Model DC-297

Disk Controller

Technical Manual

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REVISION HISTORY

ECO No.	Date	Description	Pages
0585	3/25/86	Incorporate cableless paddleboards	2-1
0593	4/15/86	Add Slip Skip	
0648	8/4/86	Add External Ground Wire to FCC cables	2-17
0974	8/28/87	Fix RAM Arbitration problem	1-9,2-5

PREFACE

This manual contains information regarding installation, testing, and operation of the ZETACO Model DC-297 Disk Controller.

The technical contents of this manual have been written based on the assumptions that the reader 1) has a working knowledge of Data General computer hardware (or has access to hardware documentation) and the operating system; 2) has some familiarity with standard installation, power, grounding and peripheral cabling procedures; and 3) has access to technical information about the disk drive(s) that will be installed with this controller.

The information in this manual is organized into five major sections:

SECTION 1.0	PRODUCT OVERVIEW - Describes the Model DC-297 Disk Controller's features, capabilities, specifications, power and interface requirements.
SECTION 2.0	INSTALLATION PROCEDURES - Contains procedures for unpacking and installing the controller, tailoring it for the system requirements, testing disk subsystems and initializing disk media.
SECTION 3.0	TROUBLE-SHOOTING, TEST PROGRAMS and CUSTOMER SERVICE - Contains information useful in fault analysis and how to get help.
SECTION 4.0	USAGE GUIDELINES - Contains information explaining the use of the DC-297 features in the system environment.
SECTION 5.0	PROGRAMMING NOTES - Contains detailed technical information for those involved in fault analysis or programming.
APPENDIX A	PROGRAM DESCRIPTIONS
APPENDIX B	TEST PROGRAMS FOR SYSTEM PROBLEMS
APPENDIX C	VIRTUAL MAPPING

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1.0 PRODUCT OVERVIEW

1.1 GENERAL DESCRIPTION

ZETACO's Model DC-297 Disk Controller is a versatile, high performance interface, designed to link up to 4 SMD disk drives to a Data General Nova or Eclipse minicomputer via the Data Channel (DCH). DC-297 emulates DG's 606X, 61XX, and 6214 (Zebra, Kismet, Vulcan) disk subsystems, and includes a feature called Virtual Mapping that yields higher capacity storage from drives that map out inefficiently under normal DG operating system parameters. No patching is required for RDOS or AOS use.

Drives with up to 2.5 MB/sec data transfer rates are supported.

DC-297 is compatible with both the FCC-compliant and the non-FCC chassis. In an FCC-compliant chassis, the Controller MUST be installed in an "I/O Only" slot; in the non-FCC chassis, the Controller may be in any Memory, Memory I/O, or I/O Only slot. Disk interface cabling is via the computer backpanel in the FCC chassis, and via the SMD header connectors on the board edge in the non-FCC chassis.

Up to four disk drives of differing sizes and transfer rates may be attached. The Disk Controller has been designed to provide optimum system throughput and reliability, and to achieve the most efficient use of the full capacities of the disk drives.

The Controller's architecture employs a dedicated microprocessor, buffers and bus acquisition control to maintain individual disk performance.

The DC-297 uses EEPROM Memory (nonvolatile, reprogrammable memory) for controller configuration. The 1/2 inch tape included with the Controller contains a configurator program used to set up the Controller with disk information and optional controller features.

The DC-297 Controller is warranted against defects in material and workmanship for up to two full years from date of factory shipment.

1.2 FEATURES - ADVANTAGES

*High speed microprocessor design supports transfer rates up to 2.5 MB per second

*Virtual Mapping allows higher formatted capacities from non-DG standard disk drives

*EEPROM Configurator Program eliminates switches, provides total software configurability in a user friendly format

*Simultaneous control of up to four SMD interfaced disk drives with varying capacities, transfer rates and media formats

*Optional shielded cabling is in compliance with FCC for RF Emission

*Sector Slip option eliminates operating system overhead associated with management of bad sectors for certain critical applications

*Incorporates an 11-bit SMD tag bus to accommodate full capacity of the larger drives

*Two sector Ping-Pong buffer

*User-definable sector interleaving

*Adjustable DCH throttle control

*Offset positioning for data error recovery

*Automatic data strobe early/late for data error recovery

*Two methods of power fail detection

*Logs the number of data corrections that have occurred on a per unit basis

*One second delay Pick/Hold on power up controls disk drive power sequencing

*Header CRC error auto re-try

*Supports dual ported drives (dual processor)

*User-definable header Sync Byte

*Fairchild "FAST" logic increases performance and reduces power consumption

1.3 SPECIFICATIONS

1.3.1 FUNCTIONAL CONTROLLER CHARACTERISTICS

Drives Per Controller:	Up to 4 single-volume or up to 2 dual-volume
Media Format:	5 available formats selectable per port with user-defined sync byte (see Figure 1.2 for detailed information)
Sector Organization:	Contiguous, or variable interleaving
Error Correction Code:	32-bit polynomial; detects and corrects burst errors up to 11 bits.
Transfer Rate:	Up to 2.5 MB per second (20 Mhz bit rate)
Emulation:	Data General 6060, 6061, 6067, 6160, 6161, 6122 and 6214 Disk Subsystems
Indicator LEDS: (See Figure 1.1)	YELLOW: UNIT DE-SELECTED - if this LED is on, it indicates that no disk units are currently selected. Either no DOA has yet been issued, or the controller is not receiving disk status properly, or the CPU issued a release command and the controller is configured for dual port enabled.

GREEN: DISK CONTROLLER BUSY - If this LED is on, it indicates that the disk controller busy flag is set.

RED: SELFTEST - when this LED is on, the controller is executing selftest. If selftest fails, the LED displays the error code by blinking on and off.

1.3.2 COMPUTER INTERFACE

The DC-297 uses the standard DG I/O and Data Channel interface, and supports standard or high speed data transfers.

CAUTION: WHEN JUMPERED FOR THE FCC CHASSIS, THE DC-297 CONTROLLER MUST BE INSERTED IN AN "I/O ONLY" SLOT. COMPONENT DAMAGE MAY OCCUR IF A SLOT OTHER THAN I/O ONLY IS USED. ZETACO'S WARRANTY IS VOID IF A NON-I/O ONLY SLOT IS USED UNDER THIS CONDITION.

The Controller's internal cabling (*) has been designed for use only in chassis with rear-mounted backpanel. In addition, because of the number of packpanel pins required for disk interfacing, only "I/O ONLY" slots will accommodate the Controller when jumpered for the FCC chassis. ("I/O ONLY" slots provide unrestricted use of more backplane pins required by the DC-297; some of these pins are reserved in memory-or-I/O slots.) A slot selection guide for various computers is provided in Section 2.3 as an aid in choosing a slot.

* Internal cabling (i.e., cabling off of the backplane) is required only to run the DC-297 Controller in the FCC-compliant chassis. For the non-FCC chassis, the internal cabling is unnecessary.

1.3.3 DISK DRIVE INTERFACE

FUNCTIONAL: SMD Standard

ELECTRICAL: Balanced line differential drivers and receivers.

OPTIONAL CABLING: EXTERNAL

"A" CABLE: 60-conductor, shielded round (for FCC chassis) or flat ribbon, twisted pair (for non-FCC chassis). "A" cable daisy-chain connected, computer to first drive, to next drive, etc. (See Table 1.1 for pin assignments.)

"B" CABLE: 26-conductor, shielded round (for FCC chassis) or flat ribbon (for non-FCC chassis). "B" cable radially connected, computer to drive. (See Table 1.2 for pin assignments.) 6' or 16' length cables are available for the "A" and "B" External Cables.

INTERNAL

(Required for FCC chassis only)

"A" CABLE: 60-conductor flat ribbon cable.

"B" CABLE: 26-conductor flat ribbon cable.

Cables are terminated with "D" connectors for panel mounting.

1.3.4 POWER REQUIREMENTS

5V (±5%) VDC @ 6.5 amps typical

-5V (±5%) VDC @ .5 amps typical

TABLE 1.1 Disk "A" (J1) Cable Pin Assignments

PIN #	SIGNAL NAME
1	TAG 1-
2	TAG 2-
3	TAG 3-
4	BIT 0-
5	BIT 1-
6	BIT 2-
7	BIT 3-
8	BIT 4-
9	BIT 5-
10	BIT 6-
11	BIT 7-
12	BIT 8-
13	BIT 9-
14	OPEN CABLE DETECTOR-
15	FAULT-
16	SEEK ERROR-
17	ON CYLINDER-
18	INDEX-
19	UNIT READY-
20	NOT USED
21	BUSY-
22	UNIT SELECT TAG-
23	UNIT SELECT 0-
24	UNIT SELECT 1-
25	SECTOR-
26	UNIT SELECT 2- (note 1)
27	UNIT SELECT 3- (note 1)
28	WRITE PROTECTED-
29	POWER SEQ. PICK- (note 2)
30	BIT 10-
31	TAG 1+
32	TAG 2+
33	TAG 3+
34	BIT 0+
35	BIT 1+
36	BIT 2+
37	BIT 3+
38	BIT 4+
39	BIT 5+
40	BIT 6+
41	BIT 7+
42	BIT 8+
43	BIT 9+
44	OPEN CABLE DETECTOR+
45	FAULT+
46	SEEK ERROR+
47	ON CYLINDER+

PIN #	SIGNAL NAME
48	INDEX+
49	UNIT READY+
50	NOT USED
51	BUSY+
52	UNIT SELECT TAG+
53	UNIT SELECT 0+
54	UNIT SELECT 1+
55	SECTOR+
56	UNIT SELECT 2+ (note 3)
57	UNIT SELECT 3+ (note 3)
58	WRITE PROTECTED+
59	POWER SEQ. HOLD (note 2)
60	BIT 10+

NOTE 1: Unit select 2- and 3- are tied to +5V via 470 ohm resistor

NOTE 2: "Pick" and "Hold" are connected internally on controller

NOTE 3: Unit select 2+ and 3+ are tied to -5V via 470 ohm resistor

TABLE 1.2 Disk "B" (J2-J5) Cable Pin Assignments

PIN #	SIGNAL NAME
1	GROUND (connected to internal cable shield)
2	SERVO CLOCK-
3	READ DATA-
4	GROUND
5	READ CLOCK-
6	WRITE CLOCK-
7	GROUND
8	WRITE DATA-
9	UNIT SELECTED+
10	SEEK END-
11	GROUND
12	NOT USED
13	NOT USED
14	SERVO CLOCK+
15	GROUND
16	READ DATA+
17	READ CLOCK+
18	GROUND
19	WRITE CLOCK+
20	WRITE DATA+
21	GROUND
22	UNIT SELECTED-

PIN #	SIGNAL NAME
23	SEEK END+
24	NOT USED
25	GROUND
26	NOT USED

1.3.5 PHYSICAL CHARACTERISTICS

DIMENSIONS: 15" X 15" X 0.5"

SHIPPING WEIGHT: 10 pounds; includes Controller, paddleboards, software tape, documentation, and cabling.

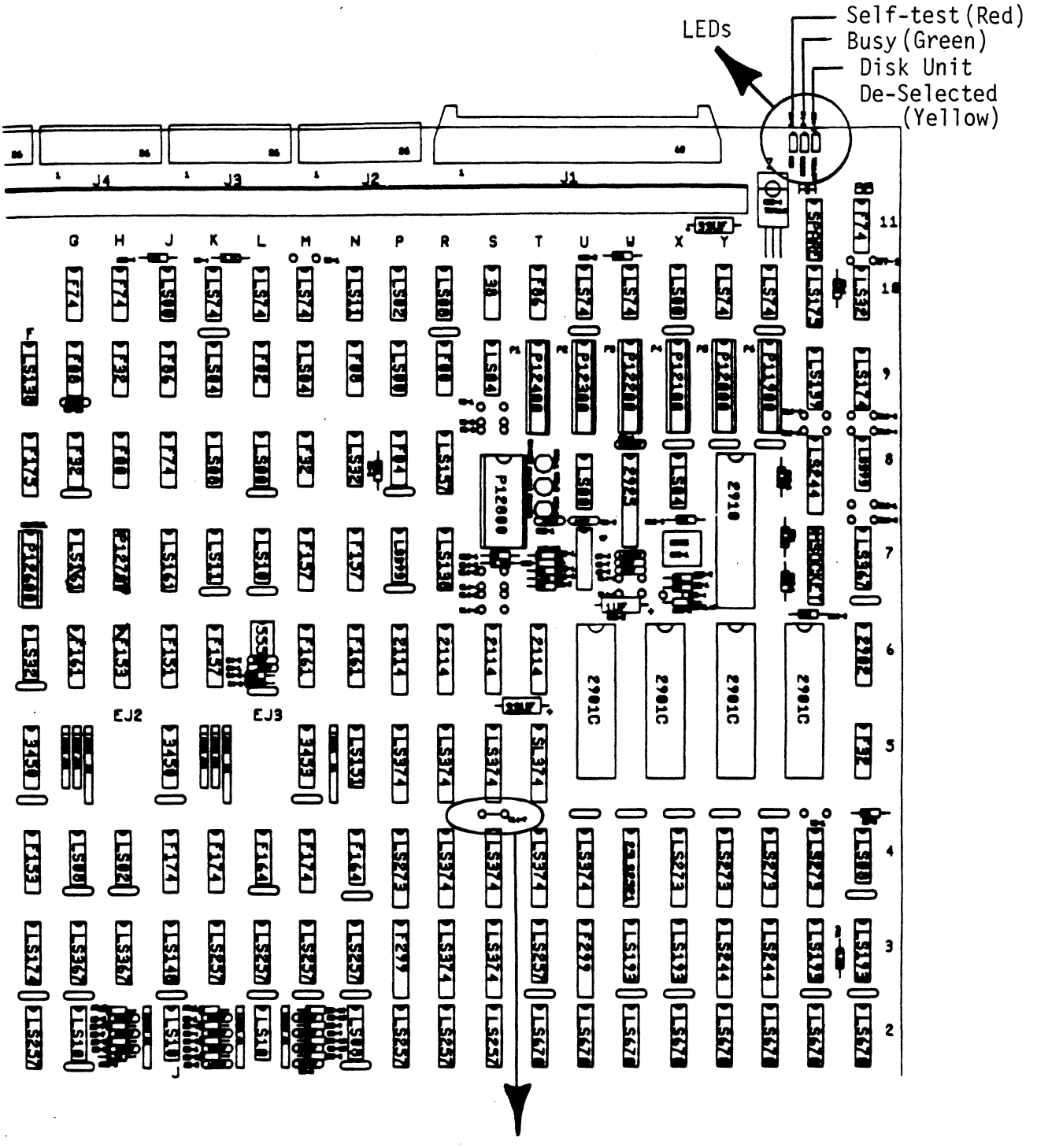
1.3.6 ENVIRONMENTAL CHARACTERISTICS

OPERATING TEMPERATURE: 0 to 55 degrees C

RELATIVE HUMIDITY: 10% to 90% (non-condensing)

Exceeds all Nova/Eclipse minicomputer temperature and humidity specifications.

FIGURE 1.1 Indicator LEDs & EEPROM Write Protect Jumper



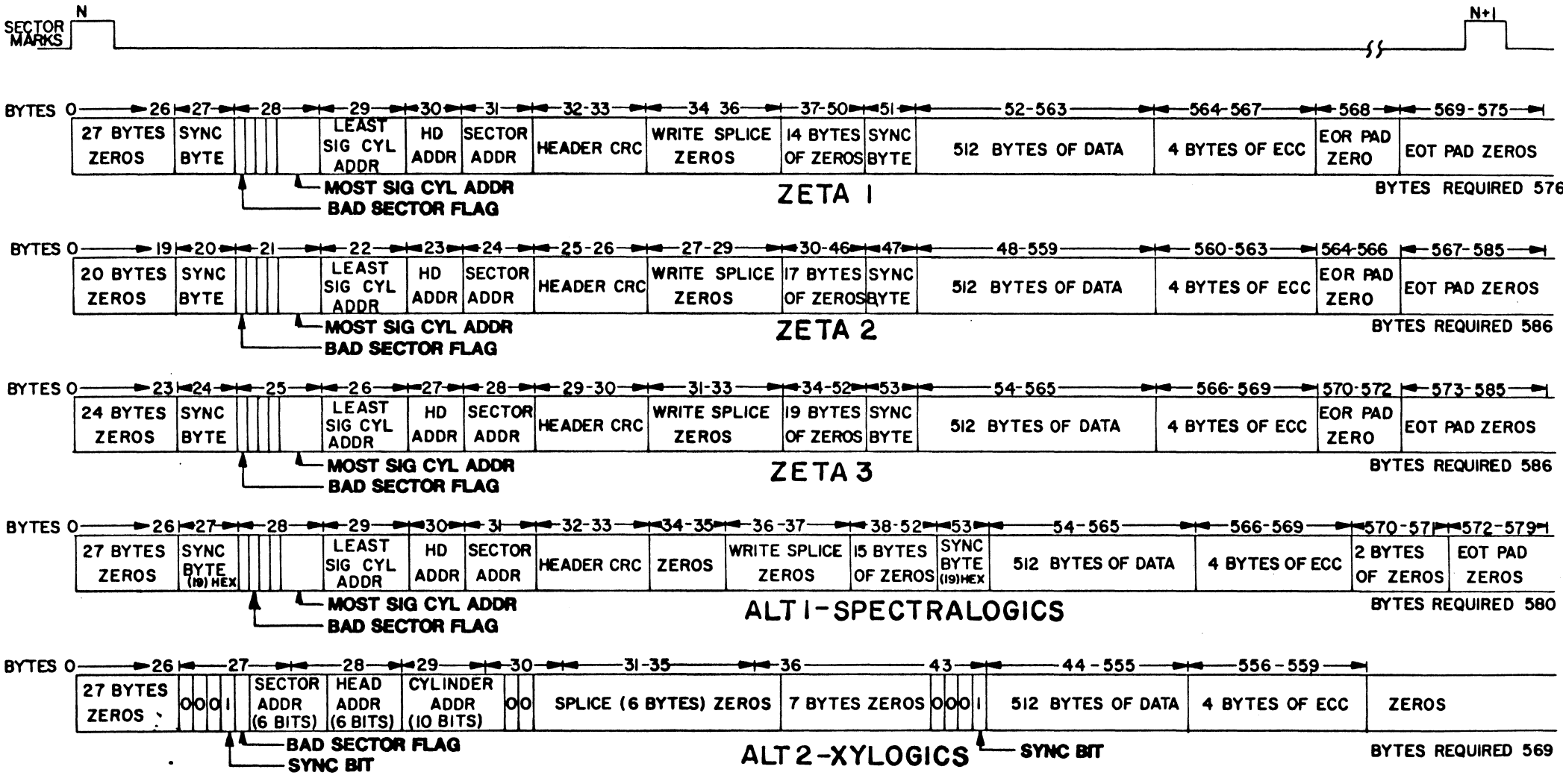


FIGURE 1.2 Disk Formats

2.0 INSTALLATION PROCEDURES

This section contains the procedures necessary for proper installation of the DC-297 Disk Controller. Please read it carefully.

Sections 2.1 through 2.8 describe the preparation and installation of the DC-297. Some information pertaining to the disk drive is also mentioned. Installation personnel should have access to hardware documentation of the computer and the disk drive. The remaining sections describe the Configurator Program, diagnostics, disk media initialization and disk sysgen examples.

The Configurator Program must be used to program the Controller with the necessary information for your particular installation. This program is included on the 1/2" magnetic tape shipped with the Controller. Unless otherwise specified prior to shipment, the tape is 1600 BPI and is marked so on the label of the tape.

The Configurator Program need only be run at installation or when re-configuring the Controller. The information will not be lost when the system is shut down, due to the use of programmable, nonvolatile memory within the Controller.

2.1 UNPACKING AND INSPECTION

The following items are shipped standard with each DC-297:

	ITEM	P/N
a)	DC-297 Controller with Cover	500-405-00
b)	"A" Paddleboard	500-425-00
c)	"B" Paddleboard	500-428-00
d)	1/2" Diagnostic Tape	400-405-00
	OR	
* e)	1/2" Diagnostic Tape with Sector Slip Option	400-405-01
f)	Technical Manual	600-405-00

* In the following pages, when information pertains equally to either tape, part number 400-405-XX will be used.

In addition, the following optional disk cables may be ordered with the Controller:

I. STANDARD-LENGTH CABLES FOR AN FCC CHASSIS

a)	Internal "A" Cable		300-000-00
b)	Internal "B" Cable		300-146-00
c)	External Primary "A" Cable	6'	300-013-00
		16'	300-013-01
d)	External "B" Cable	6'	300-011-00
		16'	300-011-01
e)	Daisy-Chain "A" Cable	6'	300-081-00
		16'	300-081-01

II. STANDARD-LENGTH CABLES FOR A NON-FCC CHASSIS

a)	External "A" Cable	16'	300-147-00
b)	External "B" Cable	16'	300-145-00

Upon receipt of the Model DC-297 from the carrier, inspect the shipping carton immediately for any evidence of damage or mishandling in transit.

If the shipping carton is water stained or damaged, contact the carrier and shipper immediately, specify the nature and extent of the damage and request that the carrier's agent be present when the carton is opened.

ZETACO's warranty does not cover shipping damage.

For repair or replacement of any ZETACO product damaged in shipment, call ZETACO to obtain return authorization instructions.

2.2 CONTROLLER PREPARATION

All setup required to define the Controller's functionality for various subsystem emulations, disk drive models and other features is done via the Configurator Program supplied on the 400-405-00 tape. The selectable hardware options on the Controller are described in the following sections.

2.2.1 DEVICE CODE SELECTION

The DC-297 can be set to any device code between 0 and 77 (octal), however, the primary device code is 27 (octal) and the secondary device code is 67 (octal). The primary device code 27 has been factory set and should be left accordingly unless another disk subsystem exists with the same device code.

A DIP Switch on the handle edge of the Controller is used to select the desired device code. Refer to Figure 2.3. Its individual switches are labeled DS0 through DS5 and correspond to the device select lines on the Controller. DS0 is the most significant bit of the six-bit device code representation.

For example, to select device code 27, all switches would be up except the switches labeled S4, S6, S7 and S8. Refer to Table 2.3.

2.2.2 FCC/NON-FCC JUMPER SELECTION

The FCC/Non-FCC jumpers are located near the "A" and "B" connectors (see Figure 2.4). There are 8 sets of jumpers with 3 rows of 10 pins each. These sets of jumpers give the option to run the DC-297 in either of two modes: for FCC chassis, or the non-FCC chassis.

To set the DC-297 in the FCC chassis mode, the jumper block must be connected across the 2 rows of pins closest to the "A" and "B" backplane connectors. All 8 jumper blocks must be moved in this manner (see Figure 2.4.1).

To set the DC-297 in the Non-FCC mode, the jumper blocks must be connected across the 2 rows of pins furthest from the "A" and "B" backplane connectors (See Figure 2.4.2).

To determine which mode to run, one fact must be ascertained; does the chassis in which the DC-297 will be installed have an "I/O ONLY" slot? If the chassis does not have an "I/O ONLY" slot, then the DC-297 MUST be set up in the non-FCC mode, and the external ribbon cables must be connected to the header connectors that are physically soldered to the outer edge of the DC-297.

FIGURE 2.3 Device Code Switch (Device Code 27 shown)

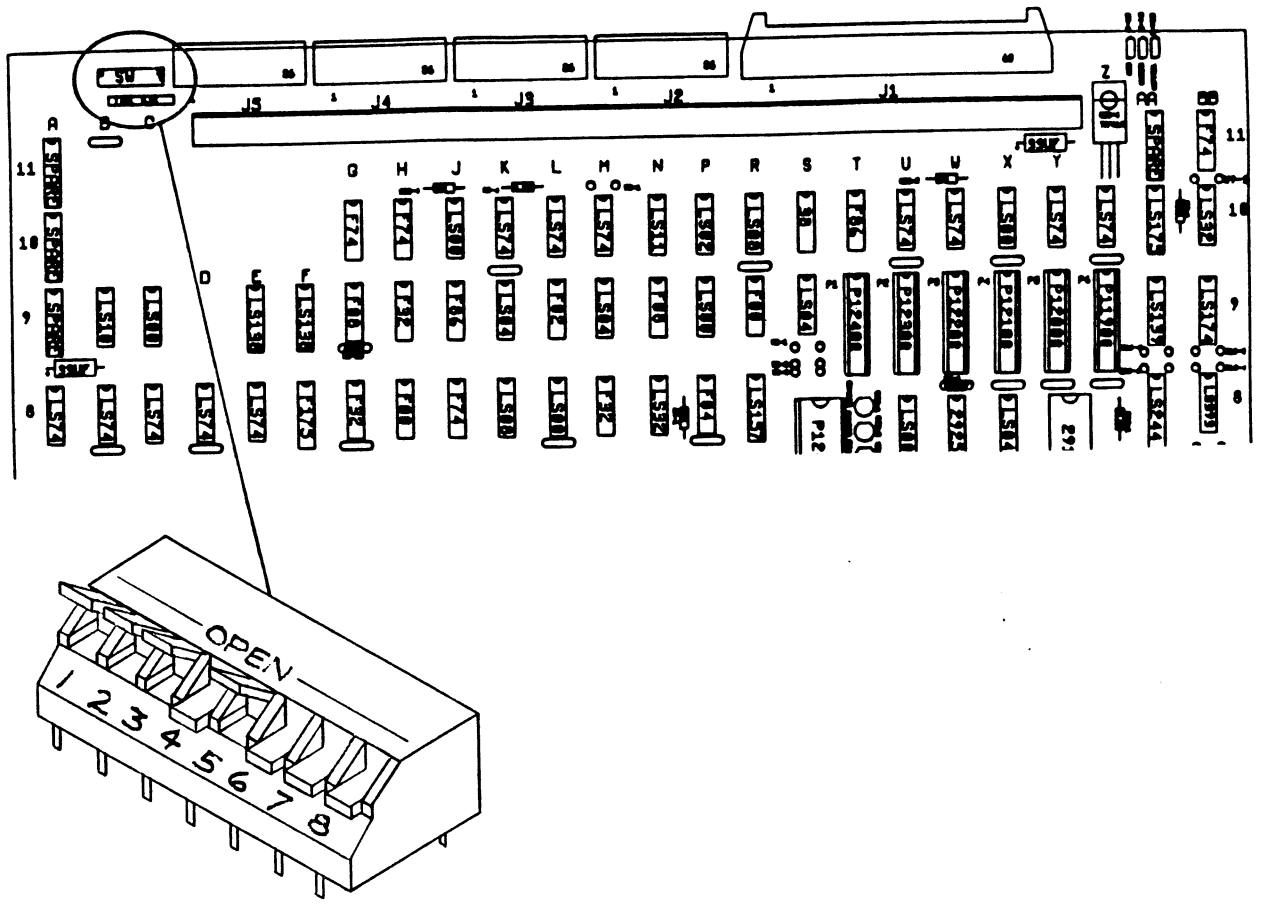


TABLE 2.3 Board Layout and Device Switch

DEVICE CODE	S1 REINIT	S2 RESERVED	S3 DS0	S4 DS1	S5 DS2	S6 DS3	S7 DS4	S8 DS5
0X	UP	UP	UP	UP	UP			
1X	UP	UP	UP	UP	DOWN			
2X	UP	UP	UP	DOWN	UP			
3X	UP	UP	UP	DOWN	DOWN			
4X	UP	UP	DOWN	UP	UP			
5X	UP	UP	DOWN	UP	DOWN			
6X	UP	UP	DOWN	DOWN	UP			
7X	UP	UP	DOWN	DOWN	DOWN			
X0	UP	UP				UP	UP	UP
X1	UP	UP				UP	UP	DOWN
X2	UP	UP				UP	DOWN	UP
X3	UP	UP				UP	DOWN	DOWN
X4	UP	UP				DOWN	UP	UP
X5	UP	UP				DOWN	UP	DOWN
X6	UP	UP				DOWN	DOWN	UP
X7	UP	UP				DOWN	DOWN	DOWN

Failure to set the jumpers in non-FCC mode for a non-I/O ONLY slot will cause extensive damage to the DC-297 as well as to the CPU and memory. A slot that is not "I/O ONLY" has additional pins allocated on the backplane to memory that are also used by the DC-297. Thus, damage will occur due to the conflict between these memory pins and the DC-297.

If the chassis has an "I/O ONLY" slot, then the DC-297 can be run in the "I/O ONLY" slot, in either mode.

When the DC-297 is jumpered in FCC mode, the SMD disk signals are routed through the computer backplane. To get these signals to the disk drive, connect the "A" and "B" paddleboards to the backplane as shown in Figure 2.7. Next, attach the "A" and "B" internal disk cables. Finally, connect the external disk cables to the internal disk cables through the computer bulkhead; the other end of these external cables must connect to the disk drive.

2.2.3 EEPROM WRITE DISABLE JUMPER

After configuration of the Controller is complete it is possible to hardware disable any further alterations to the configuration EEPROM. To write disable the EEPROM, cut foil jumper W14-7, (see Figure 1.1). Jumper W14-7 is factory installed.

FIGURE 2.4 FCC/Non-FCC Jumper Locations

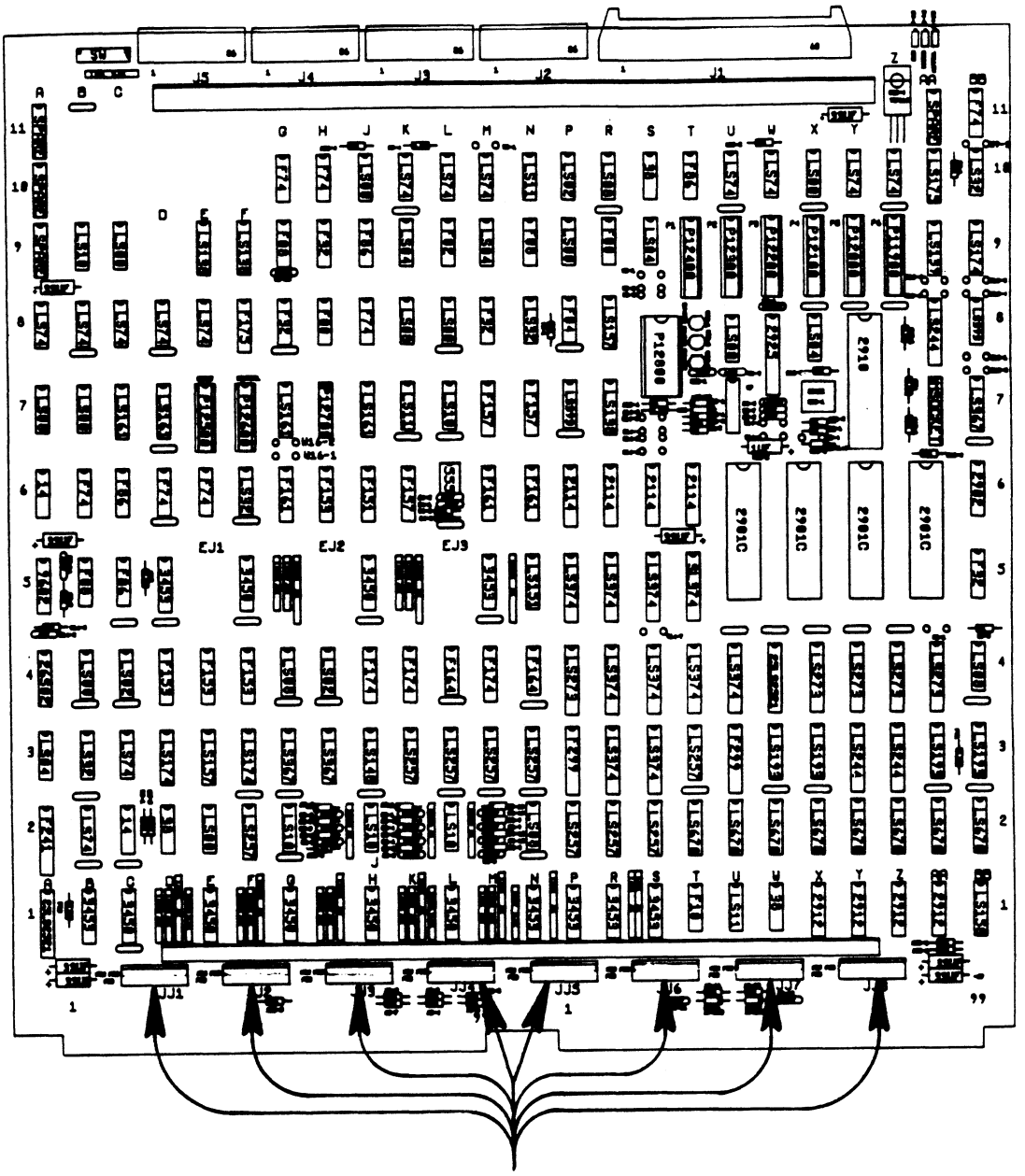
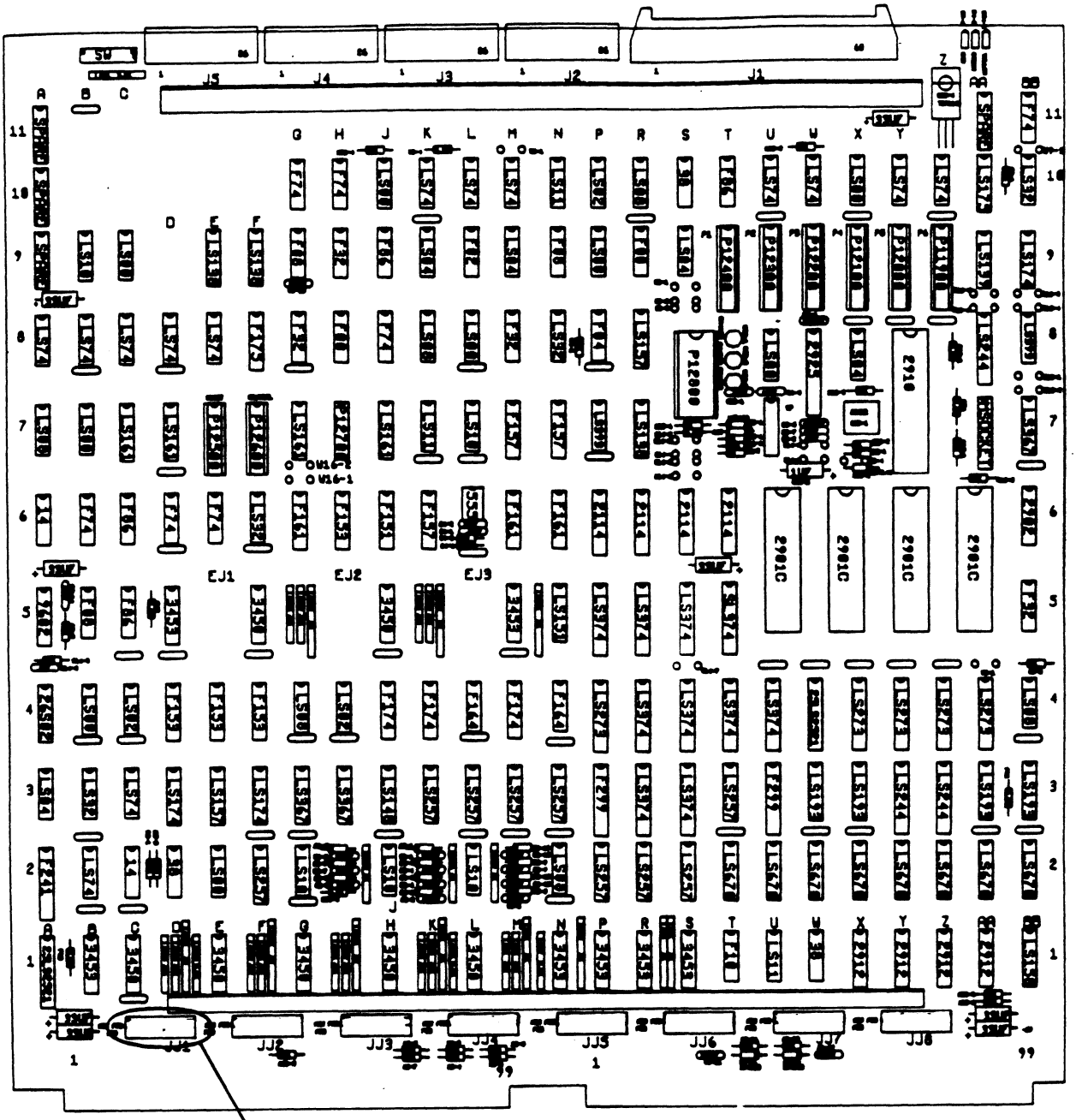
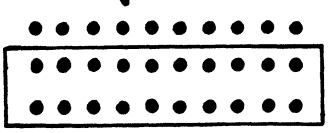


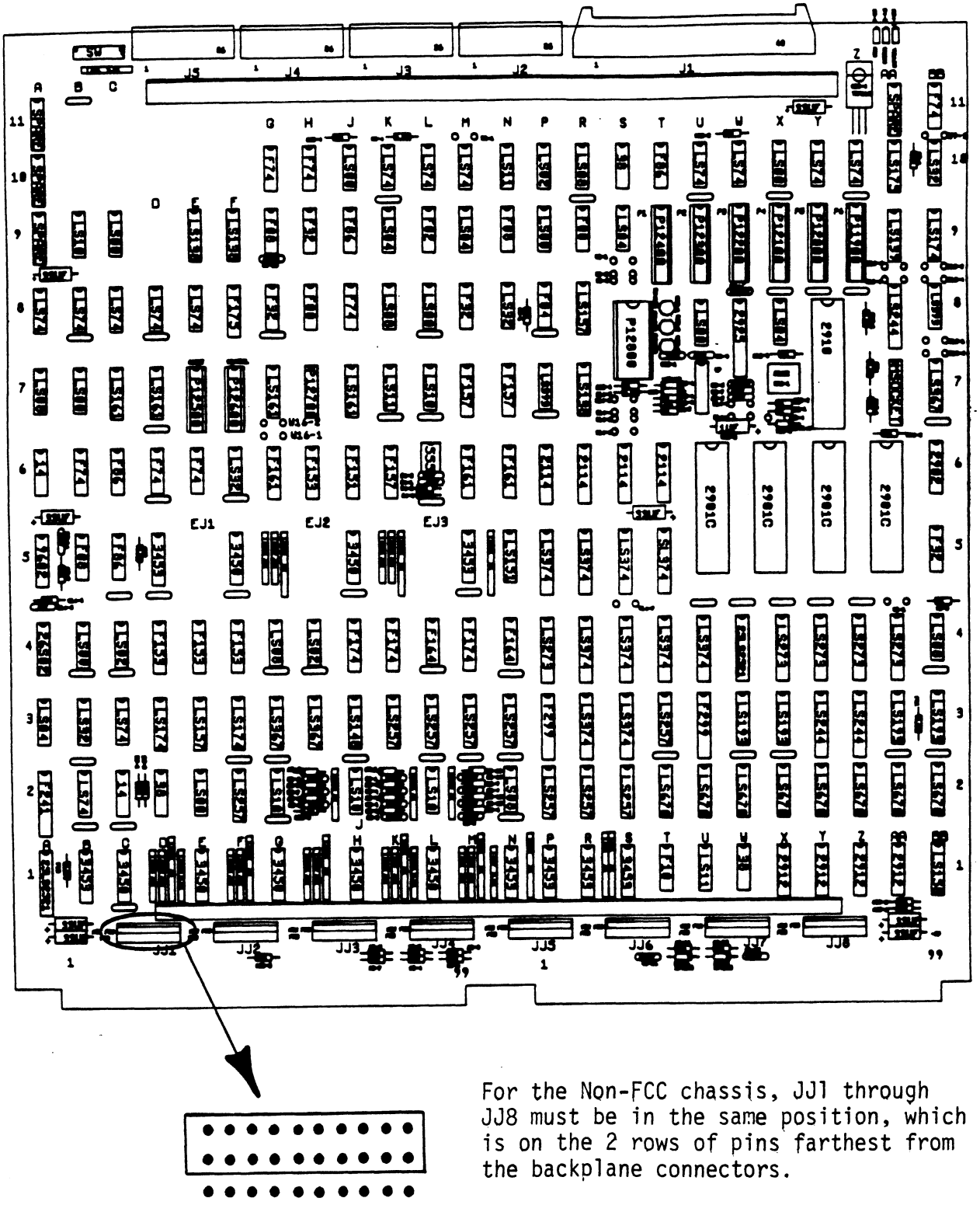
FIGURE 2.4.1 FCC/Non-FCC Jumpers (Set for FCC Compliance)





For installation in the FCC chassis, JJ1 through JJ8 must be in the same position, which is on the 2 rows of pins closest to the backplane connectors.

FIGURE 2.4.2 FCC/Non-FCC Jumpers (Set for Non-FCC Compliance)



For the Non-FCC chassis, JJ1 through JJ8 must be in the same position, which is on the 2 rows of pins farthest from the backplane connectors.

2.3 SLOT SELECTION

Below is a list of most of the DG minicomputers that the DC-297 may be used in when jumpered for FCC mode. To the right are the slot numbers of the "I/O ONLY" slots within each chassis. Do not attempt to install the Controller in any other chassis unless you are certain that the chassis contains "I/O ONLY" slots and which slots they are. Again, this is applicable only when the DC-297 is jumpered for FCC mode. For non-FCC mode, this is of no concern.

MODEL	I/O ONLY SLOTS
NOVA 4 (5 slot)	3-5
NOVA 4 (16 slot)	12-16
ECLIPSE S120 (5 slot)	3-5
ECLIPSE S120 (16 slot)	12-16
ECLIPSE S140	12-16
ECLIPSE S280	11-19
ECLIPSE S250	2-16 (optional, add-on slots)
ECLIPSE C350	2-16 (optional, add-on slots)

The Controller is a high speed DCH device. If it must occupy an "I/O ONLY" slot, (jumpered for FCC mode), ensure it is close enough in the priority chain to the CPU to receive sufficient priority. The controller must also allow sufficient priority for other high speed controllers further from the CPU. Current loading rules must also be observed for groups of slots within the chassis. Refer to your computer's Configuration Rules reference for more information.

2.3.1 PRIORITY JUMPERS

The Controller must receive two priority signals from the minicomputer backplane: Data Channel Priority In (Pin A94) and Interrupt Priority In (Pin A96). If there are vacant slots between the Controller and the processor, priority jumper wires must be installed to obtain priority continuity between controllers. To jumper across unused slots, connect A93 (Data Channel Priority Out) to A94 (Data Channel Priority In) and A95 (Interrupt Out) to A96 (Interrupt Priority In). See Figure 2.5.

If the DC-297 is to be configured at or near highest priority in an S140 computer, (slots 12-16 "I/O ONLY"), jumper the priority first up to the DC-297, then back down to the additional controller boards in slots 4 and up. See Figure 2.6 for an example.

2.3.2 POWER FAIL PROTECTION

The DC-297 Controller contains a double protection power fail scheme that disables the disk drive write circuitry through the open cable detect line.

The DG power supply outputs a signal called "POWER FAIL", which gives an early warning of power loss. This signal is located at the B21 pin of the backpanel. Some computers provide this signal on all slots; however, in others it may only be available on B21 of the top slot. To determine this for your system, consult your DG hardware manual. If you have the signal only on the top slot, to use it you must jumper-connect B21 of the Controller's slot to B21 of the top slot.

In addition, the Controller contains power fail circuitry to further protect disk drive data integrity in the event of power loss to the slot in which the Controller is installed.

FIGURE 2.5 Backpanel Priority Jumpers

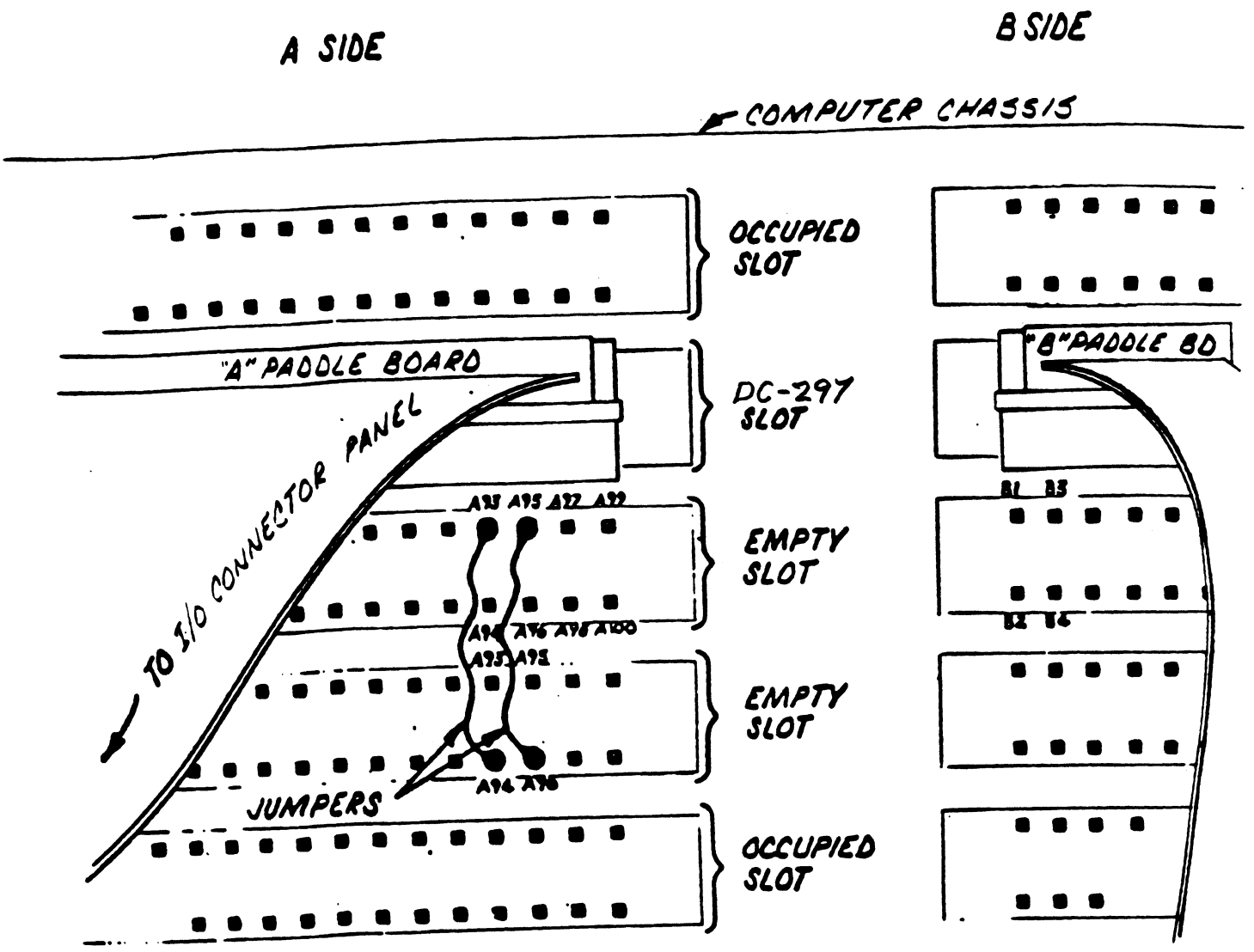
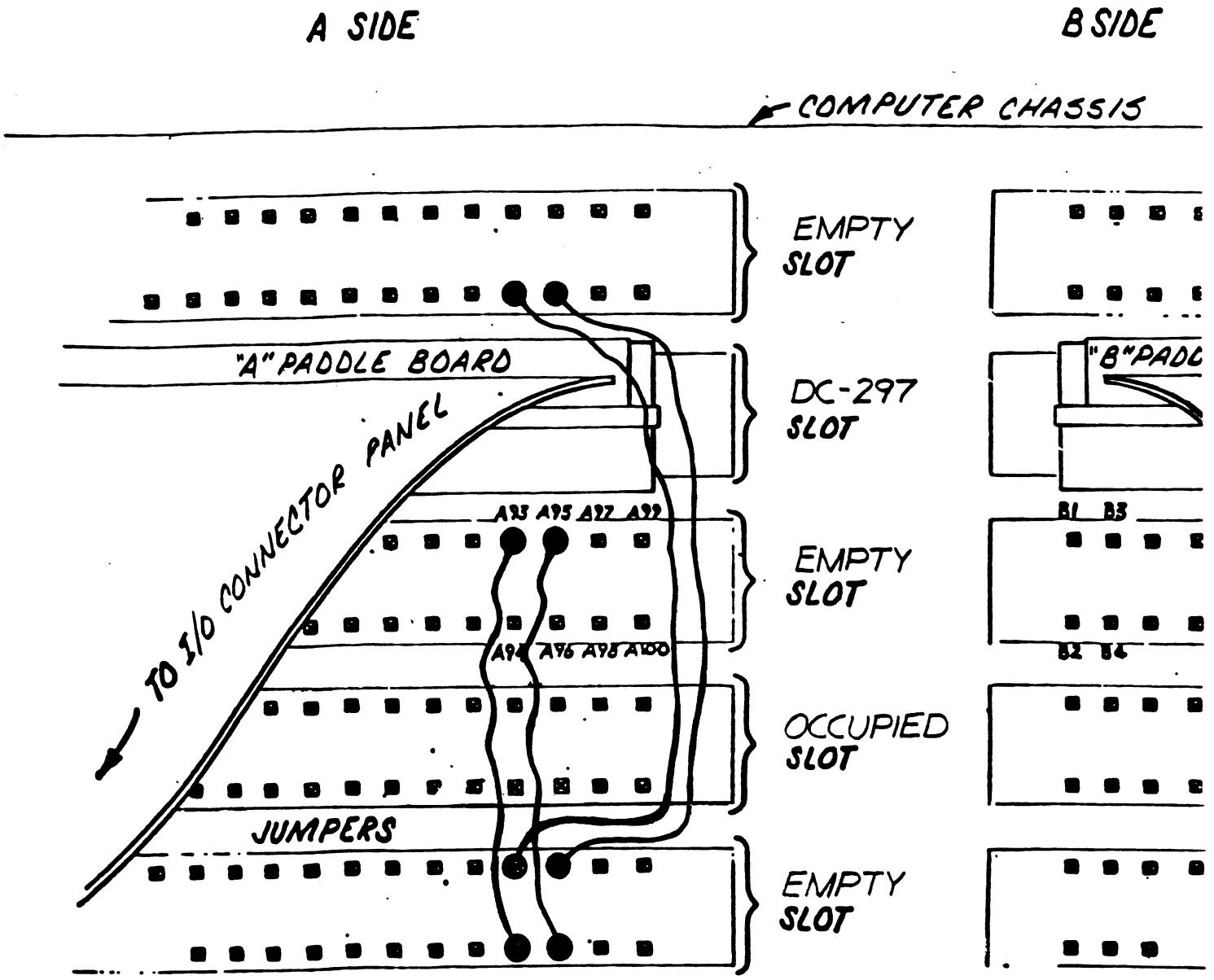


FIGURE 2.6 Backpanel Priority Jumpers (Reprioritized)



2.4 CONTROLLER BOARD INSERTION

After selecting the proper slot* (Section 2.3.), insert the Controller by fitting the board edges between the slot guides and allowing the board to follow the guides evenly. Pull out the ejectors on the two outside corners of the board and use them to provide leverage when the board meets the connector. Use equal pressure on both ejectors until the board seats firmly into the backpanel connectors.

---

*CAUTION: THE DC-297 CONTROLLER MAY ONLY BE INSERTED IN AN "I/O ONLY" SLOT WHEN JUMPERED FOR FCC MODE. COMPONENT DAMAGE WILL OCCUR IF A SLOT OTHER THAN AN "I/O ONLY" SLOT IS USED AND THE CONTROLLER IS JUMPERED FOR FCC MODE. ZETACO'S WARRANTY IS VOID IF A "NON-I/O ONLY" SLOT IS USED UNDER THIS CONDITION.

2.5 CABLE INSTALLATION

FCC and non-FCC cabling procedures differ. For FCC, follow the instructions in Sections 2.5.1 through 2.5.4. For Non-FCC, skip to Section 2.5.4.

2.5.1 PADDLEBOARD INSTALLATION (Required in an FCC Chassis)

Because the paddleboards carry signals from the cables to the backpanel, care must be taken in aligning them over the proper backpanel pins.

The computer backpanel, viewed from the rear, has the "A" side pins on the left. On computers with vertically mounted controller boards, the "A" side is on the bottom.

Locate the two rows of pins on the "A" side of the backpanel for the slot containing the DC-297 Controller. Ensure that no pins are bent. Position the "A" paddleboard block connector over all 100 pins, with the header connectors facing up. (For vertical board machines, the header connectors should face left). Press the connector securely over the pins, making sure all pins insert and do not bend, until the guide block is flush with the backpanel.

CAUTION: COMPONENT DAMAGE MAY OCCUR IF PADDLEBOARD IS MIS-ALIGNED. MAKE SURE THE BLOCK IS NOT SHIFTED RIGHT OR LEFT BY CHECKING FOR NON-INSERTED PINS ON BOTH ENDS. DOUBLECHECK THAT THE BLOCK IS POSITIONED OVER THE CORRECT TWO ROWS OF PINS, AND NOT BETWEEN SLOTS. IT MAY BE NECESSARY TO COUNT PAIRS OF ROWS TO DETERMINE CORRECT POSITIONING.

Repeat this procedure for mounting the "B" paddleboard on the "B" side of the backpanel.

2.5.2 INTERNAL CABLING (Required in an FCC Chassis)

Internal Cabling is shown in Figure 2.7. The cables are terminated with shielded connectors that mount on the I/O connector panel on one end, and a dual parallel connector block on the other end that connects to the paddleboard. Attached to each paddleboard is a 100-pin block connector that mounts onto the chassis backpanel pins.

The Internal "A" cable is the disk control cable. The Internal "B" cable is the disk data cable. Each connector is labeled appropriately.

2.5.3 MOUNTING "D" CONNECTORS (Required in an FCC Chassis)

Figure 2.8 depicts the computer I/O connector panel viewed from the back. To mount the "D" connectors to the I/O connector panel, remove the covers from the desired mounting holes on the I/O connector panel. With the mounting hardware removed from the "D" connectors, insert the connectors into the I/O connector panel and insert the hex bolts from the outside of the I/O panel. Secure each connector to the panel with the washers and nuts.

2.5.4 EXTERNAL DISK CABLING

A) Round, Shielded Cabling (Required in an FCC Chassis)

The Disk "A" Cable (P/N 300-013-XX) mounts to the I/O connector panel and is terminated with a 60-pin connector that attaches to the first disk drive.

FIGURE 2.7 Internal Cabling

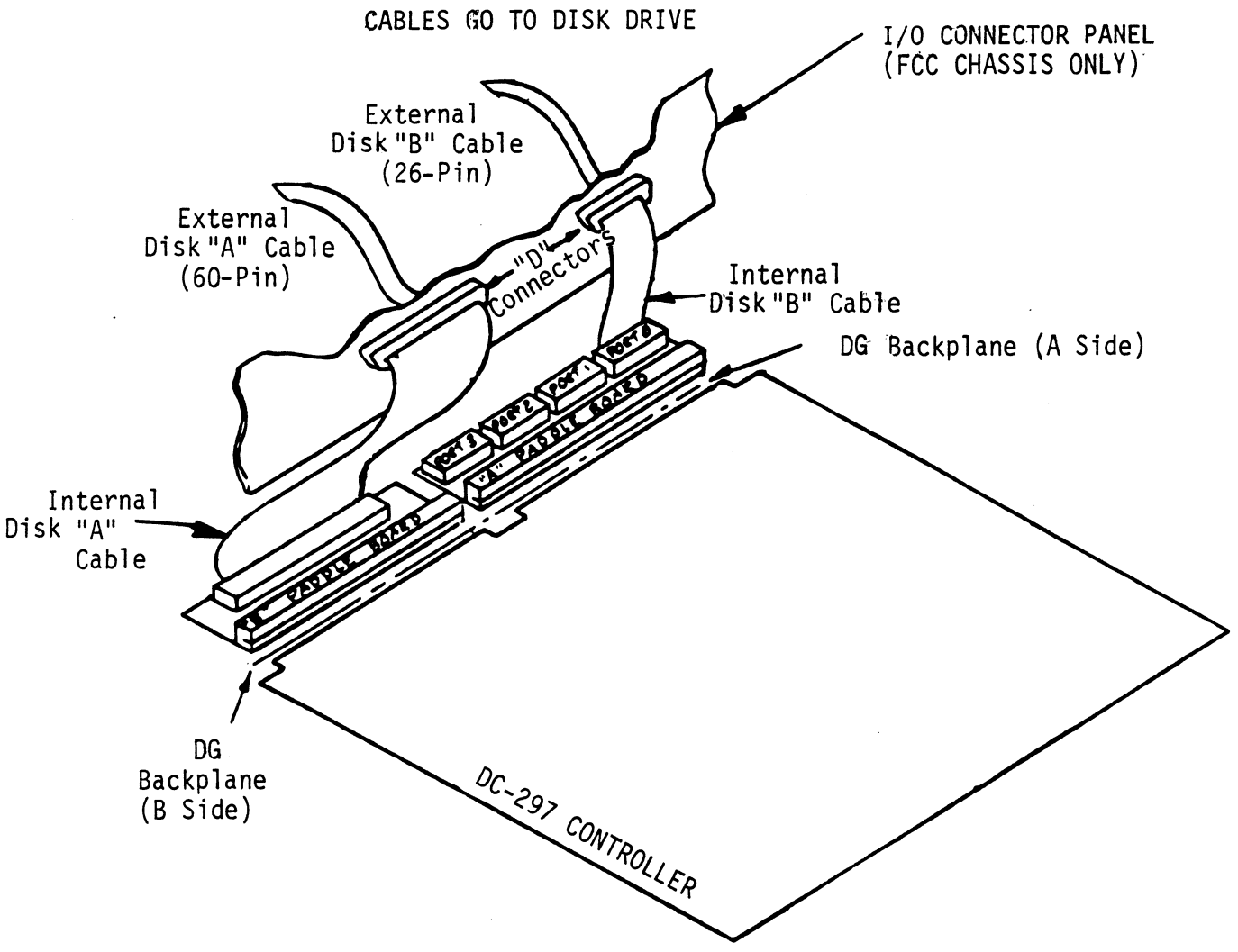
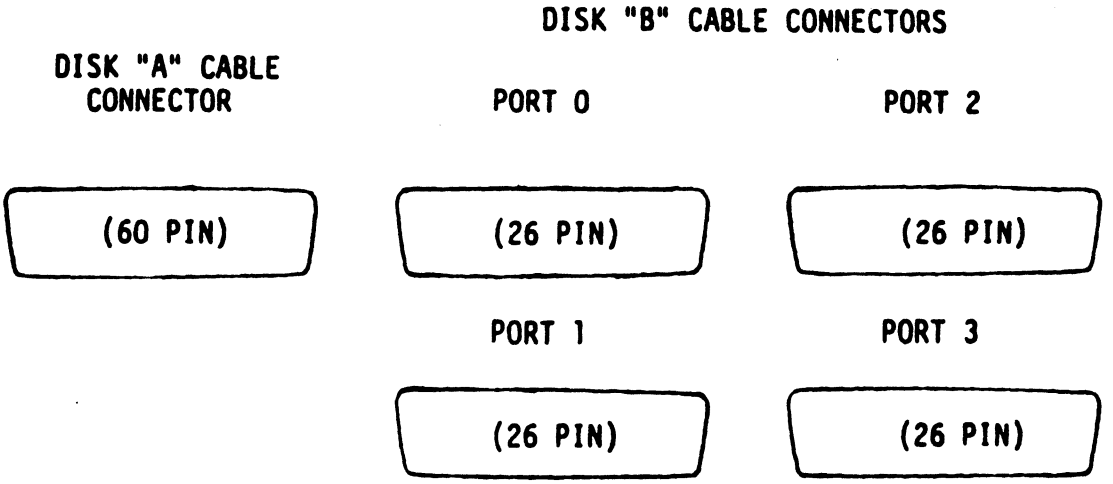


FIGURE 2.8 Connector Panel Example Layout



The Disk "B" Cable (P/N 300-011-XX) mounts to the panel and is terminated with a 26-pin connector that attaches to the disk drive. For every additional disk drive added to this Controller, one daisy chain "A" cable (P/N 300-081-XX) is required between each drive, along with another "B" cable connecting each added drive to one of the available ports on the Controller. Connect external ground wire on both A and B cables to the drive's chassis ground.

B) Shielded Round Cabling (Used in a non-FCC Chassis)

The Disk "A" Cabling (P/N 300-147-00) has 60-pin connectors on each end. The Disk "B" Cable (P/N 300-145-00) has 26-pin connectors on each end. An additional "A" and "B" cable set is required for each disk unit added to the DC-297 Controller. Be sure to observe that the arrows on the cable and the on-board connectors line up to provide proper SMD signal connection between the Controller and disk unit.

C) Disk Cabling (Used in both FCC and non-FCC Chassis)

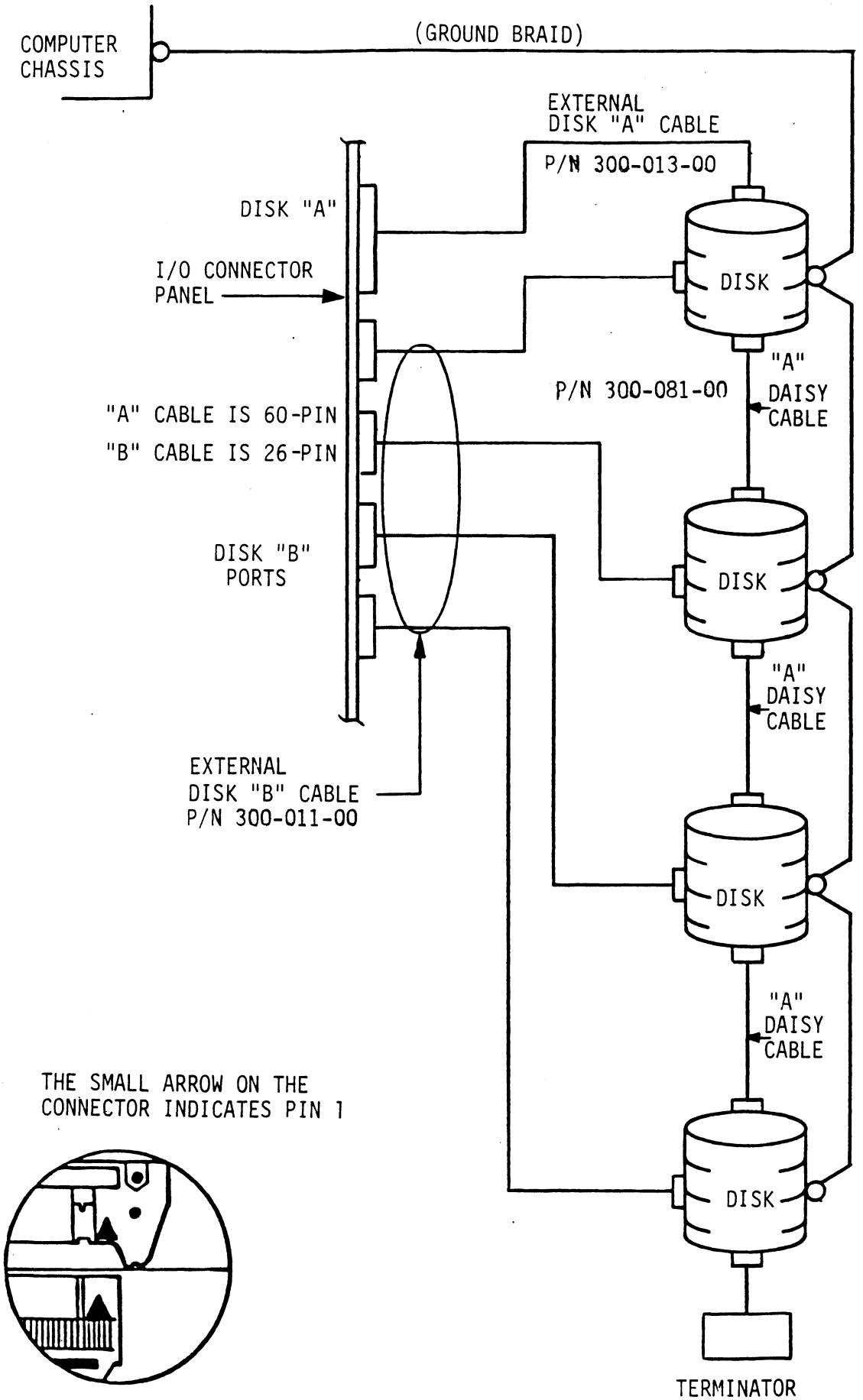
Attach the Disk "A" Cable to the appropriate on-board "A" header connector if non-FCC cabling is used; or to the appropriate backpanel "D" connector if round, FCC shielded cabling is used. Attach the other end of the "A" cable to the appropriate 60-pin header connector on the first disk drive, again observing that the arrows on header and connector align.

For additional drives, remove the terminator from the additional disk units and connect the "A" cables from drive to drive in a daisy-chain fashion as shown in Figure 2.9. Ensure that only one terminator is installed in the entire chain, positioned in the termination header of the last disk drive in the chain.

Next, connect the "B" cable(s) to the appropriate on-board header connector if non-FCC cabling is used, or to the proper backpanel "D" connector if round, FCC shielded cabling is used. The other end of each "B" cable should connect to each individual disk drive. These "B" cables are not daisy chained. Each disk unit has a "B" cable connected directly to the DC-297.

It is important to note that a drive's unit number setting does not dictate the port it must attach to. The Controller allows any unit to be attached to any of the four "B" ports and assigns individual drive characteristics on a port-by-port basis. Therefore, note which port each disk drive is attached to (Port 0 - Port 3, labeled on the connectors), so that proper drive characteristics are assigned to each port when the Configurator Program is run.

FIGURE 2.9 Disk Drive Cabling



2.5.5 SYSTEM GROUNDING

Because the power system safety ground does not necessarily satisfy all system grounding requirements, additional connections are required to earth ground, referred to as system ground. The Controller and its attached disk drive(s) must be connected to a single point ground system. Ground connections are made via ground braids that pass from drive to drive, drive to computer chassis, and computer chassis to earth ground.

WARNING: TO ENSURE PROPER GROUND RETURN TO EARTH, EACH DISK DRIVE IN THE SYSTEM MUST BE CONNECTED USING A DAISY CHAIN GROUND SYSTEM. BOTH THE AC AND DC GROUNDS WITHIN EACH DRIVE MUST BE JOINED (CONSULT YOUR DRIVE MANUAL). THE DRIVES MUST THEN BE JOINED BY A DAISY CHAIN GROUNDING BRAID AND CONNECTED TO THE GROUNDING POST AT THE REAR OF THE COMPUTER CABINET.

2.6 DISK DRIVE PREPARATION

Each disk drive will need to be set to the correct number of sectors per track, and to the desired unit number. In addition, the disk drive's installation manual should be read to see if any other setup is required.

2.6.1 SECTORS PER TRACK SELECTION

The maximum allowable number of sectors per track (under DG emulation) for each disk drive is shown in Table 2.4. Find the disk drive model that will be run on the DC-297. Adjacent to the model is the number of sectors the drive should be set to.

NOTE: If the DC-297 is configured for split sectors for any disk drive, that particular disk drive will appear to the system as two disks with half the number of sectors shown in the maximum sectors column of the table. Problems are inevitable if this number is exceeded.

TABLE 2.4 Maximum Sectors Table

DISK DRIVE MODEL NUMBER	MAXIMUM NUMBER OF SECTORS SUPPORTED
A1-AMPEX 165	35
A2-AMPEX 330	35
A3-AMPEX 980	35
A4-AMPEX 80	35
A5-AMPEX 660	35
A7-AMPEX 932	35
A8-AMPEX 964	35
A9-AMPEX 996	35
AA-APS 4830-202	70
AB-APS 4835-202	70
AC-APS 4830-337	70
AD-APS 4835-337	70
AE-APS 4830-404	70
AF-APS 4835-404	70
AG-APS 4865	70
AL-AMCODYNE 7110	32
AM-AMCODYNE 8160	35
C1-CDC 9730-80	35
C2-CDC 9730-160	35
C3-CDC 9762	35
C4-CDC 9766	35
C5-CDC 9775	35
C6-CDC 9710 (RSD)	35
C7-CDC 9715-160	35
C8-CDC 9715-340	35
C9-CDC 9715-515	51
CA-CDC LARK 9457	32
CB-CDC LARK 9455	32
CC-CDC CMD 9448-32	35
CD-CDC CMD 9448-64	35
CE-CDC CMD 9448-96	35
CF-CDC 9410-8	23
CG-CDC 9410-24	23
CH-CDC 9410-32	23
CI-CDC 9410-40	23
CJ-CDC-9412	35
D1-DATA PER. D1600	35
DA-DISC TECH 3306	35
E1-CENTURY 300	35
E2-CENTURY 302	35
E3-CENTURY 306	35

DISK DRIVE MODEL NUMBER	MAXIMUM NUMBER OF SECTORS SUPPORTED
E4-CENTURY AMS 315	35
E5-CENTURY T82	35
E6-CENTURY 160	41
E7-CENTURY AMS 513	55
E8-CENTURY AMS 380	55
E9-CENTURY AMS 571	56
EA-CENTURY C2048	32
F1-FUJITSU 2280	35
F2-FUJITSU 2284	35
F3-FUJITSU 2294	35
F4-FUJITSU 2351	48 (586 bytes/sector)
F5-FUJITSU 2311	35
F6-FUJITSU 2312	35
F7-FUJITSU 2333	70 (584 bytes/sector)
F8-FUJITSU 2331	70 (584 bytes/sector)
F9-FUJITSU 2361	70 (585 bytes/sector)
FA-FUJITSU 2298	70 (585 bytes/sector)
FB-FUJITSU 2322	35 (582 bytes/sector)
K1-KENNEDY 7380	35
K2-KENNEDY 5380	35 (572 bytes/sector)
K3-KENNEDY 53160	35 (572 bytes/sector)
K4-KENNEDY 7340	35
M1-MEGAVAULT 83	35
M2-MEGAVAULT 116	35
MA-MEMOREX 677-30	35
MB-MEMOREX 677-70	23
MC-MEMOREX 213	35
MD-MEMOREX 214	35
N1-NEC 2220	35
N2-NEC 2230	35
N3-NEC 2246	35
N4-NEC D2351	62
P1-PRIAM 15450	35
P2-PRIAM 804	35
P3-PRIAM 3350	35
P4-PRIAM 3450	23
P5-PRIAM 7050	23
P6-PRIAM 6650	35
T1-TECSTOR 85	35
T2-TECSTOR 165	35

DISK DRIVE MODEL NUMBER	MAXIMUM NUMBER OF SECTORS SUPPORTED
T3-TECSTOR 200	35
T4-TECSTOR 300	35
T5-TECSTOR 160	35
UD-USER DEFINED	128

NOTE: RDOS users below revision 7.0 are limited to 32 sectors by the operating system. If the system in which this Controller will be installed will run RDOS below revision 7.0, set the disk unit for no more than 32 sectors.

2.6.2 UNIT NUMBER, MISCELLANEOUS PREPARATION

Set the drive(s) to the desired unit numbers according to the drive manufacturers installation manual. For two or more drives, unit numbers assigned are usually consecutive, with unit "0" as the primary unit. For dual-volume drives such as CDC's CMD, Lark, etc., or drives that the Controller treats as dual-volume, (indicated in the disk drive "HELP" section of ZETACO'S Configurator Program on the 400-405-XX tape), the drive must be set to unit 0 or 2, with the next consecutive odd unit number used by the other volume of the disk drive.

On initial power-up, the Controller will delay activating Pick/Hold (which spins up the drive) for one second, thereby easing the initial current demand on the AC power source. This feature requires that the disk drive be selected for REMOTE spin-up operation.

Ensure that the disk drive you are installing has the index and sector signals on the "A" cable. If these signals are on the "B" cable only, the controller will not function correctly.

2.6.3 SPECIAL CONSIDERATIONS - VARIOUS DRIVES

FUJITSU 2351 SECTOR SELECTION

The Fujitsu 2351 should be set to 48 sectors per track by setting the number of bytes per sector to 586 and not 587 as shown in the Fujitsu 2351 manual. This eliminates the awkward, smaller last sector and makes all the used sectors equal as to the number of bytes in each sector. The following jumpers should be set for 586 bytes per sector on the Fujitsu 2351 sector card:

BC7	2-3	6-7	10-11	12-13
BD7	3-4	6-7	9-10	13-14
BE7	3-4	5-6	10-11	13-14
BF7	3-4	6-7	10-11	13-14

CDC 9457 (LARK 11) AND CDC 9455 (LARK)

Ensure options "Auto Seek On Head Change" and "Two Volumes (CMD)" are installed within the disk drive. The CDC Larks must be 32 sector type.

FUJITSU 2322 SECTOR SELECTION

The Fujitsu 2322 bytes per sector switches should be set to 582 instead of 586 (35 sectors) as shown in the 2322 manual. This allows all the sectors a more uniform number of bytes per sector and eliminates the unusable last sector. Set the bytes per sector switches as follows for 582 bytes per sector.

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

2.7 SYSTEM POWER-UP

Apply system power. The red LED on the DC-297 Controller should come on and then go off, indicating successful completion of controller selftesting. If this does not occur, refer to Section 3.0.

Functions of the other LEDs are described in Section 1.1. After selftest, all LEDs should be off, with the exception of the yellow LED which indicates the disk unit(s) is de-selected.

2.8 DISK SUBSYSTEM TESTING AND BUILDING USING THE 400-405-XX TAPE

The following procedure is recommended to prepare each disk drive for system use.

2.8.1 BOOTING THE 400-405-XX DIAGNOSTIC TAPE

System Requirements:

Data General Nova/Eclipse Family CPU/SPU
Minimum 32K Words Memory
Console Device at 10/11
Magnetic Tape Drive: 1/2" 9-Track
Printer at Device 17 for Hard Copy (Optional)

The programs supplied on the 400-405-XX 1/2" magnetic tape are the Configurator Program, Disk Maintenance Programs, System Support Programs, and Utilities.

Each of the programs on the Diagnostic tape has been written by ZETACO specifically for the DC-297 Controller. You should use this tape for media formatting, Disk Diagnostics and Reliability, Configuring and RDOS Utilities. DG's corresponding programs may not work on this controller. The disk media formatter on the Diagnostic tape will let you format the media in any of the formats.

The tape is structured so that the programs on Files 2 through 7 can be loaded and executed directly from the tape. Files 0 and 1 contain the software that enables you to boot from the tape and select the particular program you want loaded into the system. Each of the programs on Files 2 through 7 is a stand-alone program. This means that they do not need, and cannot have, an operating system running when they are executed.

Programs cannot be loaded onto your disk directly from Files 0 through 7. File 8 for RDOS and File 9 for AOS contain the programs in the standard system dump format and you can load them from these files to your disk. The procedure to boot the 400-405-XX tape is described in the four following steps:

1. Mount the tape on the tape drive and put drive ON-LINE. Be sure that the BPI setting matches that specified on the tape label (normally 1600 BPI).

2. Program Load - The method of program load varies depending on the processor being used.

If your system has front-panel switches, set them to 100022 when loading from the primary tape drive, or to 100062 when loading from the secondary tape drive. Then press reset and the program load switch.

For the S140 virtual console, set 11a to 100022 (or 100062 for secondary tape drive). Then enter 100022L (or 100062L).

For the S120 virtual console, enter 22H (or 62H for the secondary tape drive).

3. If you have the Sector Slip option (tape 400-405-01), refer to the Sector Slip Manual. If you do not, the 400-405-00 tape menu will be displayed on your console like this:

```
FILE #     PROGRAM                              FILENAME

  2        DC-297 CONFIGURATOR                  CF297.SV
  3        DISK FORMATTER                       DISKF.SV
  4        DISK DIAGNOSTIC                      DISKD.SV
  5        DISK RELIABILITY                     DISKR.SV
  6        ZDKINIT-DISK INITIALIZER             ZDKINIT.SV
             (RDOS SYSTEMS ONLY)
  7        ZDSKED-DISK EDITOR                   ZDSKED.SV
             (RDOS SYSTEMS ONLY)
  8        ".SV & .LS" FILES AND ANY UTILITIES IN
             RDOS DUMP FORMAT.
  9        ".SV & .LS" FILES AND ANY UTILITIES IN
             AOS DUMP FORMAT

FILE NUMBER?
```

If this fails to appear on the console, use the trouble-shooting section of this manual for additional information.

4. Enter the file number (2-7) you wish to execute followed by a carriage return. The tape should then load the program into memory. Operation of these programs is explained below.

2.8.2 DC-297 CONFIGURATOR

The purpose of the Configurator is to set up the controller with information unique to your particular installation. The facts are then saved within the controller in non-volatile memory. Configuration need only be done at installation time, or at any later time to adjust performance, attach new disk drive, etc.

2.8.2.1 CONFIGURING THE CONTROLLER

Configure the DC-297 with the configurator program on the 400-405-XX tape sent with the Controller. (A detailed explanation of the Configurator Program is given in Section 4.0 "Controller Usage".) If you have the Sector Slip option, refer to the Sector Slip Manual for guidelines on configuring for Sector Slip.

Note the "ECC ENABLE/DISABLE" flag for each disk drive port during controller configuration. For most situations, it is recommended that on-board error correction be disabled while running disk formatter and initializer programs. Initializer programs refer to ZDKINIT AND DFMTR. This will allow the programs to flag and detect those bad blocks which are potential problems even though they might be correctable at the time of running the initializer. However, it is also possible to run the initializer programs with ECC Correction enabled in cases where there is a need to use marginal disk media.

NOTE: We strongly recommend you save a hard copy of dialogue between operator and configurator for future reference. The program has printer output control at device code 17 (LPT). If a printer is not available, the operator should display all configuration facts using the "L" command after configuration, and record them.

Boot the 400-405-XX tape and load the Configurator (File 2) Program.

The program will display an introduction. Please read carefully before proceeding.

2.8.2.2 CONFIGURATOR HELP

The DC-297 Configurator includes two "HELP" commands; one for OPERATIONAL questions and one that suggests WHAT you might want to do. In addition, you can get an explanation for any item by responding with an "H" to the question. Please use these functions whenever you are uncertain as to what to do.

It is recommended that the "J" command be used for initial installation to allow setup of all parameters.

When configuration is complete, enable the printer output and use the "L" command to list the configuration. Use the "U" command to update the Controller and the "Q" command to end the session.

Refer to Section 4.1 of the Usage section for additional information and configurator field descriptions.

If the configurator does not function properly, refer to the Trouble-shooting section of this manual for help.

2.8.3 RDOS USERS (AOS Users Go To Section 2.8.4)

2.8.3.1 FORMATTING

Run the Disk Formatter Program provided on the 400-405-00 tape. Run at least three passes, preferably six. If you have purchased the Sector Slip option, you may wish to run the Sector Slip Formatter instead (File #4 on the 400-405-01 tape). See the Sector Slip Manual for details.

The Disk Formatter Program is a utility program designed to format and check disk packs to be used on the disk systems. It is recommended that on-board error correction for each drive be disabled throughout both formatter and initializer programs. After disk initialization, it should then be enabled by running the Configurator Program again. The Formatter Program writes header information in the header field and then writes and reads different data patterns in the data field to check the media of the disk.

This formatting process is done by first writing all the headers on the disk. When the last sector header is formatted, the program will output, "Format Done". Next, the data field is checked. Each pass of Formatter Program signifies the completion of writing every sector's data field on the disk with a data pattern and then reading the data back twice. The data written is compared to the data read for errors in the media. An example of running the Formatter Program is given below.

Boot the Disk Formatter Program from tape 400-405-00 or disk.

The following is a sample dialogue:

```
ZETACO SMD DISK CONTROLLER FORMATTER REV. XX

STARTING ADDRESSES:
     500-FORMATTER/CHECK PROGRAM
     501-CHECK PROGRAM ONLY
     502-ERROR LOG RECOVERY
     503-COMMAND STRING INTERPRETER
ENTER DEVICE CODE [27]:
SET SWPAK AS PER SECT 8.0 OR HIT (CR) TO CONTINUE
  (This refers to Section 8.0 of Appendix A.0.  For
  normal operation, a (CR) is done here.)
START TIME? - MON,DAY,YR HR,MIN
# PASSES TO FORMAT COMPLETION? - 6
UNIT      TYPE      HDS       CYLS      SEC/TRK
  0          0        5         823         32
  2          1        5         815         24
ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  0,2
UNIT:  0
ENTER TYPE OF DISK:  0
UNIT:  2
ENTER TYPE OF DISK:  1
FORMATTING UNIT 0,2
```

If errors are encountered using this program, refer to the Trouble-shooting section of this manual, Section 3.0.

2.8.3.2 RDOS USERS: DIAGNOSTICS

Run at least one pass of the Disk Diagnostic Program provided on the 400-405-XX tape.

This Diagnostic Program is provided to find failures that are related to the basic operations of the Disk Controller.

Boot the Disk Diagnostic from tape 400-405-XX or disk.

The following is a sample dialogue with the DC-297 Controller set to device 27:

```
ZETACO SMD DISK CONTROLLER DIAGNOSTIC REV. XX
STARTING ADDRESSES:
     200-DIAGNOSTIC (INITIALIZE)
     201-DIRECT ODT ENTRY
     202-RANDOM SEEK EXERCISERS
         SEEK EXER 1 IS A SINGLE DRIVE EXERCISER
         SEEK EXER 2 IS A DUAL DRIVE EXERCISER WITH
           SEEK OVERLAP
     500-DIAGNOSTIC (RESTART)
```

```
ENTER DEVICE CODE [27]:  Press carriage return
                         (carriage return uses value in
                         brackets).
ANY DUAL VOLUME UNITS?  INPUT 1  Press carriage return.
ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  Input 0,1
SET SWPAK AS PER 8.0, LISTING OR ENTER RETURN (CR) TO
  CONTINUE

     (This refers to Section 8.0 of Appendix A.1.  For
     normal operation a (CR) is done here.)

TESTING UNIT 0
.
.
.
.
UNIT       HDS        CYLS       SEC/TRK
  0         5          823          35
THESE ARE THE UNITS AND CHARACTERISTICS FOUND, DO YOU
WANT TO LOOP ON READING THEM?  ENTER 1, OTHERWISE ENTER
RETURN (CR).
.
.
.
.
ADDRESSABLE SECTORS/TRACK WITH THIS CONTROLLER IS 64.
DRIVE UNIT #0 WILL BE IDENTIFIED AS A 6160 (73 MBYTE)
BY AOS.

TEST(S) COMPLETE.
SEEK EXERCISER TESTS.
PASS
```

If errors are encountered using this program, refer to the Trouble-shooting section of this manual, Section 3.0.

2.8.3.3 RDOS USERS: RELIABILITY

Run the Disk Reliability Program on the 400-405-XX tape for at least 15 minutes. If time permits, let this program run longer to fully exercise and test the disk subsystem.

The Disk Reliability Program is a maintenance program designed to exercise and test the disk system. The program will test from one to four drives. Boot the Disk Reliability program from the 400-405-XX tape.

The following is a sample dialogue:

```
ZETACO...DISK RELIABILITY REV. XX

STARTING ADDRESSES:
     500-RELIABILITY TEST
     501-RELIABILITY TEST WITH OPTIONS
     502-DISK ADDRESS TEST
     503-COMMAND STRING INTERPRETER
     504-FORMAT ONLY
     505-RUN ALL TESTS
     506-SEEK EXERCISER
     507-RANDOM SEEK EXERCISER
     510-ERROR COUNT/LOG RECOVERY
ENTER DEVICE CODE [27]:  Depress CR
STARTING ADDRESS = 505
SET SWPAK AS PER 8.0, OR HIT (CR) TO CONTINUE
     (This refers to Section 8.0 of Appendix A.2.  For
     normal operation, a (CR) is done here.)

ARE MAPS TO BE EXERCISED (YES/NO)?  Input YES
START TIME? - MON,DAY,YR  HR,MIN    Input NO
ANY DUAL VOLUME UNITS (YES/NO)?     Input NO
UNIT      TYPE      HDS       CYLS       SEC/TRK
  0         0         5         823          32
  2         1         5         815          24
ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  Input 0,1
UNIT:  0
ENTER TYPE OF DISK:  Input 0
UNIT:  1
ENTER TYPE OF DISK:  Input 1
TESTING UNIT 0,1  (Refer to Section 3.0 if errors occur.)
```

2.8.3.4 RDOS USERS: ZDKINIT

At this point, the disk drive and its media has been tested satisfactorily and the media (data field) must be prepared for the operating system. This is accomplished with another program from the 400-405-XX tape called ZDKINIT. Run at least one pattern of this program.

Before you load any RDOS System onto a Model DC-297 Disk, YOU MUST INITIALIZE THE DISK BY RUNNING ZDKINIT. This is a stand-alone program which performs all the functions of DG's DKINIT. Please refer to DG's manual on loading an RDOS System for full details on the functionality of disk initialization.

Remember that only ZDKINIT will work correctly for Model DC-297 Disks. If you are building your system from an RDOS release tape, do NOT run File 4 on the DG tape after running ZDKINIT. DG's DKINIT cannot be run on a Model DC-297 Disk. ZDKINIT can, however, be used to initialize any DG supported disk.

STEP 1 - LOADING

Boot the ZDKINIT Program (#6) from the 400-405-XX tape.

STEP 2 - DISK TYPE

PROGRAM DISPLAYS:
DISK INITIALIZER - REV NN. NN/WITH ZETACO DISK SUPPORT - REV. 1
DISK DRIVE MODEL NUMBER?
You Respond: 6XXX

Note: Enter the X's exactly as shown above in "You Respond"

A) If the disk type is not valid -

Program Displays: ILLEGAL DISK TYPE
Step 2 will be repeated until your response is acceptable.

B) If the disk type is valid -

Program Displays: 6XXX (ZETACO Emulation) Drive Type

STEP 3 - DISK UNIT

Program Displays: DISK UNIT?
You Respond: DZx (where x indicates drive number: 0,1,.....7)

A) If the disk unit is not valid -
Program Displays: ILLEGAL DISK UNIT DECLARATION

Step 3 will be repeated until your response is acceptable.

B) If the disk unit is valid -
Program Displays:

#HEADS	#SEC/TRK	#CYLINDERS	MGB/BLK
99	99	999	Megabytes if disk >4000 blocks. Blocks if disk <4000 blocks.

The 9's in the #HEADS, #SEC/TRK and #CYL in this example are simply place holders, and do not represent a real situation. The information under these headings should represent the characteristics of the disk drive the Controller was configured for.

STEP 4 - COMMANDS AND SUBSEQUENT OUTPUT

The commands which can be selected are identical to those of DKINIT. From this point on, ZDKINIT will perform exactly as DKINIT.

2.8.3.5 THE FINAL STEPS

For the final step, run the configurator again to enable ECC Correction for each disk drive port. Now that disk drive installation is completed, correction of any data error is beneficial to system users. The disk is ready to have system data installed on it.

If this disk subsystem is to be the primary disk subsystem, then the standard RDOS build procedure (not provided in this manual) should now be continued.

NOTE: When sysgen asks, "Controller #1 6160/6161 Type?", answer NO. This allows up to four drives to be attached to the Controller. Answering YES allows only two drives.

After the system has been built, you should load the programs from the 400-405-XX tape onto the system. This will allow usage of the RDOSECC program as well as store a copy of the ZETACO disk test programs in the event that the 400-405-XX tape is misplaced or head skew problems arise on the tape drive in the future. For more insight into the RDOSECC program, see Section 4.0. To load these programs onto the system disk, bring up the system and execute a LOAD/V of File 8 from the 400-405-XX tape.

2.8.4 AOS USERS

2.8.4.1 FORMATTING

Run the Disk Formatter Program provided on the 400-405-00 tape. Run at least three passes, preferably six. If you have purchased the Sector Slip option, you may wish instead to run the Sector Slip Formatter (File #4 on the 400-405-01 tape). See the Sector Slip Manual for details.

The Disk Formatter Program is a utility program designed to format and check disk packs to be used on the disk systems. It is recommended that on-board error correction for each drive be disabled throughout both formatter and initializer programs. ("Initializer Program" refers to DFMTR.) It should then be enabled by running the configurator again after disk initialization.

The Formatter Program writes header information in the header field and then writes and reads different data patterns in the data field to check the media of the disk. The formatting process is done first by writing all the headers on the disk. When the last sector header is formatted, the program will output, "Format Done." Next, the data field is checked. Each pass of the Formatter Program signifies the completion of writing the entire data field of the disk with a data pattern and then reading the data back twice. The data written is compared to the data read for errors in the media. A sample run of the Formatter Program is given on the following page.
Boot the Disk Formatter Program (Program #3) from the 400-405-00 tape.

The following is a sample dialogue:

```
ZETACO SMD DISK CONTROLLER FORMATTER REV. XX

STARTING ADDRESSES:
     500-FORMATTER/CHECK PROGRAM
     501-CHECK PROGRAM ONLY
     502-ERROR LOG RECOVERY
     503-COMMAND STRING INTERPRETER
ENTER DEVICE CODE [27]:  Press carriage return
SET SWPAK AS PER SECT 8.0 OR HIT (CR) TO CONTINUE
     (This refers to Section 8.0 of Appendix A.0.  For
     normal operation a (CR) is done here.)
START TIME? - MON,DAY,YR  HR,MIN  Press carriage return
# PASSES TO FORMAT COMPLETION? - Input 6
UNIT      TYPE      HDS       CYLS      SEC/TRK
  0         0         5         823         35
  2         1         5         815         24
ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  Input 0,2
UNIT:  0
ENTER TYPE OF DISK:  Input 0
UNIT:  2
ENTER TYPE OF DISK:  Input 1
FORMATTING UNIT 0,2
```

If errors are encountered using this program, refer to Section 3.0, Trouble-shooting.

2.8.4.2 AOS USERS: DIAGNOSTICS

Run at least one pass of the Disk Diagnostic Program provided on the 400-405-XX tape.

This diagnostic program is provided to find failures that are related to the basic operations of the Disk Controller.

Boot the Disk Diagnostic from tape 400-405-XX or Disk.

The following is a sample dialogue for 6160 emulation (AOS) with the DC-297 Controller set to device 27:

```
ZETACO SMD DISK CONTROLLER DIAGNOSTIC REV. XX
STARTING ADDRESSES:
     200-DIAGNOSTIC (INITIALIZE)
     201-DIRECT ODT ENTRY
     202-RANDOM SEEK EXERCISERS
         SEEK EXER 1 IS A SINGLE DRIVE EXERCISER
         SEEK EXER 2 IS A DUAL DRIVE EXERCISER WITH
               SEEK OVERLAP
     500-DIAGNOSTIC (RESTART)
ENTER DEVICE CODE [27]:  Press carriage return
ANY DUAL VOLUME UNITS?  INPUT 1  Press carriage return
ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  Input 0,1
SET SWPAK AS PER 8.0, LISTING OR ENTER RETURN (CR) TO
     CONTINUE
     (This refers to Section 8.0 of Appendix A.1.  For
     normal operation a (CR) is done here.)

TESTING UNIT 0
.
.
.
UNIT       HDS        CYLS       SEC/TRK
  0         5          823          35
THESE ARE THE UNITS AND CHARACTERISTICS FOUND, DO YOU
WANT TO LOOP ON READING THEM?  ENTER 1, OTHERWISE ENTER
(CR) RETURN.
.
.
.
ADDRESSABLE SECTORS/TRACK WITH THIS CONTROLLER IS 64.
DRIVE UNIT #0 WILL BE IDENTIFIED AS A 6160 (73 MBYTE)
     BY AOS.
TEST(S) COMPLETE.
SEEK EXERCISER TESTS.
PASS            (Refer to Section 3.0 if errors occur.)
```

2.8.4.3 AOS USERS: RELIABILITY

Run the Disk Reliability Program from the 400-405-XX tape for at least 15 minutes, but preferably one complete pass to completely exercise and test the disk subsystem.

The Disk Reliability Program is a maintenance program designed to exercise and test the disk system. The program will test from one to four drives. Boot the Disk Reliability Program from tape 400-405-XX or Disk.

The following is a sample dialogue:

```
ZETACO...DISK RELIABILITY REV. XX
STARTING ADDRESSES:
     500-RELIABILITY TEST
     501-RELIABILITY TEST WITH OPTIONS
     502-DISK ADDRESS TEST
     503-COMMAND STRING INTERPRETER
     504-FORMAT ONLY
     505-RUN ALL TESTS
     506-SEEK EXERCISER
     507-RANDOM SEEK EXERCISER
     510-ERROR COUNT/LOG RECOVERY
ENTER DEVICE CODE [27]:
STARTING ADDRESS = 505
SET SWPAK AS PER 8.0, OR HIT (CR) TO CONTINUE
     (This refers to Section 8.0 of Appendix A.2.  For
     normal operation a (CR) is done here.)
ARE MAPS TO BE EXERCISED (YES/NO)?  Yes
START TIME? - MON,DAY,YR  HR,MIN
ANY DUAL VOLUME UNITS (YES/NO)?  No

UNIT       TYPE       HDS        CYLS       SEC/TRK
  0          0          5         823          35
  2          1          5         815          24

ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  0,1
UNIT:  0
ENTER TYPE OF DISK:  0
UNIT:  1
ENTER TYPE OF DISK:  1
TESTING UNIT 0,1
```

If errors are encountered using this program, refer to Section 3.0, Trouble-shooting.

2.8.4.4 DFMTR

At this point, the disk drive and its media have been tested satisfactorily and the media (data field) must be prepared for the operating system. This is accomplished with DFMTR (DG's Disk Initializer), and is not documented in this manual. Run at least one pattern of the DFMTR Program according to the procedure outlined by the DFMTR Manual.

2.8.4.5 THE FINAL STEPS

For the final step, run the configurator again to enable ECC Correction for each disk drive port. Now that disk drive initialization is completed, correction of any data error is beneficial to the system users. The disk is ready to have system data installed on it. If this disk subsystem is to be the primary disk subsystem, then the AOS build procedure (not provided in this manual) should be continued from the section after the explanation of DFMTR which has already been done. After the system has been built, you should load the programs from the 400-405-XX tape onto the system. This will allow usage of the AOSECC program as well as store a copy of the ZETACO disk test programs in the event that the 400-405-XX tape is misplaced or head skew problems arise on the tape drive in the future. For more insight into the AOSECC program, see Section 4.0. To load these programs onto the system disk, bring up the system and execute a LOAD/V of File 9 from the 400-405-XX tape.

3.0 TROUBLE-SHOOTING, TEST PROGRAMS AND CUSTOMER SERVICE

ZETACO products are supported in many ways:

-Microprocessor based self-test of over 80% of the board each time it is powered up, with LED status reporting.

-Reliability Program on 9-track tape for use during installation and trouble-shooting.

-48-hour turnaround on most factory repairs or replacement.

-Customer Support Hotline manned from 8:00 a.m. to 5:00 p.m. (Central Time) to answer your questions. 612-890-5135

-Factory-trained personnel at our Authorized Distributor and Authorized Service Organizations.

-Up to a two year warranty on all controllers in the event of a hardware failure.

NOTE: If you are referencing this section because of disk subsystem errors, but have a system on the disk that you want to retain, use Appendix C for information on which programs to run and how to set them up so the system will not be destroyed.

3.1 SELF-TEST ERRORS

The DC-297 Controller runs on-board microdiagnostics each time the board is powered up. The disk microprocessor performs independent, extensive testing of all internal controller functions. The red LED indicates self-test; the red LED is on during disk self-test (300 ms). If self-test passes, the red LED will go off and stay off.

If any subtest of self-test detects an error, the red LED will blink an error code, pause, then blink the error code again. The number of blinks between pauses identifies the malfunctioning circuit within the Controller according to Table 3.1. Depressing the computer's reset switch while the error code is being displayed causes that section to loop on the error and the LED will be on continuously.

If the red LED does not blink or go out, then the 2925 clock circuitry, the 2910, or the power fail circuit may be bad.

TABLE 3.1 Disk Self-test Error Codes

ERROR CODE	TEST	POSSIBLE FAILURE
1	EEPROM	The data in the EEPROM did not compare with expected data (55 hex). EEPROM may not have been previously burned.
2	RAM	Data read from RAM did not compare with data written. 2114, PBUS or RAM data bus may be bad.
3	SEQUENCE ERROR	A forced sequence error did not occur within a specified amount of time. Format sequencer may be bad. (No Clock)
4	SYNC DETECT	A sync detect was not made in a specified amount of time or the terminate FF may not have set. The sync register or compare logic may be bad or the terminate FF may be bad.
5	ECC	The generated ECC pattern did not compare with the expected pattern. The shift registers, ECC logic or multiplexors may be bad.

If the board fails Self-test, try any or all of the following:

1. Remove the board, clean the gold connector contacts and re-install it.

2. Disconnect paddleboards and disk drive cables.

3. Try the board in a different slot.

4. Remove the board and inspect all socketed ICs for bent pins. If any are found, gently pry the IC out of its socket, straighten the pin and re-insert it, being careful to observe proper orientation.

5. Press firmly on all socketed ICs to ensure good contact.

6. Be sure jumpers JJ1 through JJ9 are securely placed over all pins, and all jumpers are in the same position (i.e., all FCC or all non-FCC).

If the board still fails Self-test, call the Customer Support Hotline for assistance (see Section 3.4).

3.2 400-405-XX UTILITY PROGRAM ERRORS

The 400-405-XX utility programs are supplied on the 400-405-XX 1/2" magnetic tape. Included on the tape are the Configurator Program, Disk Maintenance Programs and System Support Programs and Utilities. This section explains what to do when problems are encountered with the disk subsystem during or after installation with these programs.

System Requirements

Data General Nova/Eclipse Family CPU/SPU
Minimum 32K Words Memory
Console Device at 10/11
Magnetic Tape Drive: 1/2" 9-Track
Printer at Device 17 for Hard Copy (Optional)

3.2.1 ERRORS BOOTING THE 400-405-XX TAPE

The 400-405-XX tape is structured so that the programs on Files 2 through 7 can be loaded and executed directly from the tape. Files 0 and 1 contain the software which enables you to boot from the tape and select the particular program you want loaded into the system. Each of the programs on Files 2 through 7 is a stand-alone program. This means that they do not need, and cannot have an operating system running when they are executed. Programs cannot be loaded onto your disk directly from Files 0 through 7. File 8 for RDOS and File 9 for AOS contain the programs in the standard system dump format and you can load them from these files to your disk. The procedure to boot the 400-405-XX tape is described in the four following steps.

1. Mount the tape on the tape drive and put it ON-LINE. Be sure that the BPI setting matches that specified on the tape label (normally 1600 BPI).

2. Program Load - The method of program load varies depending upon the processor being used.

If your system has front-panel switches, set them to 100022 when loading from the primary tape drive, or to 100062 when loading from the secondary tape drive. Then press reset and the program load switch.

For the S140 Virtual Console, set 11A to 100022 (or 100062 for secondary tape drive). Then enter 100022L (or 100062L).

For the S120 Virtual Console, enter 22H (or 62H for the secondary tape drive).

3. 400-405-00 menu will be displayed on your console like this:

```
FILE #    PROGRAM                              FILENAME

  2       DC-297 CONFIGURATOR                  CF297.SV
  3       DISK FORMATTER                       DISKF.SV
  4       DISK DIAGNOSTIC                      DISKD.SV
  5       DISK RELIABILITY                     DISKR.SV
  6       CSDKINIT-DISK INITIALIZER            CSDKINIT.SV
            (RDOS SYSTEMS ONLY)
  7       CSDSKED-DISK EDITOR                  CSDSKED.SV
            (RDOS SYSTEMS ONLY)
  8       ".SV & .LS" FILES AND ANY UTILITIES IN
            RDOS DUMP FORMAT
  9       ".SV & .LS" FILES AND ANY UTILITIES IN
            AOS DUMP FORMAT

FILE NUMBER?
```

If the data above is not displayed, first check that the tape unit was ON-LINE. If it was not, put it ON-LINE and boot the tape again. If the tape unit was ON-LINE, depress the break key. Check the program counter for a 377. If if is 377, check the priority chain to the tape controller. Also ensure that the boot device is correct, i.e. if the 400-405-XX tape is on the primary tape subsystem, the boot procedure uses device 22. If the program counter is any number other than 377, check that the tape's density and the tape unit are the same density.

4. Enter the file number (2 through 7) you wish to execute, followed by CR. The tape should then space forward and load the program into memory.

3.2.2 DC-297 CONFIGURATOR ERRORS

If the program locks up at any point, depress the break key and examine the program counter. The data at the address in the program counter can be used to determine which device is causing the program to loop.

3.2.3 DISK FORMATTER ERRORS

The Disk Formatter Program is a utility program designed to format and check disk packs to be used on the Disk Systems. It is recommended that on-board error correction for each drive be disabled throughout both formatter and initializer programs. It should then be enabled by running the configurator again after disk initialization.

3.2.3.1 FORMATTER ERROR DESCRIPTION

Errors during formatting occur after the header fields are written and "Formatting Done" has been output to the console. These errors are displayed when they are detected. The Controller status will be displayed with the particular problem spelled out below the status. Each status bit is also explained in the Programming Section. Most errors that can occur are Servo, Address, ECC or Ready errors.

3.2.3.2 SERVO CLOCK FAULTS

A Servo Clock Fault will terminate the format program. Note the cylinder, head and sector the error was detected on, (printed out on the console before aborting). Use the command string interpreter explained in Appendix A to seek to the cylinder noted above. Next, do a Write to the head and sector (transfer one sector) noted above. If it again errors, it is not intermittent. Now try writing to other sectors around the sector that erred. If these sectors also err, there are not enough bytes per sector (576 minimum needed) and the disk unit manual should be consulted to check the number of bytes per sector. Another cause of this error could be improperly connected cables, or that the sector and index pulses are being transmitted over the "B" cable and not the "A" cable. If these errors are intermittent, again check for improper cable connections, and recheck the disk type for which the Controller is configured via the Configurator Program.

3.2.3.3 ECC DETECTED ERRORS

There are two types of ECC detected errors: ECC Detected Errors with data printed out (data block flaws), and ECC Detected Errors without data printed out. ECC Errors will not abort the program. These errors usually mean the controller detected a flaw in the disk media.

For ECC Errors with error data printed out, up to three words of good data and bad data are printed out, along with a count number. This count number is the number of words found in the sector that are bad. For example, if six words are bad in one sector, the first three bad words will be printed out with the good and bad data and the count will be six. The formatter program automatically flags these sectors bad so the operating system does not try to use this bad media.

ECC detected errors without error data words printed out mean there is a bad spot on the media where the ECC words are written. The formatter automatically flags these sectors bad. If the errors are excessive, (every head or more) the bytes per sector could be short. Use the disk drive's technical manual to check the number of bytes per sector there are on the disk unit with the present sector setting. 576 bytes or more are required to run the DC-297.

3.2.3.4 ECC UNDETECTED ERRORS

This is a data error undetected by the ECC circuitry. ECC undetected errors will terminate the Formatter Program. Note cylinder, head and sector the error occurred on; also note the count number. Load the configurator program and verify that the Controller is configured for the right disk drive(s). If the configuration is okay, load the formatter again and bring up the command string interpreter as explained in Appendix A. Use the command string to seek to the cylinder noted previously. Next, write to the head and sector (i.e. transfer one sector). This helps verify that the problem is not intermittent. Now format the sector in question and then write to it again. If the error is still there, power down the system and then power it back up. Examine the red LED for any self-test errors. If there are none, try the DC-297 in another slot.

3.2.3.5 SURFACE OR SECTOR ADDRESS ERRORS

Surface/Sector address errors do not abort the format program. These errors usually indicate bad media in the header field. The formatter will automatically flag these sectors bad. If these errors are intermittent or excessive, check for poor disk termination, improper disk cabling or grounding, and re-check the Controller configuration for the correct disk types.

3.2.3.6 LOSS OF READY

Loss of Ready errors abort the format program. They can be caused by improper cabling or termination. These errors indicate the disk unit was not ready when a command was issued. Check that the disk unit is powered up and no faults have occurred on the disk unit.

3.2.3.7 DEFAULT CHARACTERISTICS

Normally, the ZETACO Formatter, Reliability and Diagnostic programs will display the drive characteristics previously selected with the Configurator Program. However, if the Controller does not see a unit selected from the disk drive, the following set of "default characteristics" will be displayed:

UNIT	TYPE	CYL	HEADS	SECTORS
0	0	411	5	32
1	1	823	5	32
2	2	823	10	32
3	3	823	19	32

This problem may be caused by one or more of the conditions listed below:

1. Drive Off Line
2. Cables not connected
3. Bad cable(s)
4. Incorrect cabling sequence (Is Yellow LED ON?)
5. Calling up wrong Device Code or non-existent Device Code
6. Interrupt and Priority chain broken
7. Terminator of disk drive not IN

3.2.3.8 SLOW FORMAT

The Formatter Program formats 300 MB in about 56 minutes and time is directly proportional to the disk size. If it takes more time than this, the disk is probably skipping revolutions. To alleviate this problem, reconfigure the Controller to interleave the disk. Refer to Section 4.1.6 for more information.

3.2.3.9 ADDITIONAL TROUBLE-SHOOTING FOR ALL FORMATTER PROBLEMS

For any error encountered while formatting, it is beneficial to try a different "B" port. This isolates some logic on the Controller that cannot be checked by selftest.

3.2.4 DISK DIAGNOSTIC

This Diagnostic Program is provided to find failures that are related to the basic operations of the disk controller.

3.2.4.1 DIAGNOSTIC ERROR DESCRIPTION

When the diagnostic detects an error, it prints out the test number that failed along with the actual problem. Use the SWPAK reg to help determine whether or not the error is intermittent. This is done by setting switch 3, which prints out an error percentage. Refer to Appendix B for detailed definitions of the bits in the SWPAK reg. Depressing the M key allows you to observe the contents of this register.

3.2.4.2 SERVO OFFSET FORWARD

Servo Offset Forward errors can occur in the diagnostic if the disk unit does not support the offset command. They are also caused by disk drives that return a write protect to the controller during an offset. The technical manual for the disk unit should be consulted to determine whether your disk can exhibit the offset problem. If it does, this error is invalid and can be overlooked.

3.2.4.3 SERVO OFFSET REVERSE

Servo Offset Reverse errors can occur in the diagnostic if the disk unit does not support the offset command. They are also caused by disk drives that return a write protect to the Controller during an offset. The technical manual for the disk unit should be consulted to determine whether your disk can exhibit the offset problem. If it does, this error is invalid and can be overlooked.

3.2.5 DISK RELIABILITY

The Disk Reliability Program is a maintenance program designed to exercise and test the disk system. The program will test from one to four drives. Boot the Disk Reliability Program from 400-405-XX tape.

3.2.5.1 RELIABILITY ERROR DESCRIPTION

Reliability errors are displayed when they are detected. The controller status will be displayed with the particular problem spelled out below the status. Each status bit is explained in the Programming Section, but since the error is also spelled out, referencing the Programming section may not help. Most errors that can occur are default or ready errors.

3.2.5.2 LOSS OF READY

These errors indicate the disk unit is not ready when a command was issued. Check that the disk unit is powered up and no faults have occurred on the disk unit.

3.2.5.3 DEFAULT CHARACTERISTICS

Default characteristics are displayed when the Controller does not see a unit selected from the disk drive. Refer to Secton 3.2.3.7.

3.2.5.4 ADDITIONAL TROUBLE-SHOOTING FOR ALL RELIABILITY PROBLEMS

For any error encountered while formatting it is beneficial to try a different "B" port. This isolates some logic on the Controller that cannot be checked by Self-test.

3.3 SYSTEM ERRORS

If a system error occurs, use the manual provided with the computer system to help determine what is wrong. For example, if a panic code is given, look up the code; this information could help determine how to solve the problem. Next, try to execute a similar function and see if the same results are obtained. If a BURST or a PCOPY is not working, try a DUMP. This could add vital information about the problem.

3.4 CUSTOMER SUPPORT HOTLINE

ZETACO, Inc. provides a Customer Support Hotline (*1-612-890-5135*) to answer technical questions and to assist with installation and trouble-shooting problems. The Hotline is manned by a technical team from 8:00 a.m. to 5:00 p.m. (Central Time) Monday through Friday.

To facilitate over-the-phone trouble-shooting, please fill out the checklist on the following page before placing your call.

HOTLINE TROUBLE-SHOOTING CHECKLIST

CPU_____Operating System and Rev._____

Is this Controller replacing a previously installed subsystem?_____

Device Code of new Controller:_____ Any similar subsystem in the CPU? YES NO If yes, then its Device Code:_____

Configuration Facts_____

_____

Problem Description_____

_____

Problem happens when (during DUMP, Reliability, etc.)?_____

_____

Intermittent or consistent problem?_____

Does Self-test pass?_____

Priority of Board in CPU (Slot)_____

Reviewed Interrupt and Priority Jumpers on Vacant Slots?_____

Tried Different Slot?_____

Cleaned gold-fingered contact points of board and reset board?_____

Does supplied ZETACO 1/2" tape "BOOT" correctly?_____

Is peripheral set to correct unit number, and is terminator IN?_____

For peripheral disk drives, what is Sector Switch setting?_____

Double checked PIN 1 of cable to Pin 1 of Controller, backplane and peripheral?_____

Result of ZETACO Reliability or Diagnostic:_____

3.5 PRODUCT RETURN AUTHORIZATION

When controller malfunction has been confirmed using the tests outlined in Sections 3.1 through 3.4, the board can be returned to ZETACO for warranty repair or for time-and-material repair if the product has been damaged or is out of warranty. A Return Material Authorization (RMA) number is required before shipment and should be referenced on all packaging and correspondence.

To ensure prompt response, the information outlined in the Material Return Information form on the following page should be gathered before calling your Authorized Distributor or the ZETACO Hotline for the RMA number. Please include a completed copy of the Material Return Information form with the product. Each product to be returned requires a separate RMA number and Material Return Information form.

To safeguard the Controller during shipment, please use packaging that is adequate to protect if from damage. (The original packaging is recommended.) Mark the box "Delicate Instrument" and indicate the RMA number(s) on the shipping label.

3.6 WARRANTY INFORMATION

All ZETACO controllers and couplers are warranted free from manufacturing and material defects, when used in a normal and proper manner, for a period of up to two years from date of shipment. Except for the express warranties, stated above, ZETACO disclaims all warranties including all implied warranties of merchantability and fitness. The stated express warranties are in lieu of all obligations of liabilities on the part of ZETACO for damages, including but not limited to, special, indirect or consequential arising out of or in connection with the use or performance of ZETACO's products.

MATERIAL RETURN INFORMATION

All possible effort to test a suspected malfunctioning controller should be made before returning the controller to ZETACO for repair. This will: 1) Determine if the board is actually defective. 2) Increase the speed and accuracy of a product's repair, which is often dependent upon a complete understanding of the user's checkout test results, problem characteristics, and the user system configuration. Test results for the disk controller should be obtained by performing the tests below. (Use back of page if more space is needed.)

TEST	RESULT
Self-test	_____
Formatter	_____
Diagnostics	_____
Reliability	_____

Other tests performed (system operation, errors, etc.):

Please allow our service department to do the best job possible by answering the following questions thoroughly and returning this information with the malfunctioning board.

1. Does the problem appear to be intermittent or heat sensitive? (If yes, explain.)

2. Under which operating system are you running? (RDOS, AOS) Include Revision number.

3. Describe the system configuration, (i.e. peripherals, controllers, model of computer, etc.).

4. Has the controller been returned before? Same problem?

To be filled out by CUSTOMER:

Model #:_____
Serial #:_____
RMA #:_____(Call ZETACO to obtain an RMA number.)

Returned by:

Your name:_____
Firm:_____
Address:_____
Phone:_____

4.0 CONTROLLER USAGE GUIDELINES

4.1 CONTROLLER FEATURES PROGRAMMED BY THE CONFIGURATOR

4.1.1 CONFIGURATOR HELP (H or W Command)

The DC-297 Configurator includes two "HELP" commands, one for OPERATIONAL questions and one which suggests WHAT you might want to do. In addition, you can get an explanation for any item by responding with an "H" to the question. Please use these functions whenever you are uncertain as to what to do.

4.1.2 THROTTLE BURST RATE (F Command)

This is defined as the number of word transfers that take place over the data channel during a single bus access by the disk controller. Throttle adjustment is dependent on the type of system configuration in which the Controller is installed. Too low a throttle setting could result in slow disk performance and too high a setting could cause a data late on another data channel device. The Controller may be set to burst rates of 4, 8, 16, 32, 64, 128 and 256 words per access. A burst rate of 16 is recommended for most applications.

The DC-297 allows you to select a different burst rate for each port on the Controller, thereby giving the ability to fine tune the bus to the particular speed or activity of each disk drive.

4.1.3 SYNC BYTE (M Command)

The DC-297 supports a disk media format that contains a header sync byte and data field sync byte (versus only a sync bit). The sync byte provides better header address verification and data integrity. This sync byte is user definable for each drive port. Any value between 01 hex and FF hex is acceptable, although 93 hex (223 octal) is the recommended value. When entering a sync byte use the octal number. This feature can provide a means for disk pack access security between different disk subsystems.

4.1.4 ERROR CORRECTION ENABLE/DISABLE (E Command)

When this function is enabled, on-board error correction and data strobe early/late occur automatically on bad disk data. Also, a running count of ECC corrections and successful data strobe early or late data recoveries are logged in scratch pad memory (separate count for each unit). With this function disabled, ECC corrections must be handled by the software. This feature can be selected on any port.

If any disks are going to be formatted and initialized following configuration, it is recommended that on-board ECC be disabled, then re-enabled after disk initialization.

4.1.5 MEDIA FORMAT (M Command)

The DC-297 currently offers a choice of five (5) different disk media formats to maintain compatibility with other disk subsystems. Each port is independently configurable for any of the formats. For disk drive types currently available in the Configurator through the D command, the recommended media format will be automatically assigned when the drive is selected. If you are configuring for a drive not currently listed, consult your drive manual for transfer rate specifications.

The disk media formats available are:

ZETA 1 — standard 1.25 MB/second (10Mhz) format (recommended for drives that transfer data at rates of less than 1.5 MB/second (12Mhz)).

ZETA 2 — high speed format (version of standard format designed for use with drives with transfer rates of 2.5 MB/second (20Mhz).

ZETA 3 — high speed compatible format (version of standard format designed for use with drives with transfer rates of 1.5 MB/second to 2 MB/second (16Mhz)).

ALT1 — Alternate vendor (Spectralogics) format.

ALT2 — Xylogics format.

See Figure 1.2 for detailed information.

4.1.6 INTERLEAVE FACTOR (I Command)

Sector interleaving is used to compensate for slow disk performance caused by the inability of the CPU to keep up with the transfer rate of the drive. This "data channel latency" may occur when many devices share the data channel, or when the drive transfer rate is greater than 10 Mhz. Interleaving may be used along with throttling to "tune" a system's performance. The DC-297 supports physical sector interleaving from 2:1 to 6:1, and each port can have a different interleave ratio. An interleave factor of 1 (1:1, or non-interleave) should be sufficient in most cases. However, for drives with transfer rates greater than 10 Mhz, an interleave factor of 2 or higher is recommended.

The interleaving available with I Command should not be confused with the logical interleaving available with the D Command. For a description of logical interleaving, see Section 4.1.7. When logical interleaving is in use, physical interleaving is not permitted.

4.1.7 DISK DRIVE TYPES (D Command)

This section of the Configurator Program allows the operator to assign drive characteristics on a port-by-port basis. Note that drive characteristics are assigned per "port", or "B" cable, and not per the drive's unit number setting. (Any unit can be connected to any of the four ports.) A warning will be issued when a potentially illegal configuration is attempted. "HELP" information is available throughout, by typing "H".

The DC-297 is capable of controlling virtually any disk drive that meets the SMD interface specification. The Controller may be configured to assign drives of varying capacities, transfer rates, formats, etc. to any of the four ports.

Under RDOS, the DC-297 can take advantage of the full capacity of most disk drives because ZETACO's Disk Initializer, CSDKINIT, allows deviation from standard RDOS disk emulations. To achieve the same flexibility under AOS, ZETACO has developed a tool called Virtual Mapping. To use Virtual Mapping simply answer "Y" to the Configurator question, "WILL THE CONTROLLER BE RUN IN VIRTUAL MODE?" Then use the HELP Command if you have questions. For an explanation of Virtual Mapping, see Appendix C.

Notes regarding dual volume drives:

Dual volume drives must be assigned an even unit number. A dual volume drive is treated as two logical units, so a maximum of two dual volume drives, or one dual volume and two single volume drives may be attached to the Controller.

There are two forms of dual volume drives:

The first is an actual dual volume drive designed with two physical volumes, usually one fixed and one removable cartridge. These include the Control Data Corporation Lark and 9448 (CMD), and Amcodyne's 7110.

The other form is actually a single volume drive that is "split" by the Controller into two logical units to provide the sizing characteristics necessary for DG emulation. For example, under AOS, the Fujitsu 2351 (Eagle) is split for dual 6061 emulation, and the CDC XMD 9771 is split for dual 6161 emulation.

This technique is called "logical interleaving" and is available with the D Command. When configuring for a disk for which logical interleaving is recommended, the Configurator will ask, "WILL THIS DISK REQUIRE LOGICAL INTERLEAVE? ([Y] N)". A carriage return selects logical interleaving. For further clarification, use the HELP Command (type H).

Note that when logical interleaving is in use, physical interleaving (available with the I Command) is not permitted.

Both forms of dual volume drives must have each logical unit formatted separately by the initializer programs, (CSDKINIT for RDOS or DFMTR for AOS). In the case of ZETACO's Formatter Program, which must be run prior to the initializer program, the "split" form of dual volume drives must be formatted at the same time or errors will occur. The other form of dual volume disk drive may be formatted at the same time or separately.

4.2 DISK ECC COUNTER UTILITIES

The Model DC-297 Controller maintains a counter of ECC corrections for each disk drive connected to the board. These are the corrections performed by the firmware and are therefore, invisible to the system except through these counters. The counters are automatically cleared by the reset switch on the front panel or if the Controller is powered down.

The utilities must be loaded onto disk from the 400-405-XX tape (RDOSECC.SV for RDOS and AOSECC.PR for AOS). The utilities allow you to monitor the media by displaying or modifying the counters. Depending upon your needs, you can reset the counters to zero on some regular basis: daily, weekly, monthly, etc.

Step 1 - EXECUTING THE PROGRAM UNDER CLI

A) RDOS Version - Input: RDOSECC
B) AOS Version - Input: X AOSECC

Step 2 - MAIN MENU

ZETACO - ECC FUNCTIONS

1) DISPLAY CONTROLLER ECC CORRECTIONS
2) RESET CONTROLLER ECC CORRECTIONS
3) STOP

NOTE: SELECT ONLY THOSE DRIVES WITH ZETACO CONTROLLER BOARDS. RESULTS ARE UNPREDICTABLE ON OTHER BOARDS.

ENTER SELECTION
You Respond:

1) To display the ECC corrections counter(s)
2) To modify the ECC corrections counter(s)
3) To terminate the program and return to CLI

Step 3 - ENTERING THE UNIT

IF YOU SELECTED 1 OR 2, PROGRAM DISPLAYS:
ENTER UNIT:

You Respond:
DZn (n=0, 1 ..., 7) for RDOS
DPFN (n=0, 1, 2, 3, 10, 11, 12, 13) for AOS
Carriage Return or New Line to return to Main Menu

The program will display the (decimal) value of the corrections counter for the drive selected. This step will be repeated until the response to ENTER UNIT is carriage return or new line.

Step 4 - MODIFYING THE COUNTER

If your response to the Main Menu was 2, there will be another message after STEP 3:

ENTER NEW VALUE:

You respond with the (decimal) value to which you want the counter set. The number must be between 0 and 65,535. This step will be repeated until you enter a carriage return or new line which will return you to Step 3.

5.0 PROGRAMMING NOTES

5.1 PROGRAM INSTRUCTIONS

5.1.1 SYMBOLIC DEFINITIONS USED

DXXF AC, DSKP

DXX means either DOA, DOB, DOC, DIA, DIB or DIC

F means Function: There are three functions; C, S, P. Each affects the controller differently as described below.

C - CLEAR — Resets Busy and Done flags to zero, aborts all data transfer commands, and clears data transfer status (DIA) fault bits 6, 7, 8, 9, 10, 11, 12, 13, 14 & 15. Also clears RD/WRT and drive attention flags and interrupt request.

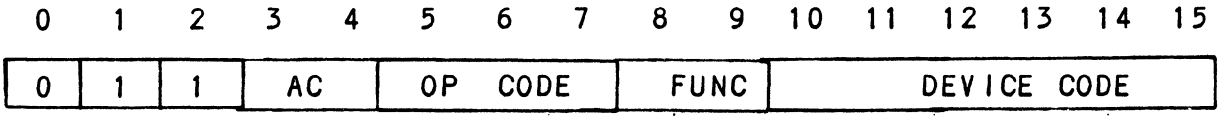
S - START — Sets busy flag, clears done and initiates one of the following commands selected by a DOA: Read, Write, Format, Read Buffers or Verify. Also clears interrupt request and data transfer status (DIA) fault bits 6, 7, 8, 9, 10, 11, 12, 13, 14 & 15.

P - PULSE — Sets control full flag and initiates one of the following commands selected by a DOA: Recal, Seek, Stop, Offset, Write Disable, Release, Trespass and Exam Controller RAM.

AC — ACCUMULATOR - There are four ACs: 0, 1, 2 and 3.

DSKP — DEVICE CODE: PRIMARY - 27 Octal
SECONDARY - 67 Octal
(Others available)

BINARY REPRESENTATION OF AN I/O INSTRUCTION



5.1.2 INTERRUPT MASKING (BIT 7)

MSKO AC

Execution of the Mask Instruction with Bit 7 equal to a one in the selected accumulator will set the interrupt mask within the controller board. This will inhibit any further interrupt requests by the controller until the interrupt mask is cleared, either by an IORST instruction or execution of the mask instruction with accumulator Bit 7 equal to a zero.

5.1.3 I/ORESET INSTRUCTION

IORST

Execution of an IORST instruction serves as a master reset to the controller board. Upon completion of an IORST the controller will attempt to select unit zero and default the command register to a read operation.

5.1.4 I/OSKIP INSTRUCTION USAGE

Used to poll the state of the controller board (command is done or busy). If the skip condition is met the next instruction is skipped, otherwise the next instruction is executed.

SKPBZ DSKP - SKIP IF BUSY FLIP-FLOP IS CLEAR.

SKPBN DSKP - SKIP IF BUSY FLIP-FLOP IS SET.

SKPDZ DSKP - SKIP IF DONE FLIP-FLOP IS CLEAR.

SKPDN DSKP - SKIP IF DONE FLIP-FLOP IS SET.

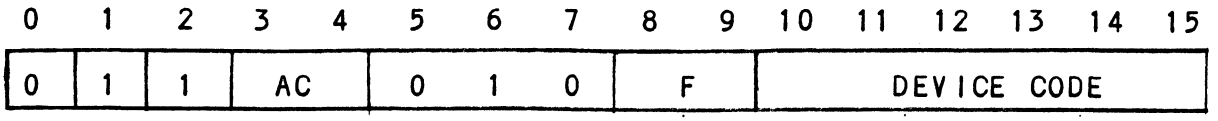
5.2 ACCUMULATOR FORMATS FOR THE I/O INSTRUCTIONS

This section explains the meaning of each bit in the accumulator used by the I/O instruction.

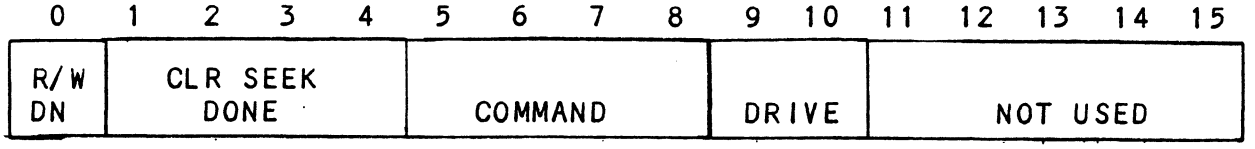
5.2.1 DOA - USED TO SPECIFY A COMMAND AND A DRIVE

DOAF AC, DSKP

5.2.1.1 BINARY REPRESENTATION



5.2.1.2 ACCUMULATOR FORMAT



BIT POSITION	FUNCTION OF THE BIT
0	Clear Read/Write Done if it is a ONE
1	Clear Seek Done Attention Flag for Drive Unit 0 if it is a ONE
2	Clear Seek Done Attention Flag for Drive Unit 1 if it is a ONE
3	Clear Seek Done Attention Flag for Drive Unit 2 if it is a ONE
4	Clear Seek Done Attention Flag for Drive Unit 3 if it is a ONE

BITS 5-8 SPECIFY A COMMAND

If bits 5-8 are set to:	COMMAND IS	FUNCTION REQUIRED TO INITIATE
0000	READ	START
0001	RECALIBRATE	PULSE
0010	SEEK	PULSE
0011	STOP DISK	PULSE
0100	OFFSET FORWARD	PULSE
0101	OFFSET REVERSE	PULSE
0110	WRITE DISABLE	PULSE
0111	RELEASE DRIVE	PULSE
1000	TRESPASS	PULSE
1001	SET ALT MODE 1	NONE
1010	SET ALT MODE 2	NONE
1011	EXAMINE RAM	PULSE
1100	DATA VERIFY	START
1101	READ BUFFERS	START
1110	WRITE	START
1111	FORMAT	START

NOTE: SEE SECTION 5.3 FOR DETAILED COMMAND DESCRIPTION.

BITS 9 - 10 DRIVE SELECTION: Issue the command to the drive specified by these bits.

00 - Drive Unit 0
01 - Drive Unit 1
10 - Drive Unit 2
11 - Drive Unit 3

DOA will reserve a previously unreserved drive. Bit position 9 is not used if 616X.

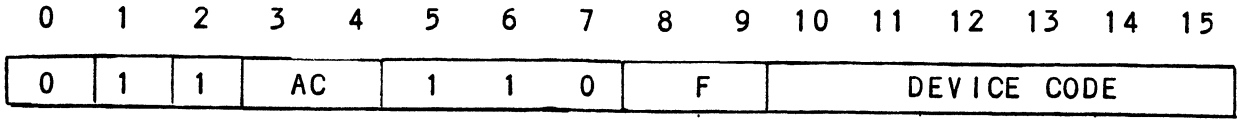
BITS 11 -15 Reserved for future consideration.

5.2.2 DOB - LOAD THE STARTING MEMORY ADDRESS

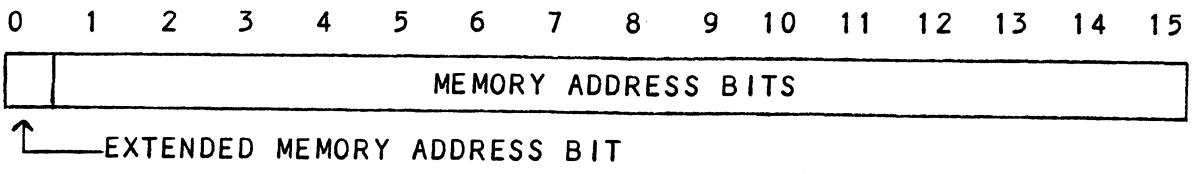
Execution of this instruction will load the controller's address counter with the contents of the specified accumulator and will be used as the starting memory address for a command that requires a data channel transfer operation.

DOBF AC, DSKP

5.2.2.1 BINARY REPRESENTATION



5.2.2.2 ACCUMULATOR FORMAT

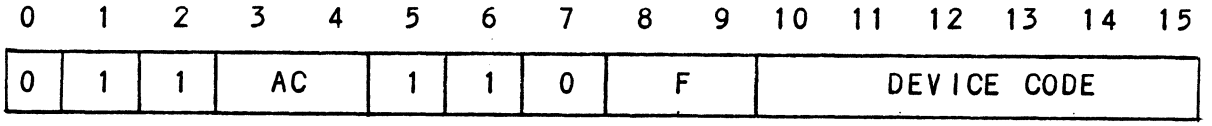


5.2.3 DOC - LOAD THE DRIVE ADDRESS

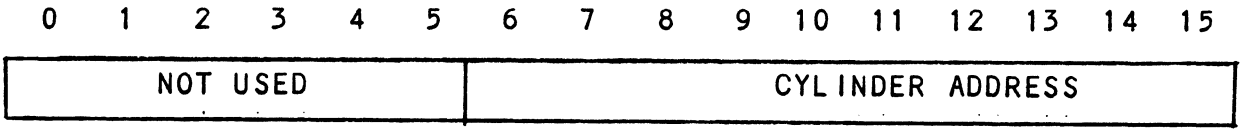
The DOC accumulator has two separate functions depending on the command issued by the DOA instruction. If the DOA command is a seek, then the DOC accumulator bits specify the cylinder (or track) to seek to. If the DOA command is a read, write, format or data verify, then the DOC accumulator bits specify the starting surface, the starting sector and the number of sectors to transfer (two's complement).

DOCF AC, DSKP

5.2.3.1 BINARY REPRESENTATION



5.2.3.2 ACCUMULATOR FORMAT (For Seek)



5.2.3.3 ACCUMULATOR FORMAT (For Read, Write, Format or Data Verify)

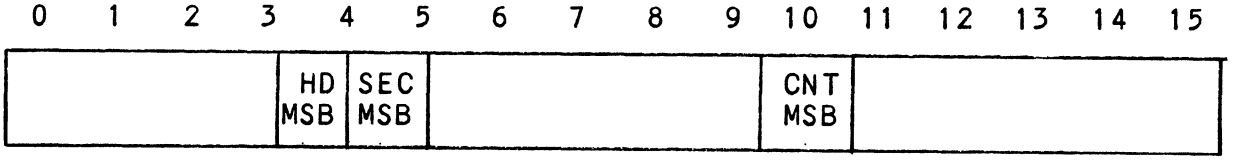
SINGLE DOC

Single DOC describes the process of executing one DOC instruction for each DOA instruction that specifies one of the four functions mentioned. This process is used to support a disk drive running 32 sectors or less and 32 surfaces or less. The reason no more than 32 sectors can be supported with Single DOC is that only five bits of the accumulator used by the DOC are used to address a sector on the disk. As a result, the sectors that can be addressed are sectors 0 to 31, or 32 sectors.

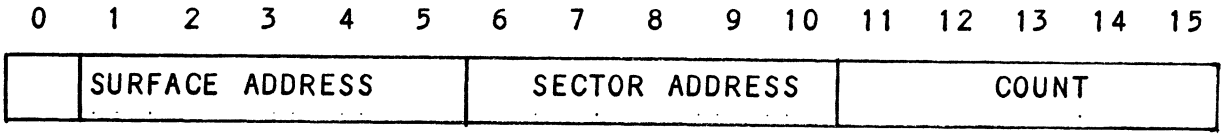
DOUBLE DOC

Double DOC refers to a process where two DOC instructions are given consecutively for each DOA command specifying a Read, Write, Format or Data Verify. This procedure is required to obtain the maximum efficiency from a disk drive capable of running more than 32 sectors. The first DOC's accumulator will contain extended disk address information and the second DOC's accumulator will contain the lower five bits of the surface, sector and count (this second DOC would be the only DOC for Single DOC). The accumulator formats for each DOC follow.

5.2.3.3.1 THE FIRST DOC



5.2.3.3.2 THE SECOND DOC



0 - NOT USED
1 - 5 STARTING SURFACE ADDRESS
6 - 10 STARTING SECTOR ADDRESS
11 - 15 2 IS COMPLEMENT NUMBER OF SECTORS TO BE TRANSFERRED.

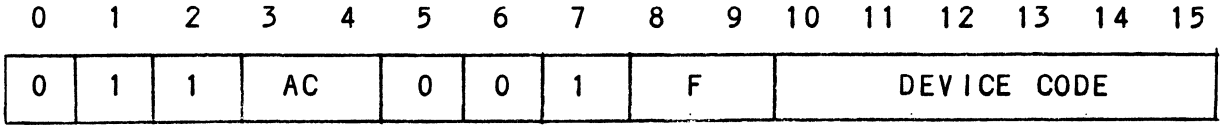
5.2.4 CONTROLLER STATUS

There is a large amount of status information shared between the disk controller and the computer; so much information that all the bits from the DIA, DIB and the DIC are not enough to satisfy the required amount of information. As a result, Alternate Mode was incorporated to change the meaning of the following DIA, DIB or DIC. There are two alternate modes, called Alternate Mode 1 and Alternate Mode 2. To invoke an alternate mode, a DOA command must be issued with the desired alternate bits set. Otherwise, the controller will return non-alternate mode status.

5.2.4.1 DIA - NON ALTERNATE MODE - READ DATA STATUS

DIAF, AC, DSKP

5.2.4.1.1 BINARY REPRESENTATION



5.2.4.1.2 ACCUMULATOR FORMAT DIA - NON ALTERNATE MODE

BIT #	DEFINITION
0	Control Full
1	Read/Write Done
2	Unit 0 Atten Done
3	Unit 1 Atten Done
*4	Unit 2 Atten Done
*5	Unit 3 Atten Done
6	Bus Error
7	Illegal Sector Address
8	ECC Error
9	Bad Sector Flag
10	Cylinder Address Error
11	Surface/Sector Address Error
12	Verify Error
13	Read/Write Timeout
14	Data Late
15	Read/Write Fault

* Bit Positions 4 and 5 are not defined if 616X Emulation.

DATA TRANSFER STATUS BIT DESCRIPTIONS

ACCUMULATOR BIT POSITION	DEFINITION	DESCRIPTION
0	CONTROL FULL	Will be a ONE when the Controller receives a pulse function. Will be a ZERO once the Controller completes the function specified by the command (Recall, Seek, Stop Disk, Offset, WRT DIS, Release, Trespass or Exam Ram).
1	R/W DONE	A ONE indicates that the Done flag was set following a data transfer command.
2-5	UNIT ATTEN DONE (UNITS 0-3)	A ONE indicates that the respective drive completed a successful seek or recalibrate operation. If the drive was unsuccessful in its attempt to seek, a positioner fault status will be indicated. A recalibrate operation will clear the fault.
6	BUS ERROR	A ONE indicates that an incorrect number of memory transfers resulted on the data channel.
7	ILLEGAL SECTOR ADDR	A ONE indicates that the starting sector address (DOC) exceeded the capacity of the drive. Done sets immediately.

8	ECC ERROR	A sector of data read from the disk did not correlate with the appended polynomial. This means that the data read does not agree with the data that was originally written.
9	BAD SECTOR FLAG	The Controller detected the bad sector flag set to a one within the sectors address header. (Done will set immediately.) This implies that the format program originally determined that the surface within this sector could not support errorless data.
10	CYLINDER ADDRESS ERROR	The Cylinder Address contained within the Sector Header did not match the requested cylinder given by the previous seek command. The Read/Write Operation will be terminated immediately.
11	SURF/SECTOR ADDRESS ERROR	This status bit may be set by one of the following cases: 1) The Surface or the Sector Address contained within the Sector Header did not match the current contents of the Controller's Surface/Sector Register (initiated by a DOC). 2) The CRC polynomial did not correlate with the Header Address.

		3) The Data Sync on a Read Command could not be detected. The Read/Write operation will be terminated immediately.
12	VERIFY ERROR	Data in memory did not agree with the data on the disk. See Verify Command.
13	READ/WRITE TIMEOUT	A Read or Write type of operation did not complete within one second.
14	DATA LATE	Not implemented.
15	*READ/WRITE FAULT FLAG	A ONE indicates that at least one bit is set in bit positions 6 through 14, or a drive fault occurred during a Read/Write transfer operation.

*Refer to Table 5.1 for a detailed description of error recovery expectations.

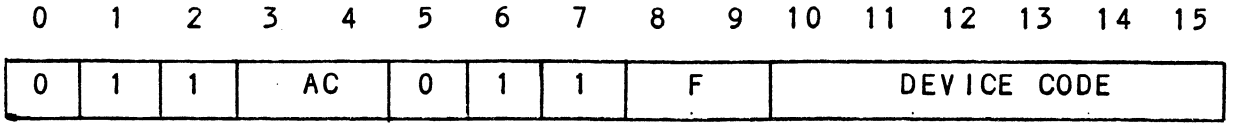
TABLE 5.1 Read/Write Faults (DIA)

	STATUS BIT POSITION	CONTROLLER ACTION	ERROR RECOVERY
BUS ERROR	6	Sets Done immediately.	New command. Re-try Read/Write Transfer. May correct the problem.
ILLEGAL SECTOR ADDRESS	7	Sets Done immediately.	New command if error reoccurs. Make sure the Controller is configured to match the drive type.
ECC ERROR	8	Sets Done at end of sector transfer.	New command. Re-tries with servo offset may correct the data. If this error is detected on a surface analysis, the bad sector flag should be set.
BAD SECTOR FLAG	9	Sets Done immediately.	New command. This sector should be ignored.
CYLINDER ADDRESS ERROR	10	Sets Done immediately.	New command. The system should diagnose this as a positioner fault.
SURFACE/ SECTOR ADDRESS ERROR	11	Sets Done immediately.	New command. Bad sector flag should be set if during surface analysis.
VERIFY ERROR	12	Sets Done at end of sector transfer.	New command. Check ECC error also to determine if the error occurred due to a flaw in the media.
READ/ WRITE TIMEOUT	13	Sets Done immediately.	New command.

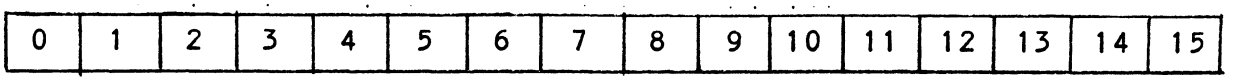
5.2.4.2 DIB - READ DRIVE STATUS

DIB AC, DSKP

5.2.4.2.1 BINARY REPRESENTATION



5.2.4.2.2 ACCUMULATOR FORMAT DIB - READ DRIVE STATUS



BIT #	DEFINITION
*0	Invalid Status
*1	Drive Reserved
*2	Trespassed
3	Ready
4	Busy
*5	Positioner Offset
6	Write Disabled
*7	ID
*8	Illegal Surface/Cylinder Address
*9	Illegal Command
*10	DC Voltage Fault
*11	Pack Unsafe
12	Positioner Fault
*13	Servo Clock Fault
*14	Write Fault
15	Drive Fault

* These Bits are undefined if 616X.

DRIVE STATUS BIT DESCRIPTIONS

ACCUMULATOR BIT POSITION	DEFINITION	DESCRIPTION
0	INVALID STATUS	A ONE indicates that Status Bits 1 through 15 should be ignored because the drive is not selected or it is in the process of being selected.
1	DRIVE RESERVED	In a dual port configuration the selected drive is currently in use by another processor.
2	TRESPASSED	Not implemented.
3	READY	Drive unit specified by a previous DOA command is selected, spindle is up to speed and positioner is on cylinder.
4	BUSY	The positioner within the currently selected drive is not on cylinder.
5	POSITIONER OFFSET	The selected Read/Write head was moved from on cylinder dead center as was specified by an offset forward or reverse command.
6	WRITE DISABLED	Status from the drive indicates that a write type of command cannot be executed.
7	ID	This Bit is a one if 6122 is selected, a zero for all other emulations.

8	ILLEGAL SURFACE OR CYLINDER ADDRESS	The requested surface or cylinder address exceeds the capacity of the drive. Read/Write operation will terminate immediately.
9	ILLEGAL COMMAND	The Controller was requested to perform a write type of command while servo is offset or write disabled is active.
10	DC VOLTAGE FAULT	Not implemented.
11	PACK UNSAFE	Conditions exists within the drive which may impair the safety of the media. This bit will be a one if a fault status is received directly from the drive interface.
12	POSITIONER FAULT	This indicates that the drive was unable to complete a seek within 500 ms, or that the positioner has moved to a position outside the recording field. The system should send a recal command to recover from this error.

13	SERVO CLOCK FAULT	A clock synchronization failure occurred between the serial data being read and the reference clock coming from the disk drive. In most cases this means that the header or data sync was not encountered within a specified amount of time. This flag would set if the format on the disk did not agree with what the controller expected. Check the configuration to make sure the proper format was selected.
14	WRITE FAULT	An abnormal condition was detected by the drive during a write type of operation.
15	*DRIVE FAULT	One or more bits are set in positions 8 through 14 or the drive detected an abnormal condition.

* Refer to Table 5.2 for a detailed description of error recovery expectations.

5.2.4.3 DIC - READ SURFACE, SECTOR AND COUNT

DICF AC, DSKP

5.2.4.3.1 BINARY REPRESENTATION

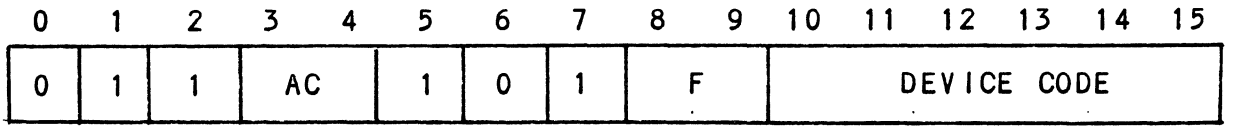


TABLE 5.2 Drive Fault (DIB)

	STATUS BIT POSITION	CONTROLLER ACTION	ERROR RECOVERY	DRIVE ACTION
ILLEGAL SURFACE	8	Command is rejected and Done is set immediately,	New Command	None
ILLEGAL CYLINDER	8	Seek Command is rejected,	New Seek or Recal Command	None
ILLEGAL COMMAND	9	Command is rejected and Done is set immediately.	New Command	None
PACK UNSAFE	11	Command is terminated.	A Recal Command, if the controller caused the Fault (i.e. exceeding the Surface or Cylinder Address or Write Command while Write is disabled).	Fault status is issued to controller. Refer to Drive Manufacturer's Specifications for Faults that cannot be cleared by Fault Clear (Recal from the controller.
POSITIONER FAULT	12	If it is detected at the start of a Read or Write Command, Pack Unsafe will also Set and the Command will terminate immediately.	Recal Command	Fault Status is issued to the controller along with Seek Error.
SERVO CLOCK	13	Read/Write Command is terminated immediately.	Reformat the surface or select the proper format on the controller. The format on the surface did not agree with the format selected on the controller.	None

5.2.4.3.2 ACCUMULATOR FORMAT DIC

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NU	CURRENT SURFACE ADDR					CURRENT SECTOR ADDR					TWO'S COMPLEMENT OF NUMBER OF SECTORS REMAINING				

5.2.5 READ STATUS - ALTERNATE MODE ONE

If a DOA is issued and the alternate 1 bits are set, the following DIA, DIB, or DIC is defined by the following Sections 5.2.5.1 through 5.2.5.3.

5.2.5.1 DIA - READ CURRENT MEMORY ADDRESS (ALT MODE 1)

After the execution of this instruction the value of the accumulator specified will contain the memory address to where the next data word transfer will take place. The memory address counter is incremented by one after each data channel transfer.

DIAF AC, DSKP

5.2.5.1.1 ACCUMULATOR FORMAT

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EXT	CURRENT MEMORY ADDRESS														

5.2.5.2 DIB - READ EXTENDED DISK ADDRESS (ALT MODE 1)

The AC will contain the current most significant bits for the surface (Bit 4), sector address (Bit 5) and two's complement count (Bit 10). These bits will allow the system to reference up to 64 heads or sectors.

DIBF AC, DSKP

5.2.5.2.1 ACCUMULATOR FORMAT

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				HD MSB	SEC MSB					CNT MSB					

5.2.5.3 DIC - NOT CURRENTLY IMPLEMENTED (ALT MODE 1)

5.2.6 READ STATUS - ALTERNATE MODE TWO

If a DOA command is done with the alternate 2 mode bits set, the following DIA, DIB or DIC accumulator bits are defined Sections 5.2.6.1 through 5.2.6.3.

5.2.6.1 DIA - READ ECC REMAINDER UPPER WORD (ALT MODE 2)

DIAF AC, DSKP

5.2.6.1.1 ACCUMULATOR FORMAT

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

5.2.6.2 DIB - READ ECC REMAINDER LOWER WORD (ALT MODE 2)

DIBF AC, DSKP

5.2.6.2.1 ACCUMULATOR FORMAT

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

5.2.6.3 DIC - NOT CURRENTLY IMPLEMENTED (ALT MODE 2)

5.3 DETAILED COMMAND DESCRIPTIONS

The command set (16 in all) provided by the Controller is basically broken up into three groups:

1. Data Transfer Command
2. Drive Commands
3. Alternate Mode Commands

The command is stored in the Controller via DOA instruction. Before any command is initiated, the selected unit must have valid status and be ready.

5.3.1 DATA TRANSFER COMMANDS

Start (Set Busy) will initiate any one of the data transfer commands. There are five data transfer commands: Read, Write, Format, Verify and Read Buffers. Up to 64 contiguous sectors may be transferred using double DOC and up to 32 contiguous sectors may be transferred using single DOC.

To read or write with this Controller, the following steps are recommended.

1. Control Full and Drive Status must be tested for proper state (i.e. no faults and ready) before commencing with a Read/Write command.

2. Send the Starting Surface and Sector Address, along with the two's complement of the number of sectors transferred. (See DOC Section 5.2.3.2.)

3. Send the Starting Memory Address of where the data should be stored or retrieved. (See DOB Section 5.2.2.)

4. Send the Command type and the desired drive unit number. (See DOA Section 5.2.1.)

5. Issue a Start Pulse.

Read/Write Termination Possibilities (Done Set):

1. All the sectors implied by the two's complement sector count were transferred.

2. A Drive or Read/Write error was encountered. DIC command should be issued to determine which sector the error occurred at.

3. Busy was cleared by an IORESET instruction or a clear pulse was issued to the Controller during the Read/Write transfer. Done will not set in this case.

5.3.1.1 READ DATA COMMAND

When Busy sets, the Controller will wait for On Cylinder if the previous seek command has not been completed yet. It will then search for the starting sector address specified by the previous DOC instruction.

The header is read and compared with the starting sector address, starting surface address and stored cylinder address to ensure that the proper sector has been physically located. Before the data can be accepted the header must match the specified address, the header CRC must be good and no bad sector flags encountered. If the header is in error or the bad sector flag is a one, the appropriate status bit and done flag is set immediately.

When the drive's RD/WRT head reaches the data field, the serial data is sent to the SMD interface, formed into parallel words by the Controller, and transferred to the buffer. When all 256 words are contained within the buffer, the ECC code appended in the data is checked to ensure proper data by reading the results of the remainder. A data error occurred if the remainder is not equal to zero. In the case of an error the controller will transfer the data into memory and then set ECC Error Flag and Done.

If the ECC Enable feature is selected, (refer to Section 3.9.1.4), the Controller will attempt to correct the data within its own buffer prior to transferring it to memory. If it determines that it is not correctable, the Controller will re-try on its own with a Data Strobe Early and if unsuccessful, again with a Data Strobe Late. If the data is still not correctable, then it will set ECC Error Flag and Done. If more sectors are to be transferred, the Controller will begin searching for the next sector while the data from the previous sector is transferred to memory.

5.3.1.2 WRITE DATA COMMAND

When Busy sets, the Controller will wait for the positioner to be on cylinder if the selected drive is still in the process of seeking. Upon completion of the previous seek operation, the Controller will transfer 256 words of data from memory to a sector buffer. The starting address of memory was specified by the previous DOB instruction.

The Controller searches for the desired sector and performs a head verification (same as the read command) before data is written onto the surface of the disk. Once the correct sector is found, the Controller will select the sector buffer previously written by the data channel control. The contents of this buffer is then written onto the disk surface preceeded by a gap and data sync. The Controller incorporates two sector buffers. Therefore, the data channel logic can write into one buffer while data is transferred to the disk from the other.

5.3.1.3 VERIFY COMMAND

When Busy sets, the Controller initially starts out as if it were a read command, (i.e. wait for on cylinder, verify header, etc.). Once a full sector is transferred from the disk to a controller buffer, a comparison is made against system memory. This is accomplished by reading a word from memory starting from the previous DOB and comparing each word of sector. If a word does not compare, data transfer status (DIA) Bit 12 and Done will set.

5.3.1.4 FORMAT COMMAND

The objective of the format command is to write the header information (surface, sector and cylinder address), on a sector. Up to 64 contiguous sectors may be formatted per command. Data that was contained within the sector will be lost (replaced by all zeros). Refer to Figure 2.2 for format details. Format is also used to set the bad sector flag.

5.3.1.5 READ BUFFERS COMMAND

Reads the contents of the currently used buffer and transfers all 256 words to memory specified by the starting address. Primarily used for diagnostic purposes.

5.3.2 DRIVE COMMANDS

IOPULSE (sets control full) initiates any one of the drive commands. There are eight drive commands: Recalibrate, Seek, Stop, Offset, Write Disable, Release, Examine Ram and Trespass.

5.3.2.1 RECALIBRATE

This command moves the heads to cylinder 0, selects Head 0 and issues a fault clear to the drive.

An IORESET switch will automatically cause a recalibrate command to be issued to Unit 0.

This command moves the heads more slowly than a seek to 0, so it should not be used for data acquisition.

5.3.2.2 SEEK

Seek moves the heads to the cylinder specified by the DOC.

The Controller stores the cylinder address for that particular unit, initiates the seek operation and clears Control Full. While that unit is busy seeking, the Controller can accept another seek command for a different unit, (overlapped seeks) or commence with a Read/Write Command for the unit busy seeking.

See the SMD Specification for the Seek Timing.

5.3.2.3 OFFSET FORWARD

This command offsets the heads forward off the track center-line. This operation is cleared by the next command. The drive does not allow write operations when the positioner is offset.

5.3.2.4 OFFSET REVERSE

This command offsets the heads reverse off the track center-line. This operation is cleared by the next command. The drive does not allow write operations when the positioner is offset.

Offset Forward or Reverse may be used as an attempt to recover data that cannot be corrected by the error correction algorithm.

5.3.2.5 WRITE DISABLE

Not implemented.

5.3.2.6 RELEASE DRIVE

Clears the reserved condition of the specified drive which this processor had previously reserved.

5.3.2.7 TRESPASS

The Controller issues a priority select to the specified drive. The drive will immediately be reserved until a release command is issued or the disk drive timout feature times out.

5.3.2.8 STOP DISK

All drives connected that are selected for remote operation will unload the heads and spin down via the pick-hold line. A console reset, IORESET instruction, or another command will spin the disk back up.

5.3.2.9 EXAMINE RAM COMMAND

This command gives the system the capability of reading from or writing to the DC-297 Controller's memory. This command must be preceeded by a DOC containing the address of the desired RAM location. See Tables 6.3 and 6.3.1 for memory map.

In order to write to RAM, Bit 0 (MSB) must be a one in the DOC address, and the data to be written is sent via the DOB. If a read RAM is implied, (DOC Bit 0 = 0), the contents of the DIC will contain the RAM data after control full clears.

This feature is used for obtaining the following information:

A. Drive Characteristics for the Formatter and Reliability Programs

B. Number of ECC Corrections by the Controller (each unit has a separate count)

C. Maintenance Testing

D. Configuring the EEPROM

E. Features that may be considered in the future

TABLE 5.3 Disk RAM Memory Map

ADDRESS (HEX)	NAME
000 - 0FF	SECTOR BUFFER 0
100 - 1FF	SECTOR BUFFER 1
200 - 2FF	SECTOR BUFFER 2 (NOT USED)
306	CYL 0
307	CYL 1
308	CYL 2
309	CYL 3
30A	CURRENT SURFACE, SECTOR, SECTOR COUNT
30B	ZADJ. SURFACE ADDR
30D	SURF - SECT
310	BAD SECTOR FLAG
311	UNIT SELECT
312	SOFT ECC DISABLE (NOT USED)
320	UNIT 0 PORT SEEK END MAP
321	UNIT 1 PORT SEEK END MAP
322	UNIT 2 PORT SEEK END MAP
323	UNIT 3 PORT SEEK END MAP
330	*ZADJ. MAX SECTOR
331	*ZADJ. MAX SURFACE
332	*ZADJ. MAX CYLINDER
333	SYNC BYTE
334	VOLUME ADDR (CMD)
335	BANK SEL
340	*UNIT 0 CORRECTION COUNT
341	*UNIT 1 CORRECTION COUNT
342	*UNIT 2 CORRECTION COUNT
343	*UNIT 3 CORRECTION COUNT
348	SECTOR VERIFICATION ENABLE
349	SECTOR COUNT
34A	LENGTH OF LAST SECTOR (COUNT * 600 NANOSEC.)
3FF	PROM ID/REVISION LEVEL

*NOTE: Reference the detailed RAM Description in Table 5.3.2 for more information on these ram locations.

TABLE 5.3.1 EEPROM Memory Map

ADDRESS (HEX)	NAME
4800	START OF PORT 0 CHARACTERISTICS
4880	START OF PORT 1 CHARACTERISTICS
4900	START OF PORT 2 CHARACTERISTICS
4980	START OF PORT 3 CHARACTERISTICS

DISK PORT CHARACTERISTICS

XX00	RCHAR SWITCHES
XX01	RPARA SWITCHES
XX02	DISK DEVICE SELECT CODE
XX03	INTERLEAVE FACTOR
XX04	THROTTLE BURST RATE
XX05	NOT USED
XX06	NOT USED
XX07	TAPE DEVICE SELECT CODE
XX08	TAPE CONFIGURATION CHARACTERISTICS
XX20	MAX SECTOR
XX21	MAX CYL-UPPER
XX22	MAX CYL-LOWER
XX23	MAX HEAD
XX24	MAX HEAD-ODD UNIT
XX25	HEAD MASK
XX26	BANK PRIORITY
XX27	SYNC BYTE
XX30 - XX7F	INTERLEAVE MAP

TABLE 5.3.2 Detailed RAM Descriptions

ADDRESS (OCTAL)	NAME	DESCRIPTION
1460-1462 (330-332 hex)	SELECTED DRIVE CHARACTER-ISTICS	These locations will be updated whenever a new drive is selected. 1460-Maximum Sector Address 1461-Maximum Surface Address 1462-Maximum Cylinder Address Allow invalid status to go away before a reference is made. Avoid writing to these locations.
1500-1503 (340-343 hex)	UNIT CORRECTION COUNTS	These locations will be incremented each time the Controller does a correction made by either the ECC algorithm or an Early/Late Re-try. The maximum count per unit is 65535 (the count will stay at maximum if there are any more corrections to that unit). The counts are initialized to zero on either a power-on or an IORESET switch. A separate count is maintained for each unit. 1500 - Unit 0 1501 - Unit 1 1502 - Unit 2 1503 - Unit 3

EXAMINE RAM COMMAND

1777-8 PROM ID/REV

DIC ACCUMULATOR

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	RES	IDENTIFICATION						REVISION LEVEL							

EXAMPLE: Identification 80 (HEX) Revision Level 6

Location 1777-8 = 100006

NOTE: Avoid referencing any locations that are not defined here.

EXAM RAM EXAMPLE

READ Contents of Loc 1500 Octal (Unit 0 corrections)

Accumulator Set Up:

A0 = 002600 (NOP Command Unit 0)
A1 = 001500 (RAM Address for DOC)

```
DOC 1, DSKP              ; Send RAM Address
DOAP 0, DSKP             ; Send NOP Command and IOPULSE
DIA 0, DSKP              ; Wait for Control Full
MOVZL# 0,0,SZC           ; To be zero
JMP. -2

DIC 2, DSKP              ; Put contents of RAM Location
                           1500 into Accumulator 2
```

WRITE To Location 1500 Octal (Clear Unit 0 Corrections)

Accumulator Set Up:

A0 = 002600 (NOP Command Unit 0)
A1 = 101500 (RAM Address for DOC)
A2 = 000000 (RAM Data)

```
DOC 1, DSKP              ; Send RAM Address
DOB 2, DSKP              ; Send RAM Data
DOAP 0, DSKP             ; Send NOP Command and IOPULSE
```

5.3.3 ALTERNATE MODES

A command that will change the context of the data received from a DIA, DIB or DIC. A command other than Alternate Mode or an IORESET will clear Alternate Mode.

5.3.3.1 ALTERNATE MODE ONE

It changes the context of DIA to read the current memory address. The ending address after a Read/Write transfer will point to the last address plus one.

5.3.3.2 ALTERNATE MODE TWO

It changes the context of the DIA and DIB command. This is used to extract the syndrome (ECC remainder not equal to zero after a read command) from the Controller in order to determine whether the data error within the sector read is correctable or not.

5.4 ERROR CORRECTION CODE (ECC)

When a write command is specified, the ECC hardware divides the data field within the sector by a fixed Generator Polynomial* and appends the resulting checkword to the data field.

*Generator Polynomial

$X-32 + X-23 + X-21 + X-11 + X-2 + 1$

When a read command is specified, the ECC hardware divides the data field and the appended checkword within the sector by a Factored Version* of the same generator polynomial. If a data error occurs, the resulting remainder is non-zero, and the data transfer status (DIA) bit position 8 is set (bit 8 will not set if the Controller was enabled to correct and the error is correctable). Be aware that there exists a small class of errors which are undetectable due to the cyclic properties of the Generator Polynomial.

*Factored Version

$(X-1 + X-2 + 1)\ \ (X-21 + 1)$

The ECC feature detects all error bursts contained within 21 or less contiguous bits in a sector and allows correction of all error bursts up to 11 contiguous bits.

5.5 FORMAT SEQUENCER

The DC-297 Disk Controller features a format sequencer which controls the disk side of the Controller. The firmware which controls this sequencer is contained in PROMS, allowing disk format changes to take place in the PROMS instead of the microprocessor firmware.

The format sequencer firmware is arranged in eight banks of 64 words each and is selectable for the format bank desired. Each bank consists of READ/WRITE/FORMAT CODE. The last bank is reserved for selftest.

5.5.1 READ/WRITE FORMATS

Each disk port of the DC-297 may be independently configured to use one of five currently available sector formats. These formats are described in Section 4.1.5. See Figure 1.2 for detailed format information.

APPENDIX B

B.0 TEST PROGRAMS FOR SYSTEM PROBLEMS

This appendix presents two tests that can be done on a disk that has a system or system data on it without destroying that system or data. This provides an avenue for trouble-shooting conditions that require utility testing, but where time does not permit the luxury of being able to rebuild a system. Be aware, however, that testing the disk in this way has a limitation which is that Write capability will not be tested.

This test requires that the Reliability Program on the 400-405-XX tape be loaded into system memory. Answer the question, "ENTER DEVICE CODE", with the correct information. Next, depress Control 0. An "@" should appear on the console. There are two different tests that can be run, a Random Seek Test or a Sequencial Seek Test. To run the Random Seek Test, enter a 501R after the prompt (@). If the Sequencial Test is desired, enter a 502R after the prompt (@). Now answer the questions the program asks as in the normal reliability testing, with the exception of one question. When the question "SET SWPAK PER 8.0 OR HIT (CR) TO CONT." is asked, enter 8 and 9. This puts the program in a Read Only mode and also bypasses data checks. Enter an "M" to verify that switches 8 and 9 are now ON, (i.e., set to 1). The 501 and 502 reliability will behave in the following manner.

A. Random Reliability Test (SA 501) With Options

You are given options on data patterns (from the Command String data). Respond with a carriage return. Also, you may choose a constant cylinder, head, sector or # of sectors. Any letter response to cylinder, head, etc. gets random function for that variable. A carriage return gets the random function for all variables.

You are also asked to respond to jitter option (YES/NO). If yes, a random delay (0-40 50ms) is inserted into the background loop to create a more asynchronous disk I/O loop.

B. Sequential Disk Address Test (SA 502)

You are given options on data (from the Command String data). Respond with a carriage return. The data will be read from all sectors. This ensures that all disk pack blocks are usable and are formatted properly. The test is then repeated for all ready disks and "PASS" is printed. The sequence is repeated indefinitely.

APPENDIX C

C.0 VIRTUAL MAPPING™

Virtual Mapping is a technique for use with AOS to obtain higher formatted capacities from non-DG-sized drives.

RDOS does not require a specific head/cylinder/sector count; AOS, however, requires that the drive be equal to or greater than the specific characteristics of a DG emulation. Sometimes, a given drive can be made to "fit" under AOS, but this is usually at the expense of storage capacity. The user ends up receiving less value for his or her data storage investment.

A solution to this is to configure the Controller for Virtual Mapping, where the only restriction is that the block size must be equal to or exceed a DG emulation block size. This form of Virtual Mapping is called Block Address Translation (BAT). The advantage of BAT is that a drive with a maximum cylinder, head, or sector address that differs greatly from a DG drive may now be considered for AOS without resorting to operating system patches.

When To Use: Use Virtual Mapping when you meet all three of these conditions:

1. AOS Environment
2. The drive does not match a specific DG emulation (head/cylinder/sector count), but
3. The drive's total number of blocks (heads x cylinders x sectors) meets or exceeds DG requirements.

How To Use: Load the DC-297 Configurator Program and follow its instructions.

C.1 SCOPE

This Appendix will identify some of the drives that currently cannot support AOS without Virtual Mapping due to the nature of their characteristics, or because they would have low media efficiency as compared to RDOS. The RDOS-to-AOS comparison will be illustrated by the aid of matrix tables. The three DG emulation groups (Zebra, Kismet, & Vulcan) will be discussed with regard to their importance to BAT. Methods of increasing capacity yield via BAT will be represented by tables.

C.2 DG DISK DRIVE SIZING CHARACTERISTICS

It is considered useful, from the drive manufacturer's point of view, to determine media efficiency by comparing unformatted capacity with formatted capacity. Unformatted capacity is defined as the product of the cylinders, heads, and bytes per track. Formatted capacity relates to the type of system requirements, i.e., the number of data bytes. Data General requires that each sector must contain 512 bytes of data. Also, each sector must include a header field for sector address verification and gap fields for adhering to drive specification (PLO Sync, Read Gate Delay, Pad, etc.).

A more effective way of indicating drive capacity with respect to Data General is to multiply the maximum characteristics (cylinder, head, and sector) times 512.

Let C = Maximum Cylinder Address
H = Maximum Head Address
S = Maximum Sector Address

Then: Byte Capacity = (C)(H)(S)(512)

Since 512 bytes per sector is a Data General constant, it simplifies further calculations to drop it and then call the product "block size".

Block size = (C)(H)(S)

As a means of comparison, it would be appropriate to suggest that RDOS is 100% efficient. That is to say, the only drive characteristic restrictions, assuming Rev. 7.0 or greater, would be 2048 cylinders, 32 heads, and 64 sectors as maximum addresses. Another way of looking at it is that these are also the maximum addresses that can be represented by the program control accumulators (i.e. DOA, DOB, & DOC).

C.2.1 DG DISK EMULATION GROUPS

BAT is bounded by the set of DG emulation block sizes to be functional in an AOS environment. There are seven different block sizes BAT can choose from for greatest media efficiency. The seven block sizes, as defined by the respective emulation, are divided up into three groups: 1) Zebra 2) Kismet 3) Vulcan. Table H.1 defines each emulation and group. Please observe the symbols assigned to each individual emulation type as they will be used frequently throughout this text.

TABLE C.1 DG Emulation Groups

ZEBRA

	CYLINDERS	HEADS	SECTORS	BLOCK SIZE	SYMBOL
6060	411	19	24	187,416	Z0
6061	815	19	24	371,640	Z1
6067	815	5	24	97,800	Z7

KISMET

	CYLINDERS	HEADS	SECTORS	BLOCK SIZE	SYMBOL
6160	823	5	35	144,025	K0
6161	823	10	35	288,050	K1
6214	843	40	35	1,180,200	K4

VULCAN

	CYLINDERS	HEADS	SECTORS	BLOCK SIZE	SYMBOL
6122	815	19	35	541,975	V

C.2.2 RESTRICTIONS WHEN GROUPING DG EMULATIONS

When more than one unit is specified, every unit must be of the same group (i.e. Zebra, Kismet, & Vulcan cannot be intermixed). When AOS sizes a drive as a Zebra the ending disk address must be coherent to that driver. Kismet and Vulcan require specific identifier flags when sized and the operating system expects all units to be of the same group.

C.3 SELECTING MAXIMUM ALLOWABLE BLOCK SIZE

This section explains the effectiveness of BAT, both functionally and intuitively, now that the basic ground rules have been discussed. Some drive types (Table C.4) with which virtual mapping would be desirable will serve as examples for this Appendix. The basic principles of BAT shall provide the necessary tools to include other non-standard drive types not contained within this list.

Since the main attribute with this feature is its ability to increase data capacity (virtually), it would be appropriate at this time to define maximum allowable block size.

Definition: Maximum allowable block size is the total number of blocks on a given disk that can be utilized according to the requirements of AOS.

C.3.1 SYSTEM UNIT TO PHYSICAL DRIVE

Any one of the drives listed in Table C.2 may be selected as an example, as they are all non-standard drive types. To best illustrate how BAT works, select a drive type from the list and step it through the following procedure.

Let D = maximum block size of any drive type.

U = DG emulation block size.

x = an element within the 7 available DG block sizes.

Drive Characteristics:
- Cd = Maximum Cylinder Address
- Hd = Maximum Head Address
- Sd = Maximum Sector Address

DG Unit Characterisics:
- Cu = Maximum Cylinder Address 411,815,823,843
- Hu = Maximum Head Address 5,10,19,40
- Su = Maximum Sector Address 24,35

D = (Cd)(Hd)(Sd) U = (Cu)(Hu)(Su)

Therefore, to meet AOS requirements the drive must support greater than or equal to the number of blocks specified by a DG drive.

D >= U(x) x: Z0,Z1,Z7,K0,K1,K4,V

To make the above equation an equality a number must be added to U(x).

Let b = the number of extra blocks.

D = U(x) + b

then b = D - U(x) It will be apparent that the smallest b is what is desired.

NOTE: If D < U(x) for all of x, then the drive cannot be supported at all by AOS.

To summarize, multiply the maximum values of the cylinder, head, and sector of the drive, and then propagate through Table C.1 to select the smallest number of extra blocks (b).

Example: CDC XMD (see Table C.2)

D = 1,409,024

Using Table C.1 then, for U(x), x = K4 (6214 emulation) as the choice for the smallest b.

C.3.2 MEDIA EFFICIENCY

Efficiency: Once the smallest b is known, media efficiency can be calculated.

Eff = U/D , Eff % = Eff X 100

Example: CDC XMD

Eff = U/D = 1,180,200 / 1,409,024 = .838
Eff% = .838 X 100 = 83.8%

TABLE C.2 Virtual Mapping Example Table for Non-DG Sized Drive Types

MANUFACTURER	DRIVE CHARACTERISTICS (C,H,S)			BLOCK SIZE (D)
DRIVE TYPE	CYL (C)	HD (H)	SECT (S)	D=(C)x(H)x(S)
CDC-FSD 9715-340	711	24	35	597,240
CDC XMD	1024	16	86	1,409,024
FUJITSU 2294	1024	16	35	573,440
FUJITSU 2312	589	7	35	144,305
FUJITSU 2298	1024	16	70	1,146,880
FUJITSU 2361	842	20	70	1,178,800
NEC 2247E	1024	5	35	179,200
NEC 2257	1024	8	35	286,720
NEC 2300	760	19	63	909,720
PRIAM 7050	1049	5	23	120,635
PRIAM 6650	1024	3	35	107,520
PRIAM 15450	1121	7	35	274,645
TECSTOR 160	700	12	35	294,000
TECSTOR 200	823	12	35	345,660
AMPEX CAP 330	1024	16	35	573,440
AMPEX 660	2048	16	35	1,146,880
AMPEX 9160	1645	5	35	287,875
CEN DATA AMS 380	845	14	55	650,650
DATA PER D1600	1116	7	35	273,420
MEGAVAULT 116	823	7	35	201,635
MEMOREX 214	589	7	35	144,305

C.4 MULTIPLE UNIT ASSIGNMENT PER DRIVE TYPE

The limitation of mapping one system unit per drive type is the fact that there are only 7 different block sizes to choose from. The number of choices of block sizes increases proportionally when more unit numbers are assigned to a drive. The respective block sizes of each emulation within a group may be added together. Two units may be assigned in the Kismet group; up to four units within the Zebra or Vulcan group. Table C.3 on the following page provides a list of additive DG block sizes per number of units. Notice the increased number of block size choices.

The same methods explained in Section C.3.0 will also be used with multiple unit assignment for top media efficiency. The starting block address for each respective logical unit assigned to a drive physically starts where the previous unit left off.

TABLE C.3 DG Block Sizes By Multiple Units

ZEBRA - 6060 = Z0 KISMET - 6160 = K0 VULCAN - 6122 = V
6061 = Z1 6161 = K1
6067 = Z7 6214 = K4
NOTE: ZEBRA, KISMET, AND VULCAN CANNOT BE INTERMIXED.

A. THREE UNITS PER DRIVE

ZEBRA	BLOCK SIZE	KISMET	BLOCK SIZE	VULCAN	BLOCK SIZE
Z7,Z7	195,600	K0,K0	K1	V,V	1,083,950
Z0,Z7	285,216	K0,K1	432,075		
Z0,Z0	374,832	K1,K1	576,100		
Z1,Z7	469,440	K0,K4	1,324,225		
Z0,Z1	559,056	K1,K4	1,468,250		
Z1,Z1	743,280				

B. THREE UNITS PER DRIVE

ZEBRA	BLOCK SIZE	ZEBRA	BLOCK SIZE
Z7,Z7,Z7	293,400	Z0,Z1,Z7	656,856
Z0,Z7,Z7	383,016	Z0,Z0,Z1	746,472
Z0,Z0,Z7	472,632	Z1,Z1,Z7	841,080
Z0,Z0,Z0	562,248	Z0,Z1,Z1	930,696
Z1,Z7,Z7	567,240	Z1,Z1,Z1	1,114,920

C. FOUR UNITS PER DRIVE

ZEBRA	BLOCK SIZE	ZEBRA	BLOCK SIZE
Z7,Z7,Z7,Z7	391,200	Z0,Z0,Z0,Z1	933,888
Z0,Z7,Z7,Z7	480,816	Z1,Z1,Z7,Z7	938,880
Z0,Z0,Z7,Z7	570,432	Z0,Z1,Z1,Z7	1,028,496
Z0,Z0,Z0,Z7	660,048	Z0,Z0,Z1,Z1	1,118,112
Z1,Z7,Z7,Z7	665,040	Z1,Z1,Z1,Z7	1,212,720
Z0,Z0,Z0,Z0	749,664	Z0,Z1,Z1,Z1	1,302,336
Z0,Z1,Z7,Z7	754,656	Z1,Z1,Z1,Z1	1,486,560
Z0,Z0,Z1,Z7	844,272		

TWO UNITS PER DRIVE TYPE:

D >= U(r,s) r,s : Z0,Z1,Z7 or K0,K1,K4

U(r,s) = r + s or V

Add b to make an equality D = U(r,s) + b
or D = r + s + b

Summary - Multiply the maximum characteristics of the drive, like before, and compare that value to Section A of Table C.3 to find the smallest b (b = D - U).

Example: CDC XMD (see Table C.2)

D = 1,409,024

Using Table C.3 then, for U(r,s), r= K4 (6214 emulation) and s = K0 (6160 emulation) as the choices for the smallest b. Therefore, U(r,s) = K0,K4 = 1,324,225

Eff% = U/D X 100 = 1,324,225 / 1,409,024 X 100 = 94% as the effective capacity yeild.

THREE UNITS PER DRIVE TYPE:

D >= U(r,s,t) r,s,t : Z0,Z1,Z7

U(r,s,t) = r + s + t

D = U(r,s,t) + b or D = r + s + t + b

Use Table C.3, Section B for smallest b (b = D - U)

FOUR UNITS PER DRIVE TYPE:

D >= U(r,s,t,u) r,s,t,u : Z0,Z1,Z7

U(r,s,t,u) = r + s + t + u

D = U(r,s,t,u) + b or D = r + s + t + u + b

Refer to Section C of Table C.3 and select the smallest b (b = D - U).

It should be noted that maximum allowable block size could have been determined entirely by the Controller. However, due to the innate unit number availability from DG, the decision of how many units are to be assigned to a drive should be left up to the user. It is how the customers might want to tailor their system, in other words, acquiring more megabytes out ot the drive by sacrificing unit numbers. This type of decision is discussed within the configuration program as well.

Section C.8 shows a progression of media efficiency increase per manufacturer type when assigning multiple units. The efficiency is also compared without Virtual Mapping to illustrate the advantage of BAT.

C.5 MAXIMUM ALLOWABLE BLOCK SIZE SUMMARIZED

Let b1, b2, b3, & b4 be the smallest number of extra blocks (b) for each respective number of unit assignments.

b1 = 1 unit per drive
b2 = 2 units per drive
b3 = 3 units per drive
b4 = 4 units per drive

then

M = D-the smallest element of b1,b2,b3,b4

C.6 MEDIA FLAW

A media flaw detected by the Controller is presented to the system when a DIA is issued (read data transfer status register) and the appropiate error flag is set (each ECC or surf/sect error). To know where the media flaw was detected on the disk surface, the system reads the ending disk address from the Controller (DIC). The ending address will be represented in DG's form, not the physical address, in terms of the drive's cylinder, head, and sector.

C.7 VIRTUAL MAPPING YIELD PER DRIVE TYPE

The following pages contain the results of calculating the efficiency gained by using BAT. Each page is categorized by manufacturer type. E-TYPE means the DG emulation chosen for top media efficiency; the word LESS indicates that the efficiency percentage is less than the calculation above it.

DRIVE MANUFACTURER: CDC

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	FSD 9715-340	CDC-XMD		
CYL	711	1024		
HD	24	16		
SECT	35	86		
BLK SIZE	597,240	1,409,024		

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	Z0	K1,K1		
EFF %	33.4	41.0		

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	V	K4		
EFF %	90.8	83.8		

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE	K1,K1	K4,K0		
EFF %	96.5	94.0		

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE				
EFF %	LESS			

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE				
EFF %	LESS			

DRIVE MANUFACTURER: FUJITSU

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	2294	2298	2312	2361
CYL	1024	1024	589	842
HD	16	16	7	20
SECT	35	70	35	70
BLK SIZE	573,440	1,146,880	144,305	1,178,800

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	K1	K1,K1	NA	V,V
EFF %	50.2	50.2	0	

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	V	V	K0	K4
EFF %	94.5	47.2	99.8	100.0

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE	Z0,Z1	V,V		
EFF %	97.5	94.5		

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE	Z1,Z7,Z7	Z1,Z1,Z1		
EFF %	98.9	97.2		

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE	Z0,Z0,Z0,Z7	Z0,Z0,Z1,Z1		
EFF %	99.5	97.5		

DRIVE MANUFACTURER: NEC

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	2247E	2257	2300	
CYL	1024	1024	760	
HD	5	8	19	
SECT	35	35	63	
BLK SIZE	179,200	286,720	909,720	

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	K0	K0	Z0,Z0	
EFF %	80.4	50.2	41.2	

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	K0	Z0	V	
EFF %	80.4	65.4	59.6	

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE		Z0,Z7	Z1,Z1	
EFF %		99.5	63.3	

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE			Z1,Z1,Z7	
EFF %			92.5	

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE			Z0,Z0,Z1,Z7	
EFF %			92.8	

DRIVE MANUFACTURER: PRIAM

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	7050	6650	15450	
CYL	1049	1024	1121	
HD	5	3	7	
SECT	23	35	35	
BLK SIZE	120,635	107,520	274,645	

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	NA	NA	K0	
EFF %	0	0	52.4	

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	Z7	Z7	Z0	
EFF %	81.1	91.0	68.2	

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE			Z7,Z7	
EFF %			71.2	

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE				
EFF %				

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE				
EFF %				

DRIVE MANUFACTURER: TECSTOR

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	160	200		
CYL	700	823		
HD	12	12		
SECT	35	35		
BLK SIZE	294,000	345,660		

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	NA	K1		
EFF %	0	83.3		

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	K1	K1		
EFF %	98.0	83.3		

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE				
EFF %	LESS	LESS		

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE	Z7,Z7,Z7	Z7,Z7,Z7		
EFF %	98.8	84.9		

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE				
EFF %				

DRIVE MANUFACTURER: AMPEX

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	CAP 330	660	9160	
CYL	1024	2048	1645	
HD	16	16	5	
SECT	35	35	35	
BLK SIZE	573,440	1,146,880	287,875	

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	K1	K1	K0	
EFF %	50.2	25.1	50.0	

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	V	V	Z0	
EFF %	94.5	47.3	65.1	

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE	Z0,Z1	V,V	Z0,Z7	
EFF %	97.5	94.5	99.1	

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE	Z1,Z7,Z7	Z1,Z1,Z7		
EFF %	98.9	97.2		

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE	Z0,Z0,Z0,Z7	Z0,Z0,Z1,Z1		
EFF %	99.5	97.5		

DRIVE MANUFACTURER: CENTURY DATA

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	AMS 380	AMS 571		
CYL	845	941		
HD	14	19		
SECT	55	57		
BLK SIZE	650,650	1,019,103		

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	K1,K1	V		
EFF %	88.5	53.2		

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	V	V		
EFF %	83.3	53.2		

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE	K1,K1	Z1,Z1		
EFF %	88.5	72.9		

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE		Z0,Z1,Z1		
EFF %	LESS	91.3		

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE		Z1,Z1,Z7,Z7		
EFF %	LESS	92.1		

DRIVE MANUFACTURER: DATA PERIPHERAL

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	D1600			
CYL	1116			
HD	7			
SECT	35			
BLK SIZE	273,420			

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	K0			
EFF %	68.5			

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	K0			
EFF %	68.5			

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE	Z7,Z7			
EFF %	71.5			

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE				
EFF %				

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE				
EFF %				

DRIVE MANUFACTURER: MEGAVAULT

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	116			
CYL	823			
HD	7			
SECT	35			
BLK SIZE	201,635			

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	K0			
EFF %	71.4			

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE	Z0			
EFF %	92.9			

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE	Z7,Z7			
EFF %	97.0			

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE				
EFF %				

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE				
EFF %				

DRIVE MANUFACTURER: MEMOREX

I. DRIVE CHARACTERISTICS AND RDOS BLOCK SIZE

	213	214		
CYL	589	589		
HD	4	7		
SECT	35	35		
BLK SIZE	82,460	144,305		

II. AOS CAPACITY WITHOUT VIRTUAL MAPPING

E-TYPE	NA	NA		
EFF %	0	0		

III. 1 SYSTEM UNIT PER PHYSICAL UNIT (min blk size = 97,800)

E-TYPE		K0		
EFF %		99.8		

IV. 2 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 195,600)

E-TYPE				
EFF %				

V. 3 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 293,400)

E-TYPE				
EFF %				

VI. 4 SYSTEM UNITS PER PHYSICAL UNIT (min blk size = 391,200)

E-TYPE				
EFF %				

```
;**************************************************************
;
; DESCRIPTION: ZETACO DISK CONTROLLER FORMATTER PROGRAM
;
;
; Product of ZETACO, 1986
;**************************************************************
        .TITL   DISKF
        .DUSR   X=1
        .NOMAC  X
;1.0    PROGRAM NAME:   DISKF.SR

;2.0    REVISION HISTORY:
;
;       REV.        DATE
;        00      02/09/83        ;
;
;        01      08/23/83        ;ADUB FOR ALT1 (STTD), AOS BSTRAP
;                                ;(400'S)
;        02      03/28/84        ;DISK PULSE COUNTER, ERROR LOGS,
;                                ;200. ERRORS, MSB FOR BAD SECTOR
;                                ;LOG, DEVICE CODE CHANGE ROUTINE
;        03      05/30/84        ;ECC ON WRITE, ZDF1
;
;        04      08/21/85        ;DISABLE VIRTUAL, UP TO 2048. CYLS
;
;        05      11/20/86        ;297, 40 HDS, DMA PTR, WELLEX,
;                                ;IORST

;3.0    MACHINE REQUIREMENTS:

;       NOVA/ECLIPSE/MV FAMILY CENTRAL PROCESSOR
;       16K READ/WRITE MEMORY
;       ZETACO DISK CONTROLLER (ZEBRA TYPE)
;       0-3 DISK DRIVES
;       TELETYPE or CRT and CONTROL

;4.0    TEST REQUIREMENTS:      N/A

;5.0    SUMMARY:

;       The ZETACO DISK CONTROLLER FORMATTER PROGRAM
;       is designed to FORMAT and CHECK DISK PACKS and
;       MEDIA to be used in DISK SYSTEMS. The PROGRAM is
;       !NOT! A MAINTENANCE PROGRAM and ASSUMES the HARDWARE
;       to be in WORKING ORDER. The PROGRAM will HALT on
;       any NON-DATA related ERRORS. It is also recommended
;       that ON-BOARD ECC be SOFTWARE or CONFIGURED DISABLED
;       when FORMATTING. The Device Code may be 20-76 OCTAL
;       with the Default being 27.

;6.0    RESTRICTIONS:
;       This Program has no Restrictions as to Single or
;       Dual Processor Hardware Configuration. However, the
;       Formatter may be run on ONLY ONE CPU at a time and
;       must be the only Program being run within the Disk
;       System.
```

```
;7.0     PROGRAM DESCRIPTION/THEORY OF OPERATION:

;       A. FORMATTER PROGRAM (STARTING ADDRESS <SA> 500)
;       The disk is first formatted after which a "FORMAT DONE"
;       message is printed. Then a 055555 pattern is written to
;       the entire pack and read back 2 times, A random seek
;       test is performed, and "PASS" is printed. The data pattern
;       is then rotated 1 bit and the WRITE/READ/READ/SEEK process
;       is repeated. At the completion of the number of passes
;       entered by the operator, A log is available to be printed
;       and the drives are released.
;*************************************************************
;       It is Recommended that at LEAST 3 PASSES (W/R/R/S);with
;       On-Board ECC DISABLED, be allowed to insure Pack Quality.
;       If time permits, longer runs will further insure
;       Reliability.
;*************************************************************
;       Any HARD DATA or ADDRESS ERRORS will result in the BAD
;       SECTOR FLAG being set in that sector. Any "SOFT DATA" or
;       "ADDRESS ERROR" ADDRESS encountered TWICE cause the BAD
;       SECTOR FLAG to be set. Any other error will cause the
;       program to print the failure and halt.

;       A HARD ADDRESS ERROR is defined as such after 2 ATTEMPTS
;       have been made BOTH resulting in an ADDRESS ERROR. A HARD
;       DATA ERROR is defined as such after 2 or MORE of 10
;       WRITE/READ RETRY'S have been unsuccessful.

;       B. CHECK PROGRAM ONLY (SA 501)
;       Same as SA 500 except that initial pack format operation is
;       bypassed.

;       C. STATISTICS
;       Type L for 1ST 200. disk addresses of BAD SECTORS, DATA and
;       ADDRESS ERRORS, plus a statistic table of overall errors.
;       **NOTE** Any character typed while executing this log will
;       end it at the next change of data type.

;       D. LOG RECOVERY (SA 502)
;       Use to recover log of program after it has stopped to get a
;       LOG PRINTOUT.

;       E. COMMAND STRING INTERPRETER (SA 503)
;       As a trouble shooting aid the service engineer may type in
;       their own TEST LOOP. After starting at 503, three ARGUMENTS
;       must be entered in response to three program questions;
;       "UNIT", "DATA", and "COMMAND STRING". All numbers must be
;       entered in OCTAL.

;       I.      UNIT:   Type unit # or carriage return
;                       to use the previous entry

;       II.     DATA:   RAN=RANDOM
;                       ALO=ALL ONES
;                       ALZ=ALL ZEROS
;                       PAT=110110 PATTERN
;                       FLO=FLOATING ONE PATTERN
;                       FLZ=FLOATING ZERO PATTERN
;                       ADR=ALTERNATING CYLINDER and
;                       HEAD,SECTOR WORDS
;                       VAR=Existing words entered previously as
;                       described below

;   A-2                 Alternatively enter a string of up to 7
```

```
;                   The words entered are used repeatedly
;                   to make up a sector block. Type carriage
;                   return to use the previous entry.

;       III.    COMMAND STRING:

;       OPTIONS 1.      READ HEAD,SECTOR,#SECTORS
;               2.      WRITE SAME
;               3.      SEEK CYLINDER
;               4.      RECALIBRATE
;               5.      LOOP (go to beginning or LR)
;               6.      DELAY N (N=DELAY in MS)
;               7.      TRESPASS
;               8.      RELEASE
;               9.      OFF (OFFSET FORWARD)
;               10.     OFR (OFFSET REVERSE)
;               11.     LR  (begin LOOP here)
;               12.     VERIFY (WRITE)
;               13.     FORMAT CYL,HD,SECTOR
;               14.     BAD (BAD SECTOR) CYL,HD,SECTOR
;               15.     MEMORY ADDR,DATA(WRITE) (CONTROLLER MEMORY COMMAND)
;               16.     Type Carriage Return to use the
;                       previous COMMAND STRING.

;               Note that either SPACES or a COMMA
;               may be used as an argument delimiter.
;               Each response is terminated by
;               typing carriage return.  If more
;               room is needed on a line, type line
;               feed to space to the next line. The
;               word "SAME" used with READ, or WRITE,
;               will cause the previous disk address
;               parameters to be used.

;       An R typed while a string is being executed will
;       cause the program to return to command string start.
;       The ESCAPE KEY will bypass UNIT and DATA prompts to
;       the command string prompt.

;       The following example would cause UNIT
;       1 to SEEK CYLINDER 50, then repeatedly
;       WRITE SECTORS 2 and 3 of HEAD 5, then
;       READ it back and CHECK.  Data is specified
;       as ALTERNATE WORDS of ZEROS then ONES.

;       UNIT: 1
;       DATA: 0,177777
;       COMMAND STRING: SEEK 50 LR WRITE 5,2,2 READ SAME LOOP

;       The following example would WRITE 0 to
;       CONTROLLER MEMORY location 1500 (OCTAL)

;       UNIT:    1
;       DATA:    N/A
;       COMMAND STRING: MEMORY 101500,0
;       NOTE: Upper memory bit = 1 defines a WRITE
```

```
;8.0  OPERATING MODES/SWITCH SETTINGS:

;8.1     SWITCH SETTINGS
;
;        Location "SWREG" is used to select the program options.
;        This Location will be set according to the answers
;        supplied by the Operator. The Options can be changed
;        or verified by using one of the commands given in Sec.
;        8.3
;
;8.2     SWITCH OPTIONS
;        Different bits and their interpretation at location
;        "SWREG" is as follows:
;
;        BIT      OCTAL    BINARY   INTERPRETATION
;                 VALUE    VALUE
;
;        1         40000     0       LOOP on ERROR
;                 000000     1       SKIP LOOPING on ERROR
;
;        2         20000     0       PRINT to CONSOLE
;                 000000     1       ABORT PRINT OUT to CONSOLE
;
;        5         02000     0       DO NOT PRINT on the LINE PRINTER
;                 000000     1       PRINT on the BYTE I/O LINE PRINTER(DC17)
;
;        11(B)     00020     0       N/A
;                 000000     1       ENABLE BAD SECTOR PRINTOUT
;
;        16(G)     00000     0       DO NOT PRINT on DMA LINE PRINTER
;                 100000     1       PRINT on DMA LINE PRINTER(DC17)
;
;8.3     SWITCH COMMANDS
;        Once the Program starts executing the state of any of
;        the Bits can be changed by Hitting KEYS 1-9, A-Z. The
;        Program will Continue Running after Updating the Options.
;        Each Key will Complement the state of the Bit affiliat-
;        ed with it, thus Bit 4 can be Altered by Hitting Key 4.
;        Setting of any Bit of Location "SWREG" will Set Bit 0.
;        (Default Mode is defined as all Bits of SWREG Set to 0)
;
;8.4     OTHER COMMANDS  (^ = CONTROL KEY)
;
;        "CR"     A "RETURN" can be typed to Continue the Program
;                 after its locked in a Switch Modification Mode
;
;        ^D       This Command given at any time will reset "SWREG"
;                 to Default Mode and Restart the Program.
;
;        ^R       This Command given at any time will Restart the
;                 Program. Switches are left with the values they
;                 had before the Command was issued.
;
;        ^O       This Command given at any time will cause the
;                 Program Control to go to ODT.
;
;        M        This Command given at any time will print the
;                 Current Operating Modes.
;
;        0        This Command given at any time will lock the
;                 Program into Switch Modification Mode where
;                 more than 1 Bit can be changed.
;
```

```
;9.0     OPERATING PROCEEDURE/OPERATOR INPUT:

;        A. Verify drive (s) are ready on-line
;        B. Load Program
;        C. To RUN other than TEST 500, Enter CONTROL "O"
;           at 9.2, Enter STARTING ADDRESS followed by an "R"

;        STARTING ADDRESS (SA)
;        200      Read Unit Characteristics and then Run FORMATTER (500)
;        500      FORMATTER/CHECK PROGRAM
;        501      CHECK PROGRAM ONLY
;        502      ERROR LOG RECOVERY
;        503      COMMAND STRING INTERPRETER

;9.1     Operator is requested to enter DEVICE CODE of CONTROLLER
;        (DEFAULT 27)
;9.2     Operator is requested to SET SWPAK followed by a Carriage
;        Return (SEE 8.3)
;9.3     MONTH, DAY, YEAR (I.E. 77...), HOUR, & MIN (If [CR] is
;        given this routine is bypassed)
;9.4     Enter # of Passes for Test Completion (If [CR] is given
;        this routine is bypassed)
;9.5     Operator is requested to enter YES/NO to CONTROLLER CORRECTION,
;        if it is enabled
;9.6     Unit Numbers, Types, and their Characteristics are then
;        Displayed, (The Operator should Verify these values) Operator
;        is then requested to enter UNIT NUMBERS to be tested(0-3)
;9.7     Operator is then requested to enter TYPE of disk ( to create a
;        User Defined enter 10)
;        A.       If TYPE entered is 10, enter 0, 1, 2, or 3 to
;                 RE-DEFINE a disk TYPE
;        B.       # of HEADS for NEW TYPE (in DECIMAL)
;        C.       # of CYLINDERS for NEW TYPE (in DECIMAL)
;        D.       # of SECTORS for NEW TYPE (in DECIMAL, CANNOT be
;                 DOWNSIZED)
;        E.       Return to 9.7

;        OPERATOR INPUT CONTROLLED PRINTOUTS ARE AS FOLLOWS:
;
;        L        = First 200. BAD SECTORS, DATA, or ADDRESSES
```

```
;10.0   PROGRAM OUTPUT/ERROR DESCRIPTION:

;       1. ERRORS- Error status is printed whenever encountered.
;       When Data Errors are found ONLY THREE are printed per
;       encounter. (see paragraph 10.3)

;       2. If Errors are encountered more than once, a count
;       will be recorded and a BAD SECTOR FLAG SET. All address
;       information will be printed in OCTAL.

;       3. ERROR REPORTING AND RECOVERY

;       All Errors are identified, and the program is routed
;       via base to a call to CKSW. with the exception of
;       ADDRESS and DATA ERRORS. The program will then loop
;       for operator intervention; on the basis of SWPAK (see 8.)

;       RECALIBRATE - Any unusual Status is reported immediately
;       and an Error return executed.

;       SEEK - Positioner Fault Status results in Status Printout
;       and Error return.

;       WRITE - Following "DONE" on a WRITE, Errors are checked
;       in the sequence shown below.  Error recovery procedure
;       is outlined for each case. If the Error is not present
;       the next check is made.

;       DRIVE STATUS (DIB) is checked 1st for both Read and Write
;       before any DIA checks are made.

;       4. READ/WRITE TIMEOUTS, DATA LATE, ILLEGAL SECTOR,
;       ECC(DATA OK), or any DRIVE FAULT- Print the illegal Status
;       and do an Error return.

;       5. ADDRESS ERROR- Repeat the Write, If Test passes the
;       second time, do a Normal return; Otherwise flag as Hard, Set
;       the BAD SECTOR FLAG for that Sector and do an Error return.

;       If a HARD Cylinder Address Error occurs, a Read on an
;       adjacent Head will be attempted to determine whether the
;       Fault should be classed as a Seek Error or an Address
;       Error. The First 30. Hard Address Errors will have their
;       Addresses Logged.

;       6. ENDING MEMORY ADDRESS -Print the Error Message,
;       Check for a DISK ADDRESS and do an Error return.

;       7. ENDING DISK ADDRESS -Print the Error Message and
;       do an Error return.


;       READ - All Read Errors with the exception of Data related
;       Errors are handled the same as described for the Write
;       operations.

;       DATA ERRORS - Data is reread 9 times. If Data is BAD on
;       2 or more of 10 tries, a HARD Error Count is incremented,
;       the BAD SECTOR FLAG is set in that Sector, and an Error
;       return is taken. If Data is good on all retries, the
;       Error is considered SOFT and a normal return is taken.

;       The 1st 200. Data Errors (HARD or SOFT) are Logged.
```

```
;11.0   DEBUG HELP:
;
;OCTAL DEBUGGER  (ODT)
;
;       This Formatter is equipped with a built in ODT which can be
;       accessed by hitting CONTROL O at any time during the execution
;       of the Program (after Setting the Parameters). On entering ODT
;       the Address of the Location having the next instruction to be
;       executed will be typed-out.
;
;       The following Conventions are used by the ODT:
;       ?       Pressing any illegal key causes the ODT to respond
;               with a "?".
;       @       ODT is ready and at your service.
;
;       An ODT Command has the following Format:
;               [ARGUMENT][COMMAND]
;       An Argument may be one of the following:
;       "EXP"   An OCTAL Expression consisting of OCTAL Numbers
;               separated by Plus (+) or Minus (-) signs. Leading
;               Zeros need not be typed.
;       "ADR"   An Address is the same as an Expression except
;               that Bit 0 is neglected.
;       A Command is a single teletype character
;
;       The Locations that can be EXAMINED and MODIFIED by the user
;       are called CELLS. These CELLS are of two Types: Internal CPU
;       Cells and Memory Locations. The Command to OPEN one of the
;       Internal Registers is of the form "nA" where n is any OCTAL
;       Expression between 0 and 7.
;
;       0-3     For ACCUMULATORS 0-3
;       4       For PC of the next Instruction to be Executed in the
;               event of a "P" Command.
;       5       CPU and TTO Status
;               BIT     INTERPRETATION
;               15      Status of TTO DONE FLAG
;               14      Status of INTERRUPTS (ION FLAG)
;               13      Status of CARRY BIT
;       6       Address of the Location having the BREAK POINT (If any)
;       7       Instruction at the BREAK POINT Location
;
;       Other Commands to OPEN Cells are:
;
;       "ADR"/  Open the Cell and Print its contents
;       ./      Open the Cell currently pointed to by the Pointer and
;               Print its contents.
;       .+"ADR"/ Add "ADR" to the Pointer, Open the Cell and Print its
;               contents.
;       .-"ADR"/ Subtract "ADR" from the Pointer, Open the Cell and
;               Print its contents.
;       "CR"    The Return Key is used to Close the Open Cell with or
;               without Modification.
;       "LF"    Line Feed is used to Close the Open Cell with or without
;               Modification and to Open the succeeding Cell.
;       CTRL    Close the Open Cell with or without Modification and
;               Open the preceeding Cell.
;       /       Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents.
;       +"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents + "ADDR".
;       -"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents - "ADR".
```

```
;       Modification of a Cell:
;
;       Once a Cell has been opened its contents can be Modified by
;       typing the New Value the Cell is to contain in the form of
;       an OCTAL Expression followed by "CR" or "LF". If a + or - is
;       typed as the first character of the Expression then the Value
;       of the Expression is Added to or Subtracted from the Old
;       contents of the Cell. The Address itself or an Expression
;       relative to the Address can be Deposited by typing a "." or
;       :,+/-OCTAL Expression". A Rubout Command given right after
;       opening a Cell allows the Modification of its contents as if
;       they were typed in just before the Command was issued.
;
;       Other ODT Commands:
;
;       RUBOUT  This Key is used to Delete ERRONEOUSLY typed digits.
;               Each time the Key is pressed the right most digit is
;               Deleted and Echoed on the Terminal. If the Rubout
;               Key is pressed right after opening a Cell then it
;               Deletes the right most digit of the Cells contents.
;               This allows the Modification of the Cell as if its
;               contents were typed in just before the Key was pressed.
;       "ADR"B  Insert a BREAK POINT at Location "ADR".
;               Only one Break Point can be inserted and any entry to
;               ODT after Executing a Break Point will cause it to be
;               Deleted.
;       D       Delete the Break Point if any.
;       P       Restart the Execution of the program at CURRENT Location
;       "ADR"R  Start Executing the program at "ADR" after an IORST.
;       K       Kill the String typed so far. The ODT responds with a
;               "?" and the Open Cell is closed without Modification.
;       =       Print the OCTAL Value of the INPUT only.
;               This will Close any Open Cells without  Modification and
;               will not Open a Cell
;
;       NOTE:   In Programs which RELOCATE THEMSELVES the
;               user should place Break Points ONLY in the
;               ORIGINAL PROGRAM AREA. If a Break Point is
;               placed outside this area the results will
;               be unpredictable.
;
;
;12.0   SPECIAL NOTES/SPECIAL FEATURES:

;       1. The Program is !NOT! a Maintenance Program and assumes
;       the HARDWARE to be in working order. The Program will
;       HALT on any NON-DATA related Errors.

;       2. It is recommended that at Least 3 Passes (W/R/R/S) be
;       allowed (see below) to insure pack quality. If time
;       permits, longer runs will further insure quality.

;13.1   PROGRAM RUNTIME:

;       Program runtimes are substantially reduced with memories
;       of 24K or larger. Runtimes are also dependant on CPU
;       Type, Drive Size and Drive Type.

        .EOT
```

```
;**********************************************************************
;
;
; DESCRIPTION: ZETACO DISK CONTROLLER DIAGNOSTIC
;
;
; Product of ZETACO, 1986
;**********************************************************************
        .TITL   DISKD
        .DUSR   X=1
        .NOMAC  X
; 1.0 PROGRAM NAME:       DISKD.SR

; 2.0 REVISION HISTORY:
;
;       REV.        DATE
;        00       02/17/83          ;
;        01       09/07/83          ;ANOTHER RDY UNIT WARNING,1 HD
;                                   ;ERR C22, AOS BOOTSTRAP(400'S),
;                                   ;NO OFFSET TESTS FOR CMD'S
;        02       03/28/84          ;295C,296 AND BMX TESTS
;                                   ;DEVICE CODE CHANGE ROUTINE
;        03       06/12/84          ;ZDF1 CHANGES, A5 TESTS 17-76
;
;        04       08/21/85          ;DISABLE VIRTUAL, WEL-RECAL,
;                                   ;DISK SIM PARMS
;        05       11/20/86          ;297, 6214, HELP, DMA PTR, IORST

; 3.0 MACHINE REQUIREMENTS:
;       NOVA/ECLIPSE/MV FAMILY CENTRAL PROCESSOR
;       MINIMUM of 16K READ/WRITE MEMORY
;       ZETACO DISK CONTROLLER (ZEBRA TYPE)
;       0-3 DISK DRIVES
;       TELETYPE or CRT and CONTROL

; 4.0 TEST REQUIREMENTS:          N/A

; 5.0 SUMMARY:
;       The ZETACO DISK CONTROLLER DIAGNOSTIC PROGRAM
;       is a HARDWARE DIAGNOSTIC for the ZETACO DISK
;       CONTROLLERS and DRIVES. The Device Code may be 20-76
;       OCTAL with the Default being 27.


; 6.0 RESTRICTIONS:
;       This Program has no Restrictions as to Single or
;       Dual Processor Hardware Configuration. However, the
;       Diagnostic may be run on ONLY ONE CPU at a time and
;       must be the only Program being run within the Disk
;       System.
```

```
; 7.0 PROGRAM DESCRIPTION/THEORY OF OPERATION:

;       7.1 "A" TESTS CHECK:

;       - BUSY, DONE, I/O BUS SELECT LOGIC
;       - DISK SELECT LOGIC, CONTROLLER RAM

;       7.2 "B" TESTS CHECK:

;       - START, BUSY, CLEAR LOGIC
;       - RECALIBRATE, ATTN, INTERRUPT LOGIC
;       - INTERRUPT DISABLE, INTA LOGIC
;       - That SEEKS to CYL'S 0;1/2 CYL MAX,and CYL MAX
;         can at least be EXECUTED and SET DRIVE BUSY.
;       - READY/SELECT LOGIC

;       7.3 "C" TESTS CHECK:

;       - That the CA REGISTER INCREMENTS properly
;         VIA DCH  or BMC REQUESTS
;       - That a WRITE can be EXECUTED
;       - SELD, CLEAR LOGIC
;       - That SEEK/WRITE Operations can be EXECUTED
;       - WRITES to Different HDS,SECTORS
;       - MULTI-SECTOR WRITES
;       - The INCREMENT HEAD LOGIC
;       - ILLEGAL SECTOR, SURFACE, CYLINDER Conditions

;       7.4  "E" TESTS CHECK:

;       - That a READ may be EXECUTED
;       - 8 SECTOR WRITE/READ OPERATIONS (9 Different
;         Data Patterns) at CYL'S 0;1/2 CYL MAX and CYL MAX
;         with Full Core Compare
;       - Data VERIFY Function (Normal and with Forced Errors)
;       - OFFSET MODES
;       - ILLEGAL COMMAND TRAPS
;       - WRITE CYL# to HEAD 0,SECTOR 0 of All Cylinders
;       - WRITE HEAD # to SECTOR 0 of All Heads on CYL 0
;       - WRITE SECTOR # to All Sectors of Head 0,CYL 0
;       - Each of the above Operations is followed by
;         a Corresponding READ/CHECK Operation to Verify
;         Disk Addressing Logic.

;       7.5  "F" TESTS CHECK:

;         The Format Logic on CYL 0,HEAD 0,SECTOR 0,
;         A SET BAD SECTOR FLAG given and TESTED.
;         The FORMAT is set to Normal after Completion
;         of these Tests.

;       7.6 "S" TESTS ARE SEEK EXERCISERS

;       - Performs RANDOM SEEKING. Each SEEK is Followed
;         by a Read to Head 0,Sector 0

;       - Performs RANDOM OVERLAPPED SEEKING to TWO DRIVES.
;         Each SEEK is Followed by a Read to Head 0,Sector 0.
;         U1 is the the Primary Unit under Test and U2
;         is the next Drive found in a 1,2,3,0 ETC. Search.
;         If only 1 Drive, Test is Bypassed. Test is only run
;         after a Pass is Achieved on All Drives.
```

```
; 8.0  OPERATING MODES/SWITCH SETTINGS:

;8.1     SWITCH SETTINGS
;
;        Location "SWREG" is used to select the program options. This
;        Location will be set according to the answers supplied by
;        the Operator. The Options can be changed or verified by
;        using one of the commands given in Sec. 8.3.
;
;8.2     SWITCH OPTIONS
;        Different bits and their interpretation at location
;        "SWREG" is as follows:
;
;        BIT     OCTAL   BINARY  INTERPRETATION
;                VALUE   VALUE
;
;        1        40000    0      LOOP on ERROR
;                000000    1      SKIP LOOPING on ERROR
;
;        2        20000    0      PRINT to CONSOLE
;                000000    1      ABORT PRINT OUT to CONSOLE
;
;        3        10000    0      DO NOT PRINT % FAILURE
;                000000    1      PRINT % FAILURE
;
;        5        02000    0      DO NOT PRINT on the LINE PRINTER
;                000000    1      PRINT on the BYTE I/O LINE PRINTER(DC17)
;
;        6        01000    0      DO NOT HALT on ERROR
;                000000    1      HALT on ERROR
;
;        7        00400    0      N/A
;                000000    1      DISABLE FORMATTING HD 0, CYL 0, SEC 0
;
;        8        00200    0      N/A
;                000000    1      RECALIBRATE during SCOPE LOOP
;
;        9        00100    0      N/A
;                000000    1      1 SECOND DELAY during SCOPE LOOP
;
;        10(A)    00040    0      N/A
;                000000    1      PRINT TEST #'S and FIRMWARE REVISIONS
;
;        11(B)    00020    0      N/A
;                000000    1      PROGRAM will EXIT to ODT when not in
;                                  TESTS F1-F3 SWT is Set to 0 upon EXIT
;        12(C)    00010    0      SKIP LONG RAM TEST
;                000000    1      LONG CONTROLLER RAM TEST
;
;        16(G)    00000    0      DO NOT PRINT on the DMA LINE PRINTER
;                100000    1      PRINT on the DMA LINE PRINTER(DC 17)
;
;8.3     SWITCH COMMANDS
;        Once the Program starts executing the state of any of
;        the Bits can be changed by Hitting KEYS 1-9, A-Z. The
;        Program will Continue Running after Updating the Options.
;        Each Key will Complement the state of the Bit affiliat-
;        ed with it, thus Bit 4 can be Altered by Hitting Key 4.
;        Setting of any Bit of Location "SWREG" will Set Bit 0.
;        (Default Mode is defined as all Bits of SWREG Set to 0)
```

```
;8.4     OTHER COMMANDS  (° = CONTROL KEY)
;
;        "CR"     A "RETURN" can be typed to Continue the Program
;                 after its locked in a Switch Modification Mode
;
;        °D       This Command given at any time will reset "SWREG"
;                 to Default Mode and Restart the Program.
;
;        °R       This Command given at any time will Restart the
;                 Program. Switches are left with the values they
;                 had before the Command was issued.
;
;        °O       This Command given at any time will cause the
;                 Program Control to go to ODT.
;
;        M        This Command given at any time will print the
;                 Current Operating Modes.
;
;        0        This Command given at any time will lock the
;                 Program into Switch Modification Mode where
;                 more than 1 Bit can be changed.
;


; 9.0 OPERATING PROCEEDURE/OPERATOR INPUT:

;        9.1 Load the Program

;        9.2 STARTING ADDRESSES
;                 200-To IDENTIFY DISK TYPE (INITIALIZE)
;                     PROGRAM then PROCEEDS to 500.
;                 201-ODT DIRECT ENTRY ONLY
;                 202-RANDOM SEEK EXERCISERS. (1 PASS of DIAG FIRST)
;                  SEEK EXER 1 is a SINGLE DRIVE EXERCISER
;                  SEEK EXER 2 is TWO DRIVE EXERCISER with SEEK OVERLAP
;                 500-DIAGNOSTIC (RESTART)

;        9.3 The Program Prints"PASS" following each
;           Complete Pass through the Tests. Random
;           Seek Exerciser performs 1000 Seeks
;           per "PASS" Message.

;        9.4 Device Code of Controller is Requested (27 is Default)

;        9.5 Unit Numbers to be Tested are Requested to which the
;            Operator Enters the Unit Numbers to be Tested, Separating
;            the Individual #'s by a <,> or <Space>.

;        9.6 Operator is Requested to Enter 1, if Unit Characteristics
;            Displayed are INCORRECT, and Wants to LOOP on Reading them.
```

```
; 10. PROGRAM OUTPUT/ERROR DESCRIPTION:
;       When an ERROR is Detected the Program Prints the ERROR
;       PC, AC'S 0,1,and 2 at the point of ERROR, the Program then
;       goes into a Scope Loop between the Entries to .SETUP and
;       .LOOP allowing the Operator to Set  SWPAK. In General the
;       ERROR PC will point to a Call ERROR.

;       The Printout will be of one of the following Formats:

;       A. STANDALONE CONTROLLER TEST FAILURES-

;       B. STATUS ERRORS

;       MODE    UNIT    #       DATA
;       CYL     #       HEAD    #       SECTOR  #
;       AC1(STATUS) SHOULD =AC0
;       DESCRIPTIONS of FAILING STATUS BITS

;       C. MEMORY/DISK ADDRESS ERROR

;       MODE    UNIT    #       DATA
;       CYL     #       HEAD    #       SECTOR  #
;       ENDING MEMORY/DISK ADDRESS ERROR
;       AC1(MA/DA) SHOULD =AC0

;       C. INTERRUPT TIMEOUT

;       MODE    UNIT    #       DATA
;       CYL     #       HEAD    #       SECTOR  #
;       INTERRUPT TIMEOUT

;       Additional Test Significance can be found in the Program
;       Listing, although it is hoped that a need for the Listing
;       will be Minimal. SWPACK(SWREG) will provide all Control
;       over Test Loop Options and Printouts.


;       Data Errors will result in the 1st 3 Good/Bad pairs and
;       their Addresses being Printed along with the Total Count.
;       If an ECC Error is Detected, the Call EHECC will
;       Acknowledge the Fact and Return to the Main Test for
;       the Data Compare. Printouts result on the 1st Error Pass
;       only. As the Check Routine Checks the entire Read Buffer,
;       any Error accompanied by an ECC Error,terminating the
;       Read, may cause all Data in succeeding Sectors to appear Bad.

;       Tests that perform a Recalibrate have a 2 SEC. Delay built
;       into the Scope Loop.  Set SWPAK 9 = 1 to Introduce an
;       additional 1 Second Delay during the Scope Loop.

;       In General each successive Test Assumes all Previous Tests
;       work. Bypassing Errors can result in confusing situations
;       in the setup of more Complex Tests.
```

```
; 11. DEBUG HELP:
;
;OCTAL DEBUGGER  (ODT)
;
;       This Diagnostic is equipped with a built in ODT which can be
;       accessed by hitting CONTROL O at any time during the execution
;       of the Program (after Setting the Parameters). On entering ODT
;       the Address of the Location having the next instruction to be
;       executed will be typed-out.
;
;       The following Conventions are used by the ODT:
;       ?       Pressing any Illegal key causes the ODT to respond
;               with a "?".
;       @       ODT is ready and at your service.
;
;       An ODT Command has the following Format:
;               [ARGUMENT][COMMAND]
;       An Argument may be one of the following:
;       "EXP"   An OCTAL Expression consisting of OCTAL Numbers
;               separated by Plus (+) or Minus (-) signs. Leading
;               Zeros need not be typed.
;       "ADR"   An Address is the same as an Expression except
;               that Bit 0 is neglected.
;       A Command is a single teletype character
;
;       The Locations that can be EXAMINED and MODIFIED by the user
;       are called CELLS. These CELLS are of two Types: Internal CPU
;       Cells and Memory Locations. The Command to OPEN one of the
;       Internal Registers is of the form "nA" where n is any OCTAL
;       Expression between 0 and 7.
;
;       0-3     For ACCUMULATORS 0-3
;       4       For PC of the next Instruction to be Executed in the
;               event of a "P" Command.
;       5       CPU and TTO Status
;               BIT     INTERPRETATION
;               15      Status of TTO DONE FLAG
;               14      Status of INTERRUPTS (ION FLAG)
;               13      Status of CARRY BIT
;       6       Address of the Location having the BREAK POINT (If any)
;       7       Instruction at the BREAK POINT Location
;
;       Other Commands to OPEN Cells are:
;
;       "ADR"/  Open the Cell and Print its contents
;       ./      Open the Cell currently pointed to by the Pointer and
;               Print its contents.
;       .+"ADR"/ Add "ADR" to the Pointer, Open the Cell and Print its
;               contents.
;       .-"ADR"/ Subtract "ADR" from the Pointer, Open the Cell and
;               Print its contents.
;       "CR"    The Return Key is used to Close the Open Cell with or
;               without Modification.
;       "LF"    Line Feed is used to Close the Open Cell with or without
;               Modification and to Open the succeeding Cell.
;       CTRL    Close the Open Cell with or without Modification and
;               Open the preceeding Cell.
;       /       Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents.
;       +"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents + "ADDR".
;       -"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents - "ADR".
```

```
;       Modification of a Cell:
;
;       Once a Cell has been opened its contents can be Modified by
;       typing the New Value the Cell is to contain in the form of
;       an OCTAL Expression followed by "CR" or "LF". If a + or - is
;       typed as the first character of the Expression then the Value
;       of the Expression is Added to or Subtracted from the Old
;       contents of the Cell. The Address itself or an Expression
;       relative to the Address can be Deposited by typing a "." or
;       :,+/-OCTAL Expression". A Rubout Command given right after
;       opening a Cell allows the Modification of its contents as if
;       they were typed in just before the Command was issued.
;
;       Other ODT Commands:
;
;       RUBOUT  This Key is used to Delete ERRONEOUSLY typed digits.
;               Each time the Key is pressed the right most digit is
;               Deleted and Echoed on the Terminal. If the Rubout
;               Key is pressed right after opening a Cell then it
;               Deletes the right most digit of the Cells contents.
;               This allows the Modification of the Cell as if its
;               contents were typed in just before the Key was pressed.
;       "ADR"B  Insert a BREAK POINT at Location "ADR".
;               Only one Break Point can be inserted and any entry to
;               ODT after Executing a Break Point will cause it to be
;               Deleted.
;       D       Delete the Break Point if any.
;       P       Restart the Execution of the program at CURRENT Location
;       "ADR"R  Start Executing the program at "ADR" after an IORST.
;       K       Kill the String typed so far. The ODT responds with a
;               "?" and the Open Cell is closed without Modification.
;       =       Print the OCTAL Value of the INPUT only.
;               This will Close any Open Cells without Modification and
;               will not Open a Cell
;
;       NOTE:   In Programs which RELOCATE THEMSELVES the
;               user should place Break Points ONLY in the
;               ORIGINAL PROGRAM AREA. If a Break Point is
;               placed outside this area the results will
;               be unpredictable.
```

```
;
; 12. SPECIAL NOTES/SPECIAL FEATURES:
;
;       12.1 If the Disk Pack has BAD SECTOR FLAGS Set on Cylinder
;       0, or on the First 8 Sectors of Head 0 of any Cylinder,
;       Error Printouts will result when the Flags are Encountered.
;
;       12.2  Tests F1-F3 alter the Format on CYL 0,HD 0,SEC 0 for
;       purpases of Checking the FORMAT Logic and BAD SECTOR Logic.
;       SWPAK7 should be Set to 1 in order to stop Program from
;       executing the Format.
;
;       12.3  Some Scope Loops will require a Recalibrate to
;       Initialize the Disk Drive following a failure. Set
;       SWPAK 8 = 1 to introduce the Recalibrate to the Unit
;       under Test.
;
;       12.4  DISK PACKS
;       Only use Disk Packs Formatted by the DISKF Pack Formatter
;       Program. The Diagnostic Program will Write over most of
;       the Disk Surface.
;
; 13. RUN TIME:
;       The Run Time for a PASS is approximately: 3 MIN.
```

A.2 Reliability Program Description

```
;**************************************************************
;--------------------------------------------------------------
;
; DESCRIPTION: ZETACO DISK CONTROLLER RELIABILITY PROGRAM
;
;
; Product of ZETACO, 1986
;**************************************************************
 --------:TITL   DISKR-------------------------------------------
         .DUSR   X=1
         .NOMAC  X
;1.0     PROGRAM NAME:    DISKR.SR

;2.0     REVISION HISTORY:
;
;        REV.       DATE
;         00       02/09/83                ;
;         01       09/07/83                ;S120 # SKP TOGETHER, STACK AND
;                                           ;AOS BOOTSTRAP AT 400, NO VERIFY
;                                           ;W/RANDOM DATA TEST 502 SWT 10
;         02       03/28/84                ;ADD RELEASE COMMAND TO RC
;                                           ;FOR DUAL PORT, DAISY CHAIN
;                                           ;DISK SECTOR PULSE COUNTER
;                                           ;DEVICE CODE CHANGE ROUTINE
;                                           ;502 PAT 24 SECTOR
;         03       05/30/84                ;ZDF1,
;
;         04       08/21/85                ;DISABLE VIRTUAL, UP TO 2048.
;                                           ;CYLS, 40 HDS
;
;         05       11/20/86                ;MULTI DC 500 & 505, DMA PTR
;                                           ;MAJOR

;3.0     MACHINE REQUIREMENTS:

;        NOVA/ECLIPSE/MV FAMILY CENTRAL PROCESSOR
;        16K READ/WRITE MEMORY
;        ZETACO DISK CONTROLLER (ZEBRA TYPE)
;        0-3 DISK DRIVES
;        TELETYPE or CRT and CONTROL

;4.0     TEST REQUIREMENTS:       N/A

;5.0     SUMMARY:

;        The ZETACO DISK CONTROLLER RELIABILITY PROGRAM is a
;        MAINTENANCE PROGRAM designed to EXERCISE and TEST the
;        ZETACO SMD DISK SUB-SYSTEMS and 1-4 DISK DRIVES. The
;        DISK DRIVES may be shared between TWO Computers.

;        The Device Code may be 20-76 OCTAL with the Default
;        being 27.
```

```
;       1. The DISK DRIVES may be shared between TWO Computers in
;       which case the following Programs may be running in each
;       Computer:

;       STARTING ADRESSES'S (SA) 500,501 RANDOM RELIABILITY
;       SA 503 COMMAND STRING (If a RELEASE Command is included
;       in the Command String)

;       If no Drives are to be Shared, there are no other
;       Restrictions as to the running of these Programs on a
;       Dual Processor System.

;       2. Any Combination of Drives may be Tested by this Program
;       at a single time.


;7.0    PROGRAM DESCRIPTION/THEORY OF OPERATION:

;       A. RELIABILITY TEST (SA 500)

;       A Random Number Generator is used to select a Disk Drive,
;       Cylinder,Head,Beginning Sector, and Number of consecutive
;       Sectors. Random Data is then Generated, Written, and Read.
;       The Sequence is repeated indefinately. If running Multiple
;       Units, Over Lapped SEEKS are employed, if the next Random
;       Unit is different from the current Unit under I/O Execution.

;       B. RELIABILITY TEST (SA 501) with OPTIONS

;       Same as A, Except that Operator is given Options on Data
;       Patterns and may choose a Constant Cylinder,Head,Sector
;       or # or Sectors. Any Letter response to CYL,HEAD ETC.
;       gets Random function for that Variable. A Carriage Return
;       only gets the Random function for all Variables.

;       The Operator is also asked to respond to JITTER OPTION
;       (YES/NO). If YES, a Random Delay(0-40,50MS) is inserted
;       into the Background Loop to create a more asynchronous
;       Disk I/O Loop.

;       C. INCREMENTAL DISK ADDRESS TEST (SA 502)

;       Operator is given Option on Data; Requested Data is first
;       Written (SEE SWPAK10) over the entire Pack. Then the Data
;       is Read from all Sectors . This insures that all Disk
;       Blocks are useable and are Formatted properly. The Test
;       is then repeated for all Ready Disks, and PASS is Printed.
;       The sequence is repeated indefinitely.

;       #NOTE
;       SWPAK8=1, puts Program into Read ONLY Mode ## SA'S 501,502 ONLY.
;       If SA 501-Data must !NOT! be Random.

;       All Numbers entered above must be in Octal. Any Non-Octal
;       input is treated as a letter. Any letter input for CYL,Head,
;       Sector, or # of Sectors gets Random function in the Reliability
;       Test with Options.
```

```
;       D. COMMAND STRING INTERPRETER (SA 503)
;       As a trouble shooting aid the service engineer may type in
;       their own TEST LOOP. After starting at 503, three ARGUMENTS
;       must be entered in response to three program questions;
;       "UNIT", "DATA", and "COMMAND STRING". All numbers must be
;       entered in OCTAL.

;       I.      UNIT:   Type unit # or carriage return
;                       to use the previous entry

;       II.     DATA:   RAN=RANDOM
;                       ALO=ALL ONES
;                       ALZ=ALL ZEROS
;                       PAT=155555 PATTERN
;                       ROT=155555 PATTERN Rotated on
;                       Successive Passes.
;                       FLO=FLOATING ONE PATTERN
;                       FLZ=FLOATING ZERO PATTERN
;                       ADR=ALTERNATING CYLINDER and
;                       HEAD,SECTOR WORDS
;                       VAR=Existing words entered previously as
;                       described below

;                       Alternatively enter a string of up to 7
;                       OCTAL 16 bit words to be used as DATA.
;                       The words entered are used repeatedly
;                       to make up a sector block. Type carriage
;                       return to use the previous entry.

;       III.    COMMAND STRING:

;       OPTIONS 1.      READ HEAD,SECTOR,#SECTORS
;               2.      WRITE SAME
;               3.      SEEK CYLINDER
;               4.      RECALIBRATE
;               5.      LOOP (go to beginning or LR)
;               6.      DELAY N (N=DELAY in MS)
;               7.      TRESPASS
;               8.      RELEASE
;               9.      OFF (OFFSET FORWARD)
;               10.     OFR (OFFSET REVERSE)
;               11.     LR  (begin LOOP here)
;               12.     VERIFY (WRITE)
;               13.     FORMAT CYL,HD,SECTOR
;               14.     MEMORY ADDR,DATA(WRITE) (CONTROLLER MEMORY COMMAND)
;               15.     Type Carriage Return to use the
;                       previous COMMAND STRING.

;               Note that either SPACES or a COMMA
;               may be used as an argument delimiter.
;               Each response is terminated by
;               typing carriage return.  If more
;               room is needed on a line, type line
;               feed to space to the next line. The
;               word "SAME" used with READ, or WRITE,
;               will cause the previous disk address
;               parameters to be used.

;       An R typed while a string is being executed will
;       cause the program to return to command string start.
;       The ESCAPE KEY will bypass UNIT and DATA prompts to
;       the command string prompt.

;       The following example would cause UNIT
```

```
;       WRITE SECTORS 2 and 3 of HEAD 5, then
;       READ it back and CHECK.  Data is specified
;       as ALTERNATE WORDS of ZEROS then ONES.

;       UNIT: 1
;       DATA: 0,177777
;       COMMAND STRING: SEEK 50 LR WRITE 5,2,2 READ SAME LOOP

;       The following example would WRITE 0 to
;       CONTROLLER MEMORY location 1500 (OCTAL)

;       UNIT:    1
;       DATA:    N/A
;       COMMAND STRING: MEMORY 101500,0
;       NOTE: Upper memory bit = 1 defines a WRITE
;
;       E. QUICKIE FORMATTER (SA 504)
;       Formats Pack and HALTS. There is NO Verify, NO Flags are
;       Set, and NO Error Checking.

;       F. RUNALL (SA 505)
;       Program alternates between the Programs described in 7.B
;       (4 Data Patterns -PAT,RAN,FLZ,FLO) and 7.C(6 Data Patterns
;       -PAT,RAN,RAN-2,ZEROES,ONES;ALT) and 7.H, and in that order.

;       G. SEEK EXERCISER (SA 506)
;       Program provides a SEEK scan sequence converging from the
;       extreme Outermost Tracks into the adjacent track in the
;       center, then diverging again to the extremes.

;       H. RANDOM SEEK EXERCISER (SA 507)
;       Program provides a Random SEEK sequence

;       ###G,H all SEEKS in G/H are followed by a 1 Sector Read but
;       with no Data Check. All SEEKS are timed with MAX,MIN, and
;       AVE. times being Logged in MS. SEEK Paths for MAX,MIN Values
;       are also Logged.

;       I.  ERROR COUNT/LOG RECOVERY (SA 510)
;       In the event a Program was stopped during a run, the Error
;       Logs may be recovered at this Starting Address.
;       ***MUST be done before any Program RESTART as Program
;       initialization Zeroes all Logs.
;


;
;
;8.0  OPERATING MODES/SWITCH SETTINGS:

;8.1     SWITCH SETTINGS
;
;       Location "SWREG" is used to select the program options.
;       This Location will be set according to the answers
;       supplied by the Operator. The Options can be changed
;       or verified by using one of the commands given in Sec.
;       8.3
;
;
;8.2     SWITCH OPTIONS
;       Different bits and their interpretation at location
;       "SWREG" is as follows:
;
;       BIT     OCTAL   BINARY  INTERPRETATION
;   A-20        VALUE   VALUE
```

```
;       1        40000  0       LOOP on ERROR
;               000000  1       SKIP LOOPING on ERROR
;
;       2        20000  0       PRINT to CONSOLE
;               000000  1       ABORT PRINT OUT to CONSOLE
;
;       4        04000  0       PRINT PASS
;               000000  1       DO NOT PRINT PASS
;
;       5        02000  0       DO NOT PRINT on the LINE PRINTER
;               000000  1       PRINT on the BYTE I/O LINE PRINTER(DC17)
;
;       6        01000  0       DO NOT EXIT to ODT on ERROR
;               000000  1       EXIT to ODT on ERROR
;
;       7        00400  0       NOT USED
;               000000  1
;
;       8        00200  0       N/A
;               000000  1       For READ ONLY MODE (SA 501,502)
;
;       9        00100  0       N/A
;               000000  1       BYPASS DATA CHECK
;
;       10(A)    00040  0       N/A
;               000000  1       DO VERIFY After WRITE (SA 502 ONLY and
;                               NOT RANDOM DATA)
;
;       11(B)    00020  0       N/A
;               000000  1       ENABLE BAD SECTOR PRINTOUTS
;
;       12(C)    00010  0       N/A
;               000000  1       HALT on DRIVE ERROR prior to
;                               Recovery RECALIBRATE Operation
;
;       13(D)    00004  0       NO TRACE
;               000000  1       TRACE PRINTOUT on ERROR
;
;       16(G)    00000  0       Do NOT PRINT on the DMA LINE PRINTER
;               100000  1       PRINT on the DMA LINE PRINTER(DC17)
;

;
;8.3    SWITCH COMMANDS
;       Once the Program starts executing the state of any of
;       the Bits can be changed by Hitting KEYS 1-9, A-Z. The
;       Program will Continue Running after Updating the Options.
;       Each Key will Complement the state of the Bit affiliat-
;       ed with it, thus Bit 4 can be Altered by Hitting Key 4.
;       Setting of any Bit of Location "SWREG" will Set Bit 0.
;       (Default Mode is defined as all Bits of SWREG Set to 0)
;
;
;8.4    OTHER COMMANDS  (° = CONTROL KEY)
;
;       "CR"    A "RETURN" can be typed to Continue the Program
;               after its locked in a Switch Modification Mode
;
;       °D      This Command given at any time will reset "SWREG"
;               to Default Mode and Restart the Program.
;
;       °R      This Command given at any time will Restart the
;               Program. Switches are left with the values they
;               had before the Command was issued.
```

```
;       ^O      This Command given at any time will cause the
;               Program Control to go to ODT.
;
;       M       This Command given at any time will print the
;               Current Operating Modes.
;
;       0       This Command given at any time will lock the
;               Program into Switch Modification Mode where
;               more than 1 Bit can be changed.
;
;9.0    OPERATING PROCEEDURE/OPERATOR INPUT:

;       A. Verify drive (s) are ready on-line
;       B. Load Program
;       C. To RUN other than TEST 505, Enter CONTROL "O"
;          at 9.2, Enter STARTING ADDRESS followed by an "R"

;       STARTING ADDRESS
;       200     Read Unit Characteristics and then RUN ALL TEST (505)
;       500     RELIABILITY TEST, ALL CYLINDERS
;       501     RELIABILITY TEST, (OPTIONS)
;       502     INCREMENTAL DISK ADDRESS TEST
;       503     COMMAND STRING INTERPRETER
;       504     QUICKIE FORMATTER
;       505     RUN ALL
;       506     SEEK EXERCISER (CONVERGING,DIVERGING PATTERN)
;       507     SEEK EXERCISER (RANDOM PATTERN)
;       510     ERROR COUNT/LOG RECOVERY
;       511     MULTIPLE DEVICE CODE ENTRY

;9.1    Operator is requested to enter DEVICE CODE of CONTROLLER
;      (DEFAULT 27).
;9.2    STARTING ADDRESS is Displayed and Operator is requested to
;      SET SWPAK followed by a Carriage Return (SEE 8.3).
;9.3    Operator is requested to enter YES/NO to Exercise Maps, If
;      present and supported.
;9.4    MONTH, DAY, YEAR (I.E. 77...), HOUR, & MINUTE (If [CR] is
;      given this routine is bypassed).
;9.5    Operator is requested to enter YES/NO if any DUAL VOLUME
;      DRIVES (CMD'S).
;9.6    Operator is requested to enter YES/NO to CONTROLLER CORRECTION,
;      if it is enabled.
;9.7    Unit Numbers, Types, and their Characteristics are then
;      Displayed, (The Operator should Verify these values) Operator
;      is then requested to enter UNIT NUMBERS to be tested (0-3).
;9.8    Operator is then requested to enter TYPE of disk ( to create a
;      User Defined enter 10)
;       A.      If TYPE entered is 10, enter 0, 1, 2, or 3 to
;               RE-DEFINE a disk TYPE
;       B.      # of HEADS for NEW TYPE (in DECIMAL)
;       C.      # of CYLINDERS for NEW TYPE (in DECIMAL)
;       D.      # of SECTORS for NEW TYPE (in DECIMAL, CANNOT be
;               DOWNSIZED)
;       E.      RETURN to 9.7

;       ## A [CR] only response to Unit Numbers, will leave Unit
;       information in previous state.

;       ## A [CR] only response to YES/NO will DEFAULT to NO.
;

;       OPERATOR INPUT CONTROLLED PRINTOUTS ARE AS FOLLOWS:

;       L       = FIRST 100. BAD SECTORS, DATA, or ADDRESSES
```

```
;       W       - SECTORS W/R, ERROR COUNTS, and on BOARD ECC and
;                 OFFSET CORRECTS
;       **NOTE** Any Character typed will end Printouts at the next
;       change of Data Type.


;10.0   PROGRAM OUTPUT/ERROR DESCRIPTION:


;       All Errors are Identified, Counted, and the Program is
;       routed via base to a call to CKSW. on the basis of Switch
;       Settings (SEE 8.2) The Program will go into a scope loop,
;       or proceed, depending on the SWPAK Settings.

;       Upon loss of Ready and a Single Drive, the Program will
;       print the appropriate Error Message and will not proceed
;       until Ready is returned. If Multiple Drives exist, The
;       Program will continue with the remaining Drives. If the
;       down Drive is placed back On-line, the Program will resume
;       Testing of that Drive. The above also applies to the loss
;       of Write enable if the Program is in a Write Mode.

;       RECALIBRATE - Any unusual Status is reported immediately
;       and an Error Return executed.

;10.1   SEEK - Positioner Fault Status increments Seek Error
;       Counter.  Any Error Status  results in Status Printout and
;       Error Return. A Recalibrate will be performed by the Error
;       Handler. Program will Log the first 20. Cylinders TO/FROM
;       on finding Seek Errors.

;10.2   WRITE - Following "DONE" on a Write, Errors are checked in
;       the sequence shown below. Error recovery proceedure is
;       outlined for each case. If the Error is not present the
;       next Check is made.

;       Drive Status (DIB) is Checked 1st for both Read and Write
;       before any DIA Checks are made.
;
;       1. READ/WRITE TIMEOUTS, DATA LATE, ILLEGAL SECTOR, PARITY,
;       DATA VERIFY; or any DRIVE FAULTS- Increment the appropriate
;       Error Count, Print the Illegal Status and do an Error Return.
;       Any Drive Fault will cause a Recalibrate to be performed by
;       the Error Handler.

;       2. ADDRESS ERROR- Repeat the Write, if Test Passes the
;       second time, Increment the Soft Address Error Count and do
;       a Normal Return; otherwise increment the Hard Address Error
;       count and do an Error Return.

;       If a Hard Cylinder Address Error occurs, a Read on an
;       adjacent Head will be attempted to determine whether the
;       Fault should be classed as a Seek Error or an Address Error.
;       The First 20. Address Errors will have their Addresses Logged.
;
;       3. BAD SECTOR- Log the Disk Address (1st 100.) and do a Normal
;       Return. No Printout will result unless SW11=1, although the
;       I/O Operation was prematurely terminated. A "SOFT" Error will
;       be Recorded if the Sector under Test Passes at Least 1 of 4
;       Retrys. The Log denotes SOFT Errors by a count greater than 0,
;       representing the Error Count tallied. ***SEE 10.3A.

;       4. ENDING MEMORY ADDRESS - Increment the Memory Address Error
;       Count, Print the Error Message, Check for a Disk Address Error
```

```
;       5. ENDING DISK ADDRESS - Increment the Disk Address Error
;       Count, Print the Error Message, and do an Error Return.

;10.3   READ - All Read Errors with the exception of Data related
;       Errors are handled the same as described for the Write
;       Operations.

;       DATA ERRORS - Data is REREAD 3 X (4X if ECC UNDETECTED) If
;       Program is in Write/Read Mode and Data ia Bad all 4 tries,
;       A Hard Error Count is incremented and an Error Return is
;       taken. If Data is Good on any of Four tries, a Soft Error
;       Count is incremented and a Normal Return is taken.

;       If the Program is in a Read ONLY Mode (IE. Read Mode for any
;       502 Program or when 505 is running a 502 Program), the Data
;       will be REREAD an additional 4 times in both Offset Forward
;       and Offset Reverse Modes before the Problem is classed as a
;       Hard Error.

;       Thus Total retries for a Hard ECC Detected Error in a Read
;       ONLY Mode is 12 (13 for ECC UNDETECTED), and 4 if in a
;       Write/Read Mode (5 if ECC UNDETECTED). ***SEE 10.3A

;       Any Successful REREADS while in an Offset Mode will be
;       Printed and Logged. The Disk Addresses of all Data problems
;       will be Printed and the First 100. will be Logged. The First
;       Three Good/Bad word pairs and respective Addresses will be
;       Printed.

;       If SWPAK9=1 (Bypass Data Check) Hard or Soft Data  Errors
;       will be determined by ECC Status.

;10.3A  ECC (ERROR CORRECTION CODE) ANALYSIS

;       All Read Passes including retries will have the ECC results
;       Logged as per the following 4 Categories:

;       1. ECC CORRECTED -The ECC detected and successfully
;       corrected the DATA ERROR.

;       2. NON-CORRECTABLE ECC -The ECC detected and CORRECTLY
;       diagnosed the Error Pattern as UNCORRECTABLE.

;       3. ECC UNDETECTED -The ECC Failed to detect a Data Error.
;       This may be a Malfunction of the ECC Logic, but it is
;       more likely one of the following problems:

;       A Failure of the Drive to Write a Sector.
;       *NOTE- A Check should be made in the Bad Sector Log to see
;       whether a Write Operation may have encountered a Soft or
;       Faulty Bad Sector indication, which would have terminated
;       the Write.

;       A Failure in the Controller Data paths.

;       4. ECC FAILED -Two Conditions may fall into this Category.

;       4A. An ECC Error was detected but with no Accompanying
;       Data Error. A Check is made to see whether the ECC Words
;       point to an Error within the two Appended Write ECC Words.
;       If such an Error is determined to be the case, the Error
;       will be Logged as Correctable and no ECC Failed message
;       will result. This type of Error should represent only a
```

```
;       Sample). If a Significantly Higher Percentage of this
;       Error results,  Then an ECC Problem would be Indicated.

;       If the ECC does not point to the two Appended Write ECC
;       Words, then an ECC Failed message (1st Pass only) will
;       result and the Actual ECC Words Read from the Controller
;       will be printed.

;       4B. An ECC Error was detected, but the ECC either Failed
;       to Correct a Correctable Error, or tried to Correct an
;       Uncorrectable Error. These Conditions (Possibly caused
;       by Problems other than ECC) will result in a printout
;       (1st Pass only) of the Simulated Write and Simulated
;       Read ECC Words plus the Actual Read ECC Words as Read
;       from the Controller.

;       The Simulated Write ECC Words are the result of a
;       Program Simulation of the ECC Logic on what the Program
;       believes to be the Write Data (A Write Error will cause
;       this Assumption to be False), and represents what the
;       Program believes should have been written as the Actual
;       two Write ECC Words on the Disk.

;       The Simulated Read ECC Words are the result of another
;       Program Simulation of the ECC Logic on the Read Data
;       in Memory, and represent what the Program believes
;       should be Read from the Controller as the two ECC
;       Words. The Actual Read ECC Words are those two Words
;       as Read from the Disk Controller.

;10.4   ERRORS- Error Status is printed whenever encountered
;       as follows:

;       'MODE'  UNIT:   'N'
;       CYL-  'N'       HEAD  'N'       SECT  'N'    #SECT  'N'
;       DIA/DIB STATUS= 'N'     'DESCRIPTIVE MESSAGE'

;       Where CYL,HEAD,SECT refer to the final Disk Address at
;       the point of Error; and #SECT refers to the Number of
;       Sectors already done in the Multiple Sector Transfer.

;       When Data Errors are found, only THREE are printed per
;       encounter plus the Total Number of Errors.(See PARA 5)
;       If the Data Error is ECC UNDETECTED and the System is
;       Mapped, the Map, Physical 1K Address, and the DCH
;       Logical Addresses are also printed.

;       When Looping is involved (Retried or for Scoping)
;       Status is printed on the 1st Pass only.

;10.5   STATISTICS -

;       Type a W during random testing to get a Report of the
;       Number of Sectors Written(and/or)Read, plus Error Counts
;       in Decimal. Also Listed is a Count for Controller
;       Corrects/Unit (on Board ECC Correction and Offset Corrects)

;       Type L for First 100. Disk Addresses of Bad Sectors and
;       Data Errors, and First 20. of Address Errors and Seek
;       Errors (Seek Path). If Error Addresses are encountered
;       more than once (1st Pass), a Count of up to 32. will be
;       recorded in the Log. Also a Count of up to 15. Hard Errors
;       will be recorded. This Count will be A subset of the the
;       first Count.
```

```
;       The Address Information will be in OCTAL while the Counts
;       will be DECIMAL.

;       Type S for Seek Timing Statistics if running either Seek
;       Exerciser.
```

```
;11.0   DEBUG HELP:
;
;OCTAL DEBUGGER  (ODT)
;
;       This Reliability is equipped with a built in ODT which can be
;       accessed by hitting CONTROL O at any time during the execution
;       of the Program (after Setting the Parameters). On entering ODT
;       the Address of the Location having the next instruction to be
;       executed will be typed-out.
;
;       The following Conventions are used by the ODT:
;       ?       Pressing any Illegal key causes the ODT to respond
;               with a "?".
;       @       ODT is ready and at your service.
;
;       An ODT Command has the following Format:
;               [ARGUMENT][COMMAND]
;       An Argument may be one of the following:
;       "EXP"   An OCTAL Expression consisting of OCTAL Numbers
;               separated by Plus (+) or Minus (-) signs. Leading
;               Zeros need not be typed.
;       "ADR"   An Address is the same as an Expression except
;               that Bit 0 is neglected.
;       A Command is a single teletype character
;
;       The Locations that can be EXAMINED and MODIFIED by the user
;       are called CELLS. These CELLS are of two Types: Internal CPU
;       Cells and Memory Locations. The Command to OPEN one of the
;       Internal Registers is of the form "nA" where n is any OCTAL
;       Expression between 0 and 7.
;
;       0-3     For ACCUMULATORS 0-3
;       4       For PC of the next Instruction to be Executed in the
;               event of a "P" Command.
;       5       CPU and TTO Status
;               BIT     INTERPRETATION
;               15      Status of TTO DONE FLAG
;               14      Status of INTERRUPTS (ION FLAG)
;               13      Status of CARRY BIT
;       6       Address of the Location having the BREAK POINT (If any)
;       7       Instruction at the BREAK POINT Location
;
;       Other Commands to OPEN Cells are:
;
;       "ADR"/  Open the Cell and Print its contents
;       ./      Open the Cell currently pointed to by the Pointer and
;               Print its contents.
;       .+"ADR"/ Add "ADR" to the Pointer, Open the Cell and Print its
;               contents.
;       .-"ADR"/ Subtract "ADR" from the Pointer, Open the Cell and
;               Print its contents.
;       "CR"    The Return Key is used to Close the Open Cell with or
;               without Modification.
;       "LF"    Line Feed is used to Close the Open Cell with or without
;               Modification and to Open the succeeding Cell.
;       CTRL    Close the Open Cell with or without Modification and
;               Open the preceeding Cell.
;       /       Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents.
;       +"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents + "ADDR".
;       -"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents - "ADR".
```

```
;       Modification of a Cell:
;
;       Once a Cell has been opened its contents can be Modified by
;       typing the New Value the Cell is to contain in the form of
;       an OCTAL Expression followed by "CR" or "LF". If a + or - is
;       typed as the first character of the Expression then the Value
;       of the Expression is Added to or Subtracted from the Old
;       contents of the Cell. The Address itself or an Expression
;       relative to the Address can be Deposited by typing a "." or
;       :,+/-OCTAL Expression". A Rubout Command given right after
;       opening a Cell allows the Modification of its contents as if
;       they were typed in just before the Command was issued.
;
;       Other ODT Commands:
;
;       RUBOUT  This Key is used to Delete ERRONEOUSLY typed digits.
;               Each time the Key is pressed the right most digit is
;               Deleted and Echoed on the Terminal. If the Rubout
;               Key is pressed right after opening a Cell then it
;               Deletes the right most digit of the Cells contents.
;               This allows the Modification of the Cell as if its
;               contents were typed in just before the Key was pressed.
;       "ADR"B  Insert a BREAK POINT at Location "ADR".
;               Only one Break Point can be inserted and any entry to
;               ODT after Executing a Break Point will cause it to be
;               Deleted.
;       D       Delete the Break Point if any.
;       P       Restart the Execution of the program at CURRENT Location
;       "ADR"R  Start Executing the program at "ADR" after an IORST.
;       K       Kill the String typed so far. The ODT responds with a
;               "?" and the Open Cell is closed without Modification.
;       =       Print the OCTAL Value of the INPUT only.
;               This will Close any Open Cells without  Modification and
;               will not Open a Cell
;
;       NOTE:   In Programs which RELOCATE THEMSELVES the
;               user should place Break Points ONLY in the
;               ORIGINAL PROGRAM AREA. If a Break Point is
;               placed outside this area the results will
;               be unpredictable.
;
```

```
;MAPPED ODT COMMANDS
;
;       In addition to the previously listed ODT Commands, there
;       is available a Command Set that allow Map Translations for
;       Debugging purposes.
;
;       Map Command Format

;       The Letter "M" is used to specify a Map Command and is
;       used in conjuction with the Set of Characters that form
;       the Map Command Group. A Map Command is thus formed by
;       using the Letter "M" and following it with the desired
;       Command Letter (Such as "MT", "MA", ETC.)
;
;       Map Command Errors
;
;       If a Map Command is entered and the Error Message "No Map"
;       appears, then either:
;       A) A Map was not found
;       B) The Program does not support Mapped ODT.

;       Map Commands
;
;       Note: All Map Commands must be preceeded by an "M" to
;       indicate that they are Map Commands.

;       "A"     Enable User "A" Map Translations
;       "B"     Enable User "B" Map Translations
;       "M"     Enable Map Translations with the last "User"
;       "U"     Disable Mapping
;       "L"     Map Supervisor Last Block
;       "E"     Print Single Map Entry
;       "T"     Print Map Entry Table
```

```
;12.0    SPECIAL NOTES/SPECIAL FEATURES:
;
;        1. A CR only response to Unit Numbers, ETC will leave
;        information in Previous State.
;
;        2. The Program will Account for up to a MAX. of 2**31 Sectors
;        Written or Read. Special Test runs exceeding this facility
;        will require an OPERATOR'S TEST LOG to augment software
;        accounting. 2**31 Sectors = Approx. 2* 10**9 Words.
;
;        4. SWPAK7=1, Program halts after write with Read Verification
;        allowing operator to change packs. SWPAK8=1, Puts Program into
;        Read only mode ## SA'S 501,502 Only. If SA 501-Data must !NOT!
;        be Variable. Start at the above selected Address.

;        5. All Numbers entered in 7.0 must be in Octal. Any Non-Octal
;        input is treated as a Letter. Any Letter input for CYL, HEAD,
;        SECTOR, or # of SECTORS gets Random function in the Reliability
;        Test with Options.
;
;        6. At times the ECC may attempt to Correct a Non-Correctable
;        Data Error and the Simulated ECC and Actual ECC will Match
;        even though an ECC Failure will have been Printed. This is
;        Due to a Failure of the ECC Polynomial itself to Distinguish
;        between two different Error Patterns. One Correctable and one
;        Uncorrectable. This is !NOT! a Hardware Failure.

;13.0    PROGRAM RUNTIME:
;
;        Program Runtimes are substantially reduced with Memories of
;        16K or Larger. Program can use up to 24K using 2 Buffers
;        and up to 32K using 4 Buffers in the Random Reliability
;        Tests.

;        Runtime is defined as Time from Start to a "PASS" Message.
;        Typical runtime for a Read only or Write only Pass of SA
;        502 (Incremental Disk Address Test) is Approx. 3 and 1/2
;        Minutes with a Nova 800 (or Faster CPU) with at least 24K
;        of Memory, and 96 Megabyte.
;
;
```

```
;
;*****************************************************************
;-----------------------------------------------------------------
;
; DESCRIPTION: ZETACO DISK CONTROLLER DIAGNOSTIC
;
;
; Product of ZETACO, 1986
;*****************************************************************
 -------:TITL   DISKD-------------------------------------------------
        .DUSR   X=1
        .NOMAC  X
; 1.0 PROGRAM NAME:      DISKD.SR

; 2.0 REVISION HISTORY:
;
;       REV.        DATE
;        00      02/17/83        ;
;        01      09/07/83        ;ANOTHER RDY UNIT WARNING,1 HD
;                                ;ERR C22, AOS BOOTSTRAP(400'S),
;                                ;NO OFFSET TESTS FOR CMD'S
;        02      03/28/84        ;295C,296 AND BMX TESTS
;                                ;DEVICE CODE CHANGE ROUTINE
;        03      06/12/84        ;ZDF1 CHANGES, A5 TESTS 17-76
;
;        04      08/21/85        ;DISABLE VIRTUAL, WEL-RECAL,
;                                ;DISK SIM PARMS
;        05      11/20/86        ;297, 6214, HELP, DMA PTR, IORST

; 3.0 MACHINE REQUIREMENTS:
;       NOVA/ECLIPSE/MV FAMILY CENTRAL PROCESSOR
;       MINIMUM of 16K READ/WRITE MEMORY
;       ZETACO DISK CONTROLLER (ZEBRA TYPE)
;       0-3 DISK DRIVES
;       TELETYPE or CRT and CONTROL

; 4.0 TEST REQUIREMENTS:          N/A

; 5.0 SUMMARY:
;       The ZETACO DISK CONTROLLER DIAGNOSTIC PROGRAM
;       is a HARDWARE DIAGNOSTIC for the ZETACO DISK
;       CONTROLLERS and DRIVES. The Device Code may be 20-76
;       OCTAL with the Default being 27.


; 6.0 RESTRICTIONS:
;       This Program has no Restrictions as to Single or
;       Dual Processor Hardware Configuration. However, the
;       Diagnostic may be run on ONLY ONE CPU at a time and
;       must be the only Program being run within the Disk
;       System.
```

```
; 7.0 PROGRAM DESCRIPTION/THEORY OF OPERATION:

;       7.1 "A" TESTS CHECK:

;       - BUSY, DONE, I/O BUS SELECT LOGIC
;       - DISK SELECT LOGIC, CONTROLLER RAM

;       7.2 "B" TESTS CHECK:

;       - START, BUSY, CLEAR LOGIC
;       - RECALIBRATE, ATTN, INTERRUPT LOGIC
;       - INTERRUPT DISABLE, INTA LOGIC
;       - That SEEKS to CYL'S 0;1/2 CYL MAX,and CYL MAX
;         can at least be EXECUTED and SET DRIVE BUSY.
;       - READY/SELECT LOGIC

;       7.3 "C" TESTS CHECK:

;       - That the CA REGISTER INCREMENTS properly
;         VIA DCH  or BMC REQUESTS
;       - That a WRITE can be EXECUTED
;       - SELD, CLEAR LOGIC
;       - That SEEK/WRITE Operations can be EXECUTED
;       - WRITES to Different HDS,SECTORS
;       - MULTI-SECTOR WRITES
;       - The INCREMENT HEAD LOGIC
;       - ILLEGAL SECTOR, SURFACE, CYLINDER Conditions

;       7.4  "E" TESTS CHECK:

;       - That a READ may be EXECUTED
;       - 8 SECTOR WRITE/READ OPERATIONS (9 Different
;         Data Patterns) at CYL'S 0;1/2 CYL MAX and CYL MAX
;         with Full Core Compare
;       - Data VERIFY Function (Normal and with Forced Errors)
;       - OFFSET MODES
;       - ILLEGAL COMMAND TRAPS
;       - WRITE CYL# to HEAD 0,SECTOR 0 of All Cylinders
;       - WRITE HEAD # to SECTOR 0 of All Heads on CYL 0
;       - WRITE SECTOR # to All Sectors of Head 0,CYL 0
;       - Each of the above Operations is followed by
;         a Corresponding READ/CHECK Operation to Verify
;         Disk Addressing Logic.

;       7.5  "F" TESTS CHECK:

;         The Format Logic on CYL 0,HEAD 0,SECTOR 0,
;         A SET BAD SECTOR FLAG given and TESTED.
;         The FORMAT is set to Normal after Completion
;         of these Tests.

;       7.6 "S" TESTS ARE SEEK EXERCISERS

;       - Performs RANDOM SEEKING. Each SEEK is Followed
;         by a Read to Head 0,Sector 0

;       - Performs RANDOM OVERLAPPED SEEKING to TWO DRIVES.
;         Each SEEK is Followed by a Read to Head 0,Sector 0.
;         U1 is the the Primary Unit under Test and U2
;         is the next Drive found in a 1,2,3,0 ETC. Search.
;         If only 1 Drive, Test is Bypassed. Test is only run
;         after a Pass is Achieved on All Drives.
```

; 8.0 OPERATING MODES/SWITCH SETTINGS:

;8.1 SWITCH SETTINGS
;
; Location "SWREG" is used to select the program options. This
; Location will be set according to the answers supplied by
; the Operator. The Options can be changed or verified by
; using one of the commands given in Sec. 8.3.
;
;8.2 SWITCH OPTIONS
; Different bits and their interpretation at location
; "SWREG" is as follows:
;

BIT	OCTAL VALUE	BINARY VALUE	INTERPRETATION
1	40000	0	LOOP on ERROR
	000000	1	SKIP LOOPING on ERROR
2	20000	0	PRINT to CONSOLE
	000000	1	ABORT PRINT OUT to CONSOLE
3	10000	0	DO NOT PRINT % FAILURE
	000000	1	PRINT % FAILURE
5	02000	0	DO NOT PRINT on the LINE PRINTER
	000000	1	PRINT on the BYTE I/O LINE PRINTER(DC17)
6	01000	0	DO NOT HALT on ERROR
	000000	1	HALT on ERROR
7	00400	0	N/A
	000000	1	DISABLE FORMATTING HD 0, CYL 0, SEC 0
8	00200	0	N/A
	000000	1	RECALIBRATE during SCOPE LOOP
9	00100	0	N/A
	000000	1	1 SECOND DELAY during SCOPE LOOP
10(A)	00040	0	N/A
	000000	1	PRINT TEST #'S and FIRMWARE REVISIONS
11(B)	00020	0	N/A
	000000	1	PROGRAM will EXIT to ODT when not in TESTS F1-F3 SWT is Set to 0 upon EXIT
12(C)	00010	0	SKIP LONG RAM TEST
	000000	1	LONG CONTROLLER RAM TEST
16(G)	00000	0	DO NOT PRINT on the DMA LINE PRINTER
	100000	1	PRINT on the DMA LINE PRINTER(DC 17)

;8.3 SWITCH COMMANDS
; Once the Program starts executing the state of any of
; the Bits can be changed by Hitting KEYS 1-9, A-Z. The
; Program will Continue Running after Updating the Options.
; Each Key will Complement the state of the Bit affiliat-
; ed with it, thus Bit 4 can be Altered by Hitting Key 4.
; Setting of any Bit of Location "SWREG" will Set Bit 0.
; (Default Mode is defined as all Bits of SWREG Set to 0)

```
;8.4     OTHER COMMANDS  (^ = CONTROL KEY)
;
;       "CR"    A "RETURN" can be typed to Continue the Program
;               after its locked in a Switch Modification Mode
;
;       ^D      This Command given at any time will reset "SWREG"
;               to Default Mode and Restart the Program.
;
;       ^R      This Command given at any time will Restart the
;               Program. Switches are left with the values they
;               had before the Command was issued.
;
;       ^O      This Command given at any time will cause the
;               Program Control to go to ODT.
;
;       M       This Command given at any time will print the
;               Current Operating Modes.
;
;       0       This Command given at any time will lock the
;               Program into Switch Modification Mode where
;               more than 1 Bit can be changed.
;


; 9.0 OPERATING PROCEEDURE/OPERATOR INPUT:

;       9.1 Load the Program

;       9.2 STARTING ADDRESSES
;               200-To IDENTIFY DISK TYPE (INITIALIZE)
;                   PROGRAM then PROCEEDS to 500.
;               201-ODT DIRECT ENTRY ONLY
;               202-RANDOM SEEK EXERCISERS. (1 PASS of DIAG FIRST)
;                SEEK EXER 1 is a SINGLE DRIVE EXERCISER
;                SEEK EXER 2 is TWO DRIVE EXERCISER with SEEK OVERLAP
;               500-DIAGNOSTIC (RESTART)

;       9.3 The Program Prints"PASS" following each
;          Complete Pass through the Tests. Random
;          Seek Exerciser performs 1000 Seeks
;          per "PASS" Message.

;       9.4 Device Code of Controller is Requested (27 is Default)

;       9.5 Unit Numbers to be Tested are Requested to which the
;           Operator Enters the Unit Numbers to be Tested, Separating
;           the Individual #'s by a <,> or <Space>.

;       9.6 Operator is Requested to Enter 1, if Unit Characteristics
;           Displayed are INCORRECT, and Wants to LOOP on Reading them.
```

```
; 10. PROGRAM OUTPUT/ERROR DESCRIPTION:
;       When an ERROR is Detected the Program Prints the ERROR
;       PC, AC'S 0,1,and 2 at the point of ERROR, the Program then
;       goes into a Scope Loop between the Entries to .SETUP and
;       .LOOP allowing the Operator to Set  SWPAK. In General the
;       ERROR PC will point to a Call ERROR.

;       The Printout will be of one of the following Formats:

;       A. STANDALONE CONTROLLER TEST FAILURES-

;       B. STATUS ERRORS

;       MODE    UNIT    #       DATA
;       CYL     #       HEAD    #       SECTOR  #
;       AC1(STATUS) SHOULD =AC0
;       DESCRIPTIONS of FAILING STATUS BITS

;       C. MEMORY/DISK ADDRESS ERROR

;       MODE    UNIT    #       DATA
;       CYL     #       HEAD    #       SECTOR  #
;       ENDING MEMORY/DISK ADDRESS ERROR
;       AC1(MA/DA) SHOULD =AC0

;       C. INTERRUPT TIMEOUT

;       MODE    UNIT    #       DATA
;       CYL     #       HEAD    #       SECTOR  #
;       INTERRUPT TIMEOUT

;       Additional Test Significance can be found in the Program
;       Listing, although it is hoped that a need for the Listing
;       will be Minimal. SWPACK(SWREG) will provide all Control
;       over Test Loop Options and Printouts.


;       Data Errors will result in the 1st 3 Good/Bad pairs and
;       their Addresses being Printed along with the Total Count.
;       If an ECC Error is Detected, the Call EHECC will
;       Acknowledge the Fact and Return to the Main Test for
;       the Data Compare. Printouts result on the 1st Error Pass
;       only. As the Check Routine Checks the entire Read Buffer,
;       any Error accompanied by an ECC Error,terminating the
;       Read, may cause all Data in succeeding Sectors to appear Bad.

;       Tests that perform a Recalibrate have a 2 SEC. Delay built
;       into the Scope Loop.  Set SWPAK 9 = 1 to Introduce an
;       additional 1 Second Delay during the Scope Loop.

;       In General each successive Test Assumes all Previous Tests
;       work. Bypassing Errors can result in confusing situations
;       in the setup of more Complex Tests.
```

```
; 11. DEBUG HELP:
;
;OCTAL DEBUGGER  (ODT)
;
;       This Diagnostic is equipped with a built in ODT which can be
;       accessed by hitting CONTROL O at any time during the execution
;       of the Program (after Setting the Parameters). On entering ODT
;       the Address of the Location having the next instruction to be
;       executed will be typed-out.
;
;       The following Conventions are used by the ODT:
;       ?       Pressing any Illegal key causes the ODT to respond
;               with a "?".
;       @       ODT is ready and at your service.
;
;       An ODT Command has the following Format:
;               [ARGUMENT][COMMAND]
;       An Argument may be one of the following:
;       "EXP"   An OCTAL Expression consisting of OCTAL Numbers
;               separated by Plus (+) or Minus (-) signs. Leading
;               Zeros need not be typed.
;       "ADR"   An Address is the same as an Expression except
;               that Bit 0 is neglected.
;       A Command is a single teletype character
;
;       The Locations that can be EXAMINED and MODIFIED by the user
;       are called CELLS. These CELLS are of two Types: Internal CPU
;       Cells and Memory Locations. The Command to OPEN one of the
;       Internal Registers is of the form "nA" where n is any OCTAL
;       Expression between 0 and 7.
;
;       0-3     For ACCUMULATORS 0-3
;       4       For PC of the next Instruction to be Executed in the
;               event of a "P" Command.
;       5       CPU and TTO Status
;               BIT     INTERPRETATION
;               15      Status of TTO DONE FLAG
;               14      Status of INTERRUPTS (ION FLAG)
;               13      Status of CARRY BIT
;       6       Address of the Location having the BREAK POINT (If any)
;       7       Instruction at the BREAK POINT Location
;
;       Other Commands to OPEN Cells are:
;
;       "ADR"/  Open the Cell and Print its contents
;       ./      Open the Cell currently pointed to by the Pointer and
;               Print its contents.
;       .+"ADR"/ Add "ADR" to the Pointer, Open the Cell and Print its
;               contents.
;       .-"ADR"/ Subtract "ADR" from the Pointer, Open the Cell and
;               Print its contents.
;       "CR"    The Return Key is used to Close the Open Cell with or
;               without Modification.
;       "LF"    Line Feed is used to Close the Open Cell with or without
;               Modification and to Open the succeeding Cell.
;       CTRL    Close the Open Cell with or without Modification and
;               Open the preceeding Cell.
;       /       Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents.
;       +"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents + "ADDR".
;       -"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents - "ADR".
```

```
;       Modification of a Cell:
;
;       Once a Cell has been opened its contents can be Modified by
;       typing the New Value the Cell is to contain in the form of
;       an OCTAL Expression followed by "CR" or "LF". If a + or - is
;       typed as the first character of the Expression then the Value
;       of the Expression is Added to or Subtracted from the Old
;       contents of the Cell. The Address itself or an Expression
;       relative to the Address can be Deposited by typing a "." or
;       :,+/-OCTAL Expression". A Rubout Command given right after
;       opening a Cell allows the Modification of its contents as if
;       they were typed in just before the Command was issued.
;
;       Other ODT Commands:
;
;       RUBOUT  This Key is used to Delete ERRONEOUSLY typed digits.
;               Each time the Key is pressed the right most digit is
;               Deleted and Echoed on the Terminal. If the Rubout
;               Key is pressed right after opening a Cell then it
;               Deletes the right most digit of the Cells contents.
;               This allows the Modification of the Cell as if its
;               contents were typed in just before the Key was pressed.
;       "ADR"B  Insert a BREAK POINT at Location "ADR".
;               Only one Break Point can be inserted and any entry to
;               ODT after Executing a Break Point will cause it to be
;               Deleted.
;       D       Delete the Break Point if any.
;       P       Restart the Execution of the program at CURRENT Location
;       "ADR"R  Start Executing the program at "ADR" after an IORST.
;       K       Kill the String typed so far. The ODT responds with a
;               "?" and the Open Cell is closed without Modification.
;       =       Print the OCTAL Value of the INPUT only.
;               This will Close any Open Cells without  Modification and
;               will not Open a Cell
;
;       NOTE:   In Programs which RELOCATE THEMSELVES the
;               user should place Break Points ONLY in the
;               ORIGINAL PROGRAM AREA. If a Break Point is
;               placed outside this area the results will
;               be unpredictable.
```

```
;
; 12. SPECIAL NOTES/SPECIAL FEATURES:
;
;       12.1 If the Disk Pack has BAD SECTOR FLAGS Set on Cylinder
;       0, or on the First 8 Sectors of Head 0 of any Cylinder,
;       Error Printouts will result when the Flags are Encountered.
;
;       12.2  Tests F1-F3 alter the Format on CYL 0,HD 0,SEC 0 for
;       purpases of Checking the FORMAT Logic and BAD SECTOR Logic.
;       SWPAK7 should be Set to 1 in order to stop Program from
;       executing the Format.
;
;       12.3  Some Scope Loops will require a Recalibrate to
;       Initialize the Disk Drive following a failure. Set
;       SWPAK 8 = 1 to Introduce the Recalibrate to the Unit
;       under Test.
;
;       12.4  DISK PACKS
;       Only use Disk Packs Formatted by the DISKF Pack Formatter
;       Program. The Diagnostic Program will Write over most of
;       the Disk Surface.
;
; 13. RUN TIME:
;       The Run Time for a PASS is approximately: 3 MIN.
```

```
;
;
;*****************************************************************
;-----------------------------------------------------------------
;
; DESCRIPTION: ZETACO DISK CONTROLLER FORMATTER PROGRAM
;
;
; Product of ZETACO, 1986
;*****************************************************************
 -------;TITL   DISKF-----------------------------------------------
        .DUSR   X=1
        .NOMAC  X
;1.0    PROGRAM NAME:   DISKF.SR

;2.0    REVISION HISTORY:
;
;       REV.        DATE
;        00      02/09/83        ;
;
;        01      08/23/83        ;ADUB FOR ALT1 (STTD), AOS BSTRAP
;                                ;(400'S)
;        02      03/28/84        ;DISK PULSE COUNTER, ERROR LOGS,
;                                ;200. ERRORS, MSB FOR BAD SECTOR
;                                ;LOG, DEVICE CODE CHANGE ROUTINE
;        03      05/30/84        ;ECC ON WRITE, ZDF1
;
;        04      08/21/85        ;DISABLE VIRTUAL, UP TO 2048. CYLS
;
;        05      11/20/86        ;297, 40 HDS, DMA PTR, WELLEX,
;                                ;IORST

;3.0    MACHINE REQUIREMENTS:

;       NOVA/ECLIPSE/MV FAMILY CENTRAL PROCESSOR
;       16K READ/WRITE MEMORY
;       ZETACO DISK CONTROLLER (ZEBRA TYPE)
;       0-3 DISK DRIVES
;       TELETYPE or CRT and CONTROL

;4.0    TEST REQUIREMENTS:      N/A

;5.0    SUMMARY:

;       The ZETACO DISK CONTROLLER FORMATTER PROGRAM
;       is designed to FORMAT and CHECK DISK PACKS and
;       MEDIA to be used in DISK SYSTEMS. The PROGRAM is
;       !NOT! A MAINTENANCE PROGRAM and ASSUMES the HARDWARE
;       to be in WORKING ORDER. The PROGRAM will HALT on
;       any NON-DATA related ERRORS. It is also recommended
;       that ON-BOARD ECC be SOFTWARE or CONFIGURED DISABLED
;       when FORMATTING. The Device Code may be 20-76 OCTAL
;       with the Default being 27.

;6.0    RESTRICTIONS:
;       This Program has no Restrictions as to Single or
;       Dual Processor Hardware Configuration. However, the
;       Formatter may be run on ONLY ONE CPU at a time and
;       must be the only Program being run within the Disk
;       System.
```

```
;7.0     PROGRAM DESCRIPTION/THEORY OF OPERATION:

;       A. FORMATTER PROGRAM (STARTING ADDRESS <SA> 500)
;       The disk is first formatted after which a "FORMAT DONE"
;       message is printed. Then a 055555 pattern is written to
;       the entire pack and read back 2 times, A random seek
;       test is performed, and "PASS" is printed. The data pattern
;       is then rotated 1 bit and the WRITE/READ/READ/SEEK process
;       is repeated. At the completion of the number of passes
;       entered by the operator, A log is available to be printed
;       and the drives are released.
;*************************************************************
;-------It is Recommended that at LEAST 3 PASSES (W/R/R/S);with
;       On-Board ECC DISABLED, be allowed to insure Pack Quality.
;       If time permits, longer runs will further insure
;       Reliability.
;*************************************************************
;-------Any HARD DATA or ADDRESS ERRORS will result in the BAD
;       SECTOR FLAG being set in that sector. Any "SOFT DATA" or
;       "ADDRESS ERROR" ADDRESS encountered TWICE cause the BAD
;       SECTOR FLAG to be set. Any other error will cause the
;       program to print the failure and halt.

;       A HARD ADDRESS ERROR is defined as such after 2 ATTEMPTS
;       have been made BOTH resulting in an ADDRESS ERROR. A HARD
;       DATA ERROR is defined as such after 2 or MORE of 10
;       WRITE/READ RETRY'S have been unsuccessful.

;       B. CHECK PROGRAM ONLY (SA 501)
;       Same as SA 500 except that initial pack format operation is
;       bypassed.

;       C. STATISTICS
;       Type L for 1ST 200. disk addresses of BAD SECTORS, DATA and
;       ADDRESS ERRORS, plus a statistic table of overall errors.
;       **NOTE** Any character typed while executing this log will
;       end it at the next change of data type.

;       D. LOG RECOVERY (SA 502)
;       Use to recover log of program after it has stopped to get a
;       LOG PRINTOUT.

;       E. COMMAND STRING INTERPRETER (SA 503)
;       As a trouble shooting aid the service engineer may type in
;       their own TEST LOOP. After starting at 503, three ARGUMENTS
;       must be entered in response to three program questions;
;       "UNIT", "DATA", and "COMMAND STRING". All numbers must be
;       entered in OCTAL.

;       I.      UNIT:   Type unit # or carriage return
;                       to use the previous entry

;       II.     DATA:   RAN=RANDOM
;                       ALO=ALL ONES
;                       ALZ=ALL ZEROS
;                       PAT=110110 PATTERN
;                       FLO=FLOATING ONE PATTERN
;                       FLZ=FLOATING ZERO PATTERN
;                       ADR=ALTERNATING CYLINDER and
;                       HEAD,SECTOR WORDS
;                       VAR=Existing words entered previously as
;                       described below

;                       Alternatively enter a string of up to 7
```

```
;                   The words entered are used repeatedly
;                   to make up a sector block. Type carriage
;                   return to use the previous entry.

;       III.    COMMAND STRING:

;       OPTIONS 1.      READ HEAD,SECTOR,#SECTORS
;               2.      WRITE SAME
;               3.      SEEK CYLINDER
;               4.      RECALIBRATE
;               5.      LOOP (go to beginning or LR)
;               6.      DELAY N (N=DELAY in MS)
;               7.      TRESPASS
;               8.      RELEASE
;               9.      OFF (OFFSET FORWARD)
;               10.     OFR (OFFSET REVERSE)
;               11.     LR  (begin LOOP here)
;               12.     VERIFY (WRITE)
;               13.     FORMAT CYL,HD,SECTOR
;               14.     BAD (BAD SECTOR) CYL,HD,SECTOR
;               15.     MEMORY ADDR,DATA(WRITE) (CONTROLLER MEMORY COMMAND)
;               16.     Type Carriage Return to use the
;                       previous COMMAND STRING.

;               Note that either SPACES or a COMMA
;               may be used as an argument delimiter.
;               Each response is terminated by
;               typing carriage return.  If more
;               room is needed on a line, type line
;               feed to space to the next line. The
;               word "SAME" used with READ, or WRITE,
;               will cause the previous disk address
;               parameters to be used.

;       An R typed while a string is being executed will
;       cause the program to return to command string start.
;       The ESCAPE KEY will bypass UNIT and DATA prompts to
;       the command string prompt.

;       The following example would cause UNIT
;       1 to SEEK CYLINDER 50, then repeatedly
;       WRITE SECTORS 2 and 3 of HEAD 5, then
;       READ it back and CHECK.  Data is specified
;       as ALTERNATE WORDS of ZEROS then ONES.

;       UNIT: 1
;       DATA: 0,177777
;       COMMAND STRING: SEEK 50 LR WRITE 5,2,2 READ SAME LOOP

;       The following example would WRITE 0 to
;       CONTROLLER MEMORY location 1500 (OCTAL)

;       UNIT:   1
;       DATA:   N/A
;       COMMAND STRING: MEMORY 101500,0
;       NOTE: Upper memory bit = 1 defines a WRITE
```

```
;8.0  OPERATING MODES/SWITCH SETTINGS:

;8.1     SWITCH SETTINGS
;
;        Location "SWREG" is used to select the program options.
;        This Location will be set according to the answers
;        supplied by the Operator. The Options can be changed
;        or verified by using one of the commands given in Sec.
;        8.3
;
;8.2     SWITCH OPTIONS
;        Different bits and their interpretation at location
;        "SWREG" is as follows:
;
;        BIT      OCTAL    BINARY   INTERPRETATION
;                 VALUE    VALUE
;
;        1         40000     0       LOOP on ERROR
;                 000000     1       SKIP LOOPING on ERROR
;
;        2         20000     0       PRINT to CONSOLE
;                 000000     1       ABORT PRINT OUT to CONSOLE
;
;        5         02000     0       DO NOT PRINT on the LINE PRINTER
;                 000000     1       PRINT on the BYTE I/O LINE PRINTER(DC17)
;
;        11(B)     00020     0       N/A
;                 000000     1       ENABLE BAD SECTOR PRINTOUT
;
;        16(G)     00000     0       DO NOT PRINT on DMA LINE PRINTER
;                 100000     1       PRINT on DMA LINE PRINTER(DC17)
;
;8.3     SWITCH COMMANDS
;        Once the Program starts executing the state of any of
;        the Bits can be changed by Hitting KEYS 1-9, A-Z. The
;        Program will Continue Running after Updating the Options.
;        Each Key will Complement the state of the Bit affiliat-
;        ed with it, thus Bit 4 can be Altered by Hitting Key 4.
;        Setting of any Bit of Location "SWREG" will Set Bit 0.
;        (Default Mode is defined as all Bits of SWREG Set to 0)
;
;8.4     OTHER COMMANDS  (° = CONTROL KEY)
;
;        "CR"     A "RETURN" can be typed to Continue the Program
;                 after its locked in a Switch Modification Mode
;
;        °D       This Command given at any time will reset "SWREG"
;                 to Default Mode and Restart the Program.
;
;        °R       This Command given at any time will Restart the
;                 Program. Switches are left with the values they
;                 had before the Command was issued.
;
;        °O       This Command given at any time will cause the
;                 Program Control to go to ODT.
;
;        M        This Command given at any time will print the
;                 Current Operating Modes.
;
;        0        This Command given at any time will lock the
;                 Program into Switch Modification Mode where
;                 more than 1 Bit can be changed.
;
```

```
;9.0    OPERATING PROCEEDURE/OPERATOR INPUT:

;       A. Verify drive (s) are ready on-line
;       B. Load Program
;       C. To RUN other than TEST 500, Enter CONTROL "0"
;          at 9.2, Enter STARTING ADDRESS followed by an "R"

;       STARTING ADDRESS (SA)
;       200     Read Unit Characteristics and then Run FORMATTER (500)
;       500     FORMATTER/CHECK PROGRAM
;       501     CHECK PROGRAM ONLY
;       502     ERROR LOG RECOVERY
;       503     COMMAND STRING INTERPRETER

;9.1    Operator is requested to enter DEVICE CODE of CONTROLLER
;       (DEFAULT 27)
;9.2    Operator is requested to SET SWPAK followed by a Carriage
;       Return (SEE 8.3)
;9.3    MONTH, DAY, YEAR (I.E. 77...), HOUR, & MIN (If [CR] is
;       given this routine is bypassed)
;9.4    Enter # of Passes for Test Completion (If [CR] is given
;       this routine is bypassed)
;9.5    Operator is requested to enter YES/NO to CONTROLLER CORRECTION,
;       if it is enabled
;9.6    Unit Numbers, Types, and their Characteristics are then
;       Displayed, (The Operator should Verify these values) Operator
;       is then requested to enter UNIT NUMBERS to be tested(0-3)
;9.7    Operator is then requested to enter TYPE of disk ( to create a
;       User Defined enter 10)
;       A.      If TYPE entered is 10, enter 0, 1, 2, or 3 to
;               RE-DEFINE a disk TYPE
;       B.      # of HEADS for NEW TYPE (in DECIMAL)
;       C.      # of CYLINDERS for NEW TYPE (in DECIMAL)
;       D.      # of SECTORS for NEW TYPE (in DECIMAL, CANNOT be
;               DOWNSIZED)
;       E.      Return to 9.7

;       OPERATOR INPUT CONTROLLED PRINTOUTS ARE AS FOLLOWS:
;
;       L       = First 200. BAD SECTORS, DATA, or ADDRESSES
```

;10.0 PROGRAM OUTPUT/ERROR DESCRIPTION:

; 1. ERRORS- Error status is printed whenever encountered.
; When Data Errors are found ONLY THREE are printed per
; encounter. (see paragraph 10.3)

; 2. If Errors are encountered more than once, a count
; will be recorded and a BAD SECTOR FLAG SET. All address
; information will be printed in OCTAL.

; 3. ERROR REPORTING AND RECOVERY

; All Errors are identified, and the program is routed
; via base to a call to CKSW. with the exception of
; ADDRESS and DATA ERRORS. The program will then loop
; for operator intervention, on the basis of SWPAK (see 8.)

; RECALIBRATE - Any unusual Status is reported immediately
; and an Error return executed.

; SEEK - Positioner Fault Status results in Status Printout
; and Error return.

; WRITE - Following "DONE" on a WRITE, Errors are checked
; in the sequence shown below. Error recovery procedure
; is outlined for each case. If the Error is not present
; the next check is made.

; DRIVE STATUS (DIB) is checked 1st for both Read and Write
; before any DIA checks are made.

; 4. READ/WRITE TIMEOUTS, DATA LATE, ILLEGAL SECTOR,
; ECC(DATA OK), or any DRIVE FAULT- Print the illegal Status
; and do an Error return.

; 5. ADDRESS ERROR- Repeat the Write, If Test passes the
; second time, do a Normal return; Otherwise flag as Hard, Set
; the BAD SECTOR FLAG for that Sector and do an Error return.

; If a HARD Cylinder Address Error occurs, a Read on an
; adjacent Head will be attempted to determine whether the
; Fault should be classed as a Seek Error or an Address
; Error. The First 30. Hard Address Errors will have their
; Addresses Logged.

; 6. ENDING MEMORY ADDRESS -Print the Error Message,
; Check for a DISK ADDRESS and do an Error return.

; 7. ENDING DISK ADDRESS -Print the Error Message and
; do an Error return.

; READ - All Read Errors with the exception of Data related
; Errors are handled the same as described for the Write
; operations.

; DATA ERRORS - Data is reread 9 times. If Data is BAD on
; 2 or more of 10 tries, a HARD Error Count is incremented,
; the BAD SECTOR FLAG is set in that Sector, and an Error
; return is taken. If Data is good on all retries, the
; Error is considered SOFT and a normal return is taken.

; The 1st 200. Data Errors (HARD or SOFT) are Logged.

```
;11.0   DEBUG HELP:
;
;OCTAL DEBUGGER  (ODT)
;
;       This Formatter is equipped with a built in ODT which can be
;       accessed by hitting CONTROL O at any time during the execution
;       of the Program (after Setting the Parameters). On entering ODT
;       the Address of the Location having the next instruction to be
;       executed will be typed-out.
;
;       The following Conventions are used by the ODT:
;       ?       Pressing any Illegal key causes the ODT to respond
;               with a "?".
;       @       ODT is ready and at your service.
;
;       An ODT Command has the following Format:
;               [ARGUMENT][COMMAND]
;       An Argument may be one of the following:
;       "EXP"   An OCTAL Expression consisting of OCTAL Numbers
;               separated by Plus (+) or Minus (-) signs. Leading
;               Zeros need not be typed.
;       "ADR"   An Address is the same as an Expression except
;               that Bit 0 is neglected.
;       A Command is a single teletype character
;
;       The Locations that can be EXAMINED and MODIFIED by the user
;       are called CELLS. These CELLS are of two Types: Internal CPU
;       Cells and Memory Locations. The Command to OPEN one of the
;       Internal Registers is of the form "nA" where n is any OCTAL
;       Expression between 0 and 7.
;
;       0-3     For ACCUMULATORS 0-3
;       4       For PC of the next Instruction to be Executed in the
;               event of a "P" Command.
;       5       CPU and TTO Status
;               BIT     INTERPRETATION
;               15      Status of TTO DONE FLAG
;               14      Status of INTERRUPTS (ION FLAG)
;               13      Status of CARRY BIT
;       6       Address of the Location having the BREAK POINT (If any)
;       7       Instruction at the BREAK POINT Location
;
;       Other Commands to OPEN Cells are:
;
;       "ADR"/  Open the Cell and Print its contents
;       ./      Open the Cell currently pointed to by the Pointer and
;               Print its contents.
;       .+"ADR"/ Add "ADR" to the Pointer, Open the Cell and Print its
;               contents.
;       .-"ADR"/ Subtract "ADR" from the Pointer, Open the Cell and
;               Print its contents.
;       "CR"    The Return Key is used to Close the Open Cell with or
;               without Modification.
;       "LF"    Line Feed is used to Close the Open Cell with or without
;               Modification and to Open the succeeding Cell.
;       CTRL    Close the Open Cell with or without Modification and
;               Open the preceeding Cell.
;       /       Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents.
;       +"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents + "ADDR".
;       -"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents - "ADR".
```

```
;       Modification of a Cell:
;
;       Once a Cell has been opened its contents can be Modified by
;       typing the New Value the Cell is to contain in the form of
;       an OCTAL Expression followed by "CR" or "LF". If a + or - is
;       typed as the first character of the Expression then the Value
;       of the Expression is Added to or Subtracted from the Old
;       contents of the Cell. The Address itself or an Expression
;       relative to the Address can be Deposited by typing a "." or
;       :,+/-OCTAL Expression". A Rubout Command given right after
;       opening a Cell allows the Modification of its contents as if
;       they were typed in just before the Command was issued.
;
;       Other ODT Commands:
;
;       RUBOUT  This Key is used to Delete ERRONEOUSLY typed digits.
;               Each time the Key is pressed the right most digit is
;               Deleted and Echoed on the Terminal. If the Rubout
;               Key is pressed right after opening a Cell then it
;               Deletes the right most digit of the Cells contents.
;               This allows the Modification of the Cell as if its
;               contents were typed in just before the Key was pressed.
;       "ADR"B  Insert a BREAK POINT at Location "ADR".
;               Only one Break Point can be Inserted and any entry to
;               ODT after Executing a Break Point will cause it to be
;               Deleted.
;       D       Delete the Break Point if any.
;       P       Restart the Execution of the program at CURRENT Location
;       "ADR"R  Start Executing the program at "ADR" after an IORST.
;       K       Kill the String typed so far. The ODT responds with a
;               "?" and the Open Cell is closed without Modification.
;       =       Print the OCTAL Value of the INPUT only.
;               This will Close any Open Cells without  Modification and
;               will not Open a Cell
;
;       NOTE:   In Programs which RELOCATE THEMSELVES the
;               user should place Break Points ONLY in the
;               ORIGINAL PROGRAM AREA. If a Break Point is
;               placed outside this area the results will
;               be unpredictable.
;
;
;12.0   SPECIAL NOTES/SPECIAL FEATURES:

;       1. The Program is !NOT! a Maintenance Program and assumes
;       the HARDWARE to be in working order. The Program will
;       HALT on any NON-DATA related Errors.

;       2. It is recommended that at Least 3 Passes (W/R/R/S) be
;       allowed (see below) to insure pack quality. If time
;       permits, longer runs will further insure quality.

;13.1   PROGRAM RUNTIME:

;       Program runtimes are substantially reduced with memories
;       of 24K or larger. Runtimes are also dependant on CPU
;       Type, Drive Size and Drive Type.

        .EOT
```

```
;
;
;*****************************************************************
;-----------------------------------------------------------------
;
; DESCRIPTION: ZETACO DISK CONTROLLER RELIABILITY PROGRAM
;
;
; Product of ZETACO, 1986
;*****************************************************************
 -------;TITL   DISKR-----------------------------------------------
        .DUSR   X=1
        .NOMAC  X
;1.0    PROGRAM NAME:   DISKR.SR

;2.0    REVISION HISTORY:
;
;       REV.      DATE
;        00      02/09/83                ;
;        01      09/07/83                ;S120 # SKP TOGETHER, STACK AND
;                                        ;AOS BOOTSTRAP AT 400, NO VERIFY
;                                        ;W/RANDOM DATA TEST 502 SWT 10
;        02      03/28/84                ;ADD RELEASE COMMAND TO RC
;                                        ;FOR DUAL PORT, DAISY CHAIN
;                                        ;DISK SECTOR PULSE COUNTER
;                                        ;DEVICE CODE CHANGE ROUTINE
;                                        ;502 PAT 24 SECTOR
;        03      05/30/84                ;ZDF1,
;
;        04      08/21/85                ;DISABLE VIRTUAL, UP TO 2048.
;                                        ;CYLS, 40 HDS
;
;        05      11/20/86                ;MULTI DC 500 & 505, DMA PTR
;                                        ;MAJOR

;3.0    MACHINE REQUIREMENTS:

;       NOVA/ECLIPSE/MV FAMILY CENTRAL PROCESSOR
;       16K READ/WRITE MEMORY
;       ZETACO DISK CONTROLLER (ZEBRA TYPE)
;       0-3 DISK DRIVES
;       TELETYPE or CRT and CONTROL

;4.0    TEST REQUIREMENTS:      N/A

;5.0    SUMMARY:

;       The ZETACO DISK CONTROLLER RELIABILITY PROGRAM is a
;       MAINTENANCE PROGRAM designed to EXERCISE and TEST the
;       ZETACO SMD DISK SUB-SYSTEMS and 1-4 DISK DRIVES. The
;       DISK DRIVES may be shared between TWO Computers.

;       The Device Code may be 20-76 OCTAL with the Default
;       being 27.
```

```
;       1. The DISK DRIVES may be shared between TWO Computers in
;       which case the following Programs may be running in each
;       Computer:

;       STARTING ADRESSES'S (SA) 500,501 RANDOM RELIABILITY
;       SA 503 COMMAND STRING (If a RELEASE Command is included
;       in the Command String)

;       If no Drives are to be Shared, there are no other
;       Restrictions as to the running of these Programs on a
;       Dual Processor System.

;       2. Any Combination of Drives may be Tested by this Program
;       at a single time.


;7.0    PROGRAM DESCRIPTION/THEORY OF OPERATION:

;       A. RELIABILITY TEST (SA 500)

;       A Random Number Generator is used to select a Disk Drive,
;       Cylinder,Head,Beginning Sector, and Number of consecutive
;       Sectors. Random Data is then Generated, Written, and Read.
;       The Sequence is repeated indefinately. If running Multiple
;       Units, Over Lapped SEEKS are employed, If the next Random
;       Unit is different from the current Unit under I/O Execution.

;       B. RELIABILITY TEST (SA 501) with OPTIONS

;       Same as A, Except that Operator is given Options on Data
;       Patterns and may choose a Constant Cylinder,Head,Sector
;       or # or Sectors. Any Letter response to CYL,HEAD ETC.
;       gets Random function for that Variable. A Carriage Return
;       only gets the Random function for all Variables.

;       The Operator is also asked to respond to JITTER OPTION
;       (YES/NO). If YES, a Random Delay(0-40,50MS) is inserted
;       into the Background Loop to create a more asynchronous
;       Disk I/O Loop.

;       C. INCREMENTAL DISK ADDRESS TEST (SA 502)

;       Operator is given Option on Data; Requested Data is first
;       Written (SEE SWPAK10) over the entire Pack. Then the Data
;       is Read from all Sectors . This insures that all Disk
;       Blocks are useable and are Formatted properly. The Test
;       is then repeated for all Ready Disks, and PASS is Printed.
;       The sequence is repeated indefinitely.

;       #NOTE
;       SWPAK8=1, puts Program into Read ONLY Mode ## SA'S 501,502 ONLY.
;       If SA 501-Data must !NOT! be Random.

;       All Numbers entered above must be in Octal. Any Non-Octal
;       input is treated as a letter. Any letter input for CYL,Head,
;       Sector, or # of Sectors gets Random function in the Reliability
;       Test with Options.
```

```
;       D. COMMAND STRING INTERPRETER (SA 503)
;       As a trouble shooting aid the service engineer may type in
;       their own TEST LOOP. After starting at 503, three ARGUMENTS
;       must be entered in response to three program questions;
;       "UNIT", "DATA", and "COMMAND STRING". All numbers must be
;       entered in OCTAL.

;       I.      UNIT:   Type unit # or carriage return
;                       to use the previous entry

;       II.     DATA:   RAN=RANDOM
;                       ALO=ALL ONES
;                       ALZ=ALL ZEROS
;                       PAT=155555 PATTERN
;                       ROT=155555 PATTERN Rotated on
;                       Successive Passes.
;                       FLO=FLOATING ONE PATTERN
;                       FLZ=FLOATING ZERO PATTERN
;                       ADR=ALTERNATING CYLINDER and
;                       HEAD,SECTOR WORDS
;                       VAR=Existing words entered previously as
;                       described below

;                       Alternatively enter a string of up to 7
;                       OCTAL 16 bit words to be used as DATA.
;                       The words entered are used repeatedly
;                       to make up a sector block. Type carriage
;                       return to use the previous entry.

;       III.    COMMAND STRING:

;       OPTIONS 1.      READ HEAD,SECTOR,#SECTORS
;               2.      WRITE SAME
;               3.      SEEK CYLINDER
;               4.      RECALIBRATE
;               5.      LOOP (go to beginning or LR)
;               6.      DELAY N (N=DELAY in MS)
;               7.      TRESPASS
;               8.      RELEASE
;               9.      OFF (OFFSET FORWARD)
;               10.     OFR (OFFSET REVERSE)
;               11.     LR  (begin LOOP here)
;               12.     VERIFY (WRITE)
;               13.     FORMAT CYL,HD,SECTOR
;               14.     MEMORY ADDR,DATA(WRITE) (CONTROLLER MEMORY COMMAND)
;               15.     Type Carriage Return to use the
;                       previous COMMAND STRING.

;               Note that either SPACES or a COMMA
;               may be used as an argument delimiter.
;               Each response is terminated by
;               typing carriage return.  If more
;               room is needed on a line, type line
;               feed to space to the next line. The
;               word "SAME" used with READ, or WRITE,
;               will cause the previous disk address
;               parameters to be used.

;       An R typed while a string is being executed will
;       cause the program to return to command string start.
;       The ESCAPE KEY will bypass UNIT and DATA prompts to
;       the command string prompt.

;       The following example would cause UNIT
```

; WRITE SECTORS 2 and 3 of HEAD 5, then
; READ it back and CHECK. Data is specified
; as ALTERNATE WORDS of ZEROS then ONES.

; UNIT: 1
; DATA: 0,177777
; COMMAND STRING: SEEK 50 LR WRITE 5,2,2 READ SAME LOOP

; The following example would WRITE 0 to
; CONTROLLER MEMORY location 1500 (OCTAL)

; UNIT: 1
; DATA: N/A
; COMMAND STRING: MEMORY 101500,0
; NOTE: Upper memory bit = 1 defines a WRITE
;
; E. QUICKIE FORMATTER (SA 504)
; Formats Pack and HALTS. There is NO Verify, NO Flags are
; Set, and NO Error Checking.

; F. RUNALL (SA 505)
; Program alternates between the Programs described in 7.B
; (4 Data Patterns -PAT,RAN,FLZ,FLO) and 7.C(6 Data Patterns
; -PAT,RAN,RAN-2,ZEROES,ONES,ALT) and 7.H, and in that order.

; G. SEEK EXERCISER (SA 506)
; Program provides a SEEK scan sequence converging from the
; extreme Outermost Tracks into the adjacent track in the
; center, then diverging again to the extremes.

; H. RANDOM SEEK EXERCISER (SA 507)
; Program provides a Random SEEK sequence

; ###G,H all SEEKS in G/H are followed by a 1 Sector Read but
; with no Data Check. All SEEKS are timed with MAX,MIN, and
; AVE. times being Logged in MS. SEEK Paths for MAX,MIN Values
; are also Logged.

; I. ERROR COUNT/LOG RECOVERY (SA 510)
; In the event a Program was stopped during a run, the Error
; Logs may be recovered at this Starting Address.
; ***MUST be done before any Program RESTART as Program
; Initialization Zeroes all Logs.
;

;
;
;8.0 OPERATING MODES/SWITCH SETTINGS:

;8.1 SWITCH SETTINGS
;
; Location "SWREG" is used to select the program options.
; This Location will be set according to the answers
; supplied by the Operator. The Options can be changed
; or verified by using one of the commands given in Sec.
; 8.3
;
;
;8.2 SWITCH OPTIONS
; Different bits and their interpretation at location
; "SWREG" is as follows:
;
; BIT   OCTAL   BINARY INTERPRETATION
;   VALUE   VALUE

```
;       1         40000  0       LOOP on ERROR
;                 000000 1       SKIP LOOPING on ERROR
;
;       2         20000  0       PRINT to CONSOLE
;                 000000 1       ABORT PRINT OUT to CONSOLE
;
;       4         04000  0       PRINT PASS
;                 000000 1       DO NOT PRINT PASS
;
;       5         02000  0       DO NOT PRINT on the LINE PRINTER
;                 000000 1       PRINT on the BYTE I/O LINE PRINTER(DC17)
;
;       6         01000  0       DO NOT EXIT to ODT on ERROR
;                 000000 1       EXIT to ODT on ERROR
;
;       7         00400  0       NOT USED
;                 000000 1

;       8         00200  0       N/A
;                 000000 1       For READ ONLY MODE (SA 501,502)
;
;       9         00100  0       N/A
;                 000000 1       BYPASS DATA CHECK
;
;       10(A)     00040  0       N/A
;                 000000 1       DO VERIFY After WRITE (SA 502 ONLY and
;                                NOT RANDOM DATA)
;
;       11(B)     00020  0       N/A
;                 000000 1       ENABLE BAD SECTOR PRINTOUTS

;       12(C)     00010  0       N/A
;                 000000 1       HALT on DRIVE ERROR prior to
;                                Recovery RECALIBRATE Operation
;
;       13(D)     00004  0       NO TRACE
;                 000000 1       TRACE PRINTOUT on ERROR
;
;       16(G)     00000  0       Do NOT PRINT on the DMA LINE PRINTER
;                 100000 1       PRINT on the DMA LINE PRINTER(DC17)
;


;
;8.3    SWITCH COMMANDS
;       Once the Program starts executing the state of any of
;       the Bits can be changed by Hitting KEYS 1-9, A-Z. The
;       Program will Continue Running after Updating the Options.
;       Each Key will Complement the state of the Bit affiliat-
;       ed with it, thus Bit 4 can be Altered by Hitting Key 4.
;       Setting of any Bit of Location "SWREG" will Set Bit 0.
;       (Default Mode is defined as all Bits of SWREG Set to 0)
;
;
;8.4    OTHER COMMANDS  (^ = CONTROL KEY)
;
;       "CR"    A "RETURN" can be typed to Continue the Program
;               after its locked in a Switch Modification Mode
;
;       ^D      This Command given at any time will reset "SWREG"
;               to Default Mode and Restart the Program.
;
;       ^R      This Command given at any time will Restart the
;               Program. Switches are left with the values they
;               had before the Command was issued.
```

```
;       ^O      This Command given at any time will cause the
;               Program Control to go to ODT.
;
;       M       This Command given at any time will print the
;               Current Operating Modes.
;
;       O       This Command given at any time will lock the
;               Program into Switch Modification Mode where
;               more than 1 Bit can be changed.
;
;9.0    OPERATING PROCEEDURE/OPERATOR INPUT:

;       A. Verify drive (s) are ready on-line
;       B. Load Program
;       C. To RUN other than TEST 505, Enter CONTROL "O"
;          at 9.2, Enter STARTING ADDRESS followed by an "R"

;       STARTING ADDRESS
;       200     Read Unit Characteristics and then RUN ALL TEST (505)
;       500     RELIABILITY TEST, ALL CYLINDERS
;       501     RELIABILITY TEST, (OPTIONS)
;       502     INCREMENTAL DISK ADDRESS TEST
;       503     COMMAND STRING INTERPRETER
;       504     QUICKIE FORMATTER
;       505     RUN ALL
;       506     SEEK EXERCISER (CONVERGING,DIVERGING PATTERN)
;       507     SEEK EXERCISER (RANDOM PATTERN)
;       510     ERROR COUNT/LOG RECOVERY
;       511     MULTIPLE DEVICE CODE ENTRY

;9.1    Operator is requested to enter DEVICE CODE of CONTROLLER
;       (DEFAULT 27).
;9.2    STARTING ADDRESS is Displayed and Operator is requested to
;       SET SWPAK followed by a Carriage Return (SEE 8.3).
;9.3    Operator is requested to enter YES/NO to Exercise Maps, If
;       present and supported.
;9.4    MONTH, DAY, YEAR (I.E. 77...), HOUR, & MINUTE (If [CR] is
;       given this routine is bypassed).
;9.5    Operator is requested to enter YES/NO if any DUAL VOLUME
;       DRIVES (CMD'S).
;9.6    Operator is requested to enter YES/NO to CONTROLLER CORRECTION,
;       if it is enabled.
;9.7    Unit Numbers, Types, and their Characteristics are then
;       Displayed, (The Operator should Verify these values) Operator
;       is then requested to enter UNIT NUMBERS to be tested (0-3).
;9.8    Operator is then requested to enter TYPE of disk ( to create a
;       User Defined enter 10)
;       A.      If TYPE entered is 10, enter 0, 1, 2, or 3 to
;               RE-DEFINE a disk TYPE
;       B.      # of HEADS for NEW TYPE (in DECIMAL)
;       C.      # of CYLINDERS for NEW TYPE (in DECIMAL)
;       D.      # of SECTORS for NEW TYPE (in DECIMAL, CANNOT be
;               DOWNSIZED)
;       E.      RETURN to 9.7

;       ## A [CR] only response to Unit Numbers, will leave Unit
;       information in previous state.

;       ## A [CR] only response to YES/NO will DEFAULT to NO.
;

;       OPERATOR INPUT CONTROLLED PRINTOUTS ARE AS FOLLOWS:

;       L       = FIRST 100. BAD SECTORS, DATA, or ADDRESSES
```

```
;       W       = SECTORS W/R, ERROR COUNTS, and on BOARD ECC and
;                 OFFSET CORRECTS
;       **NOTE** Any Character typed will end Printouts at the next
;       change of Data Type.


;10.0   PROGRAM OUTPUT/ERROR DESCRIPTION:


;       All Errors are Identified, Counted, and the Program is
;       routed via base to a call to CKSW. on the basis of Switch
;       Settings (SEE 8.2) The Program will go into a scope loop,
;       or proceed, depending on the SWPAK Settings.

;       Upon loss of Ready and a Single Drive, the Program will
;       print the appropriate Error Message and will not proceed
;       until Ready is returned. If Multiple Drives exist, The
;       Program will continue with the remaining Drives. If the
;       down Drive is placed back On-line, the Program will resume
;       Testing of that Drive. The above also applies to the loss
;       of Write enable if the Program is in a Write Mode.

;       RECALIBRATE - Any unusual Status is reported immediately
;       and an Error Return executed.

;10.1   SEEK - Positioner Fault Status increments Seek Error
;       Counter.  Any Error Status  results in Status Printout and
;       Error Return. A Recalibrate will be performed by the Error
;       Handler. Program will Log the first 20. Cylinders TO/FROM
;       on finding Seek Errors.

;10.2   WRITE - Following "DONE" on a Write, Errors are checked in
;       the sequence shown below. Error recovery proceedure is
;       outlined for each case. If the Error is not present the
;       next Check is made.

;       Drive Status (DIB) is Checked 1st for both Read and Write
;       before any DIA Checks are made.
;
;       1. READ/WRITE TIMEOUTS, DATA LATE, ILLEGAL SECTOR, PARITY,
;       DATA VERIFY; or any DRIVE FAULTS- Increment the appropriate
;       Error Count, Print the Illegal Status and do an Error Return.
;       Any Drive Fault will cause a Recalibrate to be performed by
;       the Error Handler.

;       2. ADDRESS ERROR- Repeat the Write, if Test Passes the
;       second time, increment the Soft Address Error Count and do
;       a Normal Return; otherwise increment the Hard Address Error
;       count and do an Error Return.

;       If a Hard Cylinder Address Error occurs, a Read on an
;       adjacent Head will be attempted to determine whether the
;       Fault should be classed as a Seek Error or an Address Error.
;       The First 20. Address Errors will have their Addresses Logged.
;
;       3. BAD SECTOR- Log the Disk Address (1st 100.) and do a Normal
;       Return. No Printout will result unless SW11=1, although the
;       I/O Operation was prematurely terminated. A "SOFT" Error will
;       be Recorded if the Sector under Test Passes at Least 1 of 4
;       Retrys. The Log denotes SOFT Errors by a count greater than 0,
;       representing the Error Count tallied. ***SEE 10.3A.

;       4. ENDING MEMORY ADDRESS - Increment the Memory Address Error
;       Count, Print the Error Message, Check for a Disk Address Error
```

```
;       5. ENDING DISK ADDRESS - Increment the Disk Address Error
;       Count, Print the Error Message, and do an Error Return.

;10.3   READ - All Read Errors with the exception of Data related
;       Errors are handled the same as described for the Write
;       Operations.

;       DATA ERRORS - Data is REREAD 3 X (4X if ECC UNDETECTED) If
;       Program is in Write/Read Mode and Data ia Bad all 4 tries,
;       A Hard Error Count is incremented and an Error Return is
;       taken. If Data is Good on any of Four tries, a Soft Error
;       Count is incremented and a Normal Return is taken.

;       If the Program is in a Read ONLY Mode (IE. Read Mode for any
;       502 Program or when 505 is running a 502 Program), the Data
;       will be REREAD an additional 4 times in both Offset Forward
;       and Offset Reverse Modes before the Problem is classed as a
;       Hard Error.

;       Thus Total retries for a Hard ECC Detected Error in a Read
;       ONLY Mode is 12 (13 for ECC UNDETECTED), and 4 if in a
;       Write/Read Mode (5 if ECC UNDETECTED). ***SEE 10.3A

;       Any Successful REREADS while in an Offset Mode will be
;       Printed and Logged. The Disk Addresses of all Data problems
;       will be Printed and the First 100. will be Logged. The First
;       Three Good/Bad word pairs and respective Addresses will be
;       Printed.

;       If SWPAK9=1 (Bypass Data Check) Hard or Soft Data  Errors
;       will be determined by ECC Status.

;10.3A  ECC (ERROR CORRECTION CODE) ANALYSIS

;       All Read Passes including retries will have the ECC results
;       Logged as per the following 4 Categories:

;       1. ECC CORRECTED -The ECC detected and successfully
;       corrected the DATA ERROR.

;       2. NON-CORRECTABLE ECC -The ECC detected and CORRECTLY
;       diagnosed the Error Pattern as UNCORRECTABLE.

;       3. ECC UNDETECTED -The ECC Failed to detect a Data Error.
;       This may be a Malfunction of the ECC Logic, but it is
;       more likely one of the following problems:

;       A Failure of the Drive to Write a Sector.
;       *NOTE- A Check should be made in the Bad Sector Log to see
;       whether a Write Operation may have encountered a Soft or
;       Faulty Bad Sector indication, which would have terminated
;       the Write.

;       A Failure in the Controller Data paths.

;       4. ECC FAILED -Two Conditions may fall into this Category.

;       4A. An ECC Error was detected but with no Accompanying
;       Data Error. A Check is made to see whether the ECC Words
;       point to an Error within the two Appended Write ECC Words.
;       If such an Error is determined to be the case, the Error
;       will be Logged as Correctable and no ECC Failed message
;       will result. This type of Error should represent only a
```

```
;       Sample). If a Significantly Higher Percentage of this
;       Error results,  Then an ECC Problem would be Indicated.

;       If the ECC does not point to the two Appended Write ECC
;       Words, then an ECC Failed message (1st Pass only) will
;       result and the Actual ECC Words Read from the Controller
;       will be printed.

;       4B. An ECC Error was detected, but the ECC either Failed
;       to Correct a Correctable Error, or tried to Correct an
;       Uncorrectable Error. These Conditions (Possibly caused
;       by Problems other than ECC) will result in a printout
;       (1st Pass only) of the Simulated Write and Simulated
;       Read ECC Words plus the Actual Read ECC Words as Read
;       from the Controller.

;       The Simulated Write ECC Words are the result of a
;       Program Simulation of the ECC Logic on what the Program
;       believes to be the Write Data (A Write Error will cause
;       this Assumption to be False), and represents what the
;       Program believes should have been written as the Actual
;       two Write ECC Words on the Disk.

;       The Simulated Read ECC Words are the result of another
;       Program Simulation of the ECC Logic on the Read Data
;       in Memory, and represent what the Program believes
;       should be Read from the Controller as the two ECC
;       Words. The Actual Read ECC Words are those two Words
;       as Read from the Disk Controller.

;10.4   ERRORS- Error Status is printed whenever encountered
;       as follows:

;       'MODE'  UNIT:   'N'
;       CYL-  'N'       HEAD  'N'       SECT  'N'    #SECT  'N'
;       DIA/DIB STATUS= 'N'     'DESCRIPTIVE MESSAGE'

;       Where CYL,HEAD,SECT refer to the final Disk Address at
;       the point of Error; and #SECT refers to the Number of
;       Sectors already done in the Multiple Sector Transfer.

;       When Data Errors are found, only THREE are printed per
;       encounter plus the Total Number of Errors.(See PARA 5)
;       If the Data Error is ECC UNDETECTED and the System is
;       Mapped, the Map, Physical 1K Address, and the DCH
;       Logical Addresses are also printed.

;       When Looping is involved (Retried or for Scoping)
;       Status is printed on the 1st Pass only.

;10.5   STATISTICS -

;       Type a W during random testing to get a Report of the
;       Number of Sectors Written(and/or)Read, plus Error Counts
;       in Decimal. Also Listed is a Count for Controller
;       Corrects/Unit (on Board ECC Correction and Offset Corrects)

;       Type L for First 100. Disk Addresses of Bad Sectors and
;       Data Errors, and First 20. of Address Errors and Seek
;       Errors (Seek Path). If Error Addresses are encountered
;       more than once (1st Pass), a Count of up to 32. will be
;       recorded in the Log. Also a Count of up to 15. Hard Errors
;       will be recorded. This Count will be A subset of the the
;       first Count.
```

```
;       The Address Information will be in OCTAL while the Counts
;       will be DECIMAL.

;       Type S for Seek Timing Statistics if running either Seek
;       Exerciser.
```

```
;11.0   DEBUG HELP:
;
;OCTAL DEBUGGER  (ODT)
;
;       This Reliability is equipped with a built in ODT which can be
;       accessed by hitting CONTROL O at any time during the execution
;       of the Program (after Setting the Parameters). On entering ODT
;       the Address of the Location having the next instruction to be
;       executed will be typed-out.
;
;       The following Conventions are used by the ODT:
;       ?       Pressing any Illegal key causes the ODT to respond
;               with a "?".
;       @       ODT is ready and at your service.
;
;       An ODT Command has the following Format:
;               [ARGUMENT][COMMAND]
;       An Argument may be one of the following:
;       "EXP"   An OCTAL Expression consisting of OCTAL Numbers
;               separated by Plus (+) or Minus (-) signs. Leading
;               Zeros need not be typed.
;       "ADR"   An Address is the same as an Expression except
;               that Bit 0 is neglected.
;       A Command is a single teletype character
;
;       The Locations that can be EXAMINED and MODIFIED by the user
;       are called CELLS. These CELLS are of two Types: Internal CPU
;       Cells and Memory Locations. The Command to OPEN one of the
;       Internal Registers is of the form "nA" where n is any OCTAL
;       Expression between 0 and 7.
;
;       0-3     For ACCUMULATORS 0-3
;       4       For PC of the next Instruction to be Executed in the
;               event of a "P" Command.
;       5       CPU and TTO Status
;               BIT     INTERPRETATION
;               15      Status of TTO DONE FLAG
;               14      Status of INTERRUPTS (ION FLAG)
;               13      Status of CARRY BIT
;       6       Address of the Location having the BREAK POINT (If any)
;       7       Instruction at the BREAK POINT Location
;
;       Other Commands to OPEN Cells are:
;
;       "ADR"/  Open the Cell and Print its contents
;       ./      Open the Cell currently pointed to by the Pointer and
;               Print its contents.
;       .+"ADR"/ Add "ADR" to the Pointer, Open the Cell and Print its
;               contents.
;       .-"ADR"/ Subtract "ADR" from the Pointer, Open the Cell and
;               Print its contents.
;       "CR"    The Return Key is used to Close the Open Cell with or
;               without Modification.
;       "LF"    Line Feed is used to Close the Open Cell with or without
;               Modification and to Open the succeeding Cell.
;       CTRL    Close the Open Cell with or without Modification and
;               Open the preceeding Cell.
;       /       Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents.
;       +"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents + "ADDR".
;       -"ADR"/ Close the Open Cell without Modification, and Open the
;               Cell pointed to by its contents - "ADR".
```

```
;       Modification of a Cell:
;
;       Once a Cell has been opened its contents can be Modified by
;       typing the New Value the Cell is to contain in the form of
;       an OCTAL Expression followed by "CR" or "LF". If a + or - is
;       typed as the first character of the Expression then the Value
;       of the Expression is Added to or Subtracted from the Old
;       contents of the Cell. The Address itself or an Expression
;       relative to the Address can be Deposited by typing a "." or
;       :,+/-OCTAL Expression". A Rubout Command given right after
;       opening a Cell allows the Modification of its contents as if
;       they were typed in just before the Command was issued.
;
;       Other ODT Commands:
;
;       RUBOUT  This Key is used to Delete ERRONEOUSLY typed digits.
;               Each time the Key is pressed the right most digit is
;               Deleted and Echoed on the Terminal. If the Rubout
;               Key is pressed right after opening a Cell then it
;               Deletes the right most digit of the Cells contents.
;               This allows the Modification of the Cell as if its
;               contents were typed in just before the Key was pressed.
;       "ADR"B  Insert a BREAK POINT at Location "ADR".
;               Only one Break Point can be inserted and any entry to
;               ODT after Executing a Break Point will cause it to be
;               Deleted.
;       D       Delete the Break Point if any.
;       P       Restart the Execution of the program at CURRENT Location
;       "ADR"R  Start Executing the program at "ADR" after an IORST.
;       K       Kill the String typed so far. The ODT responds with a
;               "?" and the Open Cell is closed without Modification.
;       =       Print the OCTAL Value of the INPUT only.
;               This will Close any Open Cells without  Modification and
;               will not Open a Cell
;
;       NOTE:   In Programs which RELOCATE THEMSELVES the
;               user should place Break Points ONLY in the
;               ORIGINAL PROGRAM AREA. If a Break Point is
;               placed outside this area the results will
;               be unpredictable.
;
```

```
;MAPPED ODT COMMANDS
;
;       In addition to the previously listed ODT Commands, there
;       is available a Command Set that allow Map Translations for
;       Debugging purposes.
;
;       Map Command Format

;       The Letter "M" is used to specify a Map Command and is
;       used in conjuction with the Set of Characters that form
;       the Map Command Group. A Map Command is thus formed by
;       using the Letter "M" and following it with the desired
;       Command Letter (Such as "MT", "MA", ETC.)
;
;       Map Command Errors
;
;       If a Map Command is entered and the Error Message "No Map"
;       appears, then either:
;       A) A Map was not found
;       B) The Program does not support Mapped ODT.

;       Map Commands
;
;       Note: All Map Commands must be preceeded by an "M" to
;       indicate that they are Map Commands.

;       "A"     Enable User "A" Map Translations
;       "B"     Enable User "B" Map Translations
;       "M"     Enable Map Translations with the last "User"
;       "U"     Disable Mapping
;       "L"     Map Supervisor Last Block
;       "E"     Print Single Map Entry
;       "T"     Print Map Entry Table
```

```
;12.0    SPECIAL NOTES/SPECIAL FEATURES:
;
;        1. A CR only response to Unit Numbers, ETC will leave
;        information in Previous State.
;
;        2. The Program will Account for up to a MAX. of 2**31 Sectors
;        Written or Read. Special Test runs exceeding this facility
;        will require an OPERATOR'S TEST LOG to augment software
;        accounting. 2**31 Sectors = Approx. 2* 10**9 Words.
;
;        4. SWPAK7=1, Program halts after write with Read Verification
;        allowing operator to change packs. SWPAK8=1, Puts Program into
;        Read only mode ## SA'S 501,502 Only. If SA 501-Data must !NOT!
;        be Variable. Start at the above selected Address.

;        5. All Numbers entered in 7.0 must be in Octal. Any Non-Octal
;        input is treated as a Letter. Any Letter input for CYL, HEAD,
;        SECTOR, or # of SECTORS gets Random function in the Reliability
;        Test with Options.
;
;        6. At times the ECC may attempt to Correct a Non-Correctable
;        Data Error and the Simulated ECC and Actual ECC will Match
;        even though an ECC Failure will have been Printed. This is
;        Due to a Failure of the ECC Polynomial itself to Distinguish
;        between two different Error Patterns. One Correctable and one
;        Uncorrectable. This is !NOT! a Hardware Failure.

;13.0    PROGRAM RUNTIME:
;
;        Program Runtimes are substantially reduced with Memories of
;        16K or Larger. Program can use up to 24K using 2 Buffers
;        and up to 32K using 4 Buffers in the Random Reliability
;        Tests.

;        Runtime is defined as Time from Start to a "PASS" Message.
;        Typical runtime for a Read only or Write only Pass of SA
;        502 (Incremental Disk Address Test) is Approx. 3 and 1/2
;        Minutes with a Nova 800 (or Faster CPU) with at least 24K
;        of Memory, and 96 Megabyte.
;
;
```