Model BMX-1

SMD Disk Controller

Technical Manual

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REVISION HISTORY

ECO No.	Date	Description	Pages
0385	10/18/84	Per ECO	
0531	12/18/85	Change FCC cable to Current Std.	
0523	3/4/86	New Cover	
0585	3/25/86	Incorporate cableless paddleboards	3-1
0648	8/4/86	Add External Ground Wire to FCC cables.	3-10

PREFACE

This manual provides complete instructions for installing ZETACO's model BMX-1 disk controller with cabling and tailoring the controller to meet your specific requirements. Instructions are also provided for using the programs and utilities contained on the software support tape. Detailed programming information and command descriptions have been included to aid in program development and fault analysis. The installation section steps through all phases from controller and cable installation to controller preparation using the Configurator Program to do testing and disk initialization. The information in this manual is divided into the following sections:

SECTION 1 — PRODUCT DESCRIPTION - Briefly describes the Controller and its features.

SECTION 2 — SPECIFICATIONS - Lists functional and physical characteristics of the Controller.

SECTION 3 — INSTALLATION - Contains procedures for unpacking and installing the Controller, tailoring it per system requirements, testing disk and tape subsystems and initializing disk media.

SECTION 4 — BMX-1 SOFTWARE SUPPORT PACKAGE - Describes the contents and use of the 1/2" tape included with the Controller.

SECTION 5 — TROUBLESHOOTING, CUSTOMER SUPPORT - Contains information to be used in analyzing subsystem faults and instructions on returning suspect equipment for repair.

SECTION 6 — PROGRAM CONTROL - Describes controller programming and operation.

BMX-1

Disk Drive Controller

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1.0 PRODUCT DESCRIPTION

The ZETACO BMX-1 storage module disk (SMD) controller provides a full emulation integration of Data General (DG) Nova/Eclipse/MV minicomputers, SMD interface disk drives and RDOS,AOS,MP/AOS,AOS/VS operating systems. (RDOS 7.0 and above is required for operation greater than 32 sectors). It is fully compatible with DG and DG emulating minicomputers.

It supports both Burst Multiplexer Channel (BMC) and Data Channel (DCH) transfer methods.

Advantages:

- .EEPROM allows controller to be software configured
- .Meets FCC requirements
- .Faster systems throughput
- .Increased Reliability
- .Increased capacity without patching AOS
- .Hardware or software correctable ECC
- .Full two year warranty

1.1 FEATURES

- Emulation of DG 6060,6061,6067,6160,6161,6122 and 6214 disk subsystems
- Single controller is compatible with DG's full range of BMC equipped computers
- Supports two logical disks with one physical disk drive
- Simultaneous control of up to (4) SMD interfaced disk drives
- Incorporates an eleven bit SMD tag bus to accommodate full capacity of the larger drives
- Mix drives of different capacities, transfer rates, and media formats
- On-board 32 bit error checking and correcting of burst errors up to 11 bits in length
- High speed microprocessor design supports maximum transfer rates
- On-board Self-test with error reporting and LED display
- Two sector buffer
- User-definable sector interleaving
- Adjustable DCH/BMC throttle control
- Supports overlap seeks
- Offset positioning for data error recovery
- Automatic data strobe early/late for data error recovery
- Two methods of power fail detection control open cable detect
- Logging of the number of data corrections that have occurred on a per unit basis
- One second pick delay on power up controls disk drive power sequencing
- Header CRC error auto re-try

- Adjustable BMC bus break time
- SMD cable test LED
- Controller busy LED
- Dual volume drives supported (two physical volumes)
- Supports dual ported drives
- Disk drive sector setting verification
- BMC or DCH data transfer methods
- User-definable header sync byte
- Program load (BOOT) waits for drive ready
- Meets FCC requirements (4 SMD ports off backplane)
- EEPROM eliminates switches and provides total software configurability
- EEPROM Configurator Program provides total flexibility with a "user friendly" format
- Fairchild "FAST" logic used to increase performance and reduce power consumption

2.0 SPECIFICATIONS

2.1 INTERFACE

2.1.1 DRIVE

Electrical: Standard SMD interface

Driver/Receiver: MC3450/3453 differentials

Cabling:

External: One 60 pin shielded round cable ("A" cable) for the first disk drive (daisy chained).

One 26 pin shielded round cable ("B" cable) for the first disk drive (radial).

Internal: One 60 pin ribbon cable with D connector on one end that mounts in backpanel. The other end plugs into a paddleboard. See Figure 3.1.1.

One to four 26 pin ribbon cables with D connector on one end that mounts in the backpanel. The other end plugs into a paddleboard. See Figure 3.1.1.

Multiple Drives: Up to four drives (dual volume counts as two) per controller. The 60 pin "A" cable, daisy chains from drive to drive, with the last drive in the chain receiving an "A" cable terminator. The 26 pin "B" cable connects radially to each drive. (No terminators required). Reference Figure 3.8.

Performance: The BMX-1 will function with disk drives that have data rates as high as 16 MHZ bit rate or 2.0 MByte transfer rate.

2.1.2 COMPUTER

The BMX-1 can be configured for either BMC transfer or DCH Transfer.

The BMX-1 controller is compatible with the S/140, S/280, S250*, C350*, M600*, MV/4000, MV/6000, MV/8000, MV/8000II, MV8000C and the MV/10000 for BMC applications. NOTE: Do not use Slot 25 in the MV10000. For DCH applications, the BMX-1 will function in any DG minicomputer except for the Nova 3, C150 and any other side mounted backplane models which presents paddleboard space limitations. The Nova 4, S120, S140 and S280 will accommodate the DCH applications. In addition, this controller must be plugged into an I/O only slot which some computers may not have.

CAUTION: THE BMX-1 MUST BE PLUGGED INTO AN I/O ONLY SLOT.

MODEL	I/O ONLY SLOTS
S140	12-16
S280	11-20
MV4000	12-20
MV8000-II	9-21
MV10000	13-24, 26-36
Nova 4C(5 Slot)	3-5 (DCH Only (BMC not supported))
Nova 4S/x	12-16 (DCH Only (BMC not supported))
S120	12-16 (DCH Only (BMC not supported))
MV6000	13-16 (Main Chassis)
MV8000	29-42, 48-56
MV8000C	14-20
*M600	30-37
*S250	I/O Only Backplane Option
*C350	I/O Only Backplane Option

*NOTE: BMX-1 REQUIRES MODE 3 MODIFICATION.

2.2 POWER

+5 VDC @ 8.0 Amps typical
-5 VDC @ 0.45 Amps typical

2.3 PHYSICAL

Dimensions: 15" x 15" x 1/2"

Shipping Weight: 15 pounds - includes cables, diagnostics and documentation.

Cables: 60 pin round "A" cable (external) - 15 feet
26 pin round "B" cable (external) - 15 feet
60 pin ribbon (internal) - 1.5 feet
26 pin ribbon (internal) - 1.5 feet

Paddleboards: Passive backplane paddleboard with 4 - 26 pin cable connectors. (A backplane)

Passive backplane paddleboard with 1 - 60 pin cable connector. (B backplane)

2.4 ENVIRONMENTAL

Operating Temperature: 0 to 55 degrees C

Relative Humidity: 10% to 90% (non-condensing)

Exceeds all Nova/Eclipse/MV minicomputers temperature and humidity specifications.

3.0 INSTALLATION

Please read the following BMX-1 Installation section carefully.

3.1 UNPACKING AND INSPECTION

All parts comprising of the Model BMX-1 are shipped in one container consisting of:

a) Controller (500-400-00)

b) Backplane Paddleboards
   A - 500-426-00
   B - 500-427-00

c) Internal FCC Cables (Optional)
   A - 300-104-0X
   B - 300-146-0X

d) External FCC Cables (Optional)
   A - 300-013-01 (16 feet)
   B - 300-011-01 (16 feet)

e) BMC Bus Cables (300-038-00)

f) Diagnostic Software Including Configurator (400-276-00)

g) Technical Manual (600-400-00)

On receipt of the Model BMX-1 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.

3.2 MODE AND FEATURE SELECTION

The BMX-1 has been set to Mode 1 at the factory unless specified otherwise. The BMX-1 must be configured in two ways: 1) configure to the correct CPU via 24 pin mode plug on the circuit board and the B paddleboard 2) choosing a feature select with a jumper plug on the circuit board and the B paddleboard.

First configure the mode plug to your CPU type. Three modes are possible. Modes 1 and 2 can be set or changed by the end user, while Mode 3 is configurable only at the factory. Table 3.2 clearly indicates the CPU mode selections.

MODE 1 - This is the standard configuration and provides all features to include: dual port, extended 11 bit tag bus (for use with disk drives in excess of 1024 cylinders) and remote pick hold spin up sequencing.

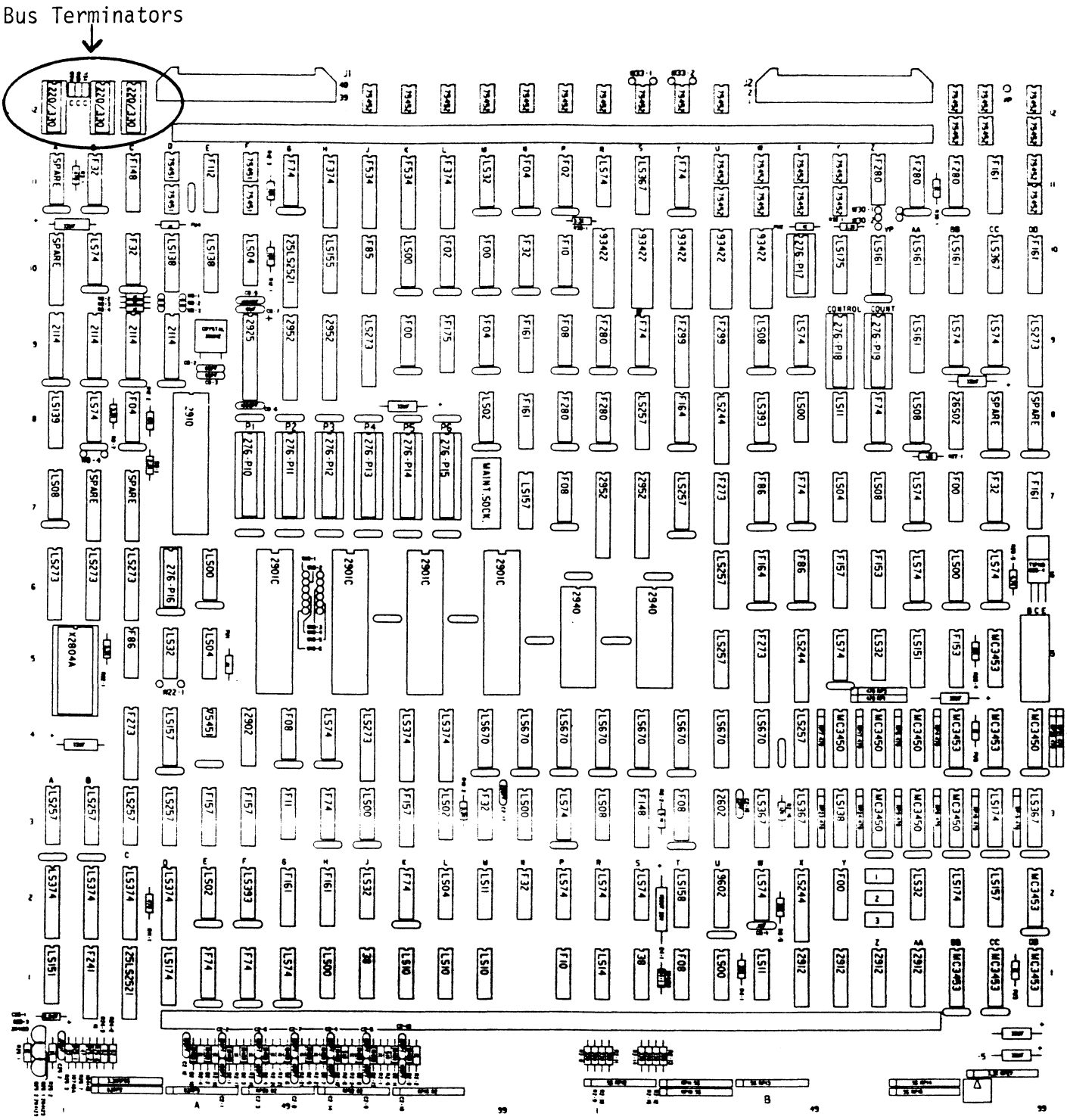
MODE 2 - Required on certain CPU types but sacrifices two of the 3 available features. You would choose one of the three following features: dual port, extended 11 bit tag bus (for use with disk drives in excess of 1024 cylinders) and remote pick hold spin up sequencing.

MODE 3 - Factory configurable only. Provides for all 3 features mentioned above.

When changing from Mode 1 to Mode 2 simply remove the 24 pin mode plug (on the BMX-1 and B paddleboard) turn it 180 degrees and re-insert. Second, choose the feature plug (on the BMX-1 board and paddleboard) for the desired feature. To determine which CPU mode to choose reference Table 3.2.

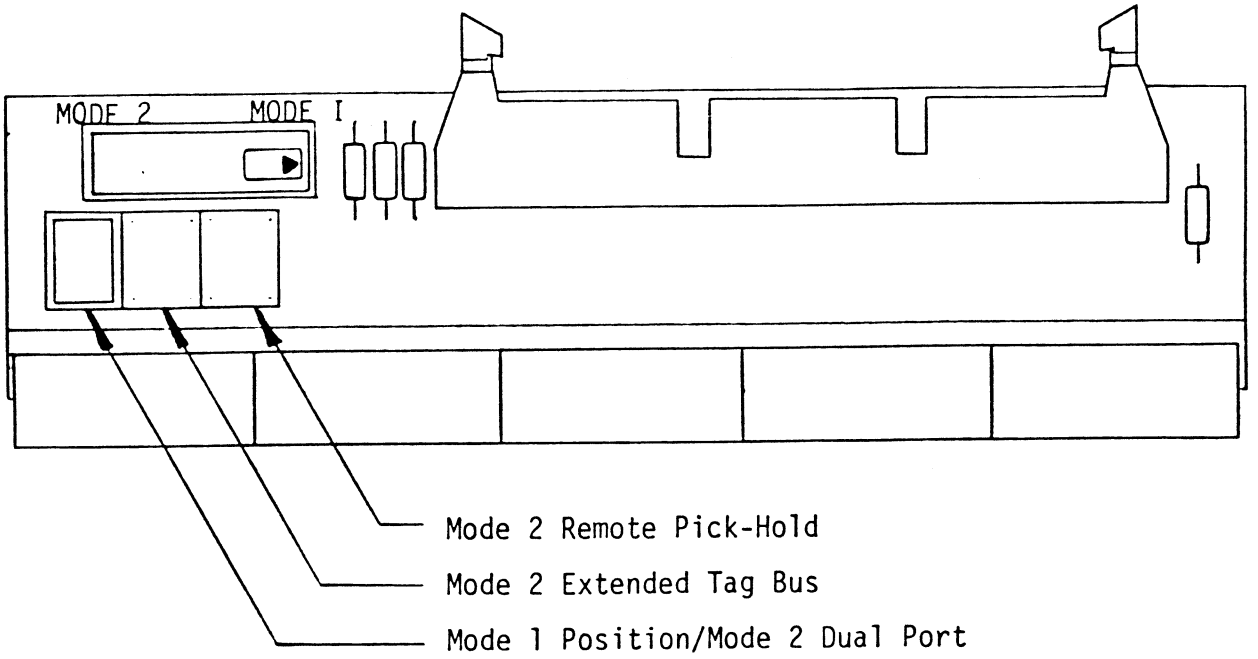
NOTE: For some CPU's the BMX-1 can be configured in either Mode 1 or Mode 2. Mode 1 is preferred since it retains all 3 features.

The feature selections are referenced in Figures 3.1 and 3.2. The 3 features are dual port, extended 11 bit tag bus (for use with disk drives in excess of 1024 cylinders) and remote pick hold spin up sequence. When you have chosen CPU Mode 1 you must have the feature select plug installed in the "Mode 1 Default/Dual Port" position. Without this feature select plug inserted properly, the Controller will not function properly.



BOARD LAYOUT

FIGURE 3.1



"B" PADDLEBOARD

FIGURE 3.2

NOTE: When you have chosen Mode 2 you have a choice of 1 of the 3 features. You cannot choose more than one. Example: for dual port-insert the feature plug marked "Mode 1 Default/Dual Port" on the circuit board and the B paddleboard.

MODEL	MODE 1	MODE 2	MODE 3 ③
S140 ⑤	X		
S250 ①			X
S280	X	ALT.	
C350 ①			X
M600			X
MV4000	X	ALT.	
MV6000 ②		X	
MV8000		X	
MV8000-II		X	
MV8000C		X	
MV10000 ④	X	ALT.	

NOTES:

① Require optional I/O only backplane.

② Do not use I/O expansion chassis slots.

③ Mode 3 is factory configurable only.

④ MV10000 REV 02 backplane and less requires Mode 2 operation.

⑤ Nova 4C, Nova 4S, Nova 4X and Eclipse S120 also require Mode 1 for DCH.

NOTE: Mode 3 is factory set with hardware changes. Mode 3 will display the Mode 1 selection plug but in reality will be configured to Mode 3. BMX-1's factory set for Mode 3 will be identified with a paste on sticker.

CPU MODE SELECTION

TABLE 3.2

3.3 BMC BUS TERMINATION

If there is more than one BMC device daisy chained on the BMC bus, then the BMC controller at the end of the bus must have the bus terminators installed. If the BMX-1 is to be installed as the last or only BMC controller, then make sure the 3 terminator DIP's are installed at locations A12,B12, and C12 on the controller board. Reference Figure 3.1.

NOTE: The BMX-1 is shipped from the factory with these terminators installed unless otherwise specified.

3.4 POWER FAIL PROTECTION

The BMX-1 disk controller contains a double protection power fail scheme. The DG CPU outputs a signal on pin B21 called "Power Fail" which gives an early warning of power loss. This is used on the BMX-1 to disable the drives write circuitry through the open cable detect line.

Slots 12-15 in the S140 do not have power fail, therefore, a jumper wire should be installed to enable this feature. Slot 16 has it available on B21. Refer to your CPU manufacturer's manual if additional information is needed.

In addition, the BMX-1 contains its own power fail circuitry to further protect drive data integrity in the event the slot where the board is installed loses power.

3.5 BOARD INSERTION

Carefully select an I/O only slot and guide the controller board into the desired slot by allowing the edges of the board to follow the guides evenly. Use the lock tabs on the two outside corners to provide leverage when the board meets the connector. Use equal pressure on both lock tabs until the board seats firmly into the backplane connectors.

CAUTION: AN I/O ONLY SLOT MUST BE USED. COMPONENT DAMAGE WILL OCCUR IF A SLOT OTHER THAN AN I/O ONLY SLOT IS USED. REFER TO SECTION 2.1.2. ZETACO'S WARRANTY IS VOID IF A NON-I/O ONLY SLOT IS USED.

3.5.1 PADDLEBOARD INSTALLATION

Two paddleboards connect onto the minicomputer backplane pins (observe which slot the BMX-1 occupies in order to determine which set of backplane pins to use for connection), one paddleboard connects to the "A" backplane and one on the "B" backplane. Make sure the CPU backplane pins are straight first, then reference Figure 3.3 for proper installation. The paddleboard (labeled "B") with the 60 pin header goes on the "B" backplane. The paddleboard (labeled "A") with the 4-26 pin headers goes to the "A" backplane.

3.6 PRIORITY SELECTION

The controller must receive two priority signals from the DG minicomputer backplane, DCH 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 DCH priority out (Pin A93) to DCH priority in (Pin A94) and interrupt priority out (Pin A95) to interrupt priority in (Pin A96).

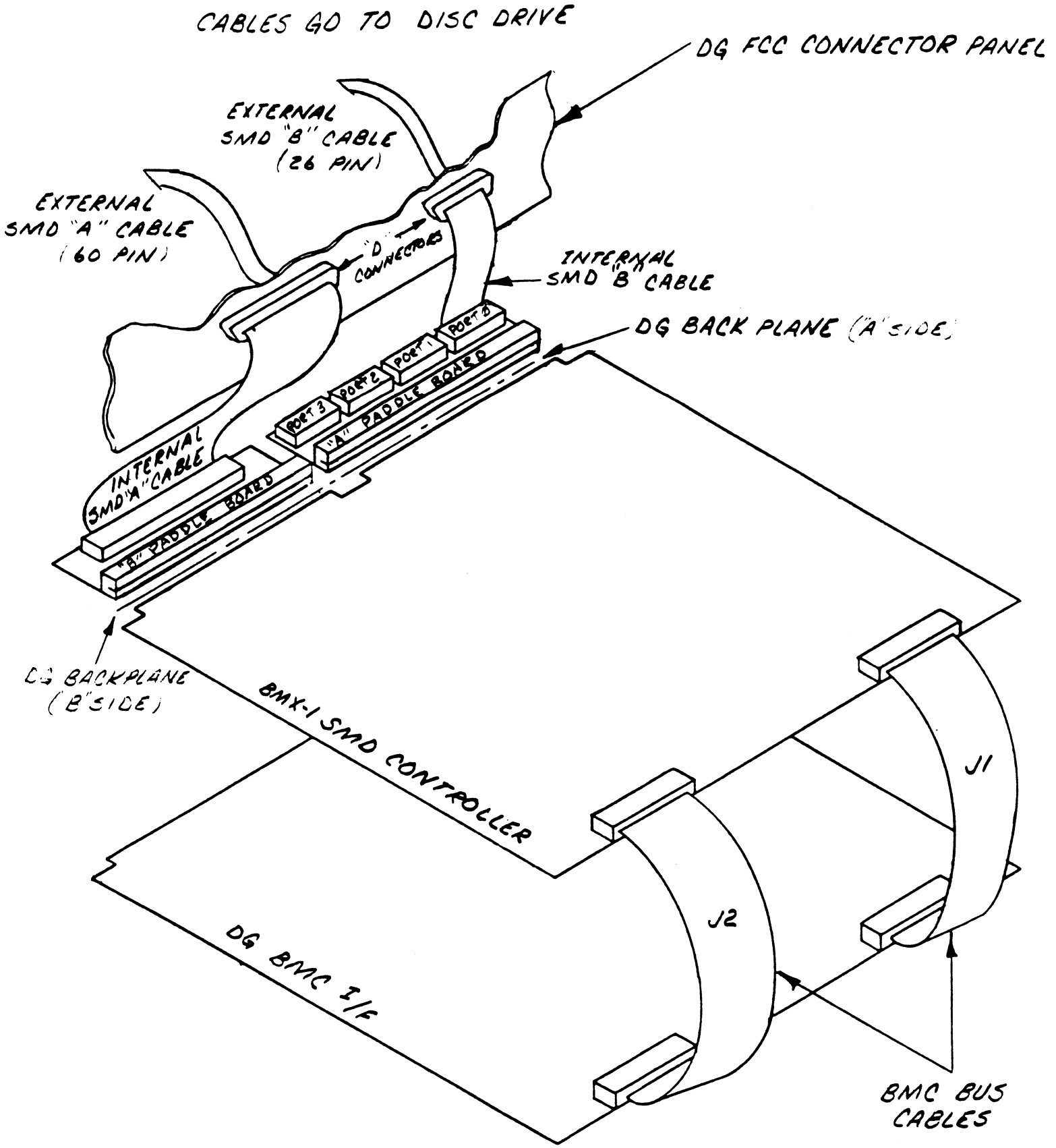
If the BMX-1 is to be configured at or near highest priority in an S140 computer, (Slots 12-16 I/O Only) jumper the priority first up to the BMX-1, then back down to the additional controller boards in Slots 4 and up.

3.7 CABLING

3.7.1 INTERNAL DISK CABLING

As shown in Figure 3.3, the 60 pin (female end) conductor cable (referred to as internal SMD "A" cable) plugs into the "B" paddleboard. The other end of this cable (D connector) mounts into the backpanel.

The 26 pin (female end) conductor cable (referred to as internal SMD "B" cable) plugs into the "A" paddleboard. The other end of this cable (D connector) mounts into the backpanel. (Observe the port assignments on the paddleboard in order to keep track on the backpanel which port is 0-3.) If more than one drive is to be connected we recommend labeling the associated port/s on the CPU connector panel.



BOARD DIAGRAM

FIGURE 3.3

3.7.2 EXTERNAL DISK CABLING

As shown in Figure 3.4, the 60 pin "A" cable connects between the appropriate backpanel D connector and the first drive then continues from drive to drive in a daisy chain fashion. The last drive in the chain must have a terminator installed in place of the daisy chain cable. This terminator is located within the disk drive.

Each drive must have a 26 pin "B" cable connected between the drive and the backpanel D connector in a radial fashion.

Connect external ground wire on both A and B cables to the drive's chassis ground.

Insure that the port is configured (by use of Configurator Program) to match the corresponding drive type plugged into that port.

Refer to the drive manufacturer's manual for proper subsystem grounding if required.

3.7.3 BMC BUS CABLING

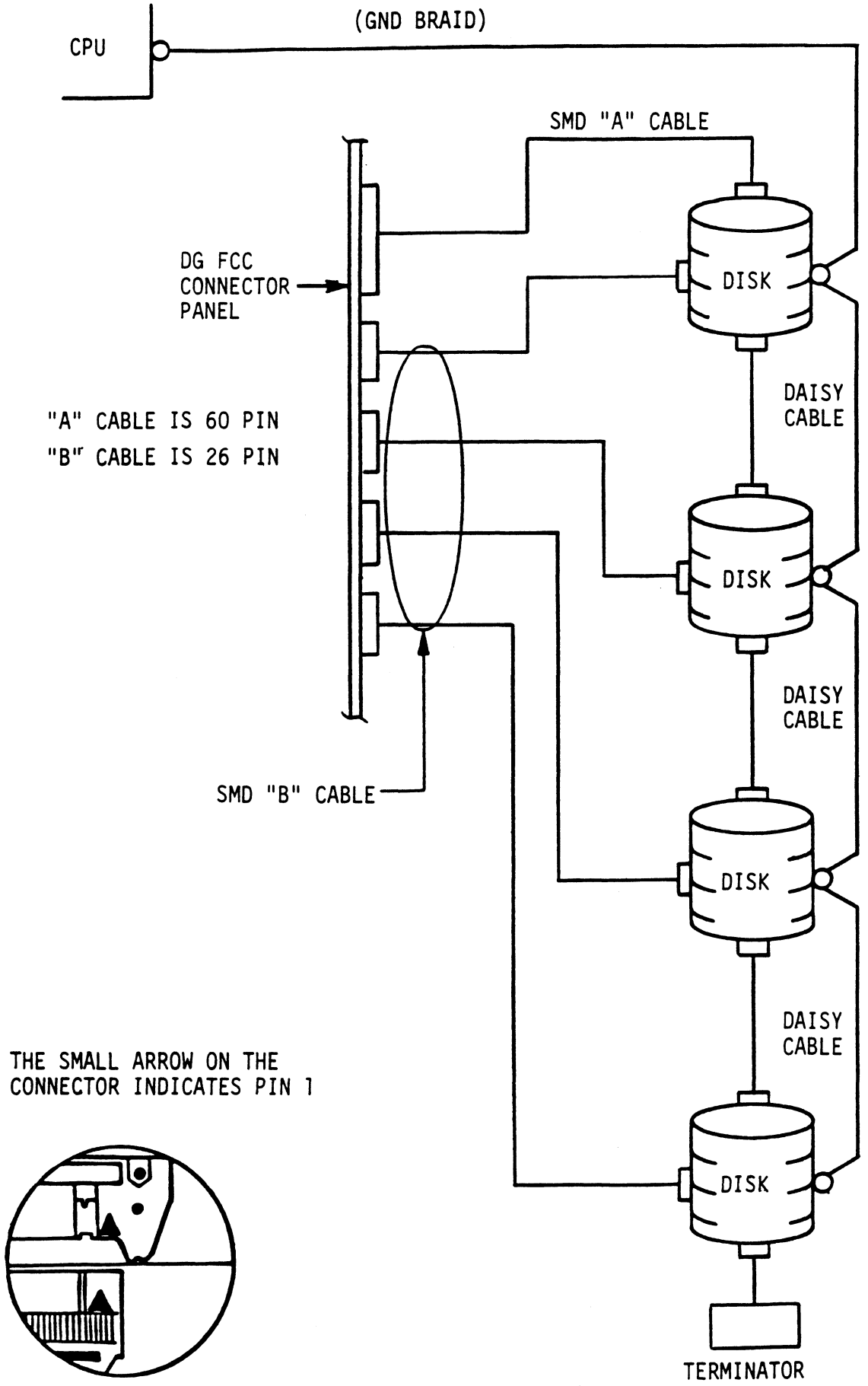
The BMC bus cables (2) provided have a single 40 conductor plug on one end and a group of 4,6, or 8 plugs on the other end. Install the BMC bus cables as shown in Figure 3.3, observing proper connector orientation, by plugging the single plug end of the cables into the DG BMC I/F and the multiple plug end of the cables into the BMX-1 and other BMC controllers.

Reference Section 3.3 for BMC termination installation.

3.7.4 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 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 component in the system must be connected using a daisy chain ground system. The AC and DC grounds within each drive may need to 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.



THE SMALL ARROW ON THE
CONNECTOR INDICATES PIN 1

DAISY CHAINING DRIVES

FIGURE 3.4

3.8 DISK DRIVE CONFIGURATION

Insure 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.

To set up the BMX-1 you must know the disk drive manufacturer and model number, the operating system revision level (RDOS Only), the DG CPU Model and the type of Format (ZETACO, ZETACO High Speed or ALT). If you are unsure of the correct sector count to use for set up of the disk drive, you may refer to the BMX-1 Configurator Program which reflects the sector count to be used for the various disk emulations. The BMX-1 Configurator Program can be run only after the BMX-1 is installed. To find your disk drive (listed alphabetically by manufacturer) within the Configurator Program, refer to the main menu and choose D (Disk Type/s) then answer the number of disks on the controller. Press H (Help) to review the disk drive characteristics. Listed with the drive manufacturer and model number are the characteristics for that drive to include heads, cylinders, sectors and unformatted capacity.

NOTE: The Configurator Program is a stand-alone utility. See Sections 3.10 and 4.2 for additional information.

3.8.1 SPECIAL CONSIDERATIONS

SPECIAL CONDISERATIONS FOR THE 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 in the Fujitsu 2351 manual. The following jumpers should be set for 586 bytes per sector:

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

SPECIAL CONSIDERATIONS FOR THE CDC 9457 (LARK II) AND

CDC 9455 (LARK)

Insure options W-4 and W-8 are installed within the disk drive. W-4 identifies Auto Seek on head change. W-8 identifies two volumes (CDC terms it CMD). The CDC Lark is 32 sectors.

3.8.2 DRIVE PICK-HOLD

On initial power up, the Controller will delay activating pick-hold (spins up drive) for one second. This feature eases the initial current demand on the AC power source. This feature requires that the disk drive be selected for remote operation. If the remote spin up feature has not been selected in Mode 2, then pick-hold is grounded which will issue a continuous pick-hold.

3.9 JUMPER SELECTABLE OPTIONS

The configuration of the BMX-1 is eased by making most of the features software configurable through a program called Configurator. Section 3.2 describes the jumper selectable features. The jumpers are configured from the factory to satisfy most cases.

3.9.1 EEPROM WRITE DISABLE

The BMX-1 provides the means to hardware disable any further alterations to the configuration EEPROM. To write disable the EEPROM, cut foil jumper W22-1 located at D5 on the controller board. Foil jumper W22-1 is factory installed.

3.9.2 LOOP ON SELF-TEST

To loop on Self-test, insert jumper W8-4 location B8 on the controller board. This is an added feature for diagnostic purposes. For typical use of diagnostics leave Loop On Self-test disabled. The BMX-1 is factory set with Loop On Self-test disabled.

3.9.3 DISABLE BMC BUS PARITY

The BMX-1 performs address and data parity checks on the BMC bus when this jumper is installed. The BMX-1 is factory set with BMC bus parity enabled unless otherwise specified. To disable parity checks, cut foil jumper W30-1 and install a jumper W30-2 at location Z11 on the controller board.

3.9.4 FAILSAFE PRIMARY DEVICE CODE

In the remote case that it becomes desirable to hardware force the device code of the BMX-1 to the primary value of 27 octal, it can be done by cutting foil jumper W33-1 at location U11 on the controller board.

NOTE: This feature would seldom be required and the jumper is factory installed to allow any device code. The BMX-1 EEPROM is factory configured to a device code of 41 octal to eliminate the possibility of conflicting device codes on initial installation.

3.10 POWERING UP AND CONFIGURING

Turn System power ON. The BMX-1 will perform an initial "Self-test" by briefly lighting a red LED. A good test is indicated by the LED turning OFF. For more details refer to Section 5.0.

Once the Self-test LED goes out, a cable test is performed. In order for the cable test to pass, the disk drive must be cabled up properly and powered on. If the yellow LED comes on, then a cabling problem may exist. An I/O reset switch will re-execute the test. Refer to Section 3.7 for proper disk cabling.

NOTE: Some disk drives may not be capable of being selected until they are spun up which will cause a cable fault. If this occurs, wait until the drive is ready and then depress the I/O Reset Switch. The green LED is used to display controller busy.

CONFIGURING THE BMX-1:

A program called BMX-1 Configurator (File #2) is supplied with the controller board on a 1/2" magnetic tape labeled 400-276-00. The Configurator Program replaces hardware switches. You must run File #2 on tape 400-276-00 in order to install your BMX-1.

NOTE: The BMX-1 has been factory set to device code 41 octal unless otherwise specified. This is to eliminate the possibility of conflicting device codes on initial installation. However, it is intended to be changed to 27 octal or whatever device code you desire. The BMX-1 disk controller has been shipped from ZETACO with most Configuration facts set to standard recommended values. However, the Controller must be tailored for the disks you will be using. Section 4.2 describes the operation of the Configurator Program.

The following is a description of the configurable features supported by the BMX-1.

3.10.1 DATA TRANSFER MODE

The BMX-1 can be configured for either DCH or BMC.

3.10.2 DEVICE CODE

The BMX-1 can be configured to any device code between 20 octal and 76 octal. However, the primary is 27 octal and the secondary is 67 octal. Device code 41 octal has been set at the factory unless otherwise specified.

If the device code is changed, it will not take affect until the computer is powered down and back up. See Section 3.10 for additional information.

3.10.3 BMC BUS PRIORITY

The BMX-1 has the capability of co-existing with up to seven other BMC controllers. However, some DG computers only support up to four BMC devices such as the MV/4000. In this case you must select priority 0 thru 3. The lower the priority number the lower the priority level. If there is more than one BMC device, make sure you select a priority level that is different than the other BMC device.

3.10.4 THROTTLE BURST RATE

This is defined as the number of word transfers that take place over either the DCH or the BMC on a single bus access. Throttle adjustment is dependent on the type of system configuration the Controller is installed into. Too low of a throttle setting could result in slow disk performance and too high of a setting could cause a data late on another DCH or BMC device. The BMX-1 supports 4, 8, 16, 32, 64, 128 and 256 word Burst Rates. A Burst Rate of 16 is recommended for DCH and 32 is recommended for BMC.

The BMX-1 allows you to select a different Burst Rate for each SMD port thereby giving the ability to fine tune the bus to a particular speed of the disk drive.

3.10.5 BREAK COUNT

This is defined as the period of time that the BMX-1 is off the BMC bus. This is utilized only in the BMC mode. With the break count set to 0 there is an inherent 1.4 microsecond OFF time (delay between requests) which is the recommended break count setting. Each additional count adds 200 nanoseconds to the OFF bus time.

If there are other BMC devices present, it may be desirable to increase this count to allow more time for the other devices to access the bus. If the break count is set too large, slow disk performance may result. A larger break count also allows the CPU more memory time.

The BMX-1 allows you to set a different break count on each SMD port which gives the ability to fine tune the bus according to disk speed.

3.10.6 SYNC BYTE

The BMX-1 supports a media format which contains a header sync byte and data field sync byte versus a sync bit. The sync byte provides better header address and data integrity. This sync byte is user-definable for each SMD port on the BMX-1. 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.

3.10.7 ERROR CORRECTION ENABLE

When this function is enabled, on-board error correction and data strobe early/late occur automatically on bad 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.

3.10.8 MEDIA FORMAT

The BMX-1 has the capability of supporting, simultaneously, up to four different types of disk media format. This also means that each SMD port could be running a totally different media format.

Currently supported is a standard ZETACO format (ZETACO) a High Speed (ZETACO H.S.), version for 15-16 MHz, an alternate format, and a DG Kismet format (optional) See Section 4.3 for detailed media format information.

We recommend using the ZETACO format due to its added features; more error checks on header, conforms to neccesary drive specifications.

3.10.9 SECTOR INTERLEAVE RATIO

The BMX-1 supports any interleave from 1:1 to 6:1 and each SMD port can have a different interleave ratio. 1:1 interleave is recommended for optimum performance and should be sufficient on the BMC in most cases. Interleaving may be desired to fine tune a systems performance. This is to avoid going a full revolution on the disk when the CPU cannot respond fast enough to catch the next consecutive sector.

If system performance is too slow to access the next consecutive sector, which is indicated by extremely slow disk performance, then an interleave factor of 2:1 or greater should be selected. To maintain optimum performance, don't select an interleave greater than is required to access the next consecutive sector in a multiple sector transfer.

3.10.10 DISK TYPES

The BMX-1 is capable of running with virtually any disk drive that meets the SMD specifications. However, when running under AOS, only those drives that meet the sizing characteristics of the supported emulations can be used. Under RDOS the BMX-1 can take advantage of the full capacity of most disk drives because DKINIT has been modified (CSDKINIT) to allow deviation from the standard DG disk emulations.

DUAL VOLUME DRIVES:

If a dual volume drive is to be connected, the drives unit number plug must be an even number. A dual volume drive is treated as two logical units, so a maximum of two dual volume drives, or one dual volume drive and two single volume drives can be connected.

NOTE: The Kismet Family - 6160, 6161 and 6214 (under AOS and AOS/VS) only allow two (single volume) drives or one dual volume to be connected.

There are two forms of dual volume drives. One has two physical volumes. (Examples are CDC Lark, Amcodyne 7110 and CDC 9448 Series.)

The other form of dual volume is treating one physical drive as 2 logical units (if drive characteristics permit). For example, Dual 6061 emulation (AOS) operation for the Fujitsu 2351 Eagle, or dual 6161 emulation (AOS) operation for the APS 4835 drive, or Dual 6122 emulation operation for the APS 4865 drive.

In all cases, dual volume drives must have both their units formatted before reading or writing.

3.11 FORMATTING

Boot up the formatter program and run a minimum of three passes or preferably six passes. For ZETACO Disk Formatter refer to Sections 4.0, 4.3 and Appendix A. For the next installation step we recommend running disk Reliability in order to exercise and test the disk system. Refer to Section 4.4 and Appendix A. If you are using AOS we recommend you run Diagnostics in addition to Reliability. Under AOS run Diagnostics first and Reliability second. Refer to Diagnostics Section 4.4. The final step involves the use of CSDKINIT for RDOS or DFMTR for AOS. Before you load any RDOS or AOS onto a Model BMX-1 disk you must initialize the disk by running CSDKINIT (RDOS) or DFMTR (AOS). For CSDKINIT refer to Section 4.6. For DFMTR refer to DG's Manual.

3.12 SYSGEN CONSIDERATIONS

Listed below is an example of part of the RDOS system generator.

1. Number of 6060/6061/6067/6122/6160/6161 Disk Controllers (0-2)

2. Device Primary ("0") or Secondary ("1")

3. Controller #1 6160/6161 Type? ("0"=NO, "1"=YES)

4. Number of Devices for Controller #1 (1-4)

5. Number of other types of Moving Head Disk Controllers (0-2)

6. Device Primary ("0") or Secondary ("1")

NOTE: On line three answer NO when running RDOS. When you answer NO you allow up to four disk drives (6160 or 6161) to be connected to the BMX-1. If you answer YES you allow only two disk drives (6160 or 6161) to be connected.

4.0 SOFTWARE - DIAGNOSTICS, CONFIGURATOR AND UTILITIES

In addition to the diagnostic functions provided by the BMX-1 controller via on-board Self-test, ZETACO provides diagnostic and utility software. The 400-276-00 magnetic tape included in the controller package contains these programs.

Each of the programs on the 400-276-00 tape have been written by ZETACO specifically for the BMX-1 controller. You should use this tape for media formatting, Disk Diagnostics and Reliability, Configurating and RDOS Utilities. DG's corresponding programs may not work on this controller. The disk media formatter on the 400-276-00 tape will let you format the media in any of the formats which are supported by the BMX-1 Controller.

4.1 USING THE 400-276-00 TAPE

The 400-276-00 tape is structured so that the programs on Files 2-7 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 2-7 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 0-7. File 8 for RDOS and File 9 for AOS (or AOS/VS) contain the programs in the standard system dump format and you can load them from these files to your disk. Even after the programs have been transferred to your disk, you should retain the 400-276-00 tape in case of disk subsystem problems.

The following sequence of events is recommended by ZETACO. Each step is described in greater detail in the subsequent sections of this chapter.

1. Mount the 400-276-00 tape and boot it.

2. Select #2 on tape menu - configure the Controller.

3. Select #3 - format the media, if you need to.

4. Select #4 - disk Diagnostics.

5. Select #5 - disk Reliability.

   NOTE: It is not essential that you run Diagnostics or Reliability, however, they will locate disk subsystem problems. It is better that this be checked out at this point than after you have loaded your data.

6. If the controller is to run in an RDOS system, select #6 to initialize the disk. If the controller will not run in an RDOS system, proceed to the disk initializer program on the DG system tape for your operating system.

7. You can load the programs from File 8 or File 9 any time after you have built your disk.

The Bootstrap Procedure for the 400-276-00 tape is:

1. Mount the 400-276-00 tape on the drive and put it on-line. Be sure that the BPI setting matches that specified on the tape label.

2. Program Load - The method of program load varies for the different processors. Some of the possibilities are described here.

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).

For MV class CPU's you must enter the full virtual console and respond to the prompt:

```
SCP-CLI>
with BOOT 22 (or 62 for secondary tape)
```

3. 400-276-00 Menu will be displayed:

```
    FILE #      PROGRAM

      2         BMX-1 CONFIGURATOR
      3         DISK FORMATTER
      4         DISK DIAGNOSTICS
      5         DISK RELIABILITY
      6         CSDKINIT-RDOS DISK INITIALIZER
      7         CSDSKED-RDOS DISK EDITOR
      8         ".SV & .LS" Files and any Utilities in
                RDOS DUMP Format
      9         ".SV & .LS" Files and any Utilities in
                AOS DUMP Format
     10         AOS/VS Utilities in AOS DUMP Format

    File Number?
```

You should enter the number opposite the program you wish to execute.

To load files from File 8 or 9, use the standard CLI Command for loading from tape.

```
RDOS:   DIR %MDIR%
        INIT MT0
        LOAD/A/R/V MT0:8
        RELEASE MT0

AOS:    SUPERUSER ON
        DIR :
        LOAD/R/V @MTA0:9
        REW @MTA0
        SUPERUSER OFF

AOS/VS: SUPERUSER ON
        DIR :
        LOAD/R/V @MTC0:9
        DELETE/V AOSECC.PR
        LOAD/R/V @MTC0:10
        REW @MTC0
        SUPERUSER OFF
```

4.2 BMX-1 CONFIGURATOR

The BMX-1 controller is configured for your particular system via software. Before you will be able to access your disk/s, the BMX-1 controller must be configured to reflect your setup. To do this, load the BMX-1 Configurator from the 400-276-00 tape per instructions in the preceding section. The Configurator Program is located on File #2 of the tape.

The program displays a heading and an introduction. You should read the introduction carefully before proceeding. Initially you must specify on which device code the BMX-1 controller is currently running. This is so that the current configuration facts can be read from the EEPROM on the Controller. If this is the initial installation, the BMX-1 will be set at device code 41 octal to eliminate the possibility of conflicting device codes.

The BMX-1 Configurator Program includes both a HELP menu for general questions and a HELP command for each item. Please use these functions whenever you are uncertain as to what to do. The purpose of the Configurator is to change the pre-set facts to reflect your environment, and then to update the EEPROM on the Controller. The Controller will then perform according to your particular specifications.

SYSTEM REQUIREMENTS TO RUN CONFIGURATOR

Nova/Eclipse or MV Family CPU with 32K Words Memory
BMX-1 Controller Board/s
Console on Device 10/11
Non-DMA Printer at 17, in order to use Logging

4.3 DISK FORMATTER

The disk formatter program is a utility designed program to format and check disk packs to be used on the disk systems. The 1/2" magnetic tape supplied contains File #3 (disk formatter). File #3 in conjunction with the BMX-1 hardware supports the three formats (ZETACO, ZETACO High Speed and Alternate).

In most cases it is recommended you disable ECC correction with the Configurator prior to running the disk formatter.

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]: 67

SET SWPAK AS PER SECT 8.0 OR HIT (CR) TO CONTINUE

START TIME? - MON,DAY,YR  HR,MIN

# PASSES TO FORMAT COMPLETION? - 6

UNIT     TYPE     HDS     CYLS     SEC/TRK     SECTOR PULSES

 0        0        5      823        32             32
 2        1        5      815        24             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
```

See formatter text at end of manual for further details.

4.4 DISK DIAGNOSTIC

This Diagnostic program is provided to find failures that are related to the basic operations of the disk controller. The ID bits (AOS) shown in the sample below will aid in checking the configuration. Switch settings for AOS are described in the Installation Section, Figure 3.6.

Load the program from the tape provided. (See 400-276-00 tape loading in Section 6.0).

The following is a sample dialogue for 6160 (AOS):

```
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 TWO DRIVE EXERCISER WITH SEEK OVERLAP
    500-DIAGNOSTIC (RESTART)

ENTER DEVICE CODE [27]: 67

ANY DUAL VOLUME UNITS?  ENTER 1

ENTER UNIT NUMBERS (0,1,2,3) TO RUN:  0,1

SET SWPAK AS PER 8.0, LISTING OR ENTER RETURN (CR) TO CONT.

TESTING UNIT 0

.
.
.
.


UNIT      HDS      CYLS      SEC/TRK      SECTOR PULSES

  0        5        823         35             35

These are the units and characteristics found, do you
want to loop on reading them?  Enter 1, otherwise enter
Return (CR).

.
.
.
.
```

See Diagnostic text at the end of the manual for further details.

```
ADDRESSABLE SECTORS/TRACK WITH THIS CONTROLLER IS 64.
DRIVE UNIT #0 WILL BE IDENTIFIED AS A 6160 (73 MBYTE)
BY AOS OR AOS/VS.
DRIVE UNIT #1 WILL BE IDENTIFIED AS A 6160 (73 MBYTE)
BY AOS OR AOS/VS.
TEST(S) COMPLETE.
SEEK EXERCISER TESTS.
PASS
```

DISK DRIVE SECTOR VERIFICATION -

The BMX-1 provides a feature which allows the diagnostic programs to display the actual number of sectors that the disk drive is set for.

This count will not include a small remaining sector at the end of the track which very often occurs.

4.5 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. (ZETACO Reliability supplied on 1/2" magnetic 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]: 67

STARTING ADDRESS = 505

SET SWPAK AS PER 8.0, OR HIT (CR) TO CONT.

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      SECTOR PULSES

 0         0         5       823          32             32
 2         1         5       815          24             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
```

See Reliability text at the end of manual for further details.

4.6 CSDKINIT - RDOS DISK INITIALIZER

(ZETACO's version of DSKINIT, referred to as CSDKINIT, is supplied on 1/2" magnetic tape.)

Initializing a Model BMX-1 disk -

Before you load any RDOS system onto a Model BMX-1 disk, YOU MUST INITIALIZE THE DISK BY RUNNING CSDKINIT. This is a stand-alone program which performs all the functions of DG's DKINIT. Please refer to DG manual on loading an RDOS system for full details on the functionality of disk initialization.

Remember that only CSDKINIT will work correctly for Model BMX-1 disks. If you are building your system from an RDOS release tape, do NOT run file 4 on the DG tape after running CSDKINIT. DG's DKINIT cannot be run on a Model BMX-1 disk. CSDKINIT can, however, be used to initialize any DG supported disk.

STEP 1 - LOADING

A) If loading from a 400-276-00 tape:

Perform the steps described for loading 400-276-00 tape in Section 4.0.

YOU RESPOND:

6

B) If loading from disk: (CSDKINIT.SV must have been previously loaded onto the disk.

Mount the disk pack which contains CSDKINT.

Set console switches to correct device code.

Press RESET and LOAD switches.

PROGRAM DISPLAYS:

FILENAME?

YOU RESPOND:

CSDKINIT or (DIR:CSDKINT, if the program file is located in directory, DIR, other than the master).

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 as shown above.

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 blks. Blocks if disk <4000 blks.

STEP 4 - ECC CORRECTION

For most situations it is recommended that you disable ECC correction while running CSDKINIT. This will allow the initializer to flag those bad blocks which are potential problems even though they might be correctable at the time of running CSDKINIT. However, it is also possible to run with ECC correction enabled in cases where there is a need for using marginal media.

STEP 5 - COMMANDS AND SUBSEQUENT OUTPUT

The commands which can be selected are identical to those of DKINIT.

From this point on CSDKINIT will perform exactly as DKINIT.

4.7 CSDSKED - RDOS STAND-ALONE DISK EDITOR

CSDSKED provides the same functions for the BMX-1 disk as DG's DSKED does for standard DG disks.
It can also be used for any DG supported disk. Please refer to the DG stand-alone disk editor manual for a complete description of the commands.

We will describe the steps necessary to run CSDSKED.

STEP 1 - LOADING

A) If loading from a 400-276-00 Tape:

Perform the steps described for loading 400-276-00 tape in Section 4.0.

YOU RESPOND:

7

B) If loading from disk: (CSDSKED.SV must have been previously loaded onto the disk).

Mount the disk pack which contains CSDSKED.

Set console switches to correct device code.

Press RESET and LOAD switches.

PROGRAM DISPLAYS:

FILENAME?

YOU RESPOND:

CSDSKED or (DIR:CSDSKED, if the program file is located in directory, DIR, other than the master).

STEP 2 - DISK TYPE

PROGRAM DISPLAYS:

DISK EDIT - REV NN.NN WITH ZETACO DISK SUPPORT - REV. 1

DISK DRIVE MODEL NUMBER?

YOU RESPOND:

6XXX

NOTE: Enter the X's as shown above.

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 blks. Blocks if disk <4000 blks.

STEP 4 - COMMANDS AND SUBSEQUENT OUTPUT

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

4.8 ECC - ECC ERROR CORRECTIONS COUNTER FUNCTIONS

The Model BMX-1 controller maintains a counter of ECC corrections for each drive connected to the board/s. 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 ECC program is currently available only for RDOS and AOS (RDOSECC.SV for RDOS and AOSECC.PR for AOS). It allows you to monitor the media by displaying or modifying the counters. Some installations may decide to reset the counters to zero on some regular basis: daily, weekly, monthly or whatever.

STEP 1 - EXECUTING THE PROGRAM UNDER CLI

A) RDOS Version

ENTER: RDOSECC

B) AOS Version

ENTER: X AOSECC

STEP 2 - MAIN MENU

CUSTOM SYSTEMS - 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 the 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 TROUBLESHOOTING

Self-test checks out all the internal functions of the controller board once for every time power is applied to the board. The test takes approximately 300 ms.

IF SELF-TEST PASSED, THE RED LED WILL GO OUT. If a failure was detected, the led will blink.

Looping on Self-test can be achieved by inserting a jumper at W8-4 which causes the microprocessor to continuously loop on the entire Self-test unless an error occurs. Refer to Section 3.2.2.

TEST	POSSIBLE FAILURE
EEPROM TEST	The data in the EEPROM did not compare with expected data (55 hex). EEPROM may not have been previously burned.
RAM TEST	Data read from RAM did not compare with data written. 2114, PBUS or RAM data bus may be bad.
BMC BUFFER TEST	Data transfer to and from the BMC buffer did not compare with the original data in buffer 0.
2940 ADDRESS GENERATOR TEST	Data read from 2940's did not compare with data written. 2940 may be bad.
ECC TEST	The generated ECC pattern did not compare with the expected pattern. The shift registers, ECC logic, or multiplexers may be bad.

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

SELF-TEST ERRORS

TABLE 5.1

CUSTOMER SUPPORT

Our warranty attests the quality of materials and workmanship in our products. If malfunction does occur, our service personnel will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions and technical advise is required, please phone ZETACO giving the serial number, board name, model number and problem description. You will be placed in contact with the appropriate technical assistance.

PRODUCT RETURN

Pre-return Checkout:

If controller malfunction is suspected, the use of test software is needed to determine if the controller is the problem and what in particular is wrong with the controller. The tests applicable to this board are listed on the next page of the manual. Please run the test sequence BEFORE considering product return.

Returned Material Authorization (RMA):

Before returning a product the ZETACO for repair, please ask for a RMA number. Each product returned requires a separate RMA number. Use of this number in correspondence and on a tag attached to the product will ensure proper handling and avoid unnecessary delays.

Returned Material Information:

Information concerning the problem description, system configuration, diagnostic program name, revision level and results, i.e., error program counter number should be included with the returning material. A form is provided for this information on the next page of the manual.

Packaging:

To safeguard your materials during shipment, please use packaging that is adequate to protect it from damage. Mark the box "Delicate Instrument" and indicate the RMA number/s on the shipping label.

(include with returning material)

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 in fact the board is defective (many boards returned for repair are not defective, causing the user unnecessary system down-time, paper work, and handling while proper testing would indicate the board is working properly). 2) Increase the speed and accuracy of a product's repair which is often dependent upon a complete understanding of the user checkout test results, problem characteristics, and the user system configuration. Checkout results for the BMX-1 SMD Controller should be obtained by performing the following tests. (Include error program counter numbers and accumulator contents if applicable).

FUNCTION	TEST	RESULT
SMD	Self-test	
	Diagnostics	
	Reliability	

Other test performed:

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

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

2. What operating system are you running under? (AOS RDOS, DDOS, DTOS).

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

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

To be filled out by CUSTOMER:

Model #:
Serial #:
RMA #:

Returned by:

(company name)

6.0 PROGRAM CONTROL

6.1 INSTRUCTION FORMAT

Symbolic form for I/O instructions:

DXXF AC, DSKP

DXX - DOA, DOB, DOC, DIA, DIB, DIC

F = Function:

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.

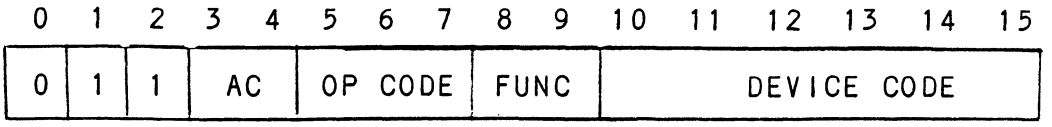
AC = Accumulator: 0, 1, 2 or 3.

DSKP = Device Code: Primary - 27 Octal

Secondary - 67 Octal

(Others available)

BINARY REPRESENTATION OF AN I/O INSTRUCTION



INTERRUPT MASK 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.

IORESET 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. The Controller ECC correction LOG is not cleared out by this instruction.

IOSKIP INSTRUCTION

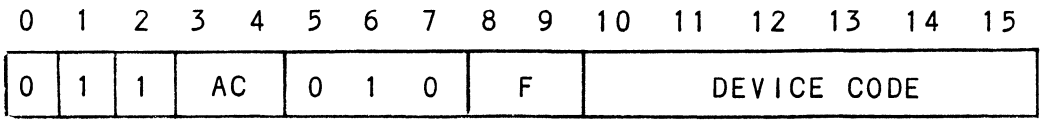
Used to poll the state of the controller board (command is done or busy). If the skip condition is met the next instruction is skipped, else the next instruction is executed.

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.

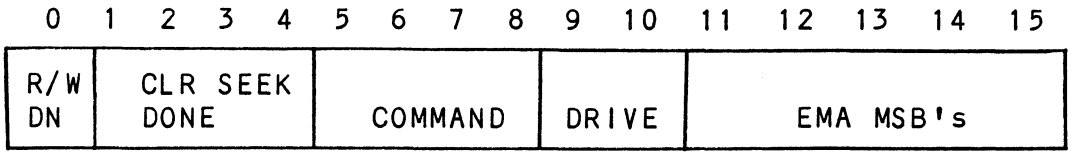
6.2 ACCUMULATOR FORMATS

6.2.1 DOA - SPECIFY COMMAND AND DRIVE

DOAF AC, DSKP



Accumulator



BIT POSITION

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

5 - 8 Specify Command

		FUNCTION REQUIRED TO INITIATE
0000	READ	START
0001	RECALIBRATE	PULSE
0010	SEEK	PULSE
0011	STOP DISC	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 6.3 for detailed command description

9 - 10 Drive Selection

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

DOA will reserve a previously unreserved drive

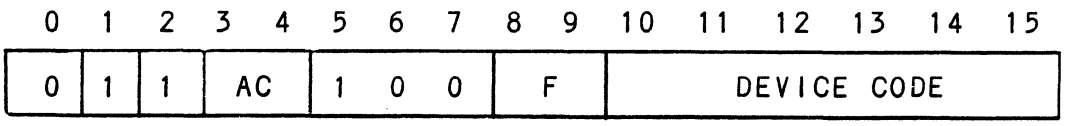
BIT Position 9 is not used if 616X

11-15 Extended Memory Address

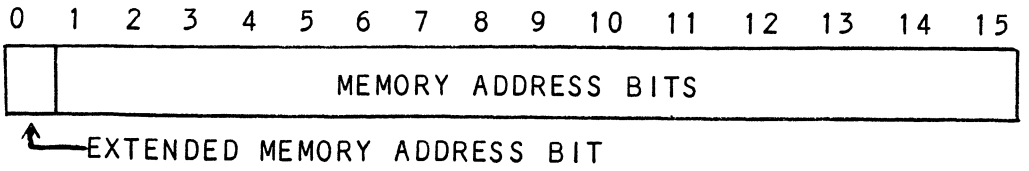
Specifies the MSB's of the Extended Memory Address

6.2.2 DOB - LOAD STARTING MEMORY ADDRESS

DOBF AC, DSKP



Accumulator

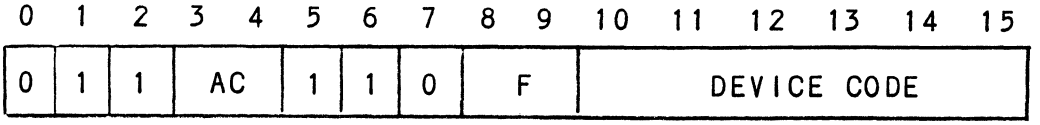


Execution of this instruction will load the controllers address counter with the contents of the specified accumulator and will be used as the starting memory address for a command that requires a DCH transfer or a BMC transfer operation.

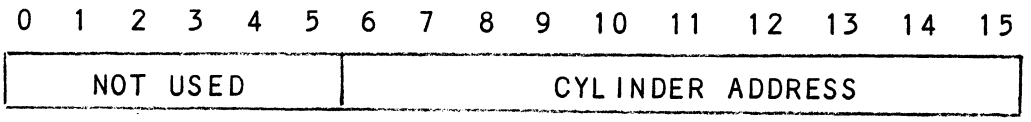
6.2.3 DOC - LOAD DRIVE ADDRESS

6.2.3.1 DOC - SPECIFY CYLINDER

DOCF AC, DSKP

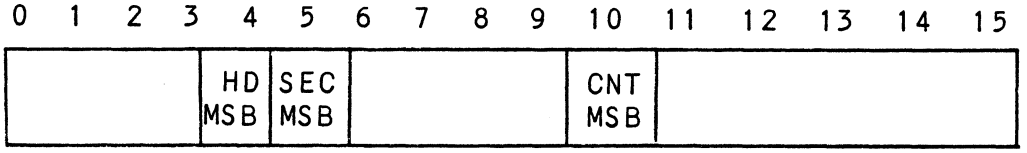


Accumulator (if previous DOA specified a Seek)

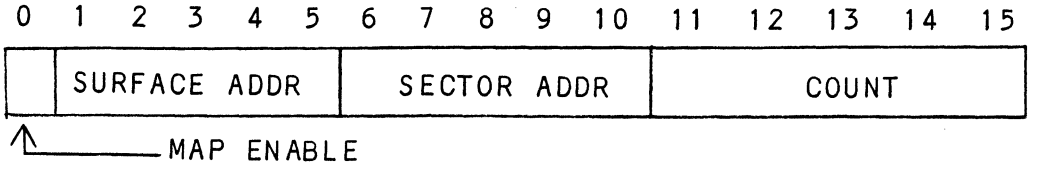


6.2.3.2 DOC - FIRST DOC SPECIFIES EXTENDED SURFACE, SECTOR AND COUNT (Double DOC mode only)

Accumulator (if previous DOA specified a Read, Write, Format or Data Verify)



6.2.3.3 DOC - SECOND DOC SPECIFIES LOWER FIVE BITS OF SURFACE, SECTOR AND COUNT (First and only DOC if single DOC mode)

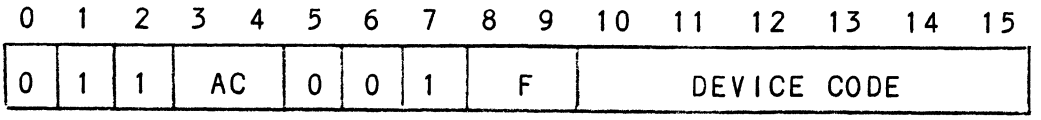


0 - Enable BMC Address Mapping
1 - 5 Starting Surface Address
6 - 10 Starting Sector Address
11-15 Two's complement of number of sectors to be transferred

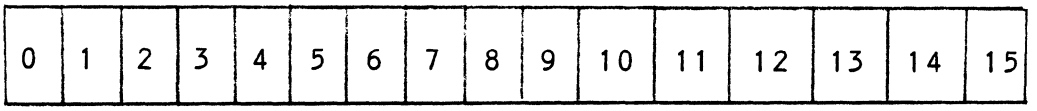
6.2.4 READ STATUS - NON ALTERNATE MODE

6.2.4.1 DIA - READ DATA TRANSFER STATUS

DIAF, AC, DSKP



Accumulator



0 - Control Full
1 - R/W Done
2 - Unit 0 Atten Done
3 - Unit 1 Atten Done
*4 - Unit 2 Atten Done
*5 - Unit 3 Atten Done
6 - BMC Bus Parity Error
7 - Illegal Sector Adr
8 - ECC Error
9 - Bad Sector Flag
10 - Cyl Addr Error
11 - Surf/Sect Addr Error
12 - Verify Error
13 - R/W Timeout
14 - Data Late
15 - Read/Write Fault

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

0	CONTROL FULL	Will be a one when the Controller receives a pulse function. Will be a zero once the Controller completes the function to the drive that was specified by the command (Recal, Seek, Stop Disk, Offset, WRT DIS, Release, Trespass and 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 PARITY ERROR	An Address or Data Parity Error occured on a Data Transfer between the Controller and the BMC Channel.
7	ILLEGAL SECTOR ADDR	The starting sector address (DOC) exceeded the capacity of the drive if set to a one. 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 Sectors Header did not match the requested cylinder given by the previous seek command. Bit 11 will set, instead, if there is no match due to a media flaw. The Read/Write Operation will be terminated immediately.
11	SURFACE/ 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 Sectors 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 6.1 for detailed description.

	STATUS BIT POSITION	CONTROLLLER ACTION	ERROR RECOVERY
BUS ERROR	6	Sets done immediately if Address error. Sets done at the end of sector xfer if data error	New command. re-try Read/Write Transfer. Insure BMC Bus Terminators are installed. If a second BMC device is connected, make sure it has a different Bus Priority.
ILLEGAL SECTOR ADDRESS	7	Sets done immediately	New command if error re-occurs. Make sure the controller is configured to match the drive type.
ECC ERROR	8	Sets done at the 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.
SURF/ SECTOR ADDRESS ERROR	11	Sets done immediately	New command. Bad sector flag should be set if surface analysis.
VERIFY ERROR	12	Sets done at the end of the 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.

READ/WRITE FAULTS (DIA)

TABLE 6.1

6.2.4.2 DIB - READ DRIVE STATUS

DIB AC, DSKP

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	AC		0	1	1	F		DEVICE CODE					

Accumulator

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

*0 - Invalid Status
*1 - Drive Reserved
*2 - Trespassed
 3 - Ready
 4 - Busy
*5 - Positioner Offset
 6 - Write Disabled
*7 - ID
*8 - III Sur/Cyl Addr
*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

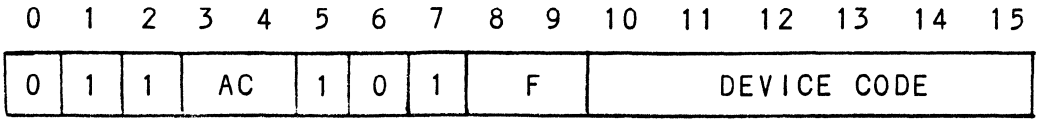
0	INVALID STATUS	A one indicates that Status Bits 1 through 15 should be ignored because the drive is not selected or it is in the process of being selected.
1	DRIVE RESERVED	In a dual port configuration the selected drive is currently in use by another processor.

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.

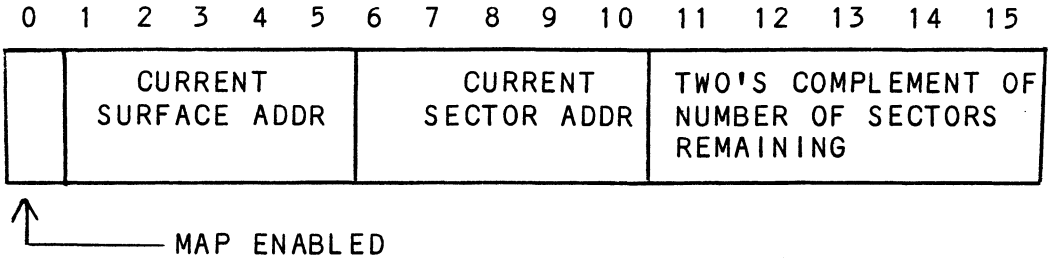
12	POSITIONER FAULT	This indicates that the drive was unable to complete a seed within 500 ms, or that the positioner has moved to a position outside the recording field. The system should send a recal command to recover from this error.
13	SERVO CLOCK FAULT	A clock synchronization failure occurred between 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.

6.2.4.3 DIC - READ SURFACE, SECTOR AND COUNT

DICF AC, DSKP



Accumulator



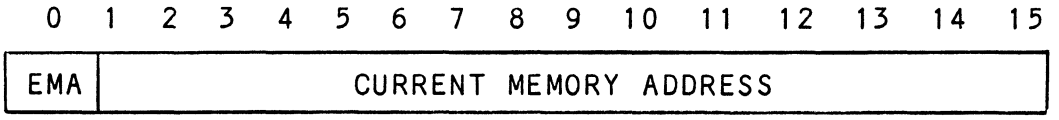
6.2.5 READ STATUS - ALTERNATE MODE ONE

See detailed description of Alternate Mode One Command. Previous DOA specified ALT Mode One for Sections 6.2.5.1 through 6.2.5.3.

6.2.5.1 DIA - READ CURRENT MEMORY ADDRESS

DIAF AC, DSKP

Accumulator



After the execution of this instruction the value of the accumulator 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 DCH or BMC transfer.

6.2.5.2 DIB - READ EXTENDED MEMORY ADDRESS

DIBF AC, DSKP

Accumulator

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

0 - BMC Mode
1 - Fixed Disk
2 - Drive 0 ID
3 - Drive 1 ID
4 - Surface Address (MSB)
5 - Sector Address (MSB)
6 - Drive 0 ID
7 - Drive 1 ID
8 - Not Used
9 - Not Used
10 - Sector Count (MSB)
11-15 - Extended Memory Address

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.

6.2.5.3 DIC - NOT CURRENTLY IMPLEMENTED

6.2.6 READ STATUS - ALTERNATE MODE TWO

See detailed description of Alternate Mode Two Command. Previous DOA specified ALT Mode Two for Sections 6.2.6.1 through 6.2.6.3.

6.2.6.1 DIA - READ ECC REMAINDER UPPER

DIAF AC, DSKP

Accumulator

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

6.2.6.2 DIB - READ ECC REMAINDER LOWER

DIBF AC, DSKP

Accumulator

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

6.2.6.3 DIC - NOT CURRENTLY IMPLEMENTED

6.3 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 a DOA instruction. Before any Command is initiated, the selected unit must have valid status and be ready.

6.3.1 DATA TRANSFER COMMANDS

Start (Set Busy) will initiate any one of the following commands: Read, Write, Format, Verify or Read Buffers up to 64 contiguous sectors may be transferred.

Read/Write Initialization Steps:

1. Control full and Drive status must be tested for proper state 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)

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

4. Send the Command type and the desired Drive Unit Number. (See DOA)

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.

6.3.1.1 READ 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 insure 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 drives 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 insure 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 Configurating section), 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.

6.3.1.2 WRITE COMMAND

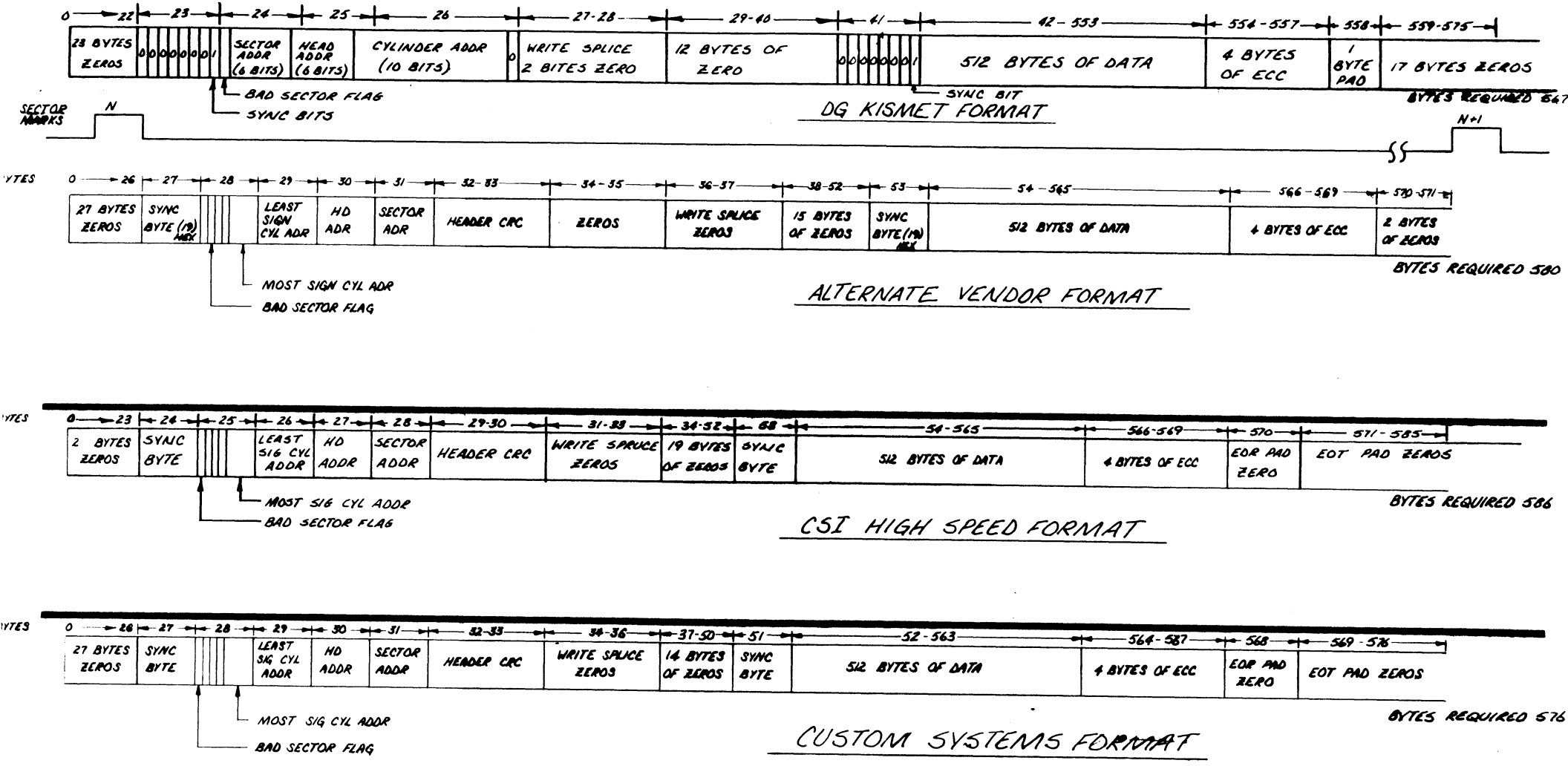
When busy sets, the Controller will wait for the positioner to be on cylinder if the selected drive is still in the process of seeking. Upon the completion of the previous seek operation, the Controller will transfer 256 words of data from memory to a sector buffer. The starting address of memory was 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 on to the surface of the disk. Once the correct sector is found, the Controller will select the sector buffer previously written by the DCH control. The contents of this buffer is then written on to the disk surface proceeded by a gap and data sync. The controller incorporates two sector buffers. Therefore, the BMC or DCH logic can write into one buffer while data is transferred to the disk from the other.

6.3.1.3 VERIFY

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.

6.3.1.4 FORMAT

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 6.2 for format details. Format is also used to set the bad sector flag.



HEADER FORMATS

FIGURE 6.2

6.3.1.5 READ BUFFERS

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.

6.3.2 DRIVE COMMANDS

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

6.3.2.1 RECALIBRATE

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.

6.3.2.2 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.

6.3.2.3 OFFSET FORWARD

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).

6.3.2.4 OFFSET REVERSE

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.

6.3.2.5 WRITE DISABLE

Not implemented.

6.3.2.6 RELEASE DRIVE

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

6.3.2.7 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 drive timeout feature times out.

6.3.2.8 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.

6.3.2.9 EXAMINE RAM COMMAND

This command gives the system the capability of reading from or writing to the BMX-1 controllers memory. This command must be proceeded by a DOC containing the address of the desired RAM location. See Tables 6.2/6.3 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.

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	EXT. DOC
30C	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,BMC PRIORITY
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

BMX-1 MICROPROCESSOR MEMORY MAP

TABLE 6.2

4800	START OF PORT 0
4880	START OF PORT 1
4900	START OF PORT 2
4980	START OF PORT 3
XX00	RCHAR SWITCHES
XX01	RPARA SWITCHES
XX02	DEVICE SELECT CODE
XX03	INTERLEAVE FACTOR
XX04	THROTTLE BURST RATE
XX05	BREAK COUNT
XX06	# OF BURSTS
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

EEPROM MAP

TABLE 6.3

1460-1462	SELECTED DRIVE CHARACTERISTICS	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	UNIT CORRECTION COUNTS	These locations will be incremented each time the controller does a correction either by 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
```

6.3.3 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.

6.3.3.1 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.

6.3.3.2 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.

6.4 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.

6.5 FORMAT SEQUENCER

The BMX-1 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 Self-test.

6.5.1 READ/WRITE FORMATS

The BMX-1 will support up to 7 different types of media formats (see Figure 6.2).

APPENDIX A

DIAGNOSTIC SUPPORT PACKAGE
GENERAL INFORMATION

BOOTSTRAP PROCEDURES
LOADING DSP FROM TAPE

1) Load desired DSP tape and put Drive On-line.

2) Perform the following steps when the system has the program load option. (If system does not have program load option consult processor manual.)

   A) Put 100022 or 100062 on console data switches 0 - 15.

   B) Program load.

      a) Press program load switch if front panel has switches.
      b) DG virtual console, enter 100022L or 100062L (if 100062 first enter 100062 in 11A).

      c) Point 4 virtual console, set switches or CPU board, enter P22 or P62.

3) Enter tape file number, followed by a carriage return of desired test.

4) If program is not self starting perform the following steps:

   A) Front Panel Switches.

      a) Put starting address on console data switches (0-15).
      b) Press examine memory.
      c) Put switch settings on console data switches (0-15).
      d) Press continue.

   B) Virtual Console.

      DG

      a) Enter switch settings in 11A through keyboard.
      b) Enter starting address (XXXXR) through keyboard.
      c) To change switch settings, enter break, change 11A through keyboard, and enter PC address when break occurred. (XXXXR)
      d) To continue on error halt, enter PC address (XXXXR).

      POINT 4

      a) Set switches on CPU board.
      b) Enter starting address (JXXXXX).
      c) To continue on error halt, enter PC address (JXXXXX).

LOADING DSP FROM TAPE TO DISK

1. The last file on the DSP tape (reference menu for number) is a dump format copy of the previous files. This allows a user to load (use RDOS load command) the files onto a disk.

2. The files can now be booted from disk (enter file name in response to filename? or pathname?).

INDEX

```
;
;*****************************************************************
;-----------------------------------------------------------------
;
; 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.
```

```
;       7.1 "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)

```
;
;       "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.
```

```
; II. 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".
```

```
;
;       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 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.
```

```
;       3. 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.
;
;       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 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.

```
;TT.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
```