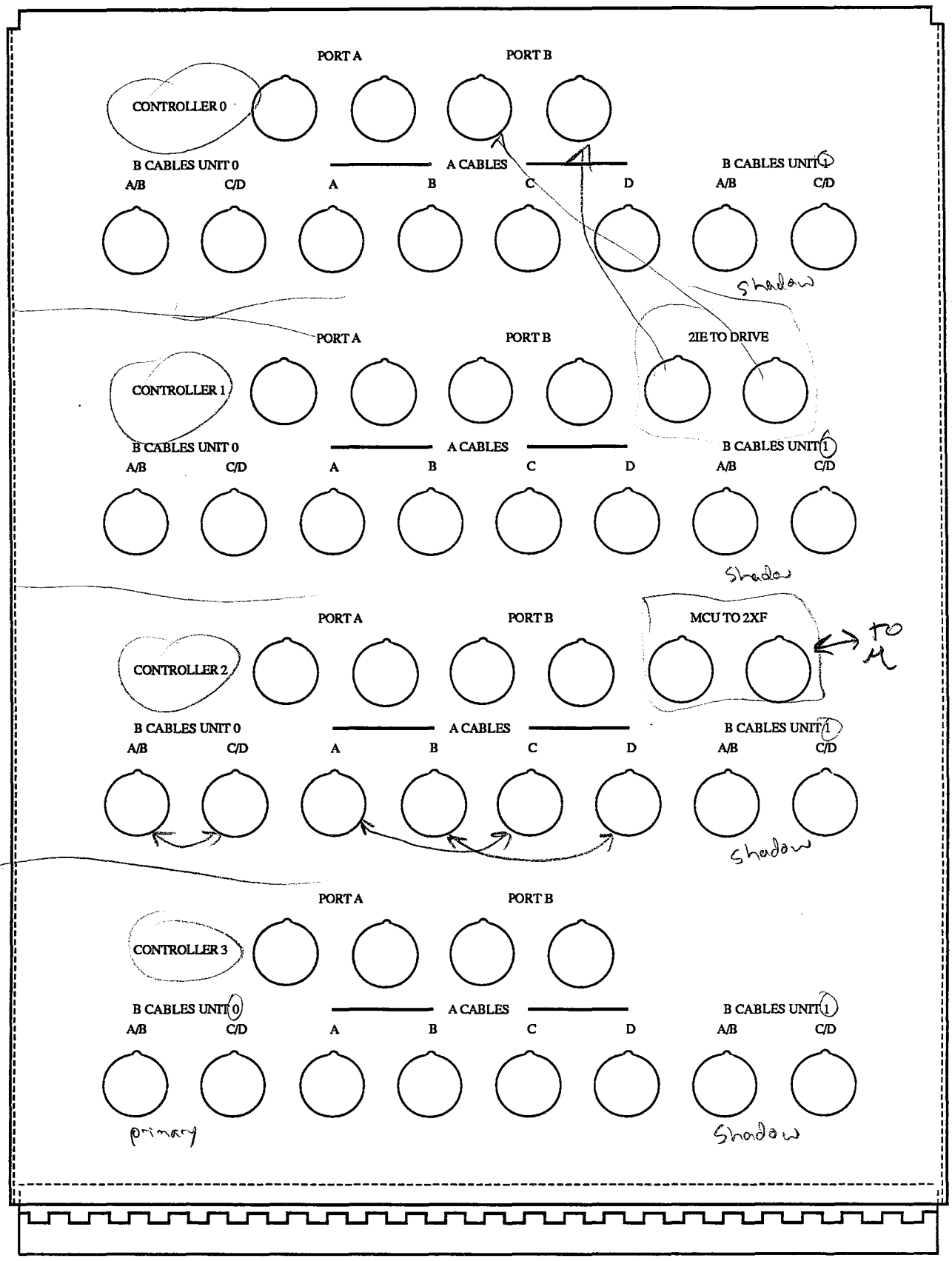
341	000777	UCDTPT	777	• Uncorrectable data pattern (default = 777)
342	002000	RDCVP	2000	• Random correction vector pass count (177777=infinity)
		* ******	SECTION 15	(Chaining - write ahead / read ahead)
343	046000	WTSCTM	46000	• Write sector time in RTC count (220 US)
344	041000	RDSCTM	41000	• Read sector time in RTC count (200 US)
345	000023	RDFSTM	23	• First sector read time (19 MS)
346	000015	WTFLTM	15	• Full 48 sector write time in milliseconds (10560 US)
347	000035	RDFLTM	35	• Full 48 sector read time in milliseconds (9600 US)
350	000550	WTCYTM	550	• Full cylinder write time in milliseconds
351	000570	RDCYTM	570	• Full cylinder read time in milliseconds
		* ******	SECTION 16	(Disk system exerciser)
352	000000	DSEMD	0	• Disk sys. exer. mode (0=I.D. labels , 1=random data)
353	000000	RLOUT	0	• Code rollout - see section 16 for details
		* ******	SECTION 17	(Seek distance / data verification)
354	000013	CDSL17	13	• Condition selector starting / ending
355	000000	ACCSEL	0	• Cylinder access selector scratch / both
356	000040	CYLSKP	40	• Number of cylinders to skip within the selected range
357	000000	DATSEL	0	• Data selector random / user specified
360	125252	OPDAPT	125252	• User specified data pattern
361	000001	PSS17	1	• Number of passes to run this test section
		* ******	SECTION 20	(Flaw table generation)
362	000000	FLAMOD	0	• Flaw table generation mode (factory / Cray)
		* ******	SECTION 21	(Disk formatting)
363	000004	FMTMDE	4	• Format mode (see the formatter section for more detail) • 0 = All IDS are written - replaces flaw table • 2 = Only Cray added IDS are written, merges new flaws • 4 = ID verify only - no writes to the disk
364	000001	VERIFY	1	• Format mode 0 verify Enable; 0 = disable, 1 = Enable
		* ******	SECTION 22	(O.S. flaw table generation)
365	000001	OSFLMD	1	• Mode of operation (seperate / combined)
366	000002	SECNUM	2	• Number of sectors allowed for O.S. table
		* ******	SECTION 23	(Surface analysis)
367	000001	SFAMOD	1	• Surface analysis mode (whole / incremental)
370	000001	PASMOD	1	• Passmode 0 = multiple pass shift counts on all sectors • 1 = multiple pass shift counts on error only
371	000000	HCPRND	0	• Test patterns (test patterns / random numbers)
372	000100	RNDPAS	100	• Number of passes in random number mode
373	000040	PASSHF	40	• Number of shifts to cinsitute one pass
374	000100	SHFCNT	100	• Multiple pass shift count (2 passes - 40 shifts per pass)
375	000002	PATNUM	2	• Number of data pat. par. (to change, double or halve)
376	021225		21225	• Data Pattern

DCUS101/82

377	014714	14714	• Data pattern
400	000000	0	• Spare data pattern location
401	000000	0	• Spare data pattern location
402	000000	0	• Spare data pattern location
403	000000	0	• Spare data pattern location
404	000000	0	• Spare data pattern location
405	000000	0	• Spare data pattern location

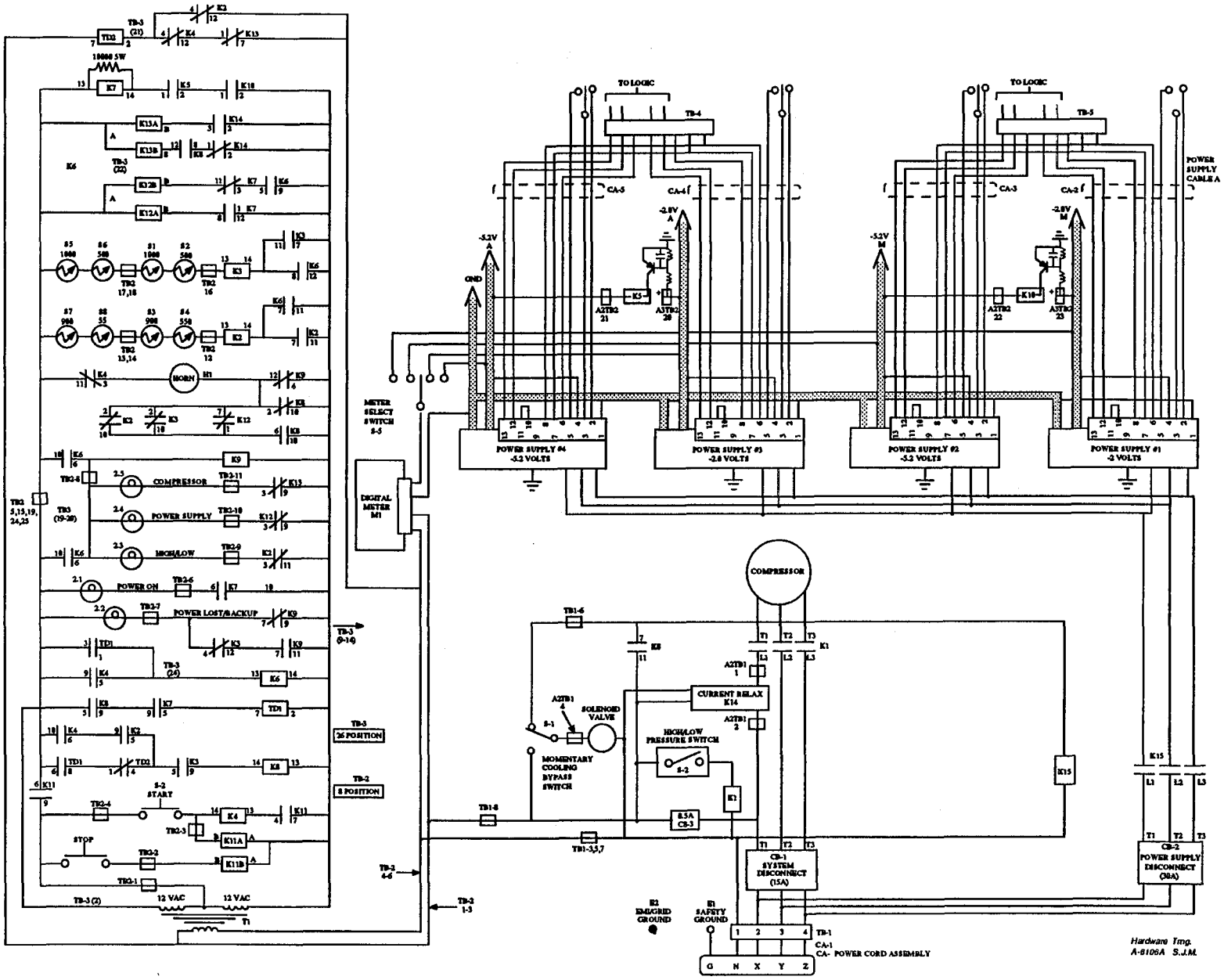


DC-40 MAINTENANCE PANEL



Hardware Tmg.
A-6407 S.J.M.

DC-40 CABLE CONTROL PANEL



DC-40 CONTROL SYSTEM (SERIAL NO. 1 - 9)

DC-40 CONTROL CIRCUIT OPERATION (SERIAL NO. 1 - 9)

Start Sequence

Start switch (S2) latches K11 which then allows 12 volt power to flow to the control circuit. S2 and K11 pull K4.

K4 pulls K6, opens the alarm circuit and opens the condensing unit fault circuit.

K6 pulls K2, K3, and K9 (K2 primary thermostat relay) (K3 back-up thermostat relay) (K9 power lost relay).

K2, K3, and K4 pull K8.

K8 pulls K15 and energizes the refrigeration solenoid and hour meter. Activation of the refrigeration solenoid causes a pressure differential in the refrigeration system which causes the condensing unit to turn on, thus pulling K14.

K14 pulls K13 (condensing unit fault relay).

K15 enables the power supplies which pull K5 and K10.

K5 and K10 pull K7.

K7 activates power on light, latches K12 (power supply fault relay) and K7 and K8 pull TD1.

TD1 holds K6 and K8 and also provides a .5 second ride through for line voltage variations.

After the system starts operation S2 can be released and K4 dropped. K4 then enables the condensing unit fault circuit and the alarm circuit.

Fault Sequence

Power Lost Fault

In the event of a power line sag TD1 provides a .5 second ride through to ensure system stability and prevent nuisance faults.

In the event the power loss lasts longer than .5 seconds TD1 will time out. When power is restored K6, K8, and K9 will be unable to pull, the system will remain shutdown and the power lost lamp will be lit and the alarm will sound.

Condensing Unit Fault

If the current through K14 (condensing unit current sense relay) drops below the holding threshold this will cause K13 (condensing unit fault relay) to drop. K13 will pull TD2 and light the condensing unit fault lamp. After TD2 times out (one minute) K8 drops causing the system to power down and the alarm to sound.

Power Supply Fault

Failure of a power supply will drop K7. K7 then drops TD1, K12 and the power on light. K12 then lights the power supply fault lamp and sounds the alarm. After a .5 second wait K6 and K8 drop causing the system to shut down, but the alarm remains.

Thermostat Fault

A primary thernostat fault drops K2 which will cause TD2 to time out, the temperature fault lamp to illuminate and the alarm to sound. After one minute TD2 drops K8, the system powers down and the alarm remains.

A back-up thermostat fault will drop K3 which lights the back-up temperature light, sounds the alarm, and drops K8 which causes system power down.

Stop Sequence

When stop switch (S1) is pushed K11 unlatches and all 12 volt power is removed from the control circuit.

DC40 REFRIGERATION SYSTEM
WEEKLY CHECKOFF SHEET

Site Name _____
Site S/N _____
DC40 S/N _____

Return completed copy monthly to
Hardware Tech Support, Chippewa Falls.

Properties of Saturated Refrigerant, R-22

Temp.	Press.
10	33
17	40
20	43
23	46
26	50

Temp.	Press.
34	60
41	70
48	81
57	95
65	111

Temp.	Press.
90	168
95	182
100	186
105	211
110	226

	DISCHARGE					SUCTION				MISCELLANEOUS					
Date Checked DD/MM/YY	Pressure	Saturation Temp.	Liquid Line Temp.	Sub-cooling	Hot Gas Temp.	Pressure	Saturation Temp.	Temp.	Super-heat	Water Temp. In	Water Temp. Out	ΔT	Oil Level	LL Glass	Initials
Nominal	170-210	97-110°	See Inst.	5-10°	170-215°	30-60	See Inst.	50-60°	15-20°				1/2	Green	

TEMPERATURE PRESSURE CHART

Vacuum - Inches of Mercury - *Italic Figures*

Pressure - Pounds Per Square Inch Gage - Bold Figures

TEMPERATURE °F.	REFRIGERANT 12	22	500	502	717
-60	*19.0*	*12.0*	*17.0*	*7.2*	*18.6*
-55	*17.3*	*9.2*	*15.0*	*3.8*	*16.6*
-50	*15.4*	*6.2*	*12.8*	*0.2*	*14.3*
-45	*13.3*	*2.7*	*10.4*	1.9	*11.7*
-40	*11.0*	0.5	*7.6*	4.1	*8.7*
-35	*8.4*	2.6	*4.6*	6.5	*5.4*
-30	*5.5*	4.9	*1.2*	9.2	*1.6*
-25	*2.3*	7.4	1.2	12.1	1.3
-20	0.6	10.1	3.2	15.3	3.6
-18	1.3	11.3	4.1	16.7	4.6
-16	2.0	12.5	5.0	18.1	5.6
-14	2.8	13.8	5.9	19.5	6.7
-12	3.6	15.1	6.8	21.0	7.9
-10	4.5	16.5	7.8	22.6	9.0
- 8	5.4	17.9	8.8	24.2	10.3
- 6	6.3	19.3	9.9	25.8	11.6
- 4	7.2	20.8	11.0	27.5	12.9
- 2	8.2	22.4	12.1	29.3	14.3
0	9.2	24.0	13.3	31.1	15.7
1	9.7	24.8	13.9	32.0	16.5
2	10.2	25.6	14.5	32.9	17.2
3	10.7	26.4	15.1	33.9	18.0
4	11.2	27.3	15.7	34.9	18.8
5	11.8	28.2	16.4	35.8	19.6
6	12.3	29.1	17.0	36.8	20.4
7	12.9	30.0	17.7	37.9	21.2
8	13.5	30.9	18.4	38.9	22.1
9	14.0	31.8	19.0	39.9	22.9
10	14.6	32.8	19.7	41.0	23.8
11	15.2	33.7	20.4	42.1	24.7
12	15.8	34.7	21.2	43.2	25.6
13	16.4	35.7	21.9	44.3	26.5
14	17.1	36.7	22.6	45.4	27.5
15	17.7	37.7	23.4	46.5	28.4
16	18.4	38.7	24.1	47.7	29.4
17	19.0	39.8	24.9	48.8	30.4
18	19.7	40.8	25.7	50.0	31.4
19	20.4	41.9	26.5	51.2	32.5
20	21.0	43.0	27.3	52.4	33.5
21	21.7	44.1	28.1	53.7	34.6
22	22.4	45.3	28.9	54.9	35.7
23	23.2	46.4	29.8	56.2	36.8
24	23.9	47.6	30.6	57.5	37.9
25	24.6	48.8	31.5	58.8	39.0
26	25.4	49.9	32.4	60.1	40.2
27	26.1	51.2	33.2	61.5	41.4
28	26.9	52.4	34.2	62.8	42.6
29	27.7	53.6	35.1	64.2	43.8
30	28.4	54.9	36.0	65.6	45.0
31	29.2	56.2	36.9	67.0	46.3
32	30.1	57.5	37.9	68.4	47.6
33	30.9	58.8	38.9	69.9	48.9
34	31.7	60.1	39.9	71.3	50.2
35	32.6	61.5	40.9	72.8	51.6
36	33.4	62.8	41.9	74.3	52.9
37	34.3	64.2	42.9	75.8	54.3
38	35.2	65.6	43.9	77.4	55.7
39	36.1	67.1	45.0	79.0	57.2
40	37.0	68.5	46.1	80.5	58.6
41	37.9	70.0	47.1	82.1	60.1
42	38.8	71.4	48.2	83.8	61.6
43	39.8	73.0	49.4	85.4	63.1
44	40.7	74.5	50.5	87.0	64.7
45	41.7	76.0	51.6	88.7	66.3
46	42.6	77.6	52.8	90.4	67.9
47	43.6	79.2	54.0	92.1	69.5
48	44.6	80.8	55.1	93.9	71.1
49	45.7	82.4	56.3	95.6	72.8
50	46.7	84.0	57.6	97.4	74.5
55	52.0	92.6	63.9	106.6	83.4
60	57.7	101.6	70.6	116.4	92.9
65	63.8	111.2	77.8	126.7	103.1
70	70.2	121.4	85.4	137.6	114.1
75	77.0	132.2	93.5	149.1	125.8
80	84.2	143.6	102.0	161.2	138.3
85	91.8	155.7	111.0	174.0	151.7
90	99.8	168.4	120.6	187.4	165.9
95	108.2	181.8	130.6	201.4	181.1
100	117.2	195.9	141.2	216.2	197.2
105	126.6	210.8	152.4	231.7	214.2
110	136.4	226.4	164.1	247.9	232.3
115	146.8	242.7	176.5	264.9	251.5
120	157.6	259.9	189.4	282.7	271.7
125	169.1	277.9	203.0	301.4	293.1
130	181.0	296.8	217.2	320.8	——
135	193.5	316.6	232.1	341.2	——
140	206.6	337.2	247.7	362.6	——
145	220.3	358.9	264.0	385.0	——
150	234.6	381.5	281.1	408.4	——
155	249.5	405.1	298.9	432.9	——

DC/DD-40 LAB SKILLS LIST

NAME: _____ DATE: _____

HOW A	HOW B	HOW C	*COMPONENT REPLACEMENT*	LEVEL
			MODULE (HDA)	
			POWER SUPPLY	
			I/O CARD (VJX)	
			R/W CARD (WNX)	
			DRIVE	
			DRIVE BELT	
			BRAKE	
			CONTROL CARD VDX	
			POWER AMP UCX	
			OPERATOR PANEL PBX	
			FAULT DISPLAY UQX	
			FILTER REPLACEMENT	
			FAN	
			MOTOR	
			HDA INTERFACE	
			RELAY BOARD	
			MOTHER BOARD	
			REGULATOR BOARD	

DC-40 DIAGNOSTIC

Circle test sections used during lab. 0 1 2 3 4 5 6 7 10 11 12 13 14 15 16 17 21 22 23 24

			FORMATTER	
			SURFACE ANALYSIS	
			WRITE O.S. FLAW TABLE	

OTHER

			ADD/REMOVE FREON FROM THE REFRIG. SYSTEM	
			READY FOR SHIPPING/INSTALLATION	
			VOLTAGE MEASUREMENT	
			RUN DIAGNOSTICS FROM CE PANEL	
			MAINTENANCE PANEL	
			REFRIGERATION ADJUSTMENTS	
			CONNECT OFFLINE TESTER	
			REPLACE A MODULE POWER SUPPLY	
			PERFORM ADJUSTMENTS ON POWER SUPPLY	
			SCOPE SECTOR	
			XMD VOLTAGE MEASUREMENT	
			VOLTAGE ADJUSTMENT	
			CHECK OUT DRIVE FROM OFFLINE TESTER	
			WRITE A PROGRAM USING MICRO DOTS	

COMMENTS: _____

_____

KEY:

	A	B	C
HOW	Shown or Video	Lecture or Theory	Performed

LEVEL Excellent - 5 Above Average - 4 Average - 3 Below Average - 2 Unsatisfactory - 1 Not Apply - N/A

Student's Signature _____

Instructor's Signature _____

If you sign this sheet, you are responsible on site for this task.

MF02W09A

HOW TO INSTALL AND USE THE MIX EDITOR

The following information can be used to set up your version of the MIX editor for your terminal type along with a few steps to get you started using the MIX editor.

The first thing that must be done is to have the file "SETUP.EDT" built for your terminal characteristics. If you happen to have either a Dialog-80, Dialog-150 and/or an Ampex 230 (emulating a D-150) the steps below should work. First, place the MIX diskette into one of the floppy drives and select that drive.

1. Type SETEDIT <cr> - A menu will be displayed

2. Type T <cr> - A new menu will be displayed on which will be several terminal types

3. Type 7 <cr> - This will select terminal type D-80 which is the closest to correct as any others. It will return to the main menu

4. Type R <cr> and at the message asking for the filename type MACRO.TXT <cr> - This will add the macro file to the terminal characteristics already there

5. Type O <cr> - The letter, not the number. At the filename request type TEMP.TXT - This will write the text file you have just built out to diskette.

6. Type E <cr> to exit SETEDIT. A message will ask if you want to create an edit file, type N <cr>

Now comes the tricky part. Go back to drive A: and

7. PIP TEMP.TXT to the A drive of the hard disk

8. With the use of some other text editor (ED or whatever), the eigth line must be modified. As it stands now, it reads "CURSOR COLROW". It must be changed to read "CURSOR ROWCOL"

9. Now that the text file has been corrected and resaved, it must be converted to binary and renamed. To do this:

10. PIP TEMP.TXT back to the MIX diskette and select the floppy drive

11. Type SETEDIT (cr) - This will get the main menu

12. Type R <cr> and at the filename request type TEMP.TXT - It will read in the corrected text file

13. Type W <cr> and at the filename request type SETUP.EDT - This will save it as a binary file useable by the editor

14. Type E <cr> - To exit

Hardware Trng.
DC4004/118 S.J.M.

Now that you have a correct version of the terminal information on the diskette, you can begin to edit. There are three files on the diskette that need to be present on the hard disk as you edit. They are EDIT.COM, EDIT.OVY, and SETUP.EDT. You can start to edit by simply typing:

EDIT (filename)

If you are creating a new file there is no need for the filename.

A message will appear saying "Reading setup file...". When it is finished an EOB* will appear, this is the end of block marker. You are now in the insert mode and ready to start typing. The keyboard is set up to be WordStar compatable; but as you learn more about this you will find it can be modified to be any way you want it.

If you are not familiar with this type of editor, on the following pages is a partial list of the command with a very brief description (kind of a ready reference) to help you get started. It is in no way complete.

To save your file and exit the editor hit the escape key and then an E. The prompt will appear requesting a filename. If the file already has a name simply hit return or else give the file a name. Then a prompt requesting a backup will appear. If you want a backup hit return. If you don't, type N and return. If you want to quit the editor without saving the file type ESCAPE followed by a Q. It will ask for a confirmation.

Again, if you have any questions or problems, contact the Diagnostics Department at (715) 723-2206. (Technical Operations Building, Chippewa Falls, WI)

A^ is the control key, it should be held down while typing the other specified key(s).

A^[is the escape key. By depressing the escape key you enter the command mode. The cursor will drop to the bottom left corner and display a < >. Command mode's full usage is explained in the book beginning on page 31.

COMMAND	DESCRIPTION
^S	Moves the cursor left one position
^A	Moves the cursor left one word
^QS	Moves the cursor to the beginning of the line
^D	Moves the cursor right one position
^F	Moves the cursor right one word
^QD	Moves the cursor to the end of the line
^E	Moves the cursor up one position
^QE	Moves the cursor to the top of the page
^R	Moves the cursor up one page
^X	Moves the cursor down one position
^QX	Moves the cursor to the bottom of the page
^C	Moves the cursor down one page
^W	Scrolls the screen up one line (does not move the cursor)
^Z	Scrolls the screen down one line (does not move the cursor)
^G	Deletes a character under the cursor
DEL key	Deletes the character to the left of the cursor
^T	Deletes word
^QY	Deletes from the cursor to the end of line
^Y	Deletes line
^U	Undoes the line deleted by ^Y (can be used to move a line)
^QT	Undoes the word deleted by ^T
^QL	Undo whatever changes were made to this line
^QJ	Joins the following line with this line
^V	Toggles insert mode on and off
^QI	Toggles auto indent on and off
^N	Insert one new line
^QN #	Inserts # number of lines
^KB	Marks the beginning of the block
^KK	Marks the end of the block
^KV or KM	Moves the block
^KC	Copies the block
^KY	Deletes the block
^KW	Writes the block to file
^KR	Reads the block from file
^KL	Makes all characters in the block lower case
^KU	Makes all characters in the block upper case
^KP	Prints block

^KO	Outputs the block to temporary file
^KI	Inputs the block from temporary file
^[SS	Split screen - it will ask for row to split horizontally, if no # is specified, it will ask for column
^O	Other screen - toggles between the split screens
^I or TAB key	Tabs right four spaces
^B	Tabs left four spaces
^[DT	Deletes tabs
^[TS	Sets tab at cursor position
^[TC	Clears tab at cursor position
^[TB #	Sets tabs at # intervals
^[TABS = #, #, #	Sets tabs at colums #, #, and #
^[LN	Toggles line numbers (do not become part of file)
^[AL	Auto line numbers that stay in file (useful for BASIC)
^KX	Saves the present file and exits the editor
^KS	Saves the present file but continues editing it
^KD	Saves the present file and creates a new file in the editor
^KQ	Quits with no save and stays in the editor
^KF	Lists the directory specified as directory path
^KJ	Deletes the file specified by filename
^KE	Writes lines to file filename
^QF	Find string - a prompt will ask for the string to find
^L	Finds the next occurance of the previously defined string
^QA	Find and replace - a prompt will ask for the string to find, then the string to replace it. When it finds a match, it will ask Replace? y/n/q. A y will replace, a n will not replace, and the search will continue until a q is typed.
^QV	Will return the cursor to the position it had prior to any of these instructions

CONTROL RELAY FUNCTIONS (SERIAL NO. 1 - 9)

K1 - Condensing unit contactor, controlled by high/low pressure switch.

K2 - Pulled by K6, self-latching, controlled by primary "T" stats, 4 sets of contacts.
A = Self-latch and temperature light B = Alarm circuit C = K8 pull D = TD2 pull

K3 - Pulled by K6, self-latching controlled by secondary "T" stats, 4 sets of contacts.
A = Self-latch B = Alarm circuit C = K8 pull and latch circuit
D = Power lost light circuit

K4 - Momentary, controlled by start switch and K11, 4 sets of contacts.
A = TD2 pull circuit B = K6 pull C = K8 pull D = Alarm power

K5 - Pulled by "A" power supplies, 1 set of contacts in K7 pull.

K6 - Pulled by K4, latched by TD1, 4 sets of contacts.
A = K9 pull B = K13B pull C = K3 pull D = K2 pull

K7 - Pulled by K5 and K10, 4 sets of contacts.
A = TD1 pull B = K12A pull C = K12B pull D = Power on light

K8 - Pulled by K4, K2, and K3, latched by TD1, TD2, and K3, 4 sets of contacts
A = Pull K15, energize solenoid and H.M. B = Pull TD1 C = Pull K12B
D = Alarm circuit

K9 - Pulled by K6, self-latching, 4 sets of contacts.
A = Self-latch B = Alarm circuit C = Power lost light D = Power lost light

K10 - Pulled by "M" power supplies, 1 set of contacts in K7 pull.

K11 - Latched by start switch, unlatched by stop switch, 2 sets of contacts.
A = K4 pull B = Passes power for all other circuit components

K12 - Latched by K7, unlatched by K7 and K6, 2 sets of contacts.
A = Alarm circuit B = Power supply light

K13 - Latched by K14, unlatched by K8 and K14, 2 sets of contacts.
A = Pull TD2 B = Condensing unit light

K14 - Latched and unlatched by flow of current to condensing unit. 1 set of contacts.
A = Latch K13 B = Unlatch K13

K15 - Pulled by K8, 3 sets of contacts used to supply power to power supplies.

TDR1 - Pulled by K8 and K7, 2 sets of contacts, delay on drop.
A = Holds K6 B = Part of hold for K8

TDR2 - Pulled by K2 or K13 and K4, 2 sets of contacts, delay on pull.
A = Part of K8 hold B = Not used

Hardware Trng.
DC4004/123 S.J.M.

2. DD-40 DRIVES

The DD-40 disk storage unit (sometimes called a drive) contains 4 XMD spindles (sometimes called spindles). This section provides the following information on the XMD spindles:

- A description of the XMD spindles
- The XMD switches and indicators
- XMD power-on and power-off procedures
- Drive address selection
- Drive head selection

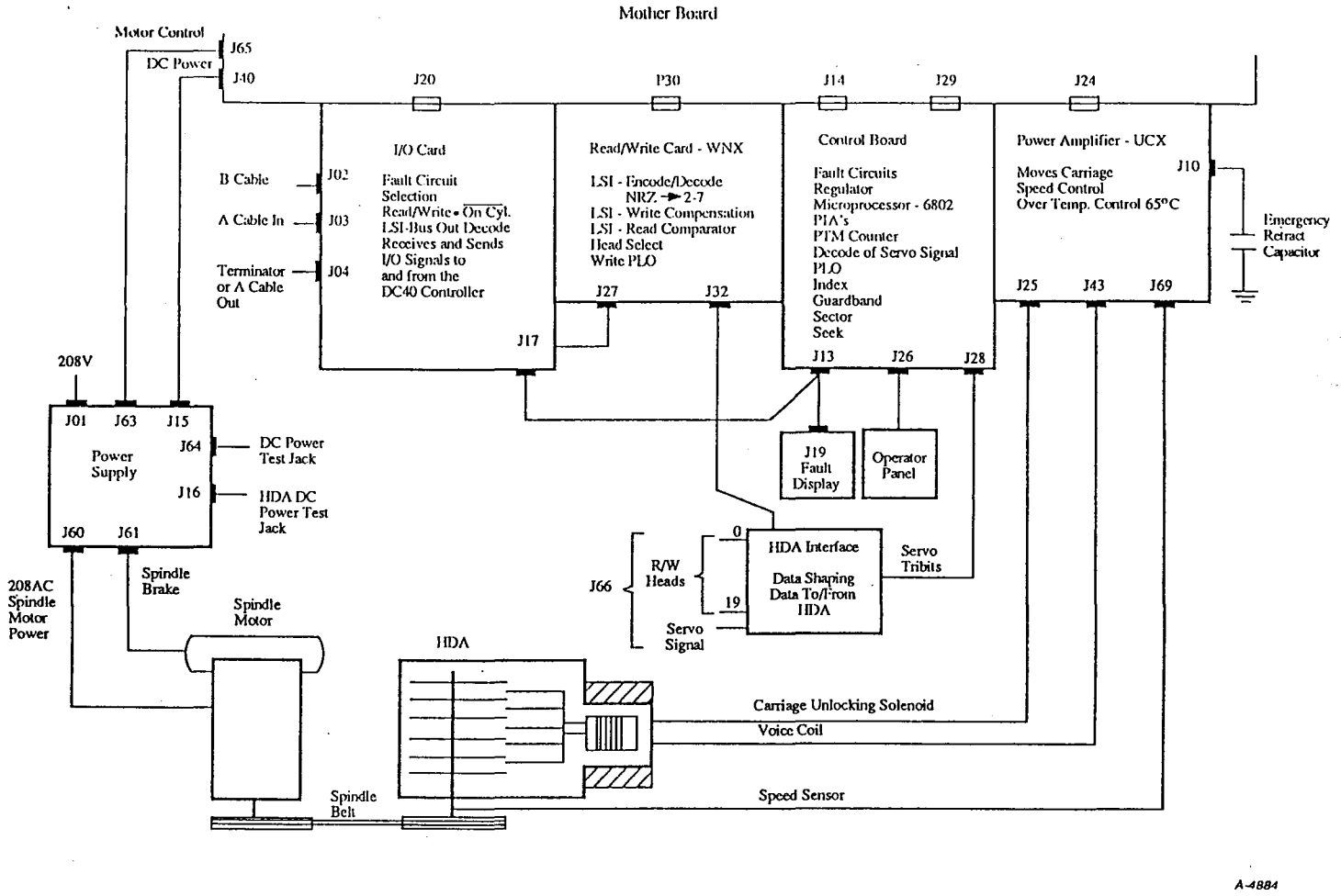
2.1 DESCRIPTION

Each XMD spindle controls reading and writing of data to 6 disks. Data is read and written across 19 heads which ride on the surface of the disks. The DD-40 drive has an internal power supply, which receives its input power from the site's main power source.

Figure 2-1 is a block diagram of an XMD spindle.

The DD-40 drives operates under direction of the DC-40 disk controller. The DC-40 communicates with the DD-40 drive by way of an interface consisting of a number of I/O lines. Some of the interface lines (e.g., those that carry commands to the drive) are not enabled if the drive is not selected by the DC-40. Unit selection enables the DC-40, which can be connected to more than one drive, to initiate and direct an operation on a specific drive.

All operations performed by the drive are related to reading and writing data. Writing and reading data is performed by heads, which are positioned over the recording surfaces of the rotating disks. There are 2 heads for each disk surface. The heads are positioned in such a way that data is written in concentric tracks around the disk surfaces. Before any read or write operation can be performed, the DC-40 must instruct the drive to position the heads over the desired tracks (called seeking) and use the head located over the surface where the operation



2-1. XMD Block Diagram

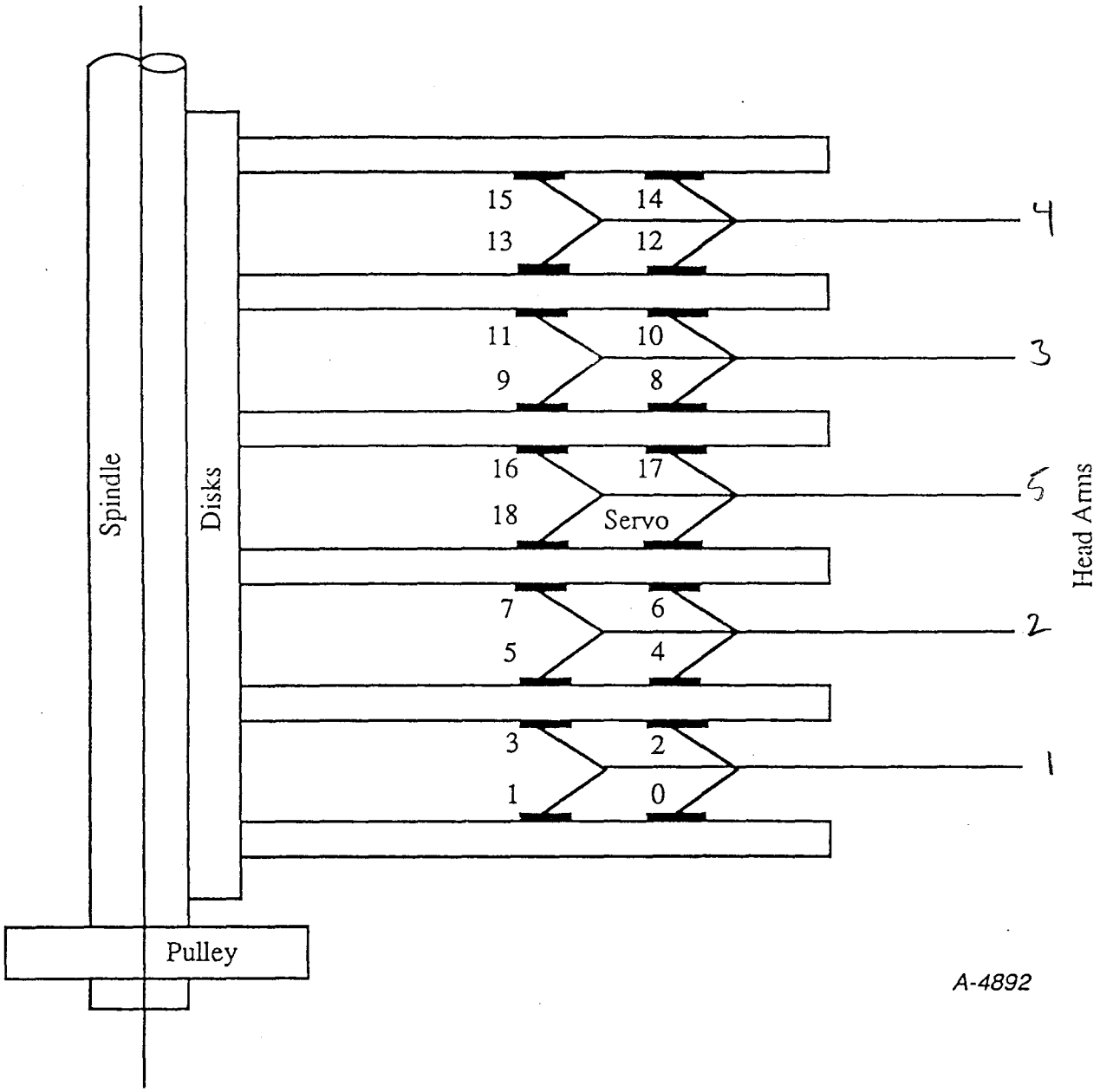


Figure 2-2. XMD Drive Head/Disk Relationship

will be performed (called head selection). An XMD spindle has 19 data heads and one servo head. Figure 2-2 shows the relationship of the heads to the disks for an XMD spindle.

After selecting a head and arriving at the correct data track, the portion of the track where the data will be written or read must be located. This is called track orientation and is done by using the Index and Sector signals generated by the spindle. The Index signal indicates the logical beginning of each track. The Sector signal indicates the position of the head on the track with respect to the index.

When the desired location is reached, the DC-40 commands the spindle to read or write data. During a read operation, the spindle recovers data from the disks and transmits it to the controller. During a write operation, the spindle receives data from the controller, processes it, and writes it on the disks.

The spindle is capable of recognizing fault conditions that may occur during its operation. When a fault condition is detected, it is indicated by a fault signal to the DC-40 and by a maintenance indicator on the XMD spindle itself.

Table 2-1 lists the specifications of the XMD spindles.

Table 2-1. XMD Spindle Specifications.

Characteristic	Specification
Size	
Height	26.4 cm (10.3 in)
Width	48.0 cm (18.9 in)
Length	76.5 cm (30.1 in)
Weight	80.1 kg (176 lbs)
Interface	
SMD-O/SMD-E	
Recording	
Total Capacity (unformatted)	
PA1A4/1A5 xmd2	858 Mbytes
PA1A6/1A7 xmd3	1359 Mbytes
Bytes per track	50,400 bytes

Table 2-1. XMD Spindle Specifications (continued)

Characteristic	Specification
Number of disks:	
850 Mbytes	5
1350 Mbytes	6
Movable data heads:	
850 Mbytes	16
1350 Mbytes	19
Servo heads	1
Tracks per inch:	
850 Mbytes	960
1350 Mbytes	1280
Physical heads per surface	2
Logical cylinders per head/disk assembly:	
850 Mbytes	1064 (0 through 1063)
1350 Mbytes	1420 (0 through 1419)
Transfer rate	
Disk speed at 3600 rpm	24.2 MHz (3,025,000 bytes/s)
Latency	
Average	8.33 ms (disk rotation speed at 3600 rpm)
Maximum	17.3 ms (disk rotation speed at 3474 rpm)
Recording	
Mode	2 through 7 code
Density	15,400 bpi (inner track)
Seek Time	
Full	30 ms

Table 2-1. XMD Spindle Specifications (continued)

Characteristic	Specification
Average	16 ms
Single track	5 ms maximum
Start Time	3 minutes 30 seconds maximum (not including power sequence delay determined by unit address in string)
Stop time	
Start switch OFF	30 seconds maximum
Power loss	30 seconds maximum

2.2 XMD SPINDLE SWITCHES AND INDICATORS

Table 2-2 lists the XMD spindle switches and indicators. Figure 2-3 shows where the switches and indicators are located on an XMD spindle.

Table 2-2. XMD Spindle Switches and Indicators Functions

Switch/Indicator	Function
	POWER SUPPLY REAR PANEL
CB1 (ON/OFF) circuit breaker	Applies site AC power to the fan and the internal power supply, which supplies the DC operating voltages to the spindle electronics.

Table 2-2. XMD Spindle Switches and Indicators Functions (continued)

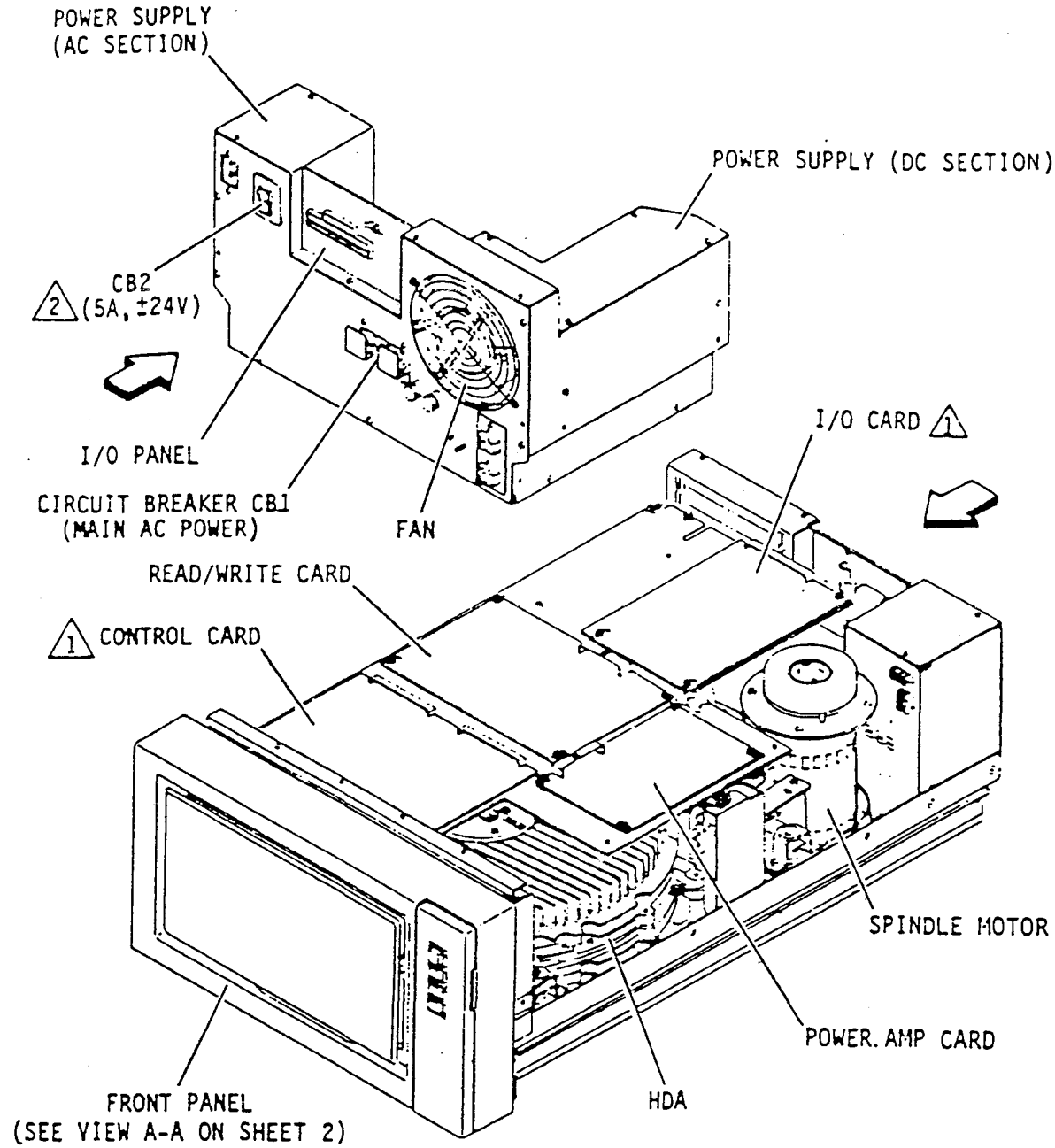
Switch/Indicator	Function
	The ±5 V supplies are protected by current limiting circuitry in the power supply.
CB2 (±24 V) circuit breaker	Protects the voice coil in the module from overheating caused by failure of the power amplifier board.
	FRONT PANEL
Logic plug/unit selected indicator	The logic plug activates switches that establish the logical address of the device. A logic plug, numbered 0, is included with each unit, and logic plugs, numbered 1 through 15, are available as options. The unit selected indicator is lit if the spindle is selected.
START switch/ready indicator	The START switch has alternate action, in for start and out for stop, and it contains the ready indicator. Pressing the START switch to the start position activates the power-up sequence, and the ready indicator flashes until the disks are up to speed, the heads are loaded, a stabilization period has elapsed, and there are no fault conditions. The ready indicator is on steady with power up complete. Pressing the START switch to release it from the start position causes the ready indicator to flash for 30 seconds.
FAULT indicator/fault clear switch	The FAULT indicator is inside the fault clear switch, and it lights if a fault exists within the spindle. It is turned off by any of the following (provided that the error condition or conditions no longer exist):

Table 2-2. XMD Spindle Switches and Indicators Functions (continued).

Switch/Indicator	Function
	• Pressing the fault clear switch • Fault clear command from the controller • Reapplying ac power to the spindle
WRITE PROTECT switch/ indicator	The operation of the WRITE PROTECT switch, or installing the write protect plug on the control board, places the spindle in the write protected mode (preventing write operations) and lights the WRITE PROTECT indicator.
	CONTROL BOARD
Sector select switches	Allows the disk to be divided into segments or sectors. The switch settings determine the number of sectors per track.
	FAULT/STATUS DISPLAY BOARD
First seek indicator	Indicates that the spindle failed the first seek/load attempt.
R/W•OC indicator	Indicates a read or write condition occurred during a seek operation (an off-cylinder condition).
WRT indicator	Indicates that a write fault occurred.
RD•WRT indicator	Indicates that a read and a write command existed simultaneously.
VOLT indicator	Indicates a below normal voltage existed.
HD SEL indicator	Indicates a multiple head selected fault has occurred.
Diagnostic mode indicator	Indicates that the spindle is in diagnostic mode (green LED).

Table 2-2. XMD Spindle Switches and Indicators Functions (continued).

Switch/Indicator	Function
Diagnostic mode switch	Places the spindle in diagnostic mode and disables the I/O.
Diagnostic execute switch	Starts and stops diagnostic tests.
Diagnostic step switch	Selects individual diagnostic tests.
Diagnostic/servo fault display	When a spindle is in diagnostic mode, the display indicates which diagnostic test is being initiated. If a failure occurs, the status code display indicates which major assembly or assemblies are the most likely cause of the problem. When a spindle is not in diagnostic mode, the display indicates error status code generated by the microprocessor.
	I/O BOARD
DEVICE ID switches	Provide a device type status code. Switch settings determine a device ID code that conforms to individual customer requirements.
I/O OPTIONS switches	Allow selection of specific I/O options. Switch settings determine which options are enabled.



NOTES:

1. SWITCHES LOCATED ON CIRCUIT BOARDS ARE ILLUSTRATED IN SECTION 3.
2. PROTECTS VOICE COIL IN MODULE.

Figure 2-3. XMD Spindle Switches and Indicators (Sheet 1 of 2)

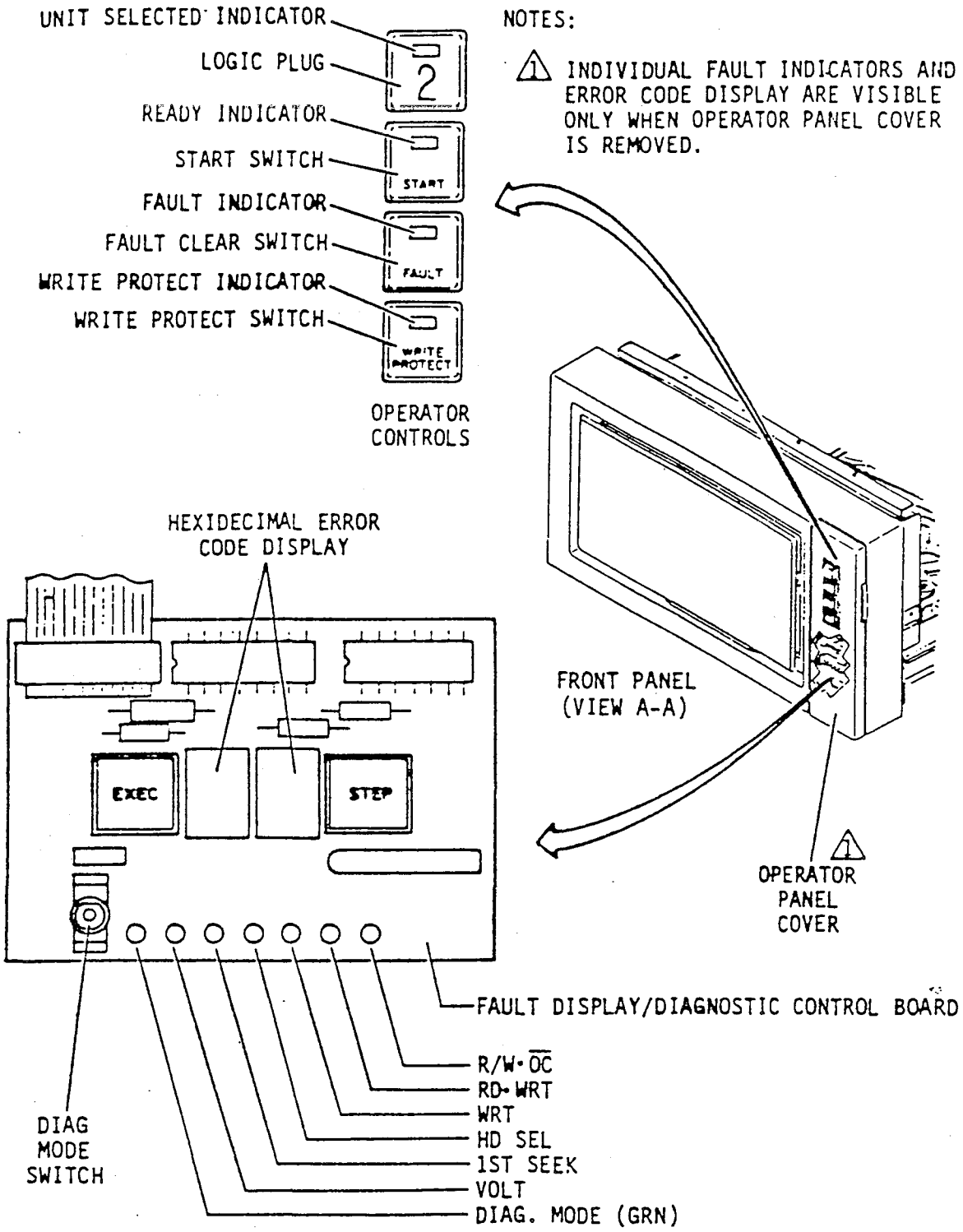


Figure 2-3. XMD Spindle Switches and Indicators (Sheet 2 of 2)

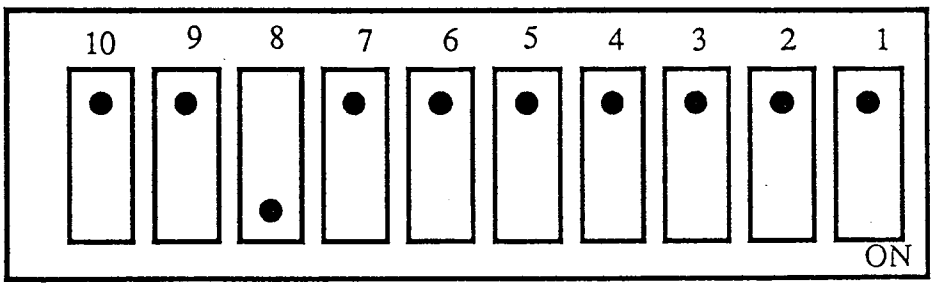
I/O BOARD SWITCH SETTINGS

On the NO board, there are two sets of switches. The set of switches at location E103 is for setting a device I.D. but is unused for drives in the DD40. The other set of switches located at C503 is used to select the I/O options. The following table gives the switch numbers (1-10) along with the switch I.D., the position of each switch and a description of the option used in the DD40. All switches are in the "OFF" position except switch number 8 which is "ON" to select the extended cylinder addressing.

SWITCH SETTINGS FOR I/O OPTIONS

Switch Number	Switch I.D.	Description of I/O Options used in the DD40
1	1A	OFF - Index & Sector in Channel 1, A Cable
2	1B	OFF - Index & Sector in Channel 1, B Cable
3	2A	OFF - Index & Sector in Channel 2, A Cable (Not Used)
4	2B	OFF - Index & Sector in Channel 2, B Cable (Not Used)
5	1D	OFF - Channel 1 Enabled
6	2D	OFF - Channel 2 Enabled (Not Used)
7	SO	OFF - Extended SMD Mode
8	XA	ON - Extended Cylinder Addressing
9	AR	OFF - Absolute Reserve Mode
10	RL	OFF - Remote Power Up

Located at C503



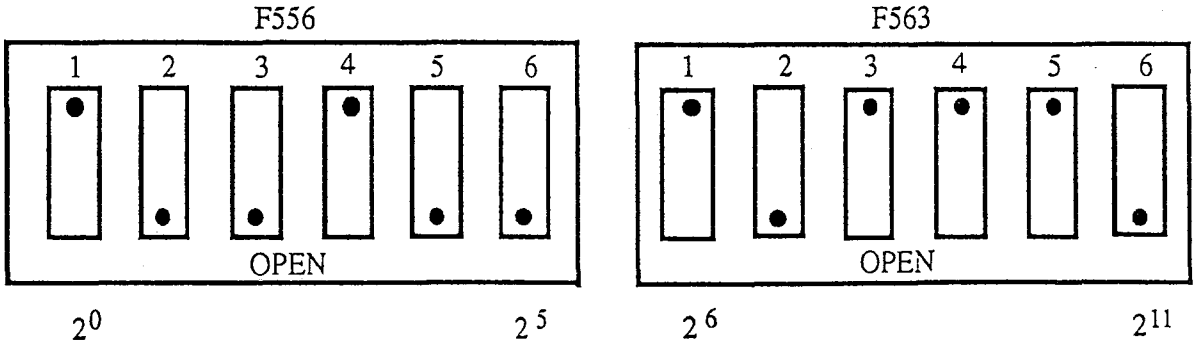
Hardware Trng.
DC4004W100M S.J.M .

The sector switches are located on the control board and are set to predetermined value to provide 12 sectors per revolution. The following table shows the location of the two switch packages on the control board, F556 and F563. It also gives the desired number of sectors in the left most column followed by the setting for each of the individual switches. Each switch is represented by either a C for closed or an O for open.

The switches preset a byte counter. The counter is incremented by each servo byte until it reaches a value of 4095 when it is preset again. Each servo byte is equal to 2.25 data bytes. The switches are shown in the following figure. Bit 2^0 is the left most switch and bit 2^{11} is the right most switch.

SECTOR SELECT SWITCH SETTINGS

Number of Sectors	Location F556 Switch Number						Location F563 Switch Number					
	1	2	3	4	5	6	1	2	3	4	5	6
6	O	O	C	O	C	O	O	C	O	C	C	C
7	C	C	C	C	C	C	C	O	O	O	C	C
8	C	C	C	C	O	C	C	C	O	C	O	C
9	C	C	C	O	C	C	O	C	C	O	O	C
10	C	C	C	C	C	C	O	C	O	O	O	C
11	C	C	O	O	C	C	C	C	C	C	C	O
12	C	O	O	C	O	O	C	O	C	C	C	O
13	O	C	O	C	C	C	O	C	O	C	C	O
14	C	C	C	C	C	C	O	O	O	C	C	O
15	O	O	C	O	C	O	C	C	C	O	C	O



SECTOR SWITCHES

POWER ON INITIALIZATION

The power on initialization is the process the drive goes through from the time power is applied until the drive is waiting for start conditions.

For power on initialization to occur, both CB1 and CB2 must be on to provide AC and DC power to the drive. Until the +5V reaches 4.9V, the drive Master clear signal is active which resets the sector count and disables the Interface Card.

When drive power reaches its desired level there is a 3 ms. delay, after which the MPU starts three self tests. These tests are:

-A check of the MPU firmware instructions.

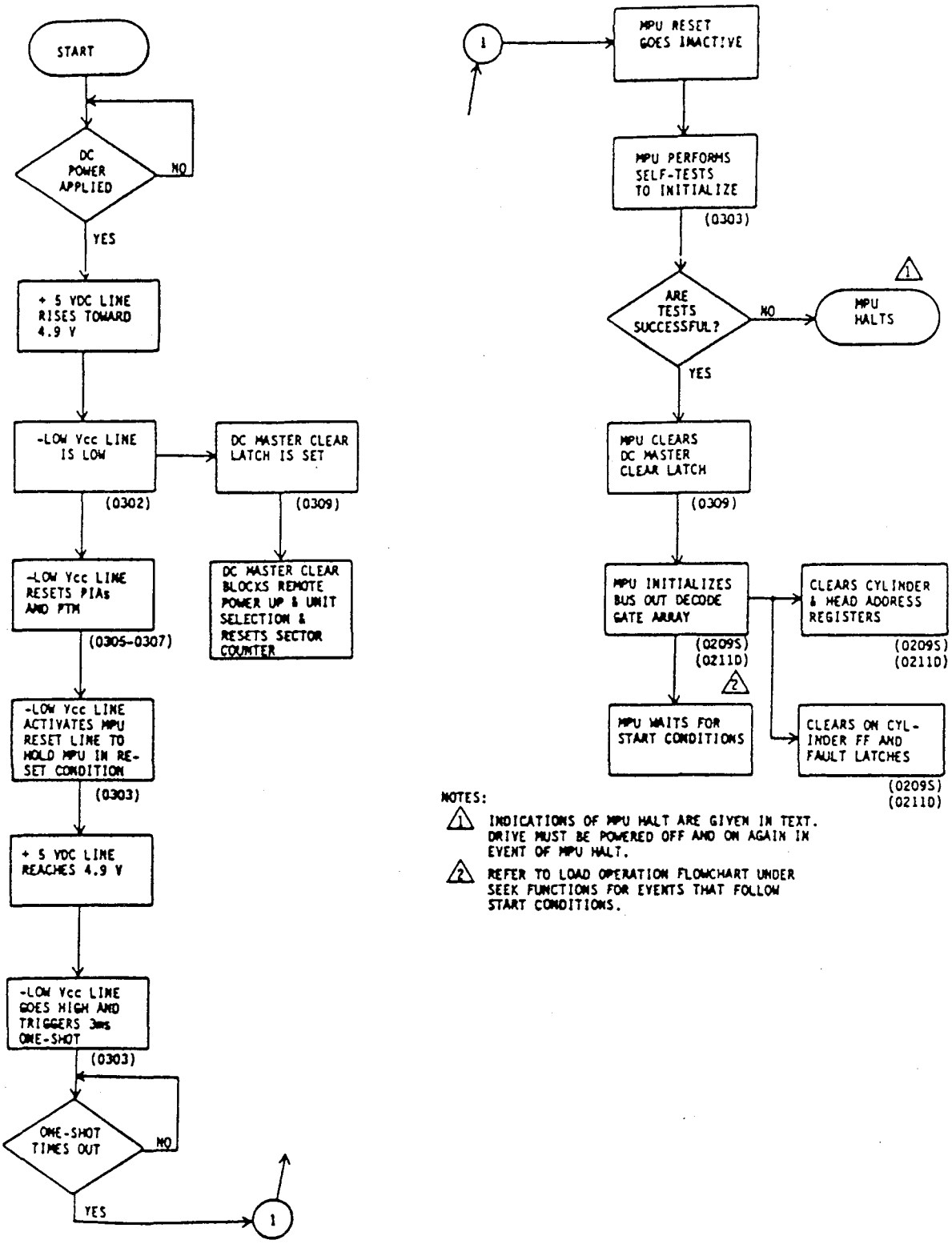
-Writing to and reading from the RAM.

-The MPU sends data to the peripheral interface adapters (PIA) and reads it back to initialize them.

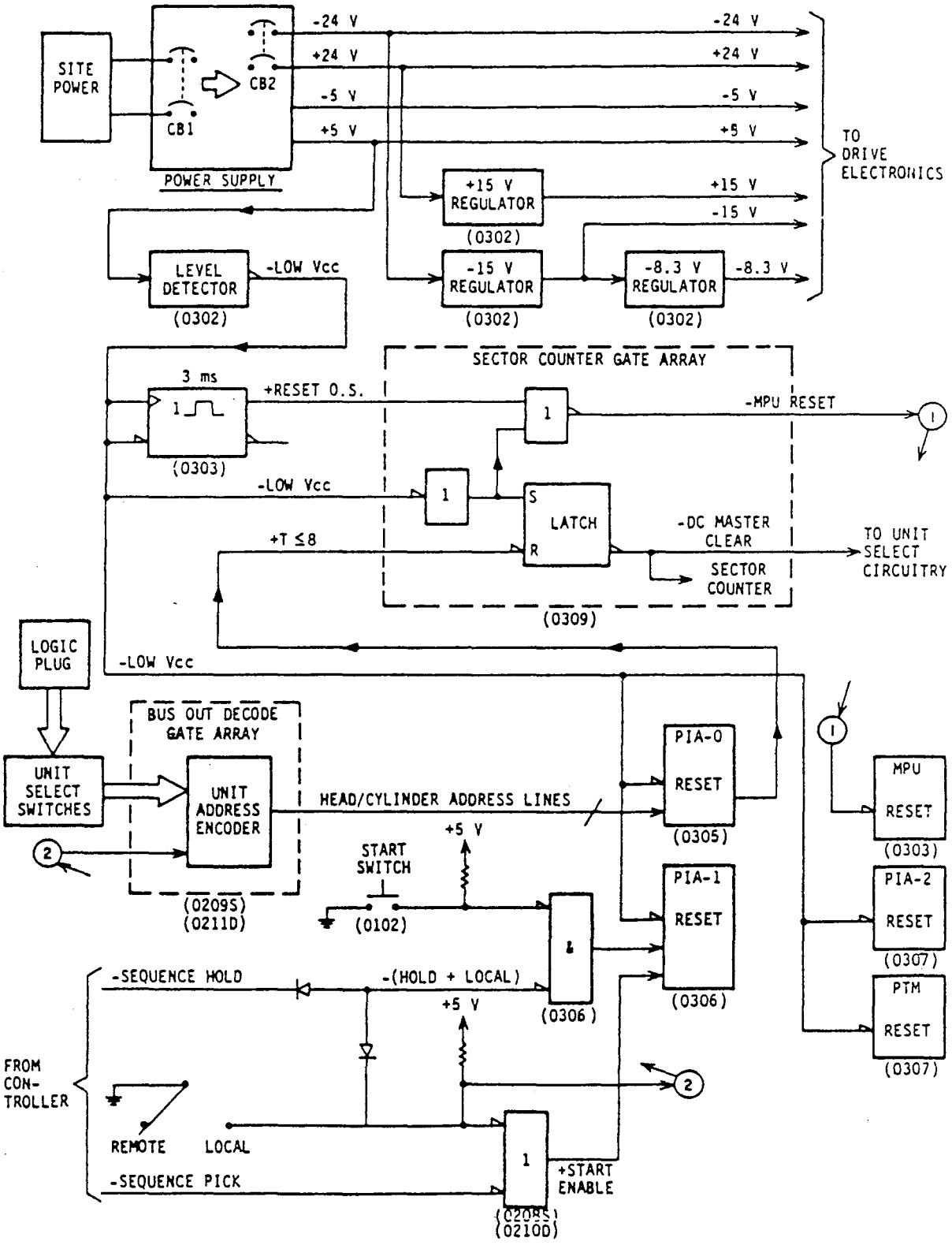
If one of the first two tests fail, the MPU stops and turns on all fault LEDs on Fault panel. If the third test fails, the MPU attempts to turn on the First Seek LED. Any fault on the power on initialization must be cleared by a power cycle.

After the self tests have been successfully completed, the Master Clear becomes inactive and the MPU clears the cylinder address register, head address register, on-cylinder FF, and the fault latches. The MPU now waits for the start conditions before starting the load operation.

Figure 2-5 shows the power on circuitry and Figure 2-6 shows the power on initialization flowchart. Both figures can be used as an aid in troubleshooting problems that occur during a power on initialization.



Power On Initialization Flowchart



Power On Circuitry

2.3 XMD POWER-ON AND POWER-OFF PROCEDURES

The power supply circuit breaker (CB1) on the power supply rear panel is usually left on, so that dc power is available to the drive.

The following procedure describes how to power-up the DD-40.

1. Press the START switch. If the LOCAL/REMOTE switch was set in the REMOTE position during drive installation, the power up sequence continues when power sequence ground is available from the controller. If the LOCAL/REMOTE switch was set in the LOCAL position, the power-up sequence begins immediately. When set to the REMOTE position, the power-up sequence of each spindle (except spindle 0) is delayed. The length of the delay is determined by the number of the unit logic plug used in increments of $\frac{1}{10}$ seconds. Delay = 10 sec X Unit plug #
2. Observe that the ready indicator (located in the START switch) flashes, indicating that power-up is in progress.
3. Observe that the ready indicator lights steadily within 3 minutes and 30 seconds, indicating that the disks are up to speed, the heads are loaded, and a stabilization period has elapsed.
4. Ensure that the FAULT indicator is off.

The power-up sequence is now complete, and the drive is ready to write data.

The following procedure describes how to power-down the DD-40.

1. Press the START switch to release it from the start position.
2. Observe that the ready indicator (located in the START switch) flashes, indicating that power-up is in progress.
3. Observe that the READY indicator goes off after approximately 30 seconds.

When power-down is complete, the heads are positioned in the landing zone and the disks are not rotating. Normally, the power supply circuit breaker (CB1) is left on to continue supplying power to the drive.

LOAD OPERATION

When the power on initialization is complete, the MPU checks the Over Temperature on the Power Amp board to make sure it is inactive and waits for the start conditions. The MPU will wait for the start switch to be depressed. When this happens, provided the remote/local switch is in the remote position and that the DD40 has its A cables connected to the DC40 to provide the correct signal on the sequence Pick and Hold lines, the MPU will start the load operation. Once these conditions are met, a delay is started. This delay is:

Unit Address X 10 sec = Delay (in Seconds)

When the delay ends the MPU unlocks the actuator, pulls the heads against the carriage stop, and the motor starts to spin. The Ready light on the operator's panel will start to flash. The MPU checks for the signal Speed OK within three to seven seconds. If Speed OK is not detected in three attempts, the MPU will stop trying and wait for CB1 to be turned off and back on again to allow another three attempts.

When Speed OK is detected by the MPU, it checks and rechecks the speed until the drive is spinning at the rated speed. This is done by counting Speed pulses.

The MPU enables the Power Amplifier, checks for any faults, and starts a 200 ms. timer. The MPU starts pulsing the voice coil to move the actuator inward. This continues until a servo signal is detected. The actuator is now moving inward. After 40 ms. the MPU checks for 32 cylinder crossing pulses. When the 32 pulses are detected, the MPU checks that the 200 ms. timer has not timed out. At this point, heads are over the data area. The actuator direction is reversed and starts moving outward under coarse control. The actuator moves in the outward direction until the outer guardband is detected. Once the outer guardband is detected the MPU checks for two cylinder pulses. The actuator is turned around and moves toward Cylinder 0. The MPU must detect at least one cyclinder pulse for the outer guardband. There is one additional cylinder pulse detected before the heads reach Cylinder 0. With one third track to go, fine control is enabled and coarse control is disabled.

The MPU checks that on-cylinder stays active for 2.1 ms. If it does not, the MPU will wait for up to 11 ms. for on-cylinder to go active and check it again. When on-cylinder stays active for 2.1 ms. and the servo signal is still present and three or more cylinder crossing pulses were not detected after on-cylinder, the MPU starts the scan cycle.

The scan cycle consists of two cycles of single track seeks from Cylinder 0 to 1419 and back to 0. (See Figure 2-7). The scan cycle is followed by the velocity calibration cycle which executes a series of 128 track seeks to calibrate the velocity measurement circuit.

At the end of the load operation, the heads are positioned to Cylinder 0. A successful load operation will take 3 minutes and 30 seconds. A successful load operation is indicated by a steady unit ready light and unit ready and seek end being sent to the controller. The DD40 is ready to receive commands from the DC40.

During the load operation, the MPU periodically checks the fault line to make sure there is no fault present. It also checks for other conditions that must be present to allow the load operation to continue. The following is a list that will cause a first seek fault.

-A fault is detected during the load operation.

-The servo signal is present before the actuator starts to move forward.

-It takes longer that 200 ms. to detect 32 cylinder pulses.

-The servo signal is lost during the reverse motion of the actuator.

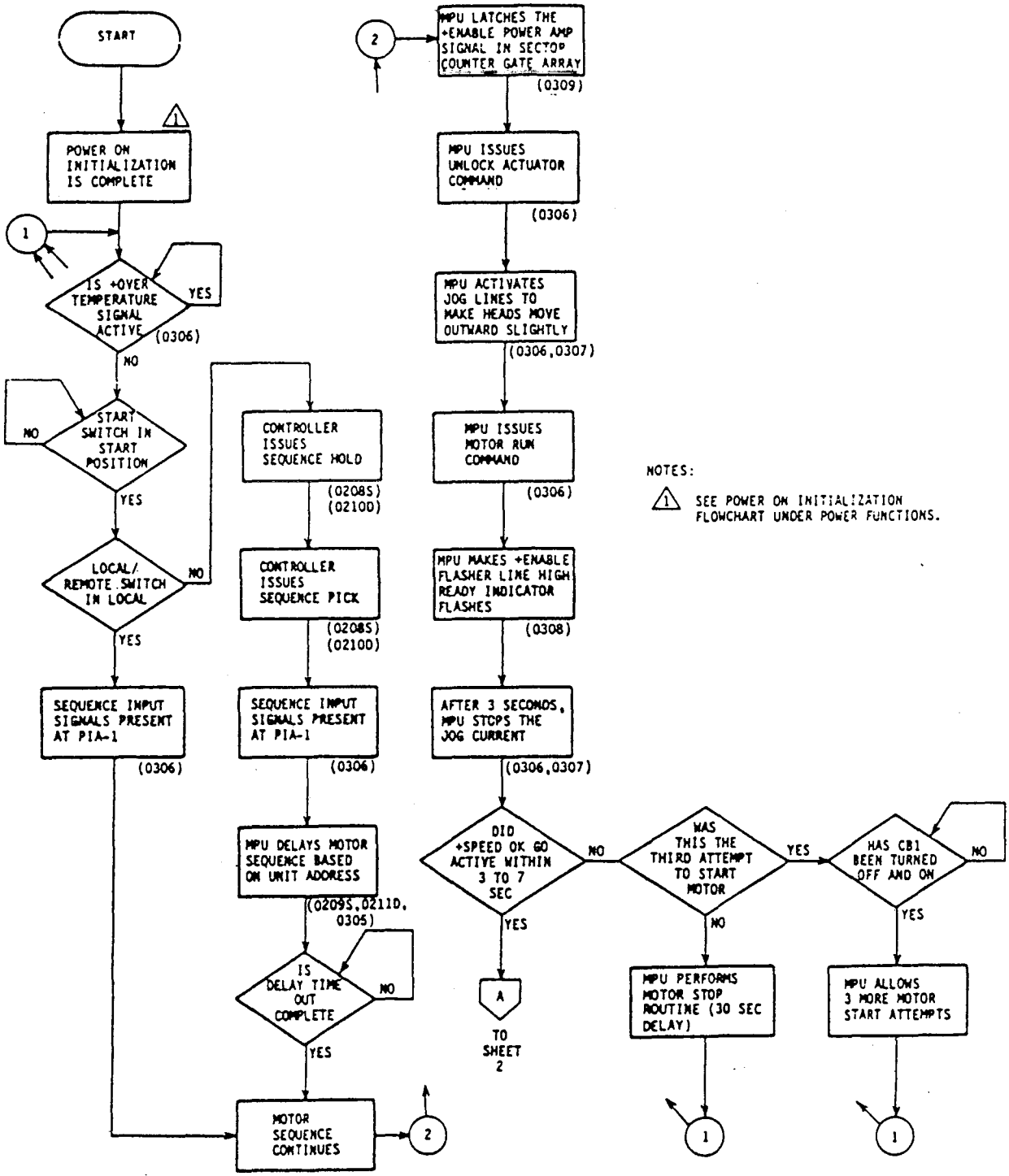
-At least one cylinder pulse of the outer guardband was not detected before Cylinder 0 was found.

-Three or more cylinder pulses are detected after Cylinder 0 has been detected.

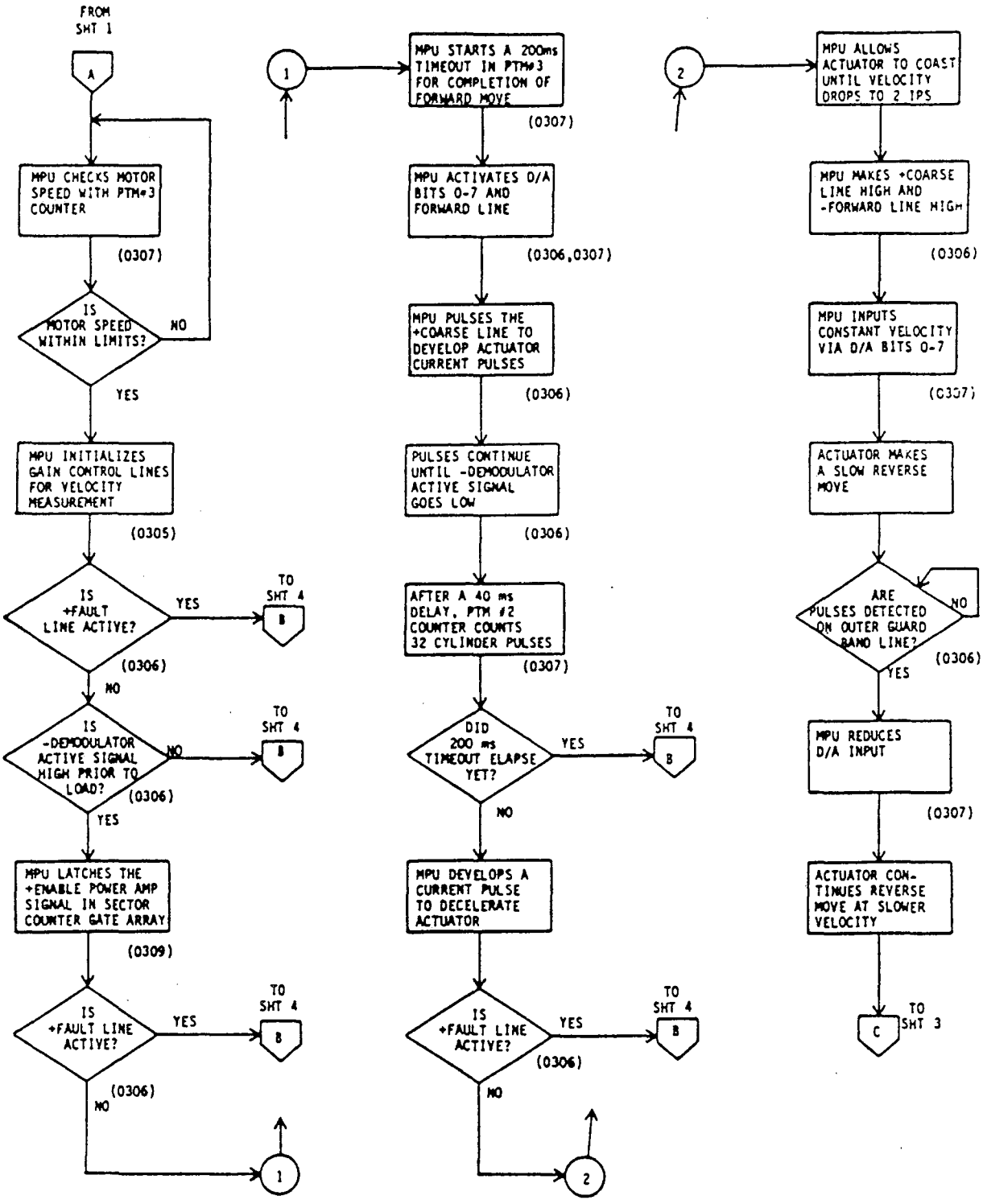
-When Cylinder 0 has been detected and on-cylinder is active, if on-cylinder goes inactive before 2.1 ms. and does not return to the active state in 11ms.

Any of the above occurances will cause the MPU to set fault first seek fault, retract and lock the actuator, and send servo status to the fault display board. When the fault is cleared, the MPU will attempt another load operation.

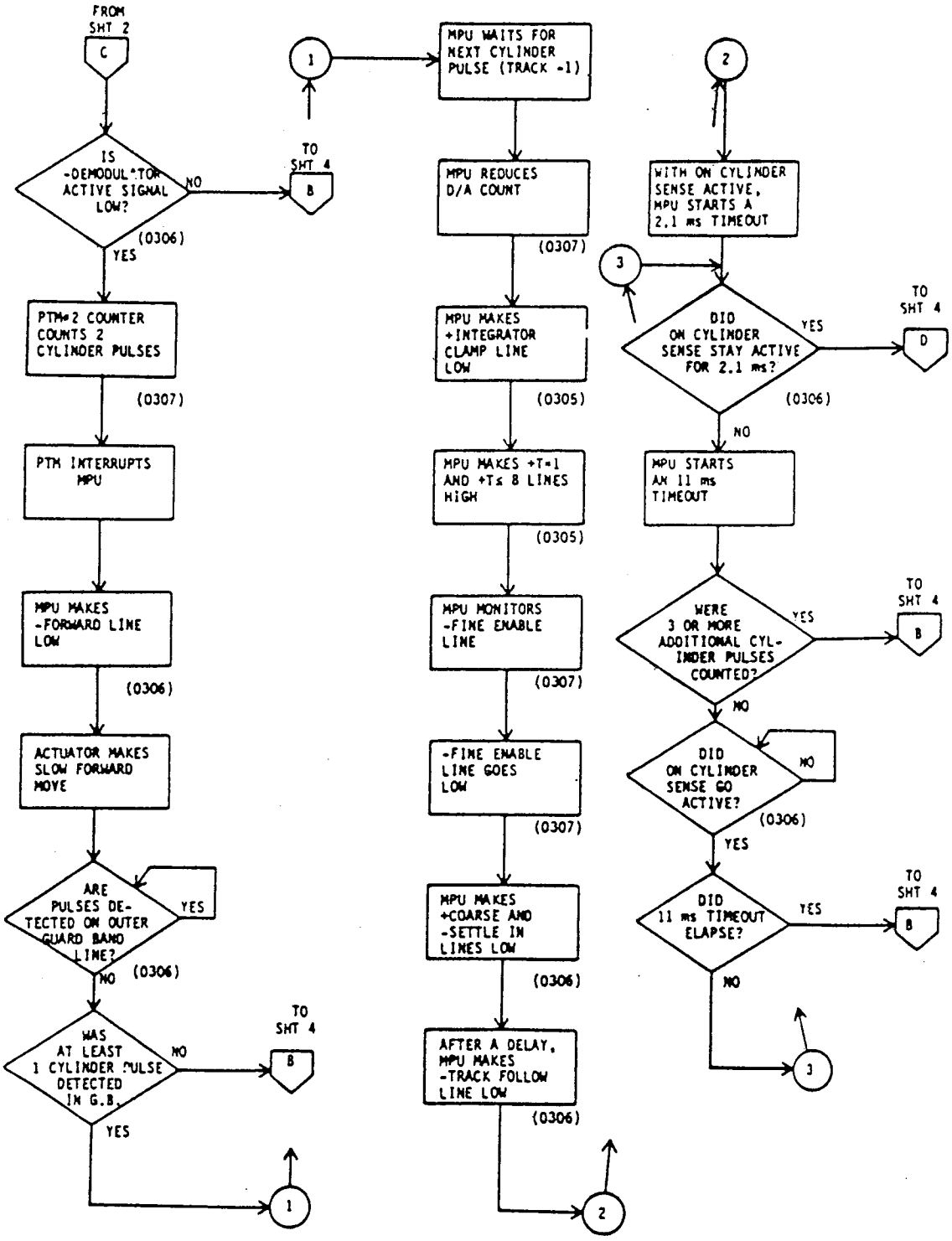
The Load Operation Flowchart gives a step by step flow of this operation. The Load Trajectory shows the movement of the actuator during the load operation.



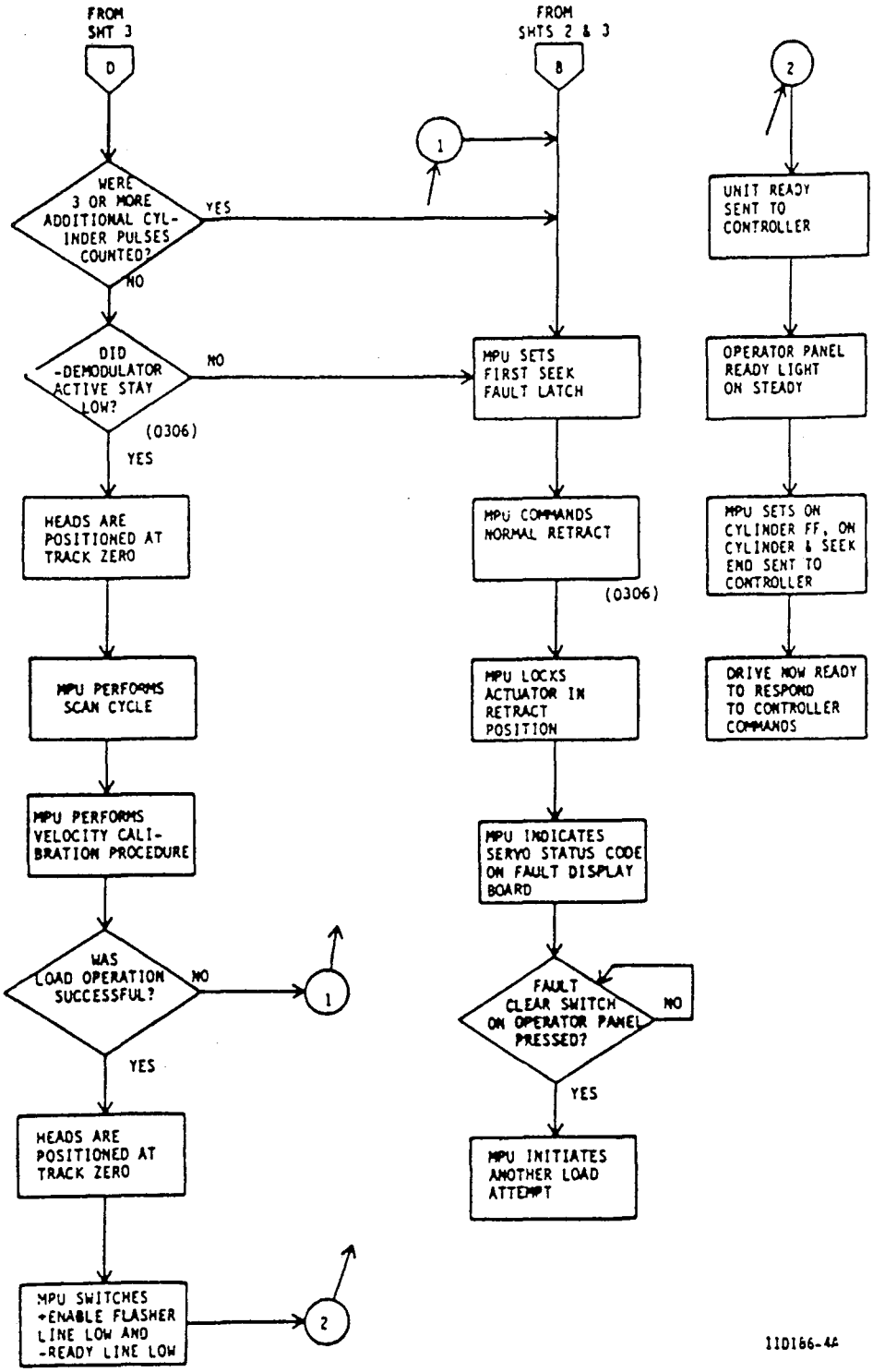
Load Operation Flowchart (Sheet 1 of 4)



Load Operation Flowchart (Sheet 2)

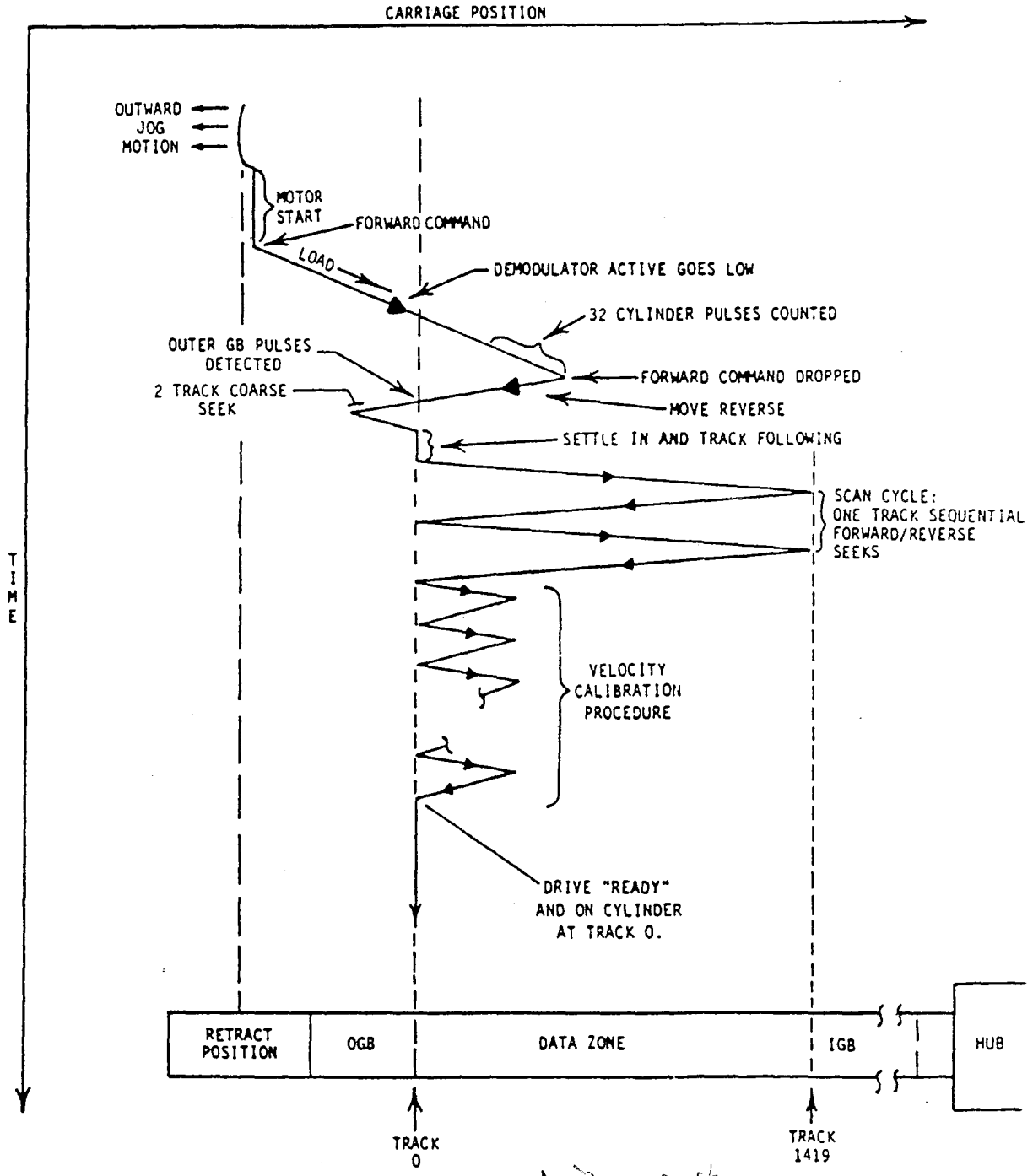


Load Operation Flowchart (Sheet 3)



Load Operation Flowchart (Sheet 4)

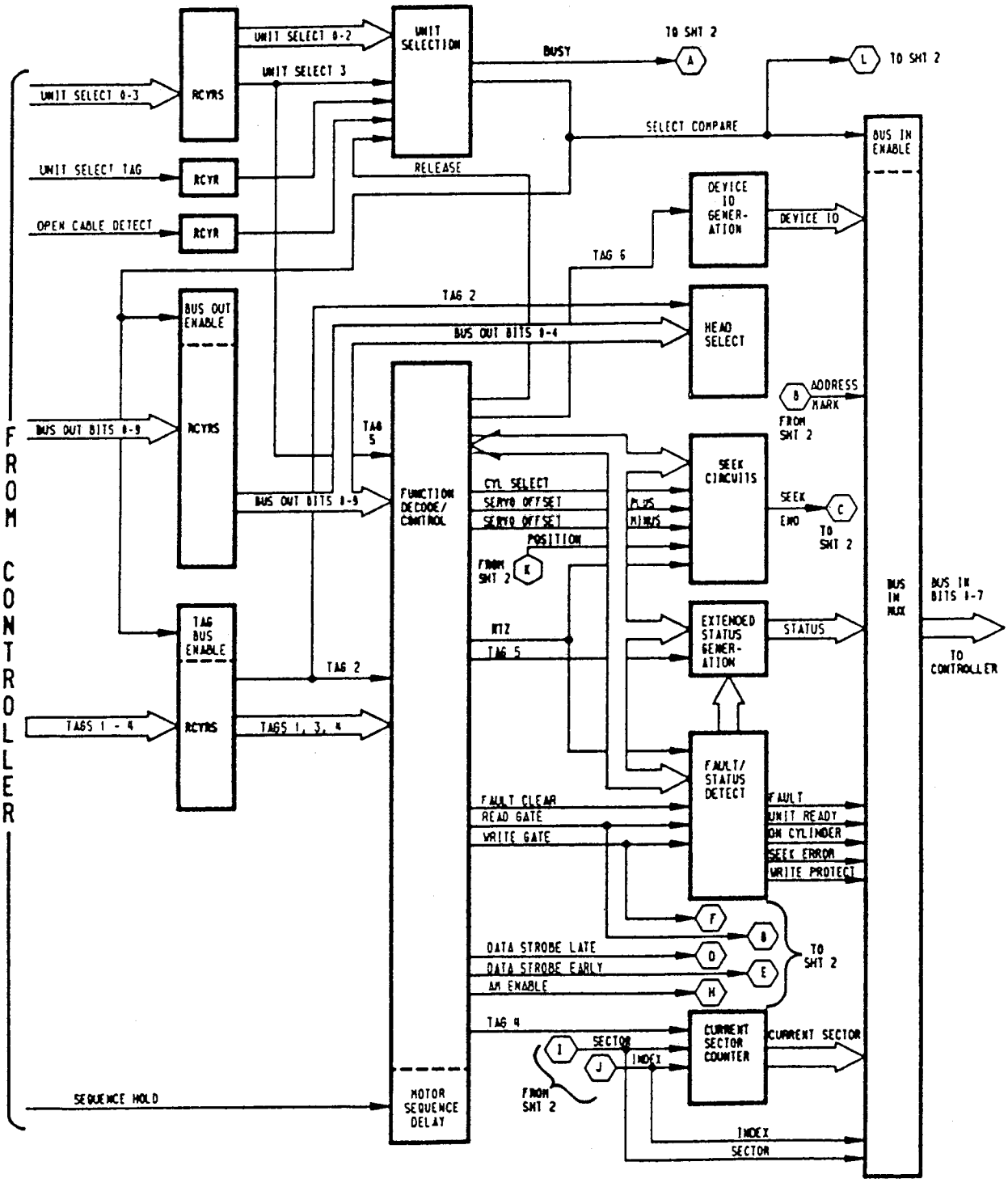
The Load Seek Trajectory summarizes what happens during the load operation. It also shows the movement of the heads with respect to the guardbands and the data zones.



if this stuff don't work "first seek fault"

Load Seek Trajectory

The I/O signals for the A cable are shown on page 2-10N, I/O Signal Processing (Sheet 1 of 2). The signals on the A cable are listed in the table on page 2-10O and a brief discription is given on the page 2-10P. The I/O signals for the B cable are shown on page 2-10Q, Sheet 2 of I/O Signal Processing figure. The signals for the B cable are listed on page 2-10R. A brief description of the B cable signals is given on page 2-10S.



I/O Signal Processing (Sheet 1 of 2)

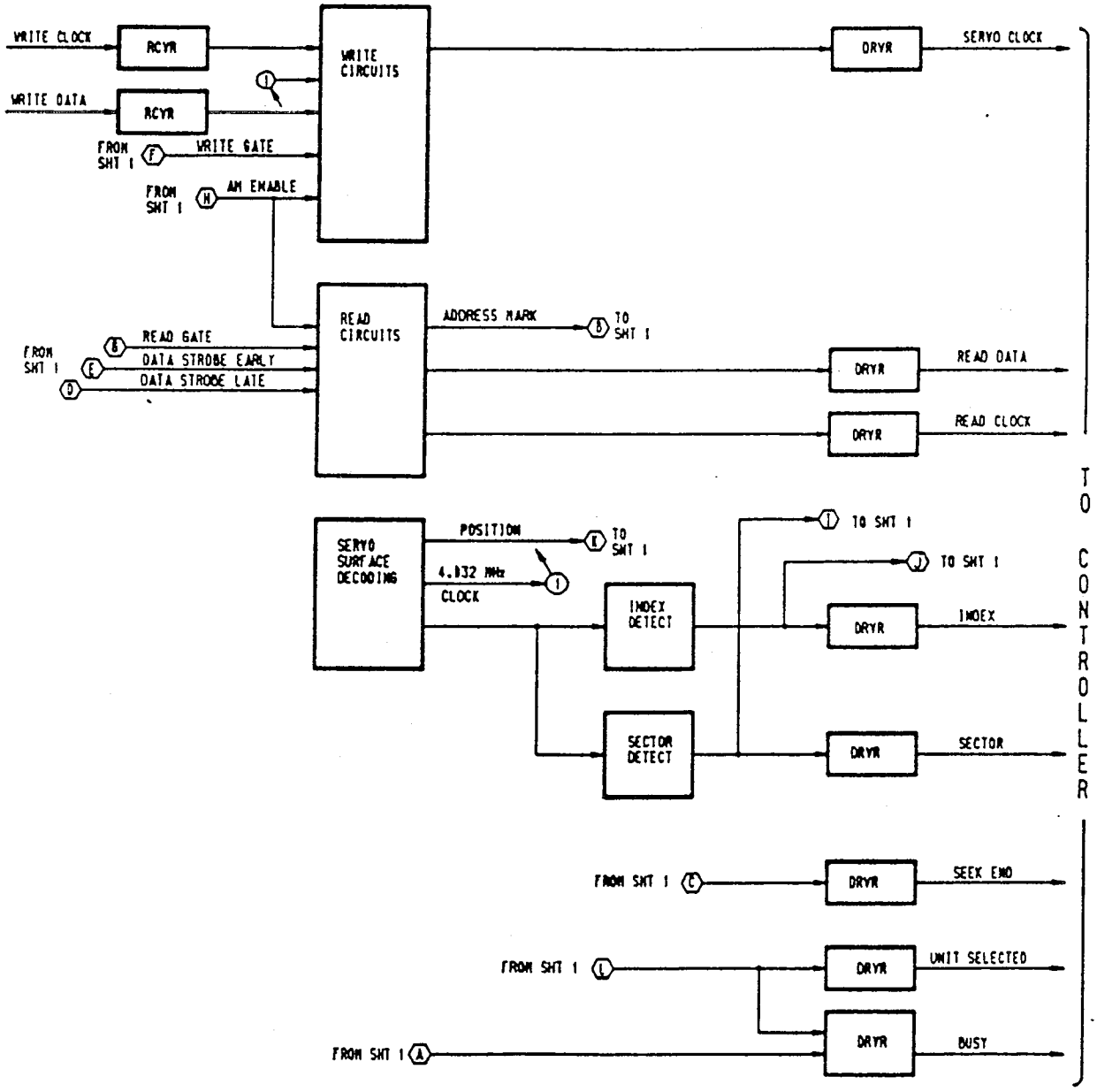
I/O BOARD - VJX

A CABLE - J03/J04

SIGNAL	DC40 - I/O	XMD - LO/HI
Unit Select Tag	R0 - 2EJ	22/52
Unit Select bit 0	R1 - 2EJ	23/53
Unit Select bit 1	R2 - 2EJ	24/54
Unit Select bit 2	R3 - 2EJ	26/56
Tag 1	R4 - 2EJ	1/31
Tag 2	R5 - 2EJ	2/32
Tag 3	R6 - 2EJ	3/33
Tag 4	R7 - 2EJ	30/60
Tag 5	R8 - 2EJ	27/57
Bus 0	R9 - 2EJ	4/34
Bus 1	R10 - 2EJ	5/35
Bus 2	R11 - 2EJ	6/36
Bus 3	R12 - 2EJ	7/37
Bus 4	R13 - 2EJ	8/38
Bus 5	R14 - 2EJ	9/39
Bus 6	R15 - 2EJ	10/40
Bus 7	R16 - 2EJ	11/41
Bus 8	R17 - 2EJ	12/42
Bus 9	R18 - 2EJ	13/43
Status 0	I18, I26, I34, I42 - 2EM	19/49
Status 1	I19, I27, I35, I43 - 2EM	17/47
Status 2	I20, I28, I36, I44 - 2EM	16/46
Status 3	I21, I29, I37, I45 - 2EM	15/45
Status 4	I22, I30, I38, I46 - 2EM	28/58
Status 5	I23, I31, I39, I47 - 2EM	20/50
Status 6	I24, I32, I40, I48 - 2EM	18/48
Status 7	I25, I33, I41, I49 - 2EM	25/45
Open Cable Detect	R34 - 2EJ	14/44
Busy	N/U	21/51
Spindle Sequence Pick	Controller GND	29
Spindle Sequence Hold	Controller GND	59

XMD A Cable Signals

Signal	Description
Unit Select Tag	This signal is sent to the drive along with the Unit Select Bits 0-2 to select the desired unit.
Unit Select Bits 0-2	These signals must be active at least 200 ns before the Unit Select Tag becomes active. Only Unit Select bit 0 is used by the DC40 to select either the Primary ($2^0 = 0$) or Shadow ($2^0 = 1$) DD40. (Unit Select Bit 3 is used on Tag 5.)
Tag 1	Lower cylinder select, bits 2^0-2^9. (When doing a cylinder select the higher bits must be sent first.)
Tag 2	Head Select/Higher Cylinder Bits. Head select bits are represented in Bus Out Bits 2^0-2^4. The upper cylinder bits (2^{10} and 2^{11}) are represented by Bus Out Bits 2^7 and 2^8. (The upper cylinder bits must be sent before the lower cylinder bits.)
Tag 3	Enable the Control bits to be sent out on the bus. When the Bus Out Bit is active it controls the following in the XMD. 2^0 - Write Gate 2^1 - Read Gate 2^2 - Offset + Offsets positioner toward the spindle for 2.75 ns. 2^3 - Offset - Offsets positioner away from the spindle for 2.75 ns. 2^4 - Clear Fault 2^5 - Not used 2^6 - RTZ 2^7 - Data Strobe Early 2^8 - Data Strobes Late 2^9 - Not Used
Tag 4 and 5 (See individual status words for bit by bit discription in Troubleshooting section of this manual.)	Selected Status Tag 4 - Sector Status Tag 5 - Extended Status B0B0=0 B0B1=0 Tag 5 - Operating Status B0B0=1 B0B1=0 Tag 5 - Diagnostic Status B0B0=0 B0B1-1 Tag 5 - Diagnostic Execute Status B0B0=1 B0B1=1
Open Call Detect	Detects loss of power in DC40
Pick	DC40 Ground
Hold	DC40 Ground
Bus In Bits 0-7	Drive Status or Selected Status



I/O Signal Processing (Sheet 2)

I/O BOARD - VJX

B CABLE - J02

SIGNAL	PRIMARY DC40 - I/O	XMD - LO/HI
Write Data	R4, R12, R20, R28 - 2EK	8/20
Ground		7
Write Clock	R5, R13, R21, R29 - 2EK	6/19
Ground		18
Servo Clock	I6, I22, I32, I42 - 2EK	2/14
Ground		1
Read Data	I5 - 2EJ	3/16
Ground		15
Read Clock	I6 - 2EJ	5/17
Ground		4
Seek End	I10 - 2EJ	10/23
Ground		11
Unit Selected	I9 - 2EJ	22/9
Ground		21
Index	I7 - 2EJ	12/24
Ground		25
Sector	I8 - 2EJ	13/26

SIGNAL	SHADOW DC40 - I/O	
Write Data	R4, R12, R20, R28 - 2EK	8/20
Write Clock	R5, R13, R21, R29 - 2EK	6/19
Servo Clock	I7, I23, I33, I43 - 2EK	2/14
Read Data	I11 - 2EJ	3/16
Read Clock	I12 - 2EJ	5/17
Seek End	I16 - 2EJ	10/23
Unit Selected	I15 - 2EJ	22/9
Index	I13 - 2EJ	12/24
Sector	I14 - 2EJ	13/26

XMD B Cable Signals

The B cable signal for spindle A and B share one 55 pin cable between the DC40 and DD40. The B cable signals for spindle C and D are shared by another cable.

Signal	Description
Write Data	NRZ Data to XMD
Write Clock	24 MHz/41.3ns
Servo Clock	24.192 MHz/41.3ns
Read Data	NRZ Data from XMD
Read Clock	24 MHz/41.3ns
Seek End	Seek End with On cylinder indicates the seek was completed as expected. Seek End without On cylinder indicates a Seek Error. When a Diagnostic Execute Status is performed, Seek End indicates test execution is complete.
Unit Selected	This is the response to a Unit Select Tag and a match between the Unit Select Bits and Drive Address.
Index	Decoded from servo tracks once per resolution.
Sector	12 Sector pulses per revolution. This is determined by the setting on the sector switches.

2.4 DD-40 ADDRESS SELECTION

The XMD spindles within the DD-40 cabinet are not individually addressable from the IOP. A spindle is selected with 3 bits of the unit select bus. The logic plug supplied with the DD-40 is inserted in the top of the operator panel. When inserted, it activates switches that establish the logical address of the DD-40. The logic plug also determines the delay before startup.

In each DD-40 cabinet, three of the four spindles are given the same number. The bottom spindle is one number higher than the other three if the DD-40 is the primary DD-40 and one number lower if it is the shadow DD-40. The top three spindles in the shadow DD-40 are one number higher than the same three spindles in the primary DD-40. Figure 2-4 shows how the addresses of the XMD spindles are specified.

The DD-40's connected to DC-40 disk controller unit 0 use numbers 0 and 1 and the DD-40's connected to disk controller unit 1 use numbers 2 and 3, and so on.

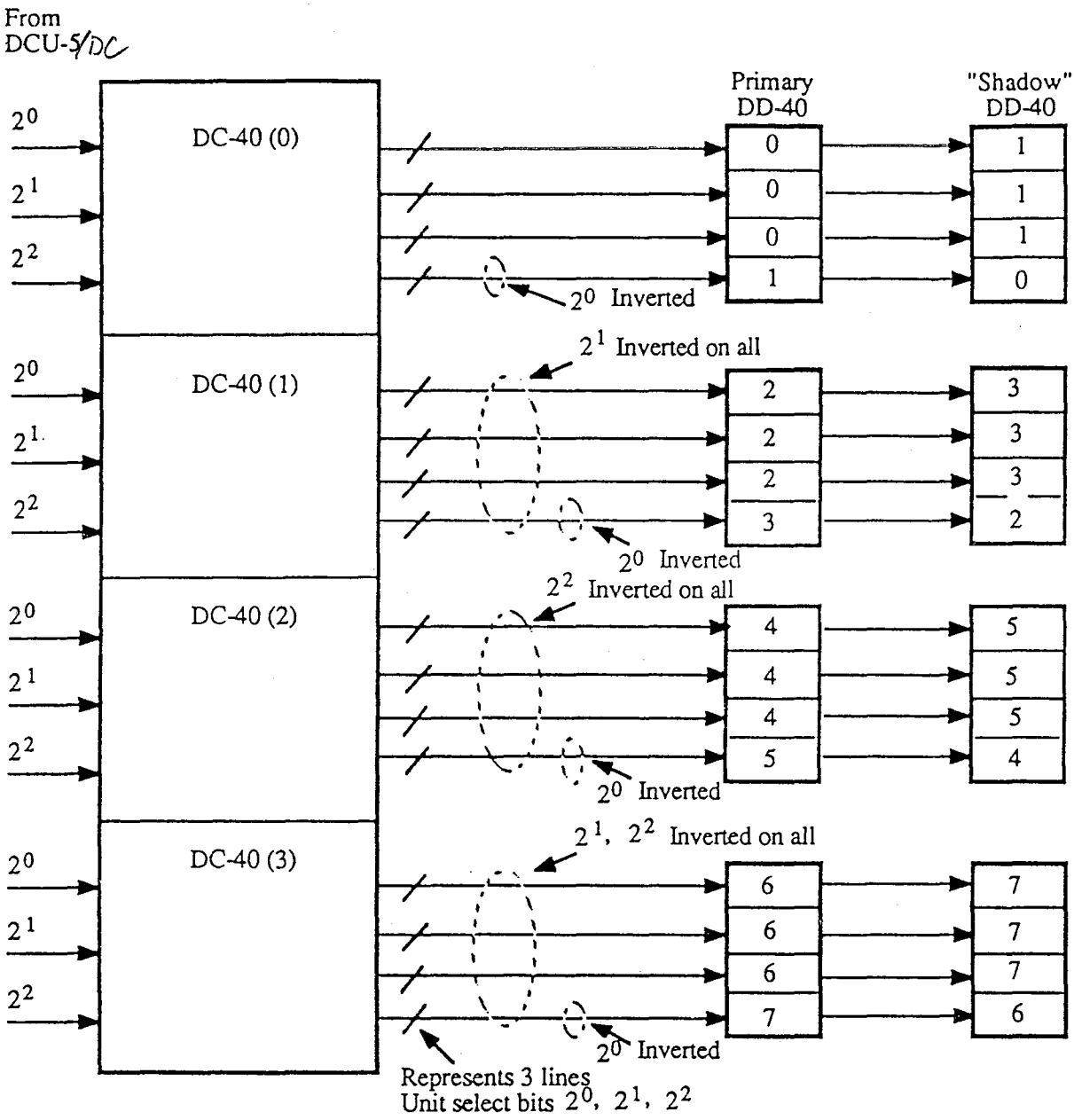
When the primary DD-40 is selected, the unit select command is issued with the lower 3 bits of the accumulator equal to 0's. The unit select tag and the lower 3 bits of the accumulator are sent to the DD-40 from the disk controller unit. Some of the bits are inverted in the drop cables to make the 3 unit select bits match the unit number when they reach the DD-40. When the shadow unit is selected, 2^0 is set in the accumulator. When the logical address of the DD-40 matches the address that is sent by the disk controller, the select compare signal is enabled if open cable detect signal is active. The select compare signal enables the transmitter and receivers. Select compare is also the unit selected signal returned to the DC-40.

When the DD-40 cabinet circuit breaker is turned on, the top three spindles of the primary DD-40 start to spin up first and the bottom spindle starts spinning 10 seconds later. For the shadow DD-40, the bottom spindle starts spinning first and the top three spindles 10 seconds later. The startup delay is the unit number times 10 seconds.

2.5 XMD SPINDLE HEAD SELECTION

The XMD spindle has 19 data heads and 1 servo head. There are 2 heads on a disk surface and 4 heads on a head/arm assembly. The heads must be positioned at the cylinder from which the data is to be read or written before a head can be selected. Only one data head can be selected at a time. Figure 2-5 shows the head select circuits of the XMD-III spindle.

The cylinder address and head address are held in registers in the bus out decode gate array. The spindle's Micro Processor Unit (MPU) uses a series of pulses on I/O control lines 1 and 2 to transfer the cylinder address to the MPU. The MPU sends another series of pulses on I/O control lines 1 and 2 that cause the bus-out gate array to output the head address. Until the spindle is commanded to do another seek, the head address is held on the head/cylinder address lines. The head/cylinder lines go to the read/write board when they address a ROM, which outputs the correct signals on arm select lines 1 through 5.



Note: 000 from DCU-5 selects all Primary drives
001 from DCU-5/DC selects all "Shadow" drives

A-4433

Figure 2-4. XMD Spindle Address Selection

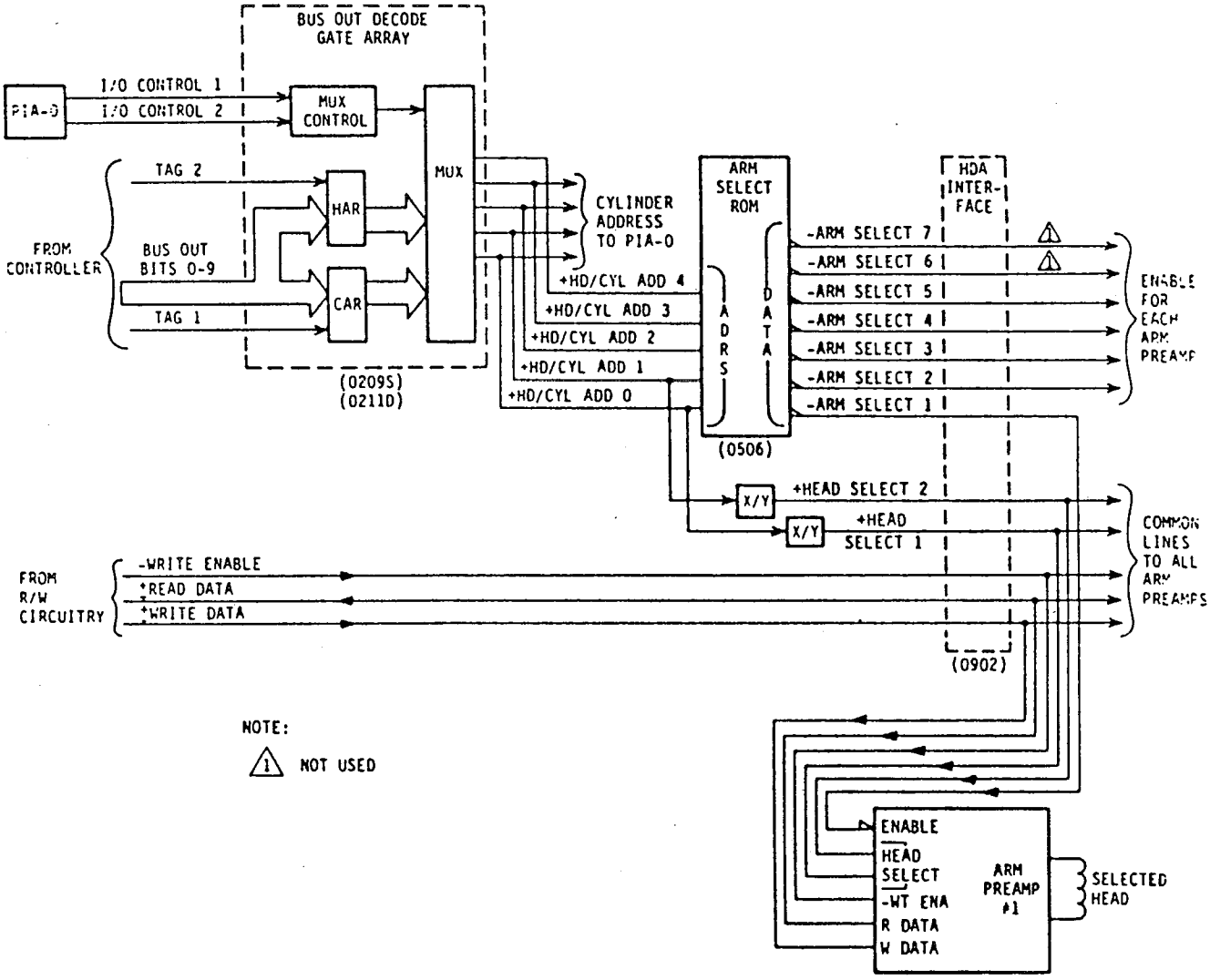


Figure 2-5. XMD Head Select Circuits

If a head address greater than 18 is received, no head is selected. If a write is attempted with no head selected, a write fault occurs.

Table 2-3 lists the head select addressing for the XMD spindles.

Table 2-3. XMD Spindle Head Select Addressing

Head (decimal)	Head (hex)	Arm	Head/Cylinder Address Lines 0	1	2	3	4
0	0	1	0	0	0	0	0
1	1	1	1	0	0	0	0
2	2	1	0	1	0	0	0
3	3	1	1	1	0	0	0
4	4	2	0	0	1	0	0
5	5	2	1	0	1	0	0
6	6	2	0	1	1	0	0
7	7	2	1	1	1	0	0
8	8	3	0	0	0	1	0
9	9	3	1	0	0	1	0
10	A	3	0	1	0	1	0
11	B	3	1	1	0	1	0
12	C	4	0	0	1	1	0
13	D	4	1	0	1	1	0
14	E	4	0	1	1	1	0
15	F	4	1	1	1	1	0
16	10	5	0	0	0	0	1
17	11	5	1	0	0	0	1
18	12	5	0	1	0	0	1

NORMAL SEEK

When the DD40 is ready and selected the controller can send it a command to do a seek. The controller sends the cylinder address to the DD40 in two parts. First, the drive receives the upper two cylinder address bits as bus out bits 2^7 & 2^8 along with the head address and Tag 2. The lower ten cylinder address bits are sent next, along with Tag 1. The maximum cylinder address is 1419. On-cylinder goes low and the MPU is interrupted via PIA-1.

The MPU pulses the Bus Out Decode array and it transfers the cylinder address 4 bits at a time to the MPU RAM where it is stored. After the cylinder address is stored, the head address is ready from the Bus Out Decode array. (See Head Selection). The MPU compares the new cylinder address to the present cylinder address to determine two things, the direction of the seek, and the distance of the seek in tracks.

Before the MPU starts the seek it checks that there is no fault, the servo signal is being detected and the speed is O.K. If no errors are detected, the MPU starts a 60 ms. timer and starts the seek.

If it is a one track seek, the MPU sets T=1 and T≤8 and starts to move the actuator. The actuator accelerates until it reaches the maximum speed for a one track seek. The actuator will coast for a period then decelerate and eventually settle on the cylinder under fine control.

If it is a seek of two or more tracks, the actuator starts moving and the MPU loads the tracks to go into a counter. The actuator continues to accelerate. Each time the servo head crosses a cylinder, a pulse is generated which decrements the counter. The actual speed of the actuator is compared to the expected speed, which is held in a table in the ROM to see if the actuator has reached the desired speed. This will be repeated until the actual speed exceeds the expected speed. When this happens, the counter for tracks to go is checked to see if it is less than 256 tracks to go. If the counter is less than 256 tracks, the actuator begins to decelerate. If the counter is at 256 or more tracks the actuator continues at a constant velocity until the tracks to go is less than 256.

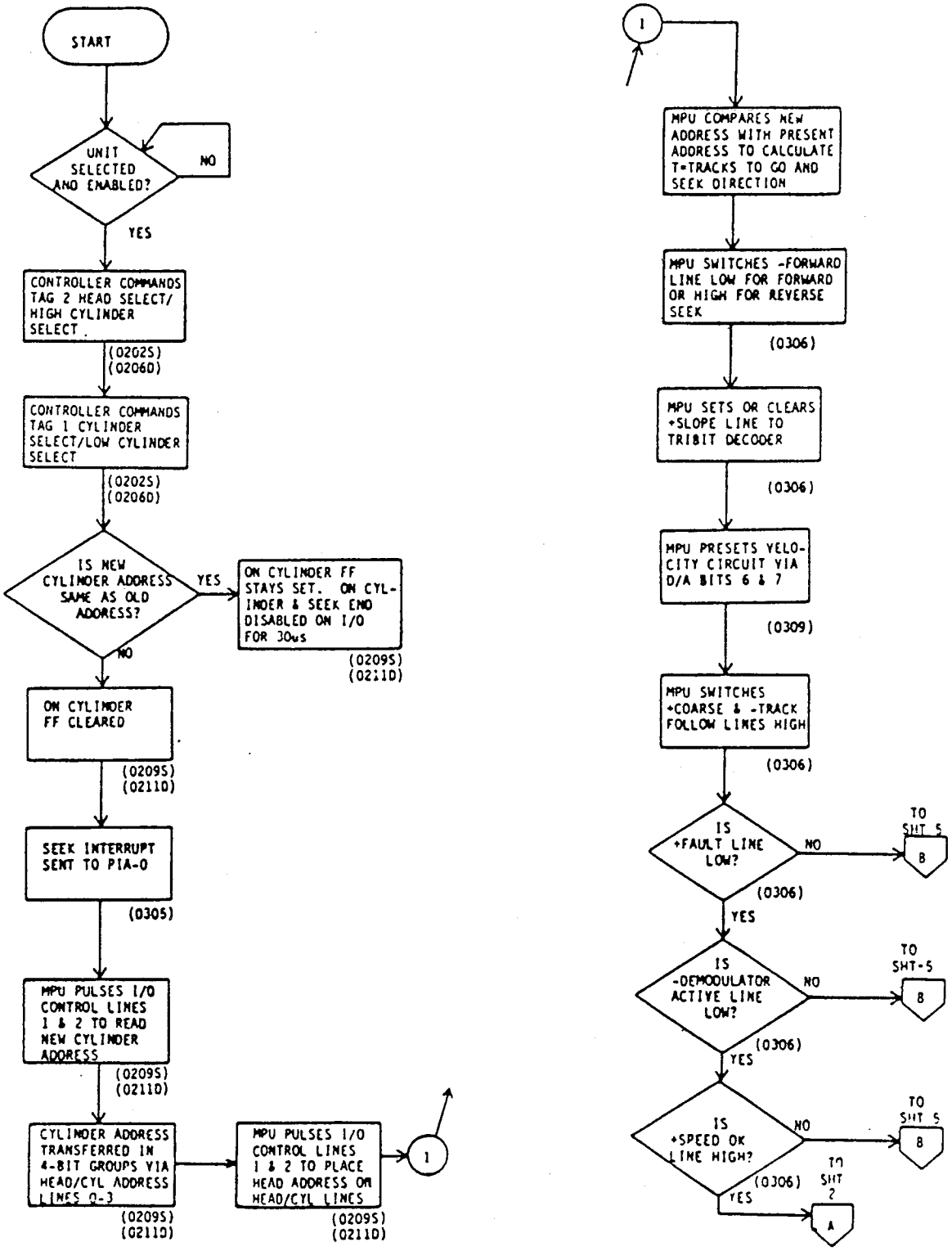
When the tracks to go is less than 256, the actuator begins to decelerate. The MPU starts to compare the actual speed to the next lower desired speed in the ROM table. When the tracks to go are less than or equal to 40, the actuator decelerates again. The MPU begins to compare to the next lower desired speed until the tracks to go are less than or equal to 8. When the last cylinder pulse is detected, the MPU sets T=1 and with 1/3 track to, go the MPU enables the fine control.

After a delay, the servo enters track follow mode. On-cylinder will become active and the MPU will check on-cylinder until it remains active for 2.1 ms. If on-cylinder does not stay active for 2.1 ms., it must return to the active state within 11 ms. so the MPU can check it again. This cycle will repeat until either the on-cylinder signal stays active for 2.1 ms. or the 11 ms. timer expires before on-cylinder returns to the active state.

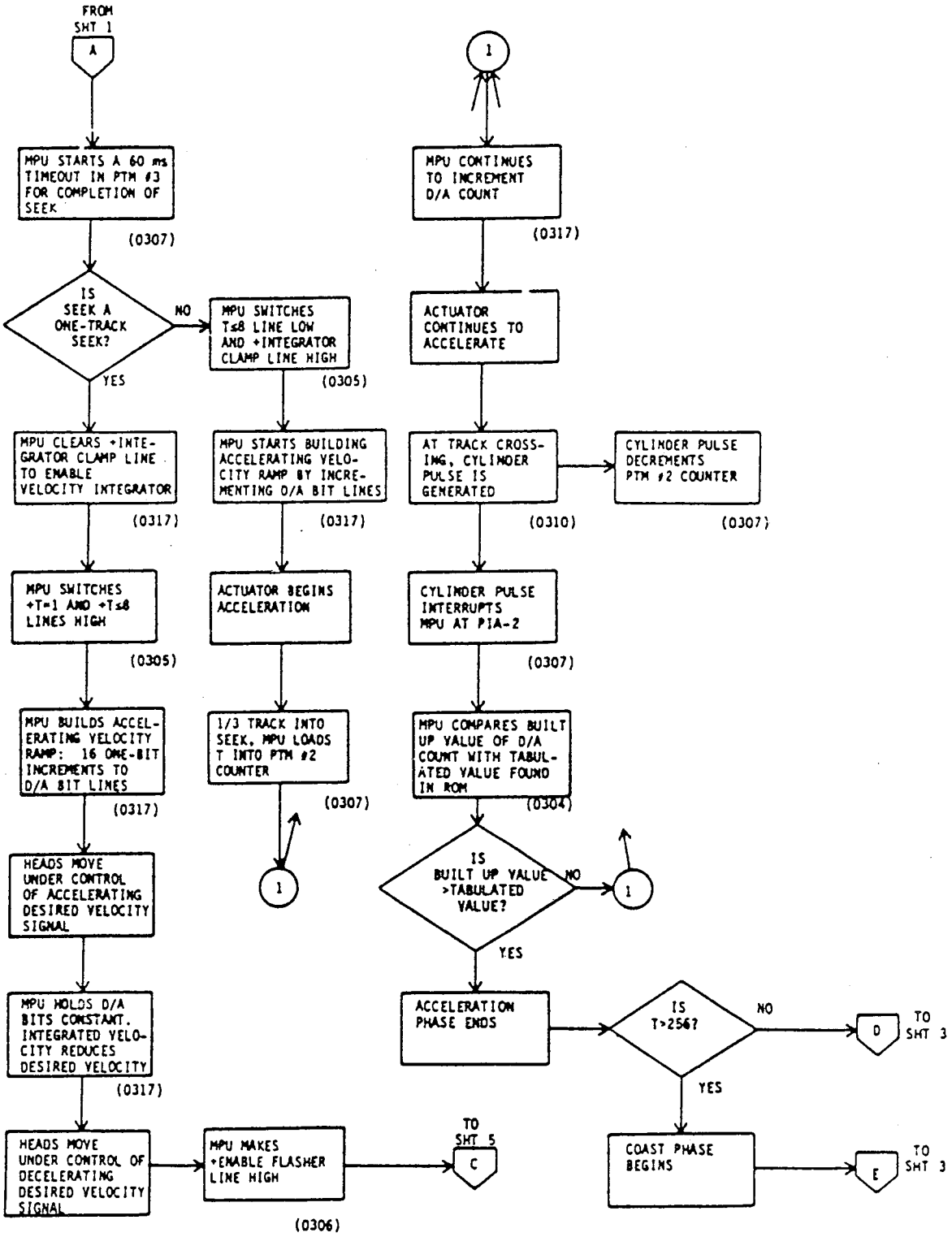
If the seek was successful, the drive will send seek end to the controller.

At the beginning of the seek, the MPU checks the fault signal, the servo signal, and the speed O.K. signal to make sure that it is safe to proceed with the seek operation. At the end of the seek, the MPU checks the servo signal, that no guardband is being detected and that the seek was completed within 60 ms. The 11 ms. timer cannot expire before on-cylinder returns to the active state. If the MPU detects an error in any of the above conditions, it drops all servo commands, stops the actuator, sends seek error to the controller, and waits for a return to zero command from the controller.

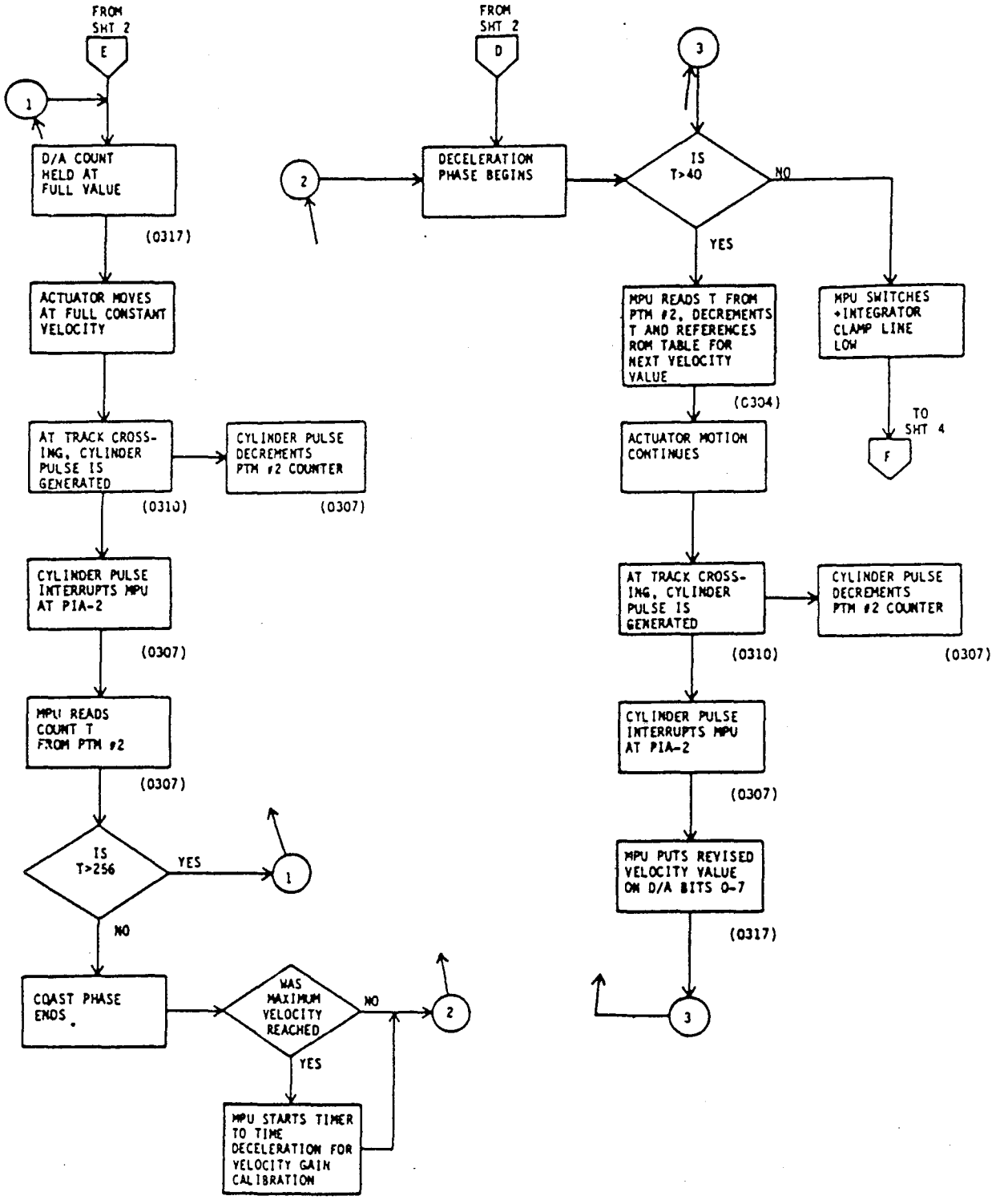
When the actuator reaches the maximum speed for any given seek, the MPU will check the deceleration time and adjust the velocity gain if necessary.



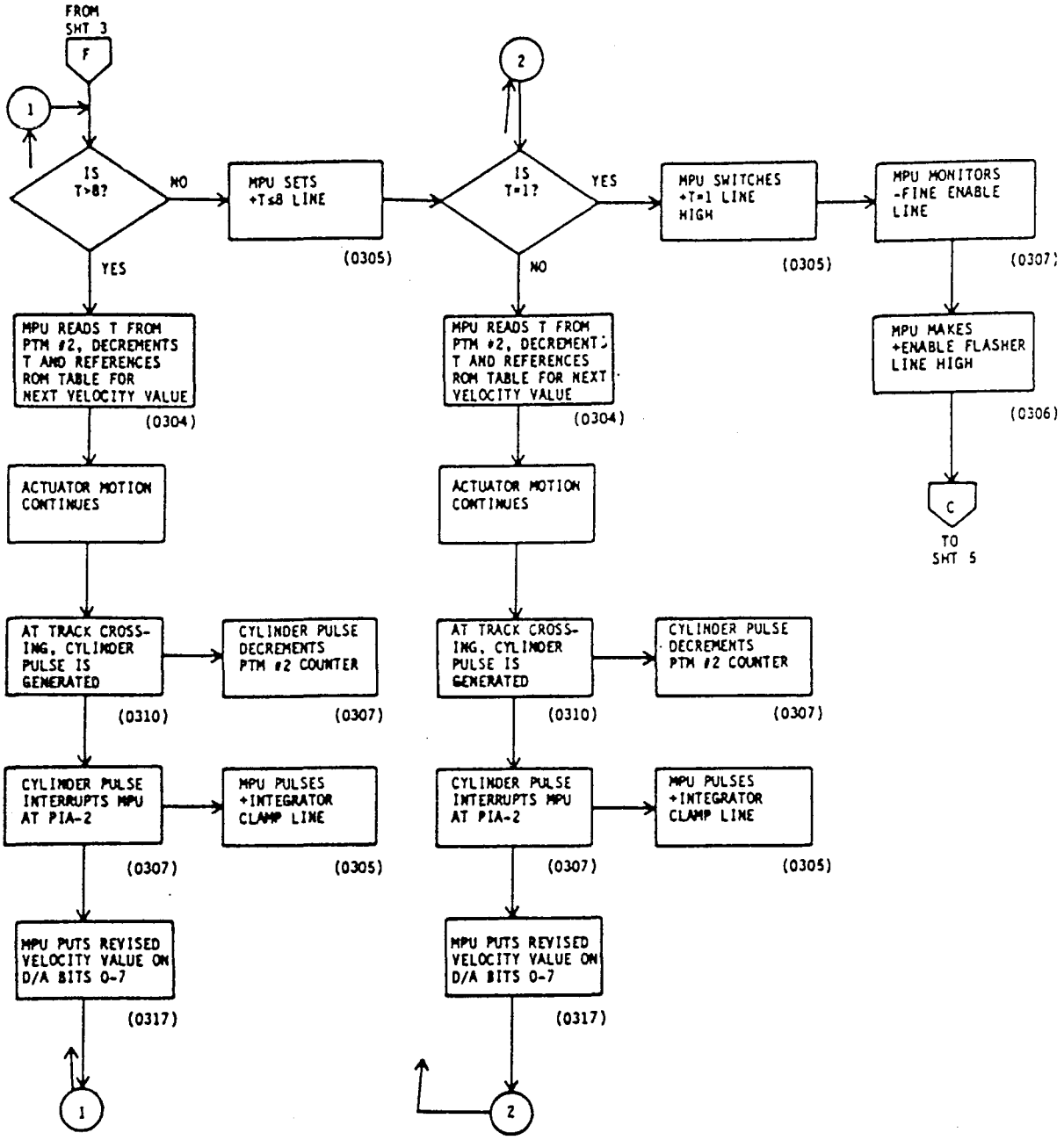
Normal Seek Flowchart (Sheet 1 of 5)



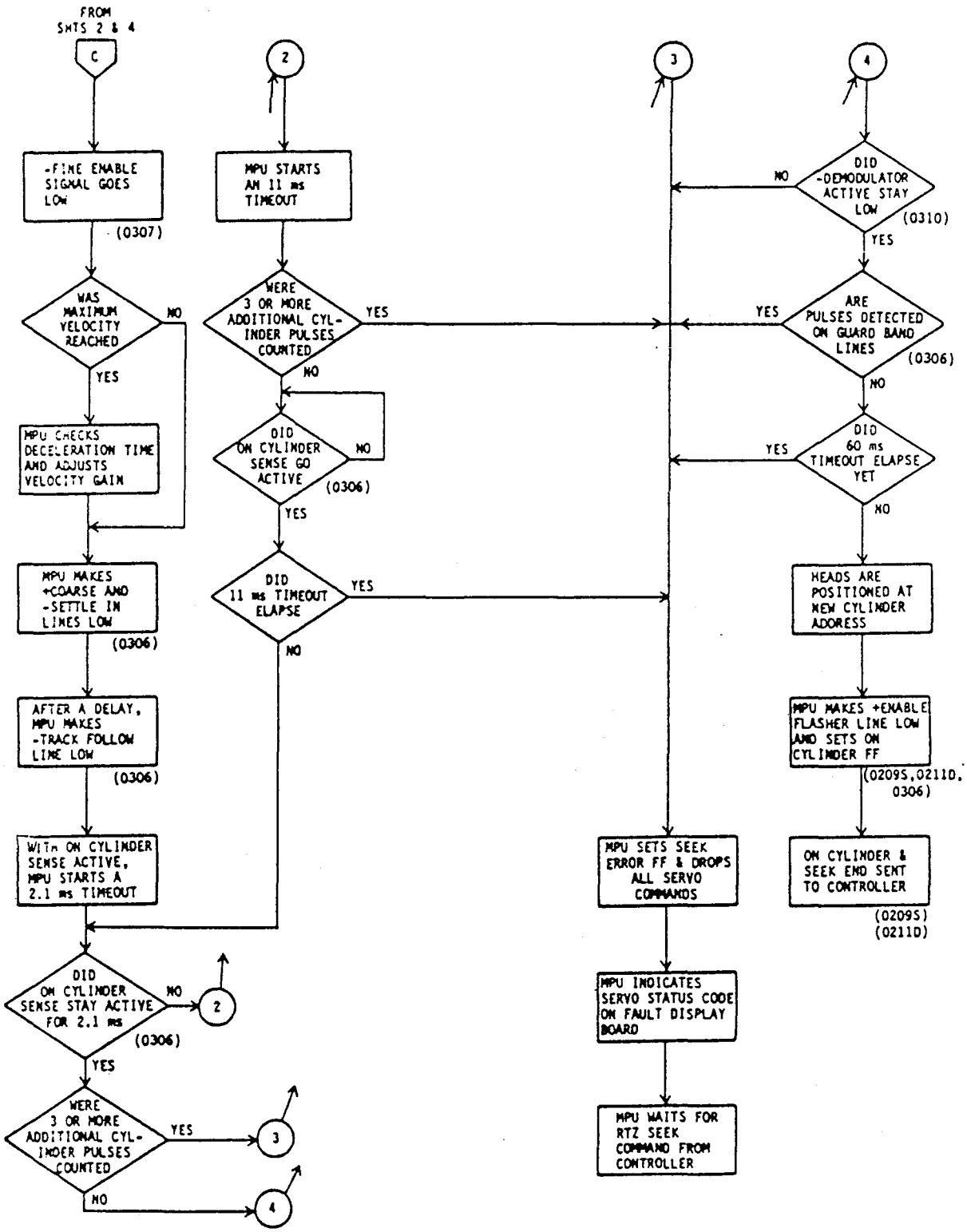
Normal Seek Flowchart (Sheet 2)



Normal Seek Flowchart (Sheet 3)



Normal Seek Flowchart (Sheet 4)



Normal Seek Flowchart (Sheet 5)

RETURN TO ZERO SEEK

During a normal seek operation, if a seek error occurs the only method of clearing it is to issue a return to zero command from the controller. (A seek error does not set the fault signal and therefore cannot be cleared by depressing the fault switch.) To do this the controller sets bit six true on the bus out and sends Tag 3 to the interface board.

When the bus out decode gate array on the interface board decode the return to zero it clears the cylinder register, the head register, on-cylinder FF and the seek error FF, all contained in the bus out gate array. The MPU receives a return to zero interrupt from the bus out gate array.

The return to zero interrupt will cause the MPU to stop the actuator motion and start moving it in an outward direction under coarse control. The acutator continues to move outward until the outer guardband is detected. Once the outer guardband is detected, the MPU checks for two cylinder pulses before reversing the direction of the actuator. The actuator begins to move toward Cylinder 0. The MPU must see at least one cylinder pulse for the outer guardband. There is one additional cylinder pulse detected before the heads reach Cylinder 0. With one third track to go fine control is enabled and course control is disabled.

The MPU checks that on-cylinder stays active for 2.1 ms. If it does not, the MPU will wait for up to 11 ms. for on-cylinder to go active and check it again. When on-cylinder stays active for 2.1 ms., the MPU checks other conditions that would indicate an error occurred before proceeding. These conditions are that there were not three or more cylinder pulses detected after on-cylinder was detected, that the servo signal is present and that no guardband is being detected. The MPU will continue if no error condition is found.

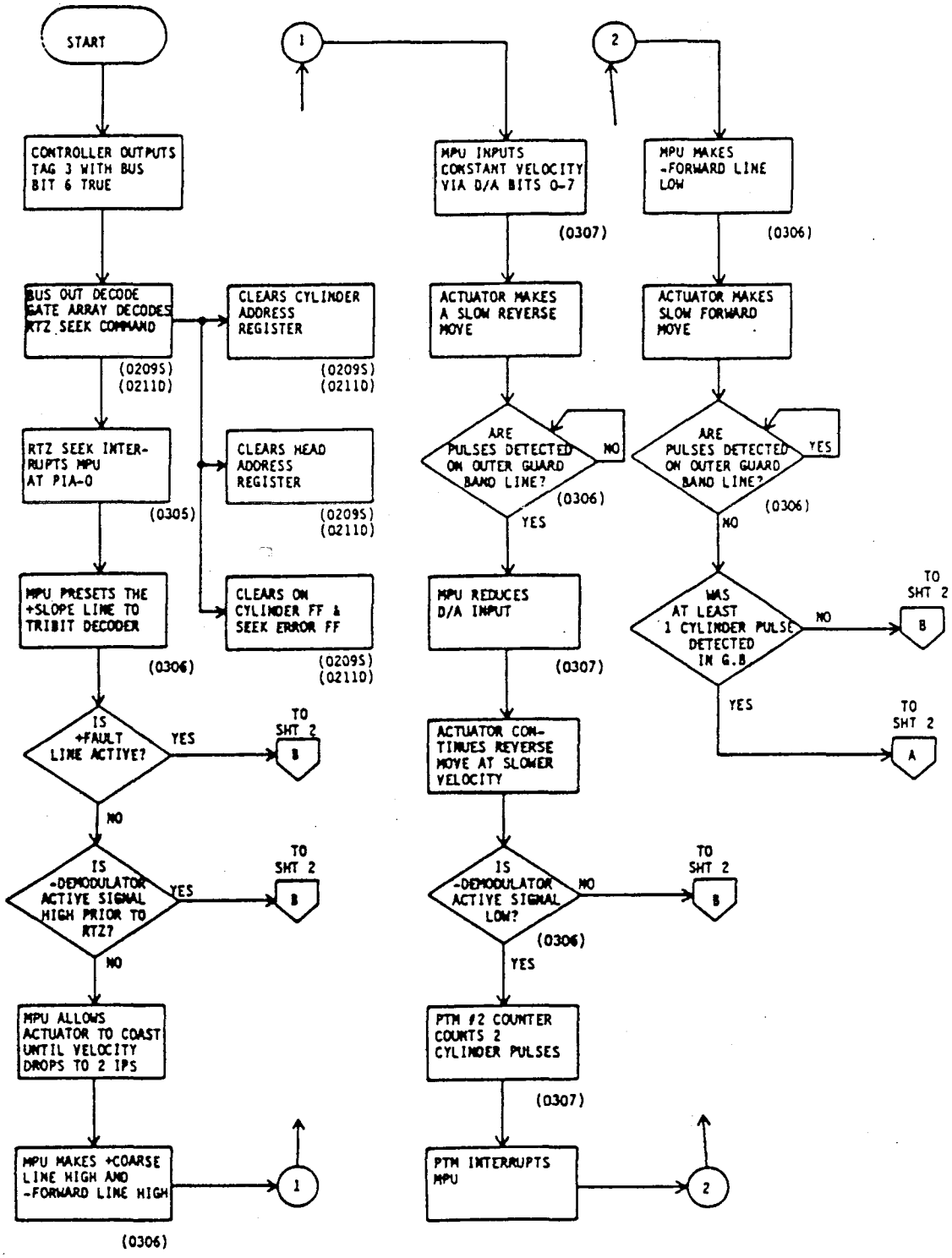
If the return to zero seek was completed in less than 60 ms. the MPU performs a velocity gain calibration. The ready light will be on steady and seek end and drive ready will be sent to the controller. The DD40 is now ready to receive commands from the DC40.

During the return to zero seek the MPU periodically checks condition that will determine if the operation should be continued. The following list shows the conditions that will cause the return to zero operation to be stopped.

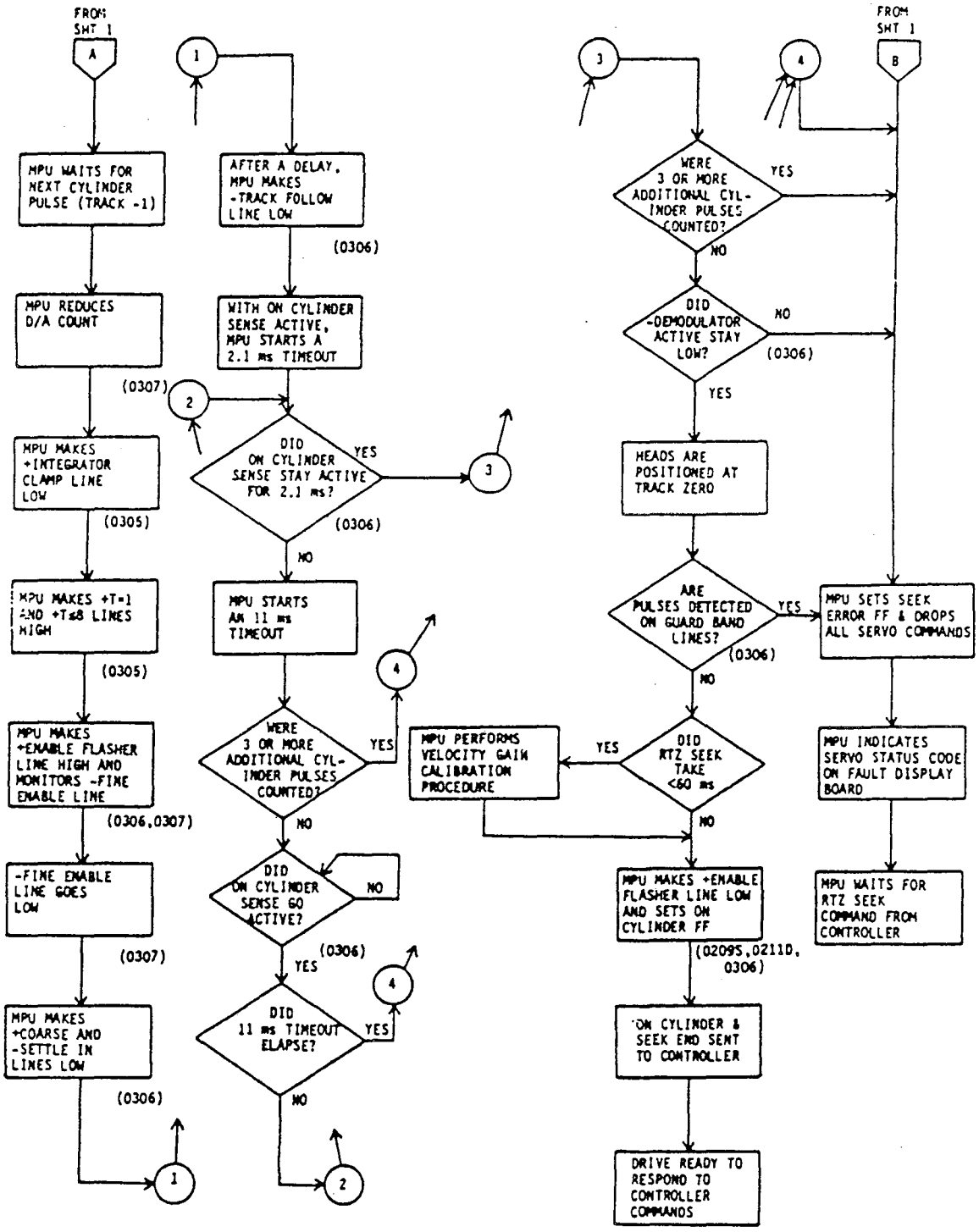
- -A fault is detected at the beginning of the return to zero.
- -The servo signal is not present at the beginning of the return to zero.
- -The servo signal is lost after the outer guardband is detected.
- -One or more cylinder pulses from the outer guardband was not detected before Cylinder 0 was found.
- -Three or more cylinder pulses are detected after Cylinder 0 has been detected.
- -When Cylinder 0 has been detected and on-cylinder is active, if on-cylinder goes inactive before 2.1 ms. and does not return to the active status in 11 ms.

Any of the above occurances will cause the MPU to set the fault light, flash the ready light, send servo status code to the fault display board and send seek error to the controller. The operating status select can be used by the controller to read the servo status code.

The return to zero flowchart gives a step by step flow of this operation.



Return to Zero (RTZ) Seek (Sheet 1 of 2)



Return to Zero (RTZ) Seek (Sheet 2)

2.6 WRITE CIRCUIT

Figure 2-6 is a block diagram of the write circuit. This circuit has four main parts: the write PLO, the 2 through 7 encoder, write compensation, and arm preamp. The write operation begins when the DC-40 controller sends tag 3 and bus-out bit 0 is true. The NRZ data starts coming from the controller at this time, synchronized by the 24.2 MHz clock. The servo clock is sent to the DC-40 controller and returned to the spindle as the write clock.

The write PLO generates the following:

- 24.2 MHz servo clock, which is sent to the controller by way of the I/O board.
- 12.096 MHz clock used in the read comparator
- 48.8 MHz 2F clock used in the 2 through 7 data encoder. The 2F clock is also used as an input to the frequency dividing circuit.

The 4.032 output from the divider is used for comparison with the 4.032 MHz reference frequency 4.032 MHz). This comparison keeps the 48.4 MHz 2F clock stable.

The encoder gate array changes NRZ data to 2 through 7 data. Table 2-4 shows the relationship between NRZ and 2 through 7 code words.

Table 2-4. Relationship Between NRZ and 2 Through 7 Codes

NRZ Code Words	2 Through 7 Code Words
00	1000
01	0100
100	001000
101	100100
111	000100
1100	00001000
1101	00100100

The NRZ data is broken down into seven NRZ code words. For each NRZ code word, there is a there is a corresponding 2 through 7 code word. The 2 through 7 encoder receives from the I/O board the following signals: write clock, write gate and write data. The encoder chip looks for one of the seven NRZ words. When a word is recognized, the 2 through 7 equivalent word is sent to the write compensate circuit. In the write compensate circuit, 2 through 7 data goes through a pulse shaping circuit, a shift register, and a patten decode. The purpose of this circuit is to compensate for peak shift in the data on the drive. The part of the circuit that compensates for peak shift is divided into two parts. One part is for tracks less than 768 (outer zone tracks) and one part is for tracks greater than 768 (inner zone tracks). The data is sent out on one of the four data lines early, late, normal, or block

R/W CARD

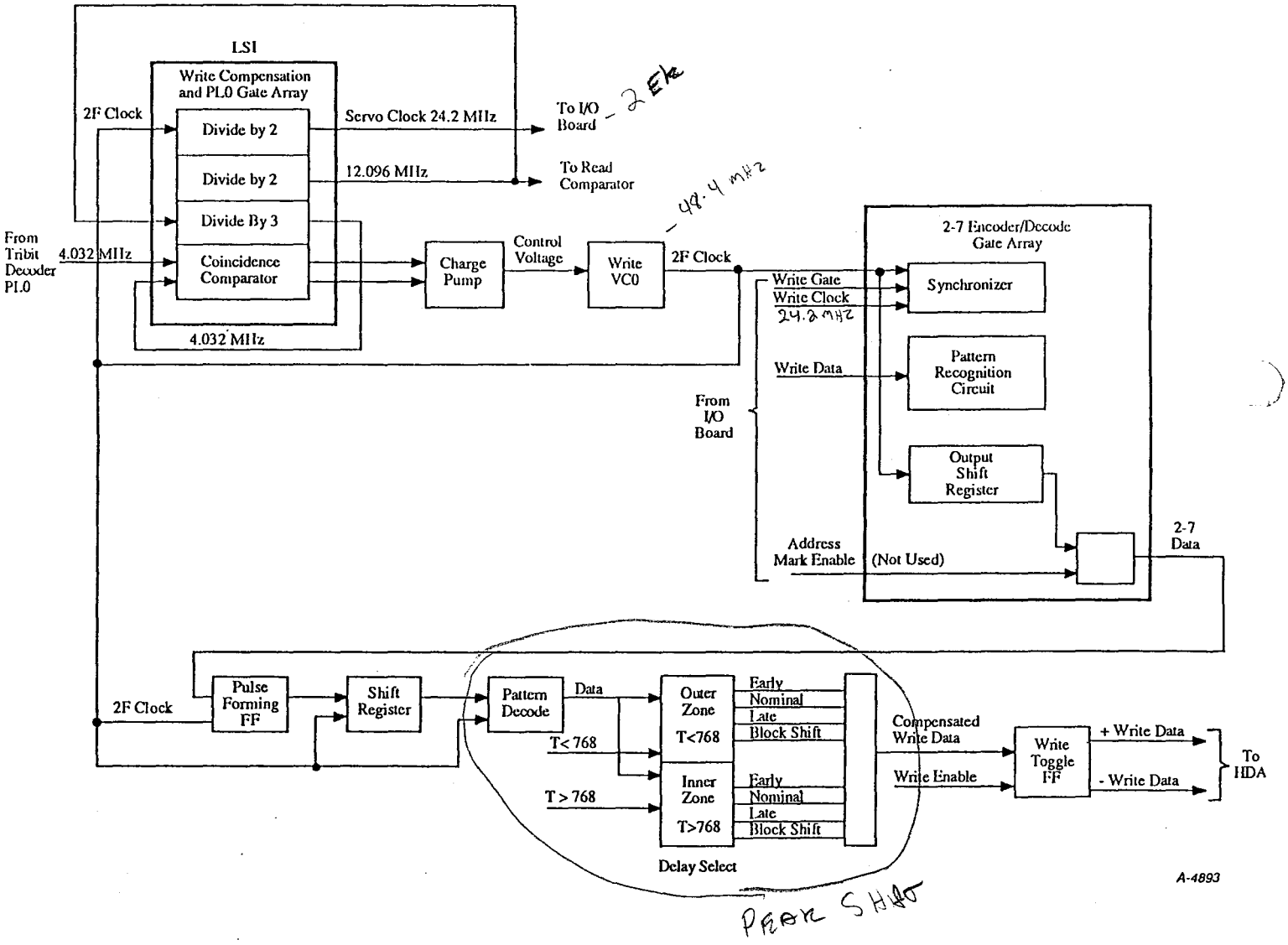


Figure 2-6. Write Circuit Block Diagram

shift. The write enable signal is used as an enable for the write toggle flip-flop (F/F). As a bit arrives on a data input line, the write toggle F/F toggles. If the F/F starts at 0, the first 1 bit sets it, the next clears it, and so on. From the write toggle F/F the data goes to the selected preamp inside the module and to the selected head.

The write enable allows the operation to continue as long as 1) write protect is off, 2) there are no faults, 3) the drive is at the correct speed, 4) the power amp is enables, and 5) the write gate is on.

2.7 READ CIRCUIT

Figure 2-7 is a block diagram of the read circuit. Data is read by the selected head and sent to the read buffer amplifier by way of the preamp. The data is split into low resolution data and high resolution data. Each kind of data is sent through a waveshaping network. When the data is changed from analog to digital data, it enters the data latch chip, which reduces the high frequency noise. From the data latch, the 2 through 7 data is sent to the read comparator and the PLO circuit, where the data is synchronized to the 48.4 MHz clock.

The data is sent to the 2 through 7 decode gate array, which looks for one of the 2 through 7 data words and sends out the corresponding NRZ data word. The NRZ data is synchronized to the 24.2 MHz read clock and sent to the controller by way of the I/O board.

2.8 FAULT AND ERROR CIRCUITS

Figure 2-8 shows the fault and error detection circuitry. There are two kinds of errors: those erros that are indicated by a fault and those that are not. When a fault is indicated, the XMD spindle sends the DC-40 controller fault and write protected. The MPU drops the ready signal and tries to identify the fault. The MPU reads the seven fault latches from the bus-out decode gate array and lights the corresponding LED on the fault display board.

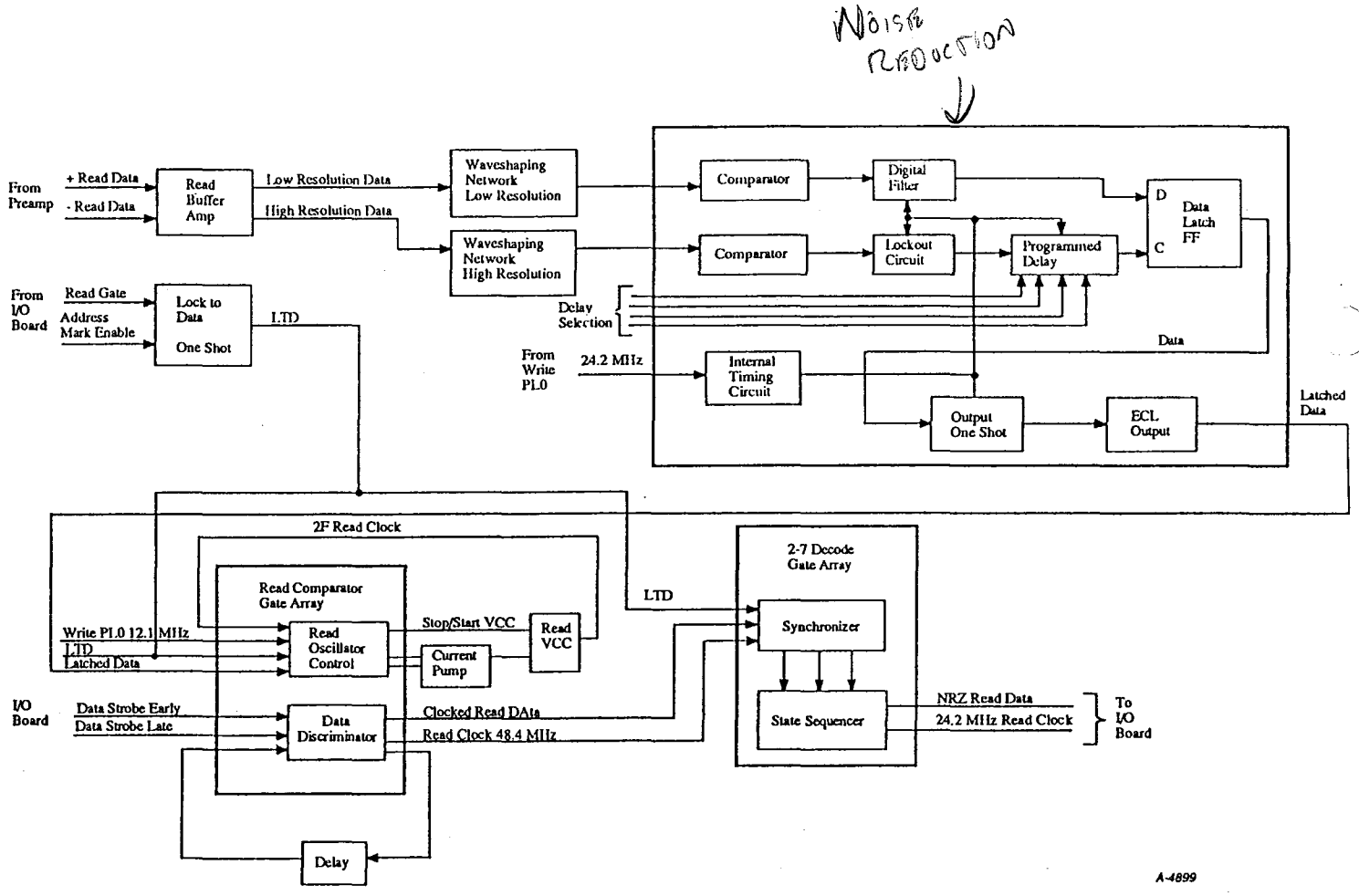


Figure 2-7. Read Circuit Block Diagram

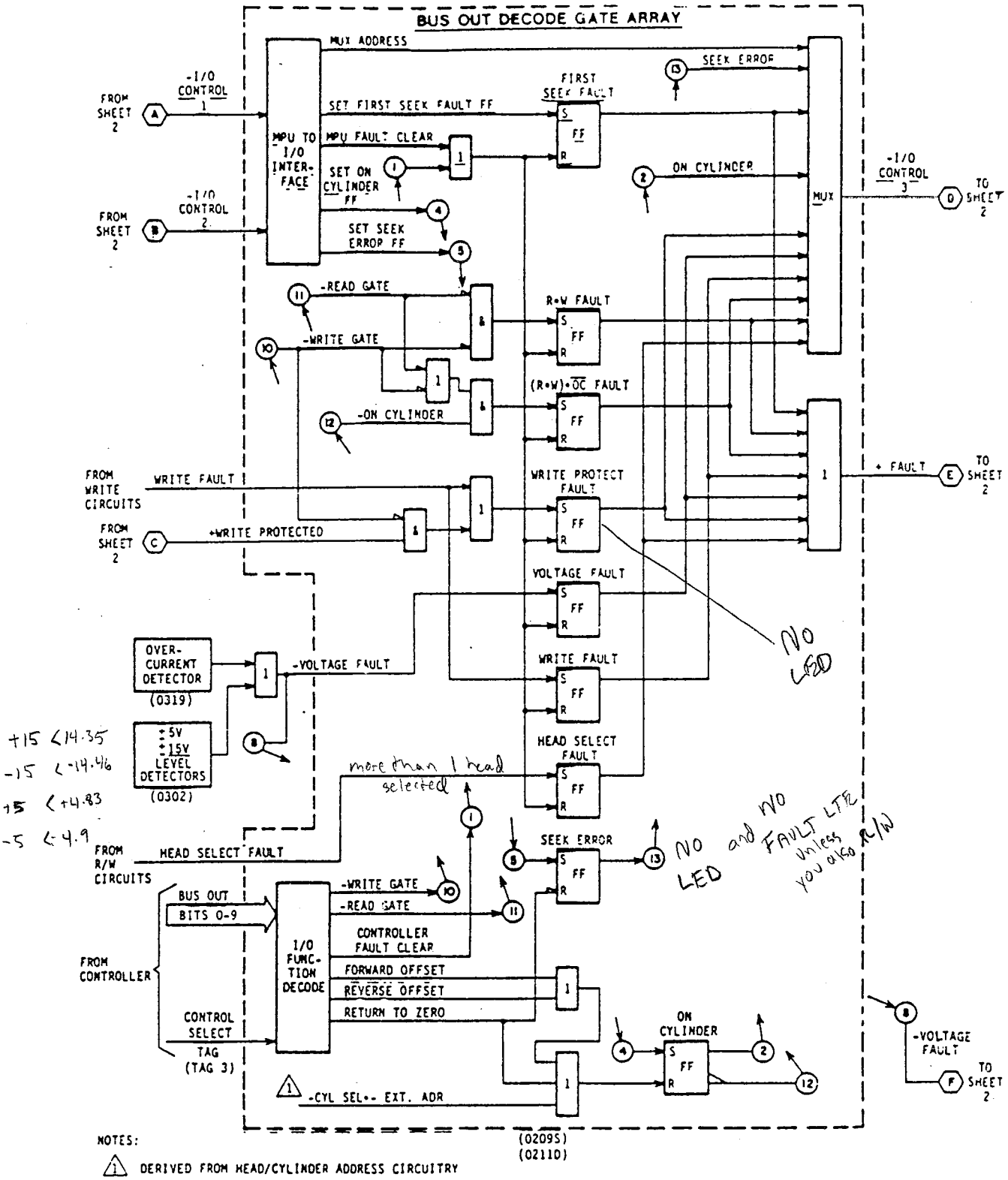


Figure 2-8. Fault and Error Detection Circuitry (page 1 of 2)

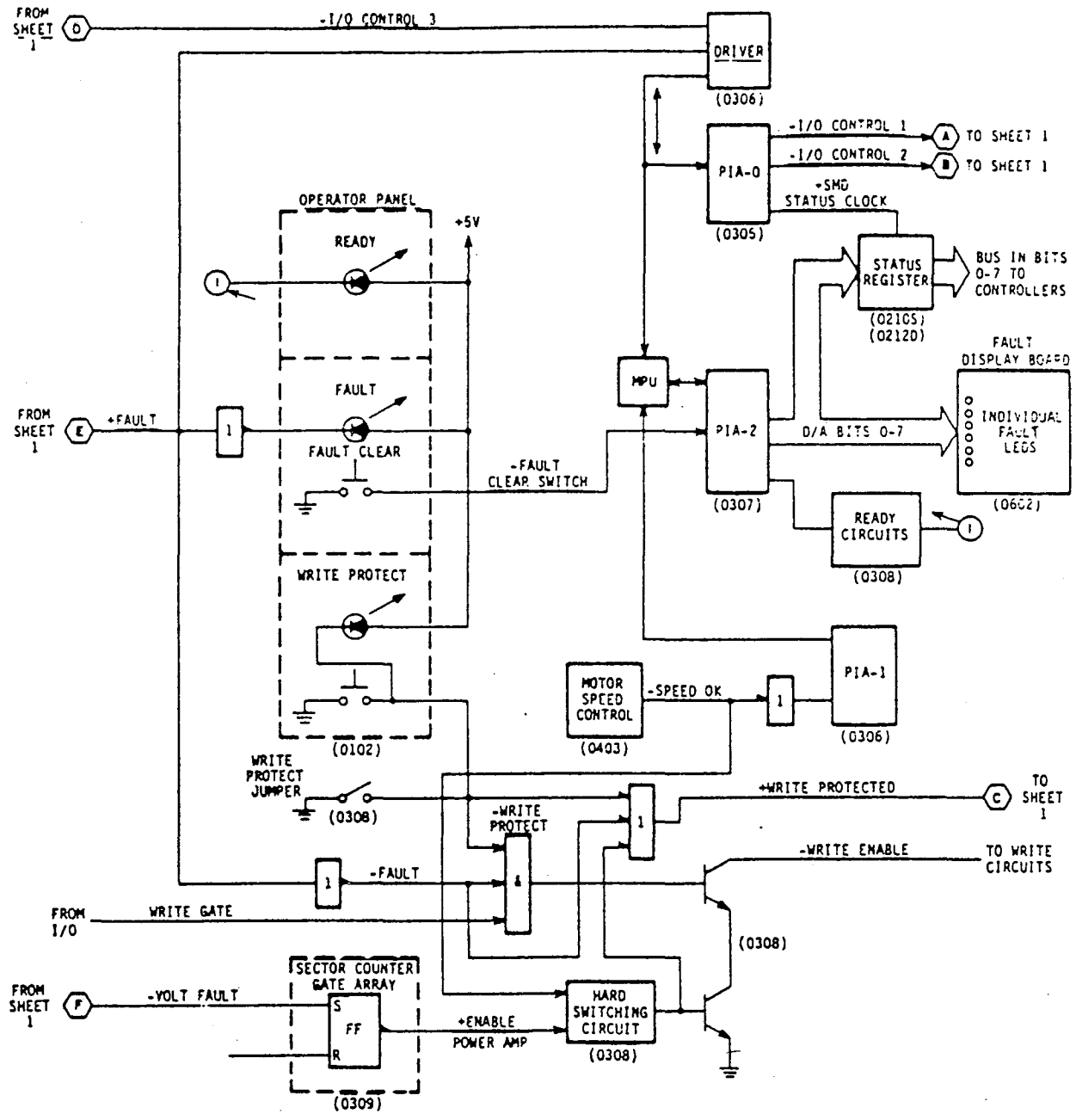


Figure 2-8. Fault and Error Detection Circuitry (page 2 of 2)

The fault light indicates the following faults:

- Voltage fault
- Read or write and off cylinder
- Write fault
- Head select fault
- Read and write fault
- Write and write protected fault*
- First seek fault

  * This signal does not have a corresponding LED on the fault display board.

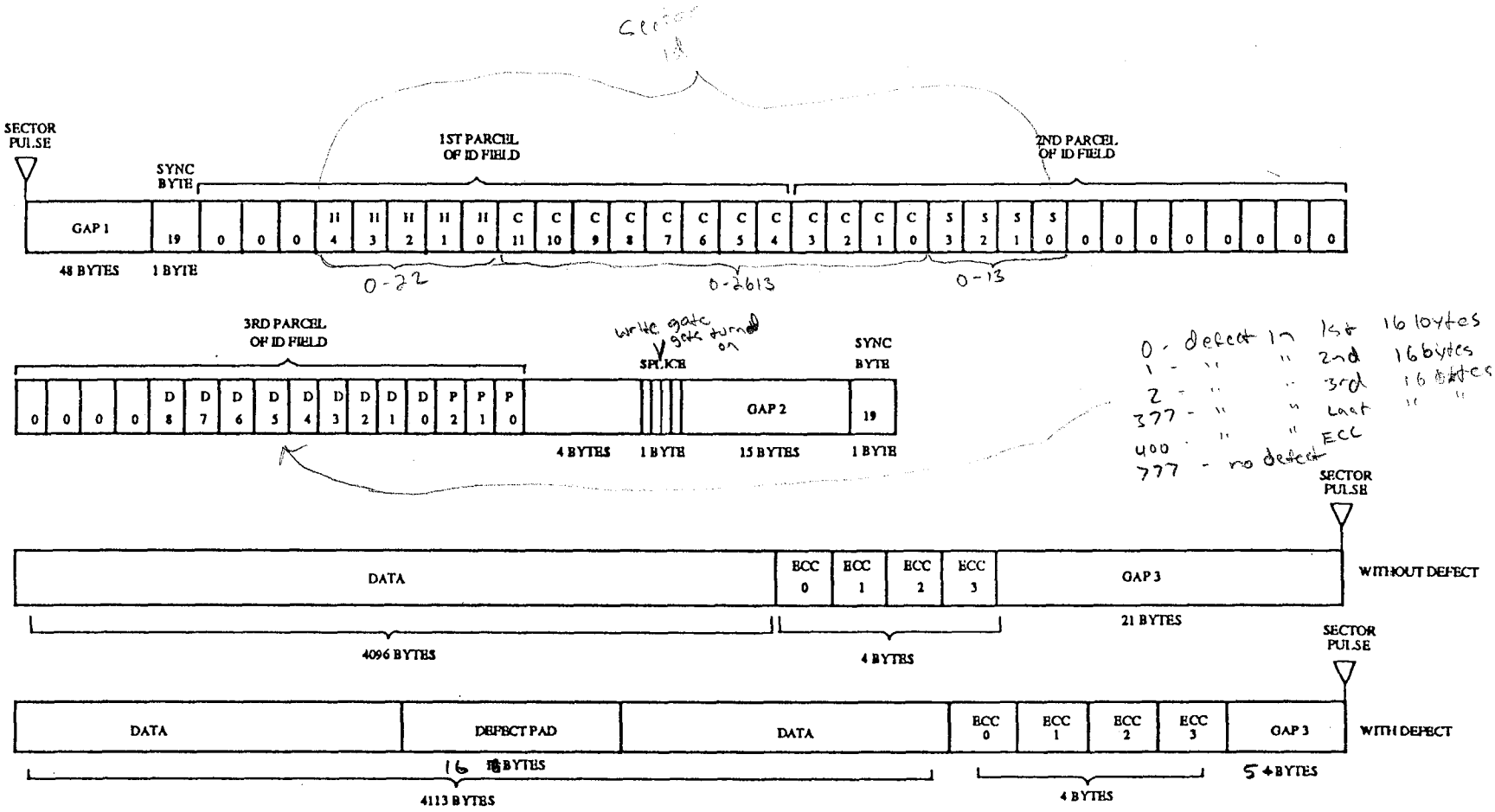
There are two error conditions that do not cause a fault: motor speed error (less than 2100 RPM) and seek error (cleared by RTZ).

For more information on the fault signals and errors, see pages 1-142 through 1-150 in Control Data manual 83325100.

DD40 SECTOR FORMAT

Each track in the 3340 is divided into 48 sectors, twelve sectors on each of the four spindles. The following figure shows the format of one sector. The length of one sector is 4198 bytes or 1866 servo bytes. The sector I.D. is six bytes in length. The first three bytes contain the actual I.D. of head, cylinder and sector. These three bytes are used on the 2EJ to detect when the correct sector is under the heads. The fourth byte is all zeros. The last two bytes contain the defect parameter which is protected by three bits of parity. The defect parameter is used on the 2EK to point to where within the data field the defect appears. When the head reaches the defect in the data field, the defect parameter is used to disable the read or write logic until the 17 byte defect pad has passed under the data head.

The bottom half of the diagram shows a data field without a defect and one with a defect. Notice that the last gap (Gap 3) is 17 bytes shorter when there is a defect than when there is no defect. The same amount of data is written in the data field and the sector has the same number of total bytes whether or not there is a defect. The data field is followed by four bytes of Error Correction Code (ECC) which is generated by the 2EK on the data field. Gap 3 is normally 21 bytes if there is no defect present in the data field or 4 bytes if a defect exists in the data field. There are two sync bytes in each sector, one prior to the I.D. and the other prior to the data field.



A-4427

H0-4 = Head 1-19 decimal, 0-22 Octal

C0-11 = Cylinder 0-1420 decimal, 0-2614 Octal

S0-3 = Sector 1-12 decimal, 0-13 Octal

D0-8 = Defect parameter If there is no defect in the sector, the parameter equals all 1's

P0-2 = Defect Parity Bits

XMD SECTOR FORMAT

Unhiddable flaw
1) id field = all one's
2) flaw entry defect parameter = 7777

cyl 2612 User Flaw table
unhiddable flaws
hiddable flaws
7777 7777 7777 7777 7777

3. CABLING

Figure 3-1 shows the cable connections between a DCU-5 in the IOS and a DC-40. Each controller in the DC-40 is connected to a DCU-5 by a bus-in and bus-out cable. Two DCU-5's can be connected to each controller (one through the A port and one through the B port). One DCU-5 can access a controller at a time.

The cable between the DCU-5 and the DC-40 is normally 50 ft long, but it can be up to 80 ft long.

Figure 3-2 shows the DD-40 drive configuration and bulkhead cable ports. Figure 3-3 shows the cable connections of a DC-40 controller to primary and shadow DD-40's.

Each controller can be cabled to a primary and a shadow DD-40. A controller has eight cables, four A cables and four B cables. The four A cables are connected to four IN ports, one for each drive, in the primary DD-40. If there is a shadow DD-40 on the controller, A cables are connected from OUT ports on the primary DD-40 to IN ports on the shadow DD-40.

Two B cables are connected from the controller to the primary DD-40 and two to the shadow DD-40. Each B cable contains identical sets of signals. One B cable contains the signals for spindles A and B and the other contains the signals for spindles C and D. Each B cable separates into two cables, one for each spindle, when it goes from the bulkhead to the back of the DD-40. Unlike the A cables, the B cables are not daisy-chained from the primary to the shadow DD-40. Separate B cables carry the B cable signals from the DC-40 to the shadow DD-40.

The A and B cables are connected from the bulkhead to the back of the spindles. The cables that make this connection are 10 in. longer for a given spindle than for the spindle below it. If a shadow DD-40 is not connected to the controller, a terminator on the primary DD-40 terminates the A cable signals. If a shadow DD-40 is connected, A cables take the signals from the spindles to the OUT ports on the bulkhead, from which they can be linked to the shadow DD-40. The A cables are terminated on the shadow DD-40.

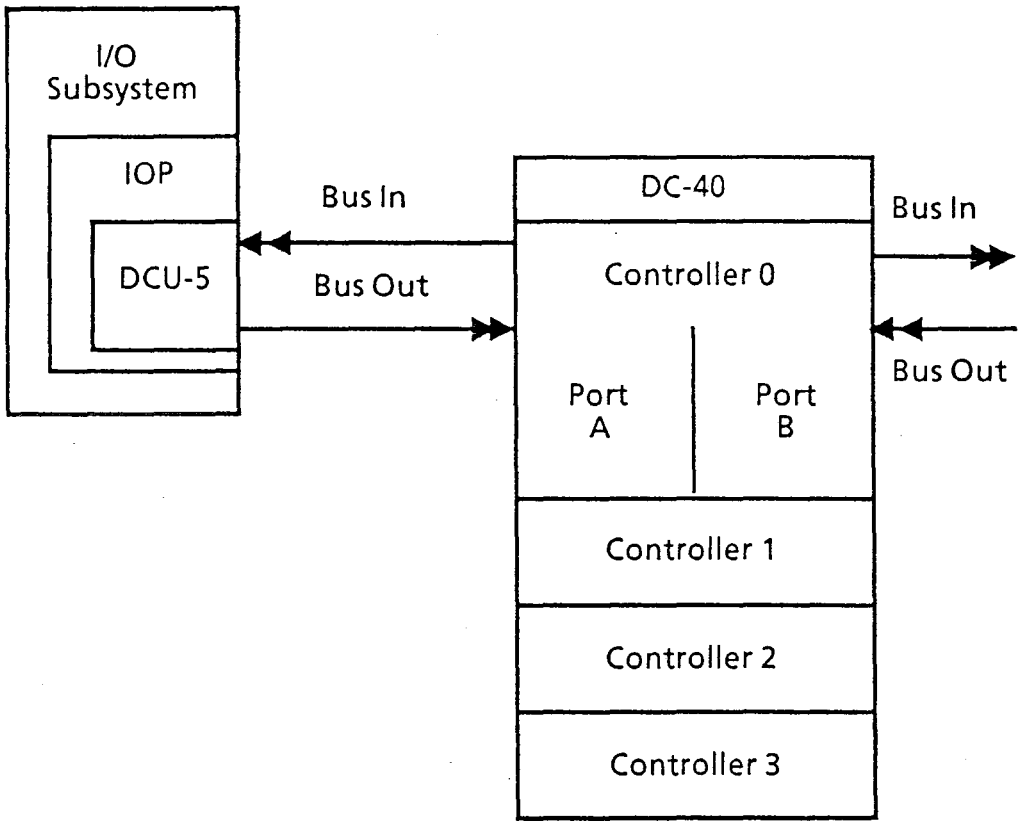


Figure 3-1. DC-40 to IOS Communication

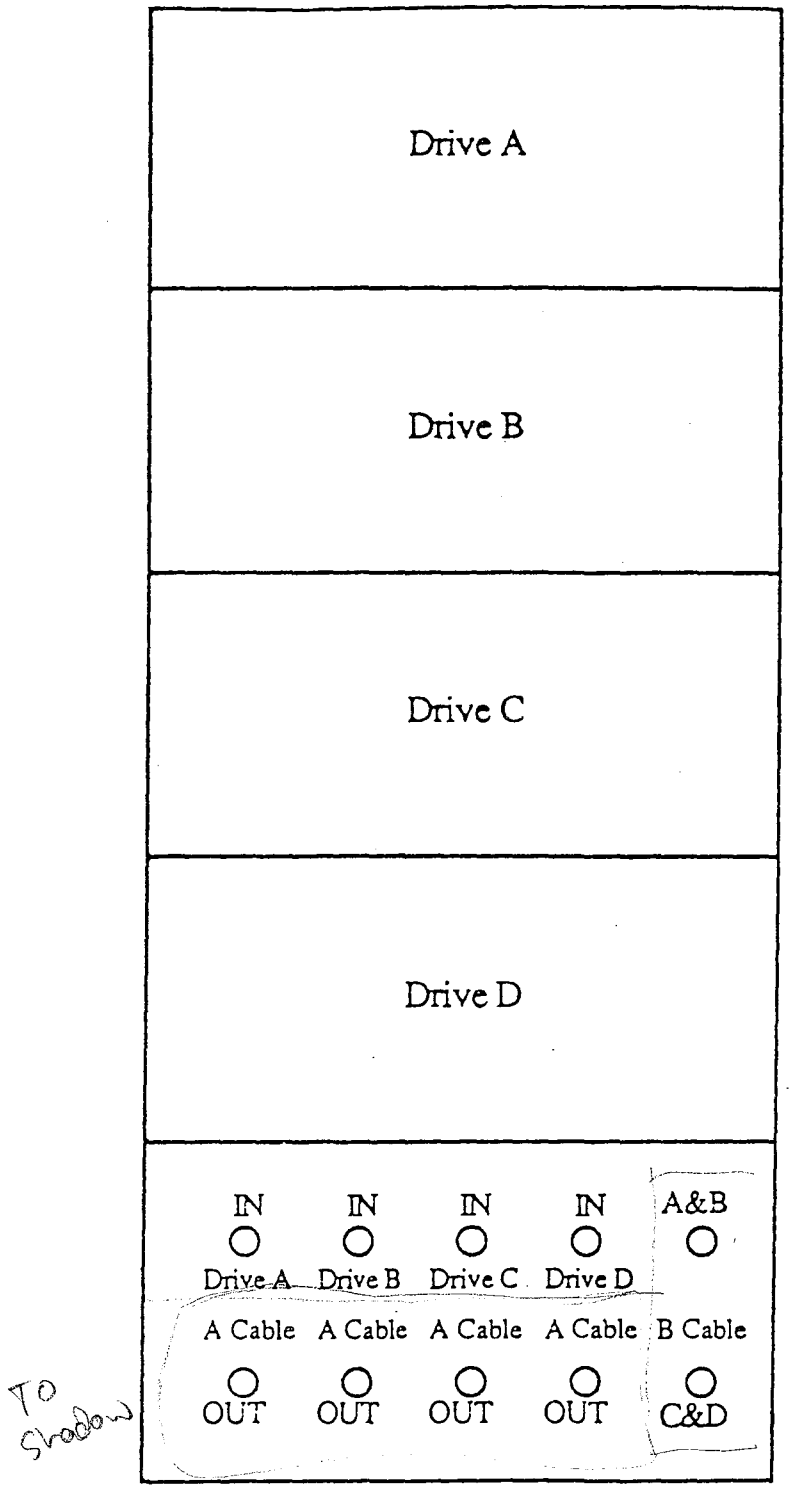


Figure 3-2. DD-40 Drive Configuration and Bulkhead

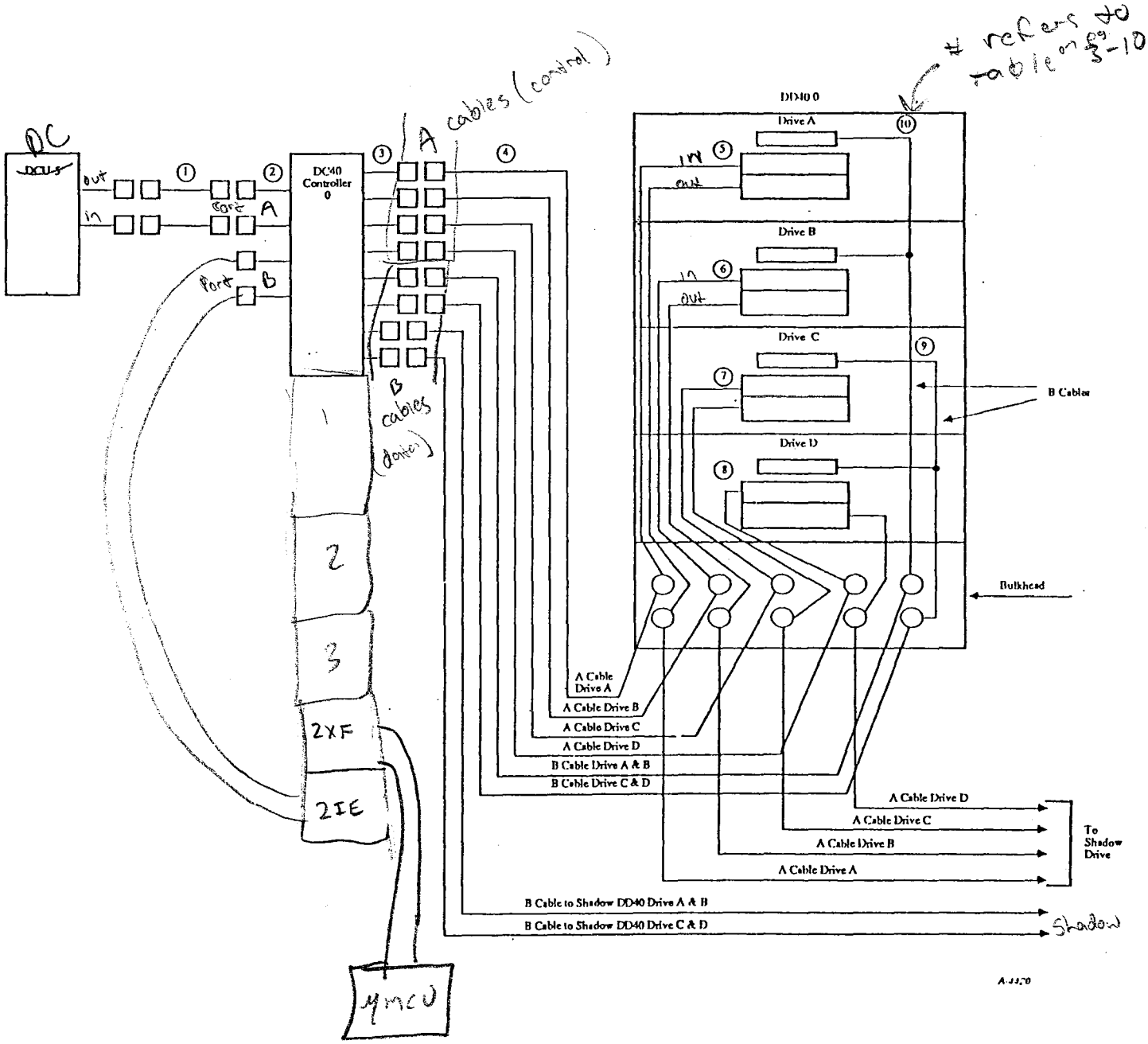


Figure 3-3. DC-40/DD-40 Cabling Diagram

Table 3-1 lists the pin assignments for the A cable that connects the DC-40 controllers to the primary and shadow DD-40s. Table 3-2 describes the A cable signals.

Table 3-1. A Cable Pin Assignments

Signal Name	Inverted Pin	Normal Pin
Unit select Tag	22	52
Unit select 1 (Bit 0)	23	53
Unit select 2 (Bit 1)	24	54
Unit select 3 (Bit 2)	26	56
Tag 1 - Cyl select lower 10 bits	1	31
Tag 2 - Head addr., upper 2 cyl addr.	2	32
Tag 3 - control bits	3	33
Tag 4	30	60
Tag 5	27	57
Bus 0	4	34
Bus 1	5	35
Bus 2	6	36
Bus 3	7	37
Bus 4	8	38
Bus 5	9	39
Bus 6	10	40
Bus 7	11	41
Bus 8	12	42
Bus 9	13	43
Status 0	19	49
Status 1	17	47
Status 2	16	46
Status 3	15	45
Status 4	28	58
Status 5	20	50
Status 6	18	48
Status 7	25	55
Open cable detect	14	44
Busy	21	51
Spindle sequence pick		29
Spindle sequence hold		59

Table 3-2. XMD A Cable Signals

Signal	Description
Unit select tag	This signal is sent to the drive along with unit select bits 0 through 2 to select the desired unit.
Unit select bits 0 through 2	These signals must be active at least 200 ns before the unit select tag becomes active. Only unit select bit 0 is used by the DC-40 to select either the primary (2^0 = 0) or shadow (2^0 = 1) DD-40. (Unit select bit 3 is used on tag 5.)
Tag 1	Lower cylinder select, bits 2^0 through 2^9. (When doing a cylinder select, the higher bits must be sent first.)
Tag 2	Head select/higher cylinder bits. Head select bits are represented in bus-out bits 2^0 through 2^4. The upper cylinder bits (2^{10} and 2^{11}) are represented by bus-out bits 2^7 and 2^8. (The upper cylinder bits must be sent before the lower cylinder bits.)
Tag 3	Enable the control bits to be sent out on the bus. When the bus-out bit is active, it controls the following in the XMD: • 2^0 - Write gate • 2^1 - Read gate • 2^2 - Offset - offsets positioner toward the spindle. • 2^3 - Offset - offsets positioner away from the spindle. • 2^4 - Clear fault • 2^5 - Not used • 2^6 - RTZ • 2^7 - Data strobe early • 2^8 - Data strobe late • 2^9 - Not used
Tags 4 and 5	Selected status

Table 3-2. XMD A Cable Signals (continued)

Signal	Description
(See the trouble shooting section for a description of the individual status words.)	Tag 4 - Sector status Tag 5 - Extended status B0B0 = 0 B0B1 = 0 Tag 5 - Operating status B0B0 = 1 B0B1 = 0
Tags 4 and 5	Selected status Tag 5 - Diagnostic status B0B0 = 0 B0B1 = 1 Tag 5 - Diagnostic execute status B0B0 = 1 B0B1 = 1
Open cable detect	Disables the DD-40 when a loss of power in the DC-40 occurs.
Pick	DC-40 ground
Hold	DC-40 ground
Bus-in bits 0-7	Drive status or selected status

Table 3-3 lists the pin assignments for the B cable that connects the DC-40 controllers to the primary and shadow DD-40s. Table 3-4 describes the B cable signals.

Table 3-3. B Cable Pin Assignments

Signal Name	Inverted Pin	Normal Pin
Ground	A	B
Servo Clock 24.2 mHz	b	c
Read Data	a	V
Ground	D	E
Read Clock 24.2 mHz	d	e

Table 3-3. B Cable Pin Assignments (continued)

Signal Name	Inverted Pin	Normal Pin
Write Clock	w	x
Ground	F	G
Write Data	f	g
Unit Selected	J	H
Seek End	h	i
Ground	y	z
Index	JJ	KK
Sector	GG	HH
Ground	NN	PP
Ground	AA	BB
Ground	MM	LL
Servo Clock	DD	CC
Read Data	FF	EE
Ground	j	k
Read Clock	K	L
Write Clock	m	n
Ground	N	P
Write Data	p	q
Unit Selected	S	R
Seek End	r	s
Ground	T	U
Index	t	u
Sector	V	W
Ground	C	X
Ground	Y	Z

The B cable signal for spindles A and B share one 55-pin cable between the DC-40 and the DD-40. The B cable signals for spindles C and D are shared by another cable.

Table 3-4. XMD B Cable Signals

Signal	Description
Write data	NRZ data to XMD

Table 3-4. XMD B Cable Signals (continued)

Signal	Description
Write clock	Clocks write data into the drive (24 MHz/41.3 ns)
Servo clock	Used by the DC-40 to synchronize the transfer of write data to the servo clock (24.192 MHz/41.3 ns)
Read data	NRZ data from XMD
Read clock	24 MHz/41.3 ns
Seek end	Seek end with on-cylinder indicates the seek was completed as expected. Seek end without on-cylinder indicates a seek error. When a diagnostic execute status is performed, seek end indicates test execution is complete.
Unit selected	This is the response to a unit select tag and a match between the unit select bits and drive address.
Index	Decoded from servo tracks once per revolution.
Sector	Twelve sector pulses per revolution. This is determined by the setting on the sector switches.

Table 3-5 gives the part numbers of the drop and interconnect cables for the DCU-5, DC-40, and DD-40. The reference numbers correspond to the numbers on Figure 3-3.

Table 3-5. Part Numbers of the Drop Cables and Interconnect Cables

Cable	Number
DC-40 to DCU-5 Interconnect Cables	① Cable PN 10559201 Socket PN 01106500 Plug PN 01106600
DC-40 Drop Cables (to DCU-5)	② Bus In Cable PN 02203500 Bus Out Cable PN 02203501 55 Pin Socket PN 01106500 55 Pin Plug PN 01106600
DC-40 Drop Cables (to DD-40)	③ A and B Cables PN 12021000 61 Pin Plug PN 01110400
DD-40 to DC-40 and DD-40 to DD-40 Interconnect Cables	④ A and B Cables PN 01110500
DD-40 Bulkhead to Disk Drive Cables	⑧ A Cable - 70" - PN 12019700 ⑦ - 80" - PN 12019701 ⑥ - 90" - PN 12019702 ⑤ -100" - PN 12019703 ⑨ B Cable - 70/80" - PN 12019800 ⑩ -90/100" - PN 12019801
A and B Cable 61-Pin Bulkhead Connector	PN 01234600
A Cable 60-Pin Flat-Cable-Type Connector	PN 01311300
B Cable 26-Pin Flat-Cable-Type Connector	PN 01311200

4. THEORY OF OPERATIONS

This section is a theory of operations for the modules of the DC-40. The DC-40 has the following modules:

- 2EI channel interface module - receives data from the DCU-5 on a write and passes data to the DCU-5 on a read.
- 2EB full-track buffer module - buffers read and write data.
- 2EM disk multiplexer module - provides control for reads and writes.
- 2EJ disk controller module - controls an XMD spindle in the DD-40.
- 2EK disk-data and error-correction module - performs error correction and defect detection on data read from the disk.

A DC-40 has four controllers. Each controller has four 2EJ modules and one of each of the other modules. A controller can control one primary and one shadow DD-40, each of which has four XMD spindles.

The DC-40 adapts the signals and protocol of the DCU-5 to the spindles in the DD-40. The DC-40 performs the following functions:

- Controls up to 32 DD-40s.
- Buffers read and write data transfers between the DCU-5 and the DD-40s.
- Passes control functions to the selected spindles.
- Generates error-correction codes for write data.
- Checks read-correction codes and and computes a correction vector for correcting read data.
- Controls the distribution of read/write data over 48 sectors per cylinder using 12 sectors from each of the four spindles.
- Passes status from the spindles to the DCU-5.

Figure 4-1 is a chassis map of the DC-40. Figure 4-2 is a block diagram of the DC-40.

4.1 2EI MODULE

The 2EI module (see figure 4-3) receives write data from the DCU-5 and sends it to the 2EB module's full-track buffer. The 2EI module also receives read data from the full track buffer and sends it to the DCU-5. There are two ports on the 2EI module, so that data can be received from or sent to different locations on each port. Port A or B must be selected before data can be sent through the port. The port is selected with either a select the port function (010007) or a select the DD-40 drive function. A 010001 select code specifies the shadow DD-40 and a 010000 select code specifies the primary DD-40.

4.1.1 2EI MODULE - FUNCTION DECODE

When the DC-40/DD-40 receives a function code from the DCU-5, a 4-bit function code is latched into the F terms and a corresponding 16-bit function parameter is latched into the A terms. (Port A or B must be selected.) The same clock is used to clock in the function code, the function parameter, and data when doing a write. Once the function code and function parameter are latched, the function code is sent to the function decode. At the same time, the function code and function parameter go to the parity checking circuit.

The following three conditions block the go function (term QO) from going to the 2EM module: command error (term B12), parity error (term F41), and diagnostic mode (term F30). Two clock periods (CPs) pass after the function is latched before go function (term R48) and the function code (terms R49 through R52) are sent to the 2EM module. They are followed by the function parameter in the next 4 CPs, 4 bits each CP.

4.1.2 2EI MODULE - WRITE

When data is received from the DCU-5, it passes through the U terms and is latched in terms A20 through A36 for port A or terms A40 through A56 for port B (terms A36 and A56 are parity bits.) The data and the parity bit are sent to the parity checking circuit. If a parity error is detected on a data transfer, it is flagged in the general status. From the A terms, the data enters terms A0 through A15 and is latched in the M terms. Terms M0 through M15 receive the even parcels and terms M20 through M35 receive the odd parcels. The odd parcels go to bank A and the even parcels go to bank B on the 2EB module.

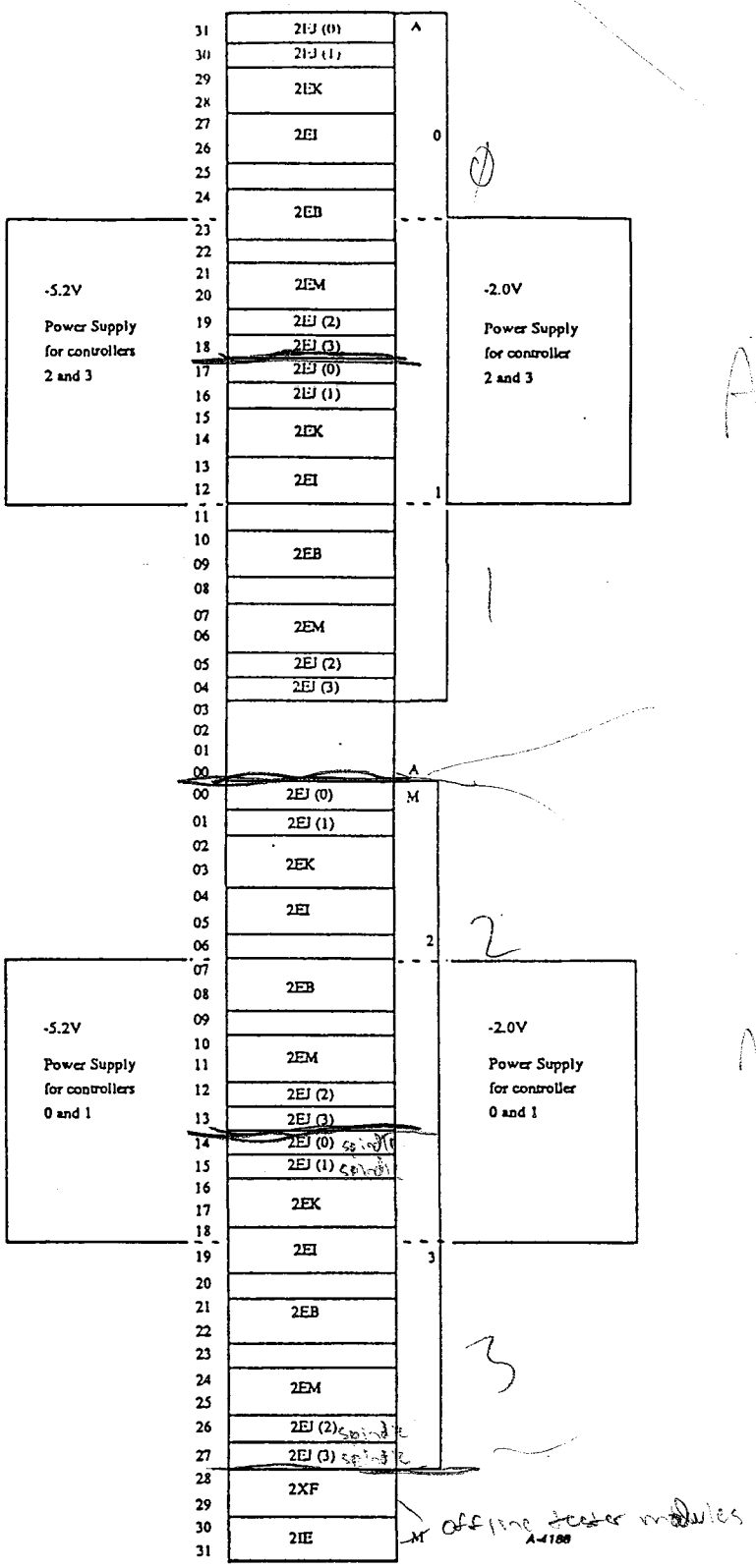


Figure 4-1. DC-40 Chassis Map

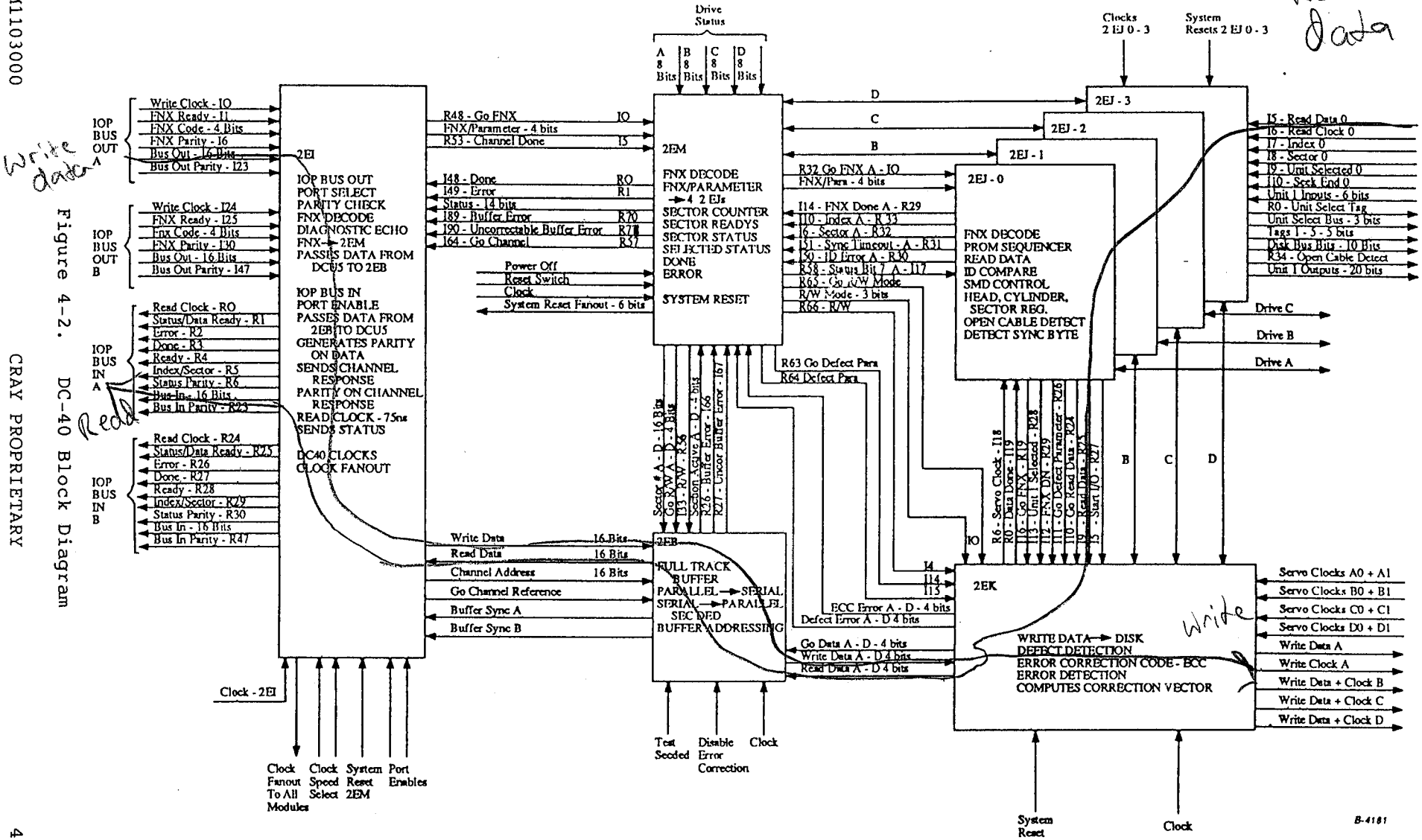


Figure 4-2. DC-40 Block Diagram