HEWLETT hp PACKARD

INSTALLATION AND SERVICE MANUAL

MODEL 7905A CARTRIDGE DISC SUBSYSTEM

(HP 30129A Subsystem for HP 3000 Computer Systems)

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30229-60001

OPTIONS COVERED

This manual covers option 015 to the subsystem.

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PREFACE

This manual contains service information for the HP 7905A Cartridge Disc Subsystem. The subsystem described in this manual is used as an integral part of the HP 3000 Computer System to provide I/O capability between the system and the HP 7905A Disc Drive.

The contents of this manual are organized in four sections as follows:

a. Section I. Section I contains general information relative to the subsystem physical features and specifications.

b. Section II. Section II contains installation instructions for the subsystem.

c. Section III. Section III contains theory of operation for the subsystem.

d. Section IV. Section IV contains servicing instructions with preventive and corrective maintenance information.

This manual should be retained and used with related documentation for the HP 3000 Series II Computer System or the pre-Series II HP 3000 Computer System. The related documentation for the HP 3000 Series II Computer System includes the following:

a. *HP 3000 Series II Computer System Service Manual*, part no. 30000-90018.

b. *HP 3000 Series II Computer System Signal and Power Distribution Manual*, part no. 30000-90021.

c. *HP 13037A Disc Controller Installation and Service Manual*, part no. 13037-90006.

d. *HP 7905A Disc Drive Installation and Service Manual*, part no. 07905-90007.

e. *Stand-alone HP 30129A Cartridge Disc Diagnostic*, part no. 30129-90007.

f. *HP 29425A Cabinet Manual*, part no. 29425-90001.

The related documentation for the pre-Series II HP 3000 Computer System includes the following:

a. *HP 30001A CPU/IOP Servicing Manual*, part no. 30001-90003.

b. *HP 30005A/30006A Memory Servicing Manual*, part no. 30005-90001.

c. *HP 30030A Selector Channel Maintenance Manual*, part no. 30030-90001.

d. *HP 13037A Disc Controller Installation and Service Manual*, part no. 13037-90006.

e. *HP 7905A Disc Drive Installation and Service Manual*, part no. 07905-90007.

f. *Stand-alone HP 30129A Cartridge Disc Diagnostic*, part no. 30129-90006.

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GENERAL INFORMATION

SECTION I

1-1. INTRODUCTION.

1-2. This manual describes the HP 7905A Cartridge Disc Subsystem which provides mass storage facilities for HP 3000 Computer Systems. The manual also contains detailed information about the interface unit, HP part number 30229-60001, which is not documented in its own manual. The HP 3000 Series II disc drive is shipped installed in an HP 29425A Cabinet. This cabinet is described in the cabinet manual part number 29425-90001.

1-3. This first of four sections describes the subsystem and the devices which make up the subsystem.

1-4. DESCRIPTION.

1-5. The HP 7905A Cartridge Disc Subsystem provides an HP 3000 Computer System with a fully automatice, random access, mass storage memory. The subsystem consists of a disc controller (on three HP 3000 I/O-type boards), a cartridge disc drive, and an interface unit (on one HP 3000 I/O-type board). See Figure 1-1. The interface unit interfaces the disc controller to the HP 3000 I/O system.

1-6. DISC DRIVE.

1-7. Each disc drive has one fixed disc platter which is not removable and one removable, front-loading, single platter, disc cartridge. Each platter has a top surface and a bottom surface making four surfaces, numbered 0 through 2 and servo per disc drive. Each surface, has a read/write head which is capable of storing (writing) data on the surface in 411 concentric tracks numbered 0 through 410. The data on the servo surface consists of servo tracks which are used as a reference to maintain the read/write heads centered over the data tracks, therefore, only three surfaces are available for data storage.

1-8. Data storage on the discs is organized into cylinders (tracks), heads (surfaces), and sectors. The read/write heads are mechanically coupled so as to be positioned at any time over the same numbered tracks of each surface. A cylinder is then defined as the set of three tracks which can be written on or read from without head movement. (An "imaginary" cylinder is formed by any three of the same numbered tracks of each surface.) Cylinder addresses are, therefore, the same as those of the tracks which form them, 0 through 410. Although only one of the three data tracks of a cylinder can be written on or read from at a time, it is possible to automatically switch between heads on different surfaces.

1-9. Each track contains 48 sectors numbered from 0 to 47. Each sector is capable of storing 128 data words. The storage capacity of each disc is, therefore, the product of 3 (surfaces) times 400 (tracks guaranteed per surface) times 48 (sectors per track) times 128 (words per sector) or 7,372,800 data words. The sector numbers are logically staggered from surface to surface by one sector for each successively numbered surface to allow cylinder address verification after head switching and checking of track status before further reading or writing operations are permitted. Track status may be spare, privileged, or defective.

1-10. DISC CONTROLLER.

1-11. The disc controller is a microprocessor-controlled unit capable of connecting multiple disc drives to a high level interface. In this subsystem, the high level interface is an HP 3000 Computer System, reached by way of the HP 30229-60001 interface unit printed circuit assembly (PCA). Other important features provided by the disc controller include:

a. Automatic incremental or decremental seek.

b. Automatic track sparing.

c. Data transfer error correction.

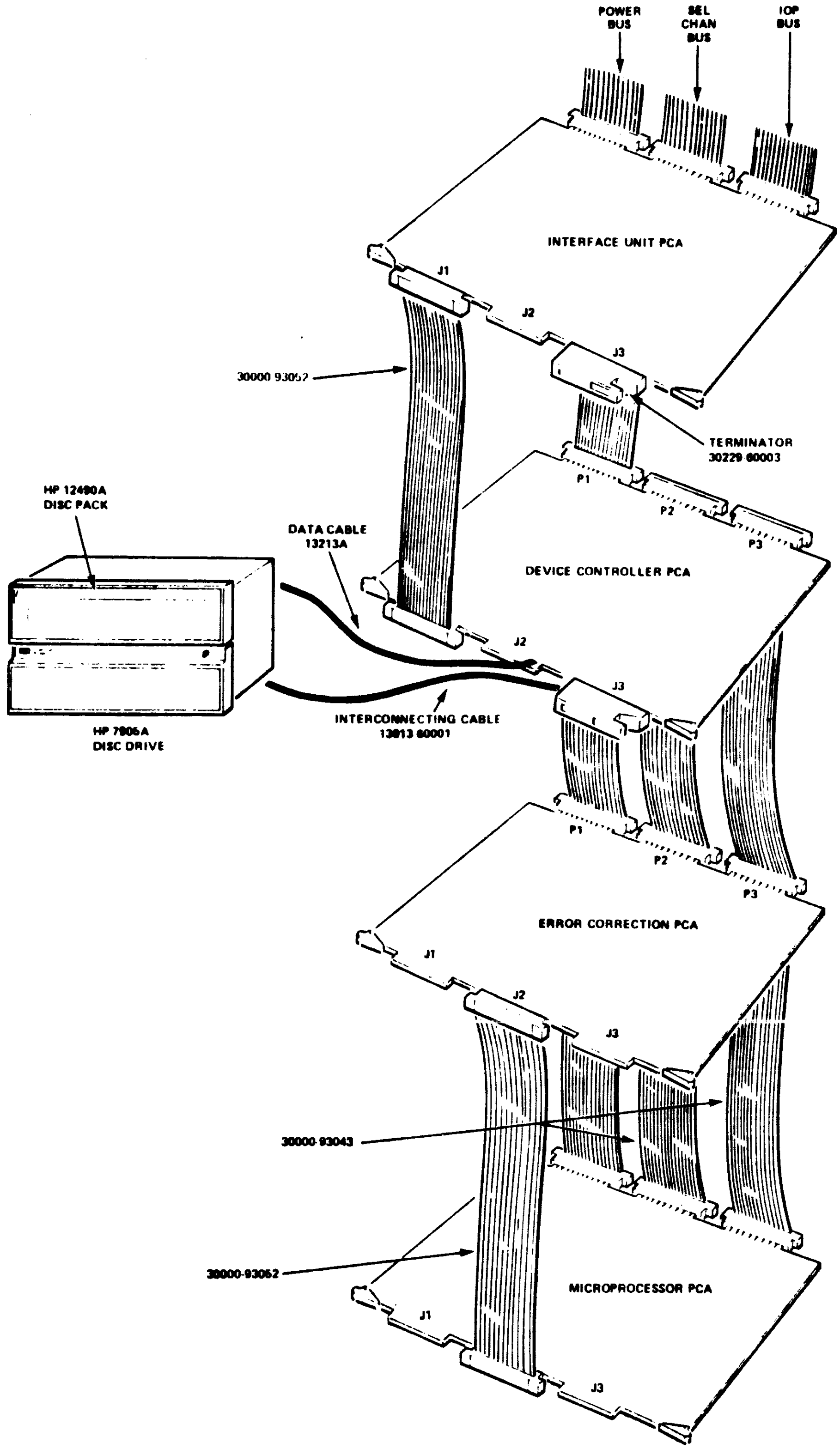
d. Automatic retry of transfers after error detection.

1-12. The disc controller consists of three printed circuit assemblies, each of which was designed to reside on a six-connector I/O-type board so that they can occupy a slot in the I/O portion of the HP 3000 Computer System. They are named Device Controller PCA, Microprocessor PCA, and Error Correction PCA.

1-13. INTERFACE UNIT.

1-14. The two-way transfer of data and subsystem commands and status between the subsystem and the user system is by way of an interface unit. Communication between the HP 3000 and its interface unit is done via the IOP and selector channel busses.

1-15. This subsystem employs the 30229-60001 Interface Unit PCA to link the disc controller and disc drive to an HP 3000 Computer System.



7511-1

Figure 1-1. Cartridge Disc Subsystem

1-16. EQUIPMENT FURNISHED.

1-17. Equipment furnished for the base HP 7905A Cartridge Disc Subsystem (product number 30129A) consists of the following:

a. HP 7905A Cartridge Disc Drive with an HP 12940A Formatted Disc Cartridge

b. HP 29425A Cabinet for the HP 7905A Disc Drive.

c. HP 13013A Option 002 Multi-Unit Cable. The cable length is 5.49 meters (18 ft).

d. HP 13213A Option 001 Data Cable. The cable length is 7.62 meters (25 ft).

e. HP 30229A Cartridge Disc Interface Kit.

NOTE

The total length of all HP 13013A cables in the system may not exceed 74 feet.

1-18. The HP 30229A Cartridge Disc Interface Kit consists of:

a. An interface unit printed-circuit assembly (PCA) part no. 30229-60001.

b. A disc controller comprised of three printed-circuit assemblies; a microprocessor PCA part no. 13037-60001, a device controller PCA part no. 13037-60002, and an error correction PCA part no. 13037-60004.

c. Four flat cables; two part number 30000-93043 and two part number 30000-93052.

d. A terminator assembly part no. 30229-60003.

1-19. An HP 30329A Disc Drive add-on product incorporates one or more disc drives into a HP 3000 Computer System. Each HP 30329A consists of:

a. HP 7905A Cartridge Disc Drive with an HP 12940A Formatted Disc Cartridge.

b. HP 29425A Cabinet for the HP 7905A Disc Drive.

c. HP 13013A Option 003 Multi-Unit Cable. The cable length is 2.44 meters (8 ft).

d. HP 13213A Option 002 Data Cable. The cable length is 15.24 meters (50 ft).

1-20. OPTIONS AVAILABLE.

1-21. Subsystem option 015 provides for operating the subsystem from a 230-volt, single-phase, 50 Hertz source by furnishing disc drives having that capability.

1-22. SPECIFICATIONS.

1-23. Pertinent specifications for disc drive and disc controller are described in their respective service manuals. The interface unit requires 3.6 amperes at +5 volts when installed in the HP 3000 Computer I/O card cage.

INSTALLATION

SECTION II

2-1. INTRODUCTION.

2-2. This section provides information needed to integrate the HP 7905A Disc Cartridge Subsystem into an HP 3000 Computer System.

CAUTION

Do not use any portion of the disc drive as a hand hold when moving the HP 29425A Cabinet. The disc drive may be damaged.

2-3. JUMPER CONFIGURATIONS.

2-4. There are four sets of jumpers which must be configured before the board can be installed in the computer card cage. These sets represent device number, interface address, preset disable, and interrupt mask. The four areas for jumper installation on the Interface Unit PCA are shown in Figure 2-1. Table 2-1 summarizes the jumper descriptions. There is no parity jumper on this PCA because it is not required by the selector channel.

2-5. When a jumper is installed to select a "1" or "0" or to enable "E" or disable "D", the body of the jumper covers the position designator of the desired state leaving the position designator for the undesired state visible. Note in the selection made in Figure 2-1 that Preset Disable is enabled, the Device Number is binary 0000101 (octal 005), and the Interface Address is binary 000.

2-6. PRESET DISABLE.

2-7. The preset disable jumper is provided so that any clear signal to the interface unit can be prevented from affecting the disc controller. The jumper should be placed in the enable position.

2-8. DEVICE NUMBER.

2-9. The device number jumpers assign a number to each subsystem so that it may be identified by the HP 3000 I/O system. These subsystem numbers (in the range of %3 to %177) are set to a number known to the disc driver when the system is configured. A jumper in position "1" or "0" results in a logical "1" or "0", respectively, in the DRT address in memory for this device (subsystem).

2-10. INTERFACE ADDRESS.

2-11. Position these three jumpers to 0.

2-12. INTERRUPT MASK.

2-13. The interrupt mask jumper is provided to allow selective setting and clearing of the interrupt mask indicator. This feature is not implemented by standard HP 3000 software, therefore, set to E (enable).

Table 2-1. Interface Unit PCA Jumpers

JUMPER NAME	REFERENCE DESIGNATION	DESCRIPTION
Preset Disable	W1	One jumper with two possible positions, E and D. The jumper must be set to E for this subsystem.
Device Number	W2-W8	Seven jumpers which program the device number of the subsystem. The device numbers range from %3 to %177. Normally set to %5.
Interface Address	W9-W11	Three jumpers which program the interface unit address for use by the disc controller to identify this subsystem as one particular subsystem of a group of subsystems. Set to 0 for this subsystem.
Interrupt Mask	W12	Assigns the subsystem to an interrupt mask group when installed in positions 0 through 15, or enables subsystem response to all Set Mask commands when installed in the ENABLE position, or disables subsystem response to all Set Mask commands when installed in DISABLE position. Normal position is E.

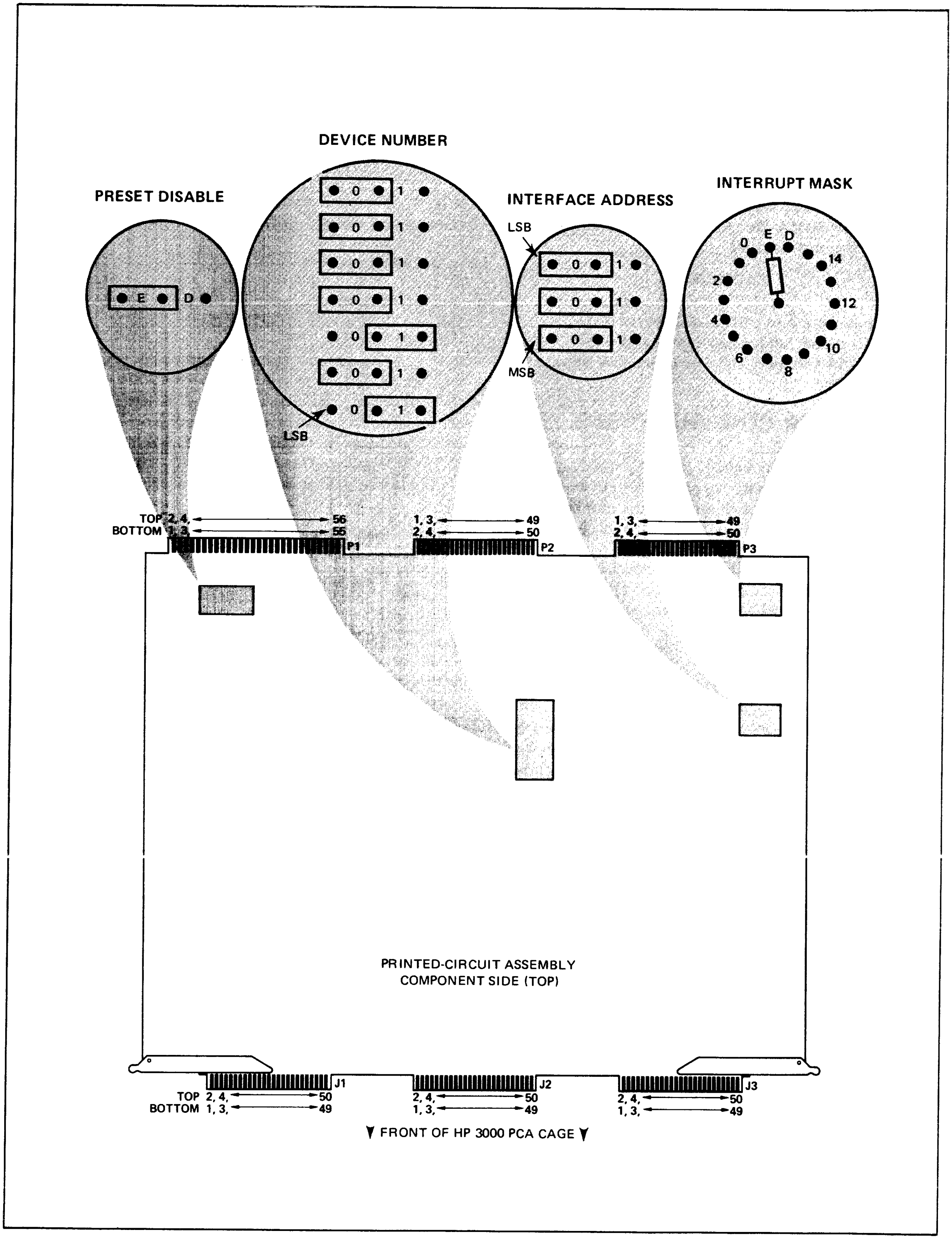


Figure 2-1. Interface Unit PCA Jumper Locations

2-14. BOARD LOCATION AND INSTALLATION.

2-15. Locate the interface unit PCA (part no. 30229-60001) in the I/O area of the computer system near the selector channel to minimize cable lengths. The slot used will have P2 cabled to the channel bus and P3 cabled to the IOP bus. There must be three slots available immediately beneath the interface unit PCA to receive the disc controller PCAs.

2-16. The three PCAs of the disc controller are located in the same PCA board module as the interface unit. The device controller PCA (part no. 13037-60002) is immediately beneath the interface unit PCA with the error correction PCA (part no. 13037-60004) next and the microprocessor PCA (part no. 13037-60001) last. A second configuration is allowed which has the device controller PCA above the interface unit PCA, the error correction PCA above the device controller PCA, and the microprocessor PCA above the error correction PCA. These two configurations, one the inversion of the other, are the only configurations allowed.

2-17. CABLING.

2-18. Observe the following caution.

CAUTION

When cabling the subsystem, ensure that system power is off. Also, some cables and associated hardware demand proper orientation before being connected, otherwise the hardware might be damaged.

2-19. The cartridge disc subsystem is cabled as follows:

a. A flat cable, part number 30000-93052, connects J1 of the interface unit PCA to J1 of the device controller PCA. Another connects J2 of the error correction PCA to J2 of the microprocessor PCA. See Figure 1-1.

b. A flat cable, part number 30000-93043, interconnects the P2 connectors of the device controller PCA, error correction PCA, and microprocessor PCA. Another interconnects the P3 connectors of the same three assemblies.

c. A data cable, part number 13213A, connects from one of eight connectors (J4 through J11) on the device controller PCA to connector A7P4 on the rear of the disc drive. There is one of these cables for each disc drive in the subsystem. See Figure 2-2 and its inserts C and B.

d. An HP 13013A Multi-Unit cable connects from J3 of the device controller to a T-connector at the terminal bracket on the rear of the first disc drive. A flat cable is brought out from the rear of the disc drive to connect via a cable-to-cable adapter or via a terminator PCA to the T-connector. The connection is via cable-to-cable adapter if the installation has more than one disc drive or via the terminator PCA if this is the only disc drive in the installation. See Figure 2-2 and its insert A.

e. In installations containing more than one disc drive, a Multi-Unit cable connects the control lines from the T-connector of one drive to the T-connector of the next drive in line. The flat cable from the rear of each disc drive will connect via a cable-to-cable adapter to the T-connector unless this is the last drive in line. The connection is made via a terminator PCA for the last drive only.

NOTE

The total length of all HP 13013A Multi-Unit cables in the system may not exceed 74 feet.

f. The HP 29425A Cabinet is supplied with a 20-ampere power cord and a keyed plug. The customer will need to install a special AC receptacle. The receptacle needed is the 20-ampere NEMA type 5-20R. (A Hubble part no. 5362 or equivalent will serve the purpose.) If the subsystem contains option 015 (operation of the disc drive on 230-volts, single-phase, 50 Hz power), the customer must provide for all electrical hardware required from his power mains to the power input terminals of the cabinet. Refer to the *HP 29425A Cabinet Installation and Service Manual.*

2-20. FIELD ADD-ON.

2-21. Appendix A contains additional information for HP 7905A Cartridge Disc Subsystems (product number 30129A) installed as an add-on to HP 3000 Computer Systems in the field.

2-22. REPACKING FOR SHIPMENT.

2-23. If one of the devices is to be shipped to Hewlett-Packard for service or repair, attach a repair order to the faulty instrument identifying the owner and indicating the service or repair to be accomplished. Include all symptoms of the malfunction, the model number and full serial number of the instrument.

2-24. Place the instrument in the original container if available or a suitable replacement.

2-25. If original container is not used, wrap instrument in heavy paper and place in an inner container. Use adequate packing material around all sides of the instrument and place a cardboard strip over the display panel face. Place the instrument and inner container in a heavy carton or wooden box and bind with strong tape or metal bands. Mark shipping container with "Delicate Instrument", "Fragile", etc.

NOTE

In any correspondence, identify the instrument by model number and serial number prefix.

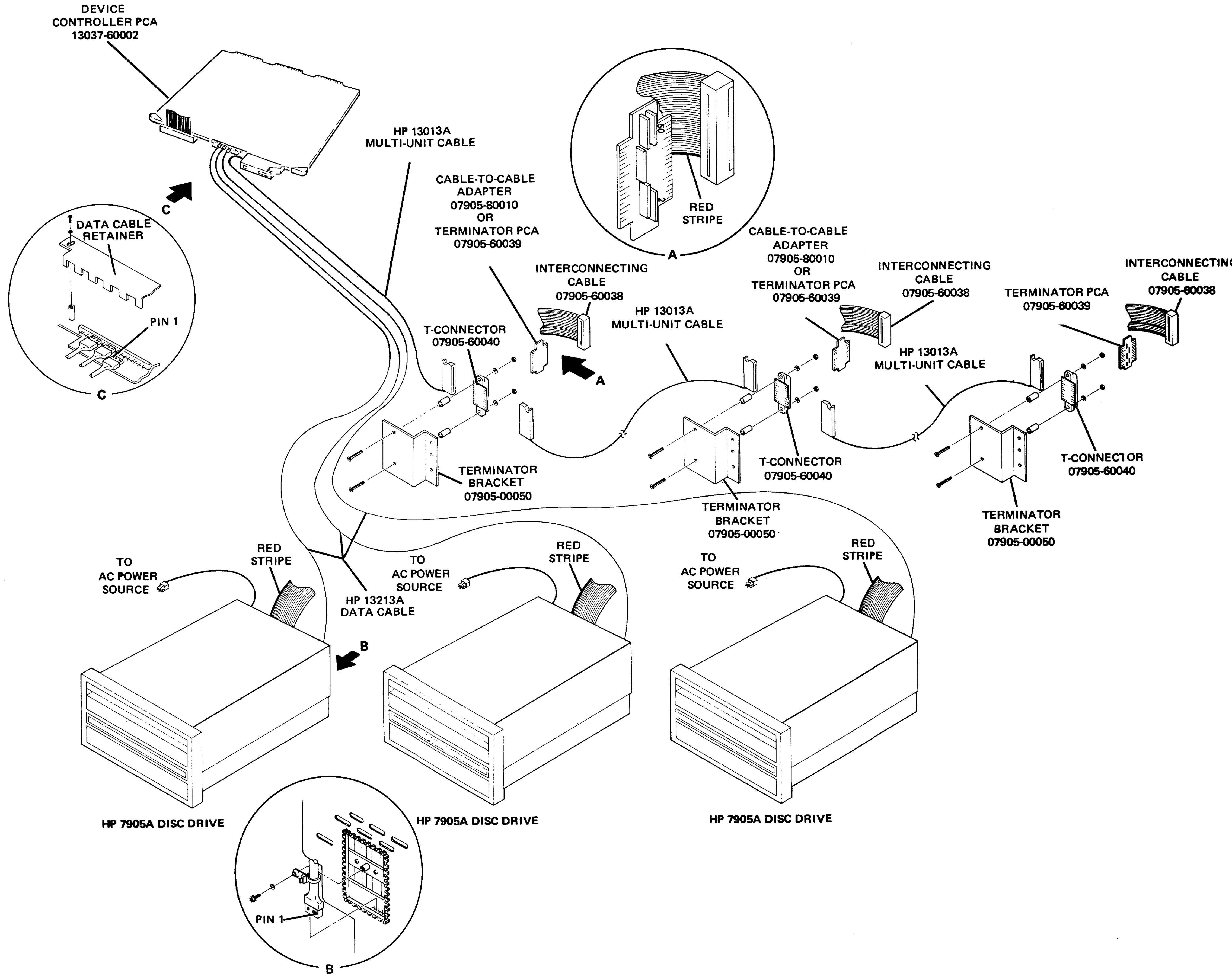


Figure 2-2. Disc Driver Interconnection Diagram

THEORY OF OPERATION

SECTION III

3-1. INTRODUCTION.

3-2. The theory of operation in this section describes the subsystem hardware as it is typically manipulated by HP-furnished software and firmware as a result of normal operation of the system.

3-3. SUBSYSTEM-LEVEL DESCRIPTION.

3-4. A subsystem block diagram is shown in Figure 3-1 which shows how the disc subsystem components relate to each other to certain other system components. The major subsystem components are the interface unit, the disc controller, and the disc drive.

3-5. INTERFACE UNIT.

3-6. The transfer of data and subsystem commands and status between the disc subsystem and user systems is done by way of the interface unit. Command storage is provided by the interface unit to accommodate disc drive and disc controller availability. For example, a command may be issued to this subsystem; however, the disc controller is busy, therefore, the command is stored to be implemented when the drive is available.

3-7. The interface unit communicates with the system's IOP and selector channel and with the subsystem's disc controller. The interface unit responds to an SIO command on the IOP bus by sending a request to the selector channel to start an SIO program. The interface unit also sends its device number to the selector channel and sets an SIO BUSY flag to enable the interface unit to respond to selector channel commands.

3-8. DISC CONTROLLER.

3-9. The disc controller, a microprocessor controlled device, interfaces via a device bus with multiple disc drives and via an interface bus with the interface unit. System interface functions performed by the controller include signal format conversion, command storage, and data transfer supervision. Signal conversion is required to perform parallel-to-serial (outbound) and serial-to-parallel (inbound) data transfers. Command storage is provided by the controller to accommodate disc drive availability, etc. For example, a command may be issued to the drive; however, the drive is not ready at this time. Therefore, the command is stored to be implemented when the drive is available. A total of 22 commands are provided to allow the computer to control operation of the disc drives by way of the disc controller. The commands provided and their code assignments are given in Table 3-1 which also provides a brief description of the function of each command.

3-10. DISC DRIVE.

3-11. The HP 7905A Disc Drive is the mass storage device for the subsystem. It has a removable cartridge and a single fixed disc. The removable cartridge is a front loading plastic enclosure with a 14 inch diameter disc.

3-12. Data storage on the disc is organized into surfaces, cylinders, and tracks. On the HP 7905A Disc Drive there are two platters and, therefore, four recording surfaces. Three surfaces are for the storage of data since one contains servo tracks which are used as a reference for maintaining the read/write heads centered over the tracks containing data.

3-13. A cylinder is defined as the set of tracks which can be read or written on without head movement. There are 411 cylinders numbered 0 to 410 with the lower numbered cylinders located towards the outer edge of the disc. Although only one data track is ever read or written on at a time, it is possible to switch between heads on different surfaces.

3-14. Each track contains 48 sectors numbered from 0 to 47. Sector numbers are logically staggered by one sector for each successively higher numbered surface to allow cylinder address verification after head switching. Automatic head switching always occurs at the end of sector 47. The staggered sector numbers also allow checking of track status before further reading or writing operations are permitted. Track status may be assigned by setting bits in the initialize command (13) to the disc subsystem. See Table 3-1. Status may be assigned spare, protected, or defective.

3-15. The recording format of a track is shown in Figure 3-2. Individual sectors are separated by a gap which is equivalent to about nine words. The beginning of each sector is flagged by a sector mark which is read from the servo track. An index mark indicates the location of sector 0. A modulo 48 sector counter located in the drive is initially cleared by the index mark. The sector counter is then counted up one by each sector mark to indicate where the read/write heads are currently positioned on the track.

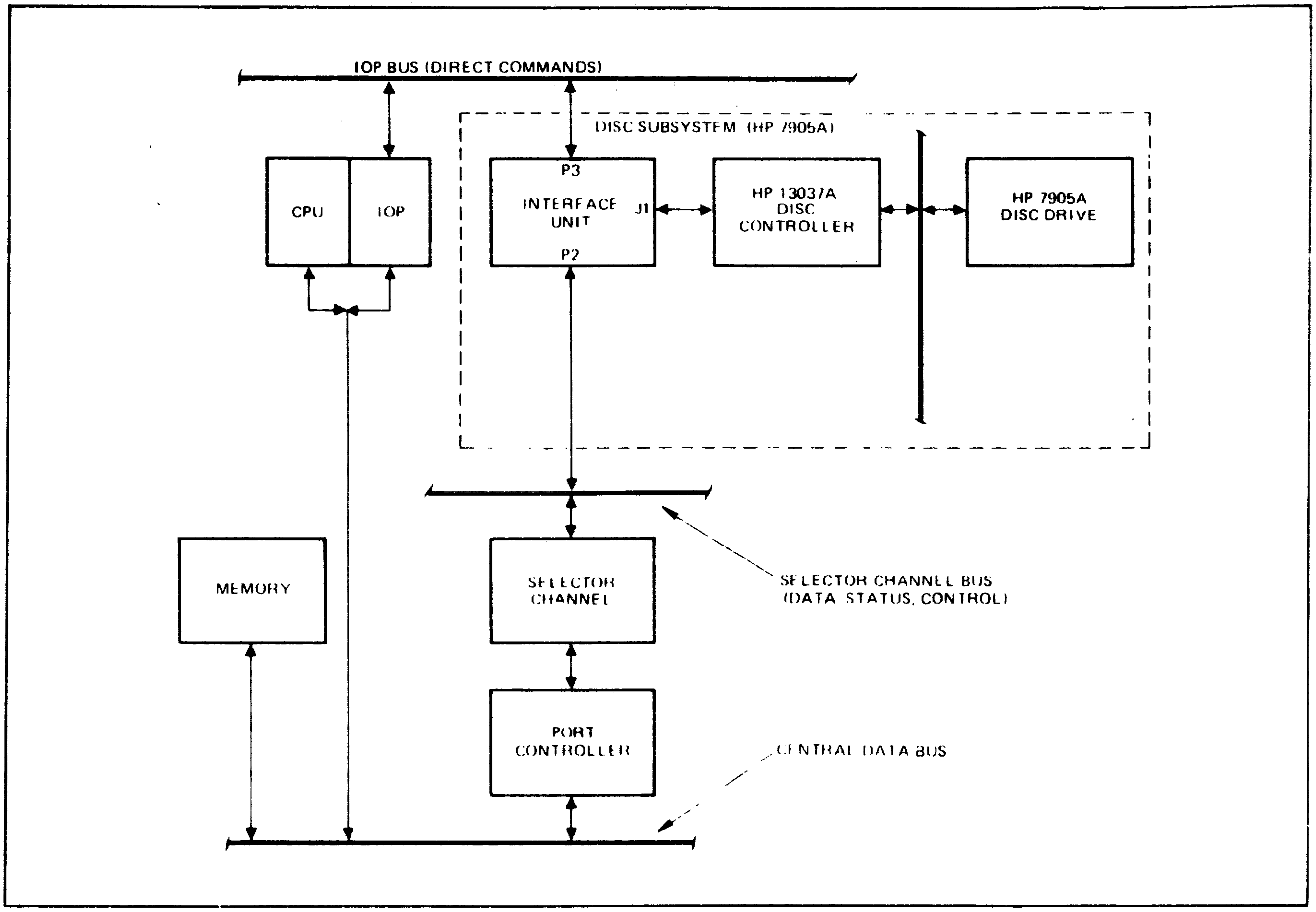


Figure 3-1. Disc Subsystem Interfaced with HP 3000 Computer System

3-16. The recording format for a sector is shown in Figure 3-3. Each sector contains 148 16-bit words comprised of a 13-word preamble, a 128-word data block, and a 7-word postamble. The first 11 words of the preamble are used to synchronize a phase-locked loop for control of an oscillator whose output is used to detect ones or zeros in the data to be read from the disc. The other two words in the preamble contain track status and the complete address of the data in the sector to allow data protecting, address error checking, and automatic track sparing. The seven words in the postamble are provided to allow error checking and error correction to be performed.

3-17. The word storage capacity per disc drive is dependent on the usable number of words per sector (128), sectors per track (48), tracks per surface (411), and surfaces per drive (3). For each HP 7905A Disc Drive, the storage capacity is 7,575,552 words. The data transfer rate is 450,000 words per second.

3-18. CONTROL.

3-19. The primary function of the cartridge disc subsystem is to perform those operations required to store or access data on the storage media of the disc drives. This includes the ability to perform operations as follows:

a. Position the read/write heads over a designated track.

b. Locate a particular record or part of a record.

c. Write or read a record or part of a record.

d. Transfer status information to the using system.

3-20. Operation of the subsystem is controlled by commands issued by the using system. These commands are described in Table 3-1. The disc controller executes these commands with assistance from the interface unit and the disc drive. Table 3-1A shows the relationship between the command code and the octal value of the command as it would be seen in an octal dump. (It is assumed that bits 8 and 9 are zeros.)

3-21. Interface between the interface unit is conducted on the IOP bus, the power bus, and the selector channel bus. A description of the signals on each of these buses is given in Tables 3-2, 3-3, and 3-4, respectively. Subsystem signals between the interface unit and the disc controller are described in Table 3-5.

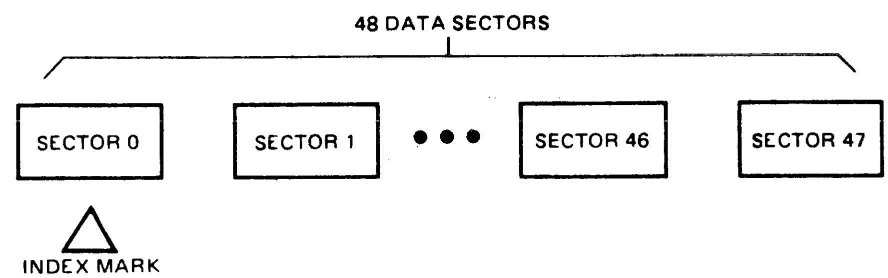
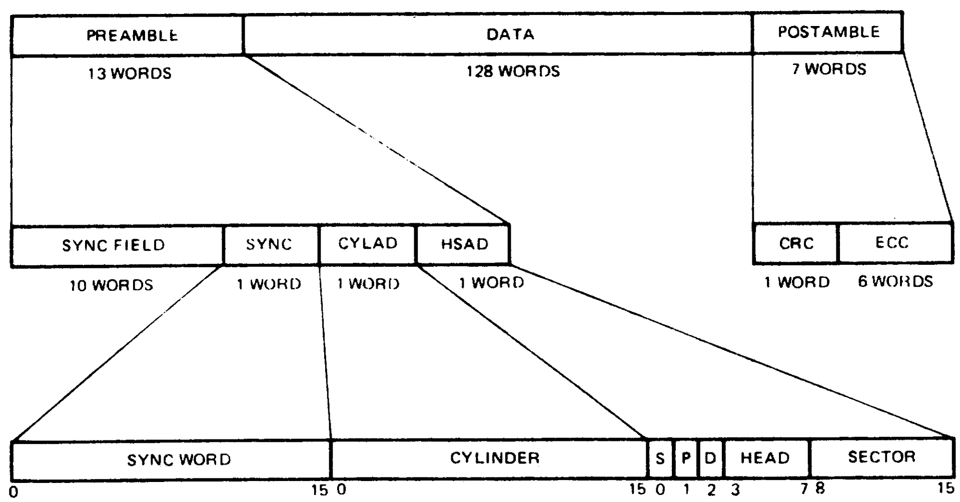


Figure 3-2. Track Recording Format



PREAMBLE — 13 WORDS FOR SYNCHRONIZATION AND ADDRESSING
DATA — 128 WORDS OF DATA
POSTAMBLE – DATA CHECKING AND ERROR CORRECTION INFORMATION
SYNC FIELD — 10 WORDS (160 BITS) OF 0'S
SYNC – SYNC WORD — 100376_8 IF ECC FIELD IS VALID
100377_8 OTHERWISE
CYLAD CYLINDER ADDRESS
HSAD — HEAD ADDRESS (LOGICAL)
SECTOR ADDRESS (LOGICAL)
S IF "1", SPARE TRACK IN ACTIVE USE
P IF "1", PROTECTED TRACK
D IF "1" DEFECTIVE TRACK
CRC – CYCLIC REDUNDANCY CHECK — 1 WORD OF CHECK INFORMATION
ECC ERROR CORRECTION CODE — 6 WORDS OF CHECK AND CORRECTION INFORMATION

Figure 3-3. Sector Recording Format

Table 3-1. Disc Subsystem Commands

CODE	COMMAND	COMMAND EFFECT
00	Cold Load Read [000 | HD | SECTOR] 0 5 6 7 8 15 HD HEAD	After issuing a seek to unit 0, cylinder 0, head H, sector S, the controller reads the disc-resident bootstrap; stops when interface unit sets EOD.
01	Recalibrate [001 | H | UNIT] 0 8 9 15 H HOLD BIT	Disc drive number U positions its read/write heads over cylinder 0. "H" is the hold bit. Any command which could alter a disc drive's status has a hold bit position to tell the controller to hold this specific disc drive for this one CPU.
02	Seek [002 | H | UNIT] 0 7 8 9 15 [CYLINDER] 0 15 [0 | HEAD | SECTOR] 0 2 3 7 8 15	Upon receipt, controller waits for two words with cylinder, head, and sector addresses. A seek to that location is issued to the disc drive U.
03	Request Status* [003 | H | UNIT] 0 8 9 15	Upon receipt, controller returns two status words to the interface.
04	Request Sector Address* [004 | H | UNIT] 0 7 8 9 15	Upon receipt, controller returns the logical address of the sector currently passing under the heads of the specified unit.
05	Read [005 | H | UNIT] 0 7 8 9 15	The controller begins reading from the 128-word sector last addressed by a seek command,the sector last addressed by an address record command, or the sector following the last one read until interface sets EOD or OVERRUN.
06	Read Full Sector [006 | H | UNIT] 0 7 8 9 15	Same as 05 except reading includes 138 words, which is the full sector contents, not only the 128 data words.

Table 3-1. Disc Subsystem Commands (continued)

CODE	COMMAND	COMMAND EFFECT
07	Verify 007 (bits 0–7) | H (bit 8) | UNIT (bits 9–15) SECTOR COUNT	Upon receipt, controller waits for the word containing the sector count to see how many sectors are to be verified. If it is 0, it is interpreted as 65,536 (2^{16}). The controller begins reading from the sector last addressed by a seek command, the sector last addressed by an address record command, or the sector following the last one read until the sector count is 0. Data is not sent to the interface but simply checked.
10	Write 010 (bits 0–7) | H (bit 8) | UNIT (bits 9–15)	The controller begins writing on the sector last addressed by a seek command, the sector last addressed by an address record command, or the sector following the last one read until the interface sets EOD or OVERRUN.
11	Write Full Sector 011 (bits 0–7) | H (bit 8) | UNIT (bits 9–15)	Same as 10 except writing includes 138 words per sector which is the full sector contents, not only the 128 data words.
12	Clear 012 (bits 0–7) | bits 8–15 unused	The controller transmits CLEAR to the disc drives, clears any clock offset, turns off timer, clears status, clears busy on the interface and disconnects all disc drives.
13	Initialize S (bit 0) | P (bit 1) | D (bit 2) | 013 (bits 0–7) | H (bit 8) | UNIT (bits 9–15) S FLAG TRACK SPARE P FLAG TRACK PROTECTED D FLAG TRACK DEFECTIVE	This command, sometimes called Write Address, is the same as 10 except that bits 0, 1, and 2 of the command word are used to set the status of the tracks; spare(S), protected(P), defective(D).
14	Address Record 014 (bits 0–7) | bits 8–15 unused	This command in the same format as a seek command 02 accepts two words of a logical address which is set in the controller but not transmitted to the disc drive.
15	Request Syndrome* 015 (bits 0–7) | bits 8–15 unused	This command returns seven words which contain correction data for "possibly correctable" results of data from Read, Cold Load Read, Read with Offset, or Read without Verify command.

Table 3-1. Disc Subsystem Commands (continued)

<table>
<tr><th>CODE</th><th>COMMAND</th><th>COMMAND EFFECT</th></tr>
<tr><td>15</td><td>Request Syndrome (continued)
<table><tr><td>S</td><td>P</td><td>D</td><td>STATUS</td><td></td></tr></table>
<table><tr><td>CYLINDER</td></tr></table>
<table><tr><td>HEAD</td><td>SECTOR</td></tr></table>
<table><tr><td>DISPLACEMENT</td></tr></table>
<table><tr><td>PATT1</td></tr></table>
<table><tr><td>PATT2</td></tr></table>
<table><tr><td>PATT3</td></tr></table>
</td><td>Eleven words are returned and have the following significance:

WORD 1

Bits 0 through 7 are the only valid bits in word 1. Bit 0 is the spare track bit, bit 1 is the protected track bit, bit 2 is the defective track bit, and bits 3 through 7 are status bits. Status may be "Correctable" (%017) or "Uncorrectable" (%10). If uncorrectable, ignore displacement and pattern words or, if correctable, correction data is available in displacement and pattern words.

WORDS 2 AND 3

These words contain the logical address of the sector in which the error occurred.

WORD 4

The displacement word indicates, relative to the first data word, the beginning word of the sector where the first bit error occurred.

WORDS 5, 6, AND 7

The pattern words are exclusive-ORed with the bad data words. The corrected data words are stored back in the buffer.</td></tr>
<tr><td>16</td><td>Read with Offset
<table><tr><td>016</td><td>H</td><td>UNIT</td></tr><tr><td>0 7</td><td>8</td><td>9 15</td></tr></table>
B BUSY
<table><tr><td></td><td>A</td><td>D</td><td>CYLINDER OFFSET</td></tr><tr><td>0 5</td><td>6</td><td>7</td><td>8 15</td></tr></table>
</td><td>Same as a normal read (05) but requests an offset parameter word before executing. It sends the cylinder offset to the selected unit and may advance (A) or delay (D) the separator clock with respect to the data. Offsets are removed on completion.</td></tr>
<tr><td>17</td><td>Set File Mask
<table><tr><td>017</td><td>RETRY COUNT</td><td>A</td><td>S</td><td>M</td><td>A</td></tr><tr><td>0 7</td><td>8 11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr></table>
S = AUTOMATIC TRACK SPARING
M = SURFACE MODE (bit 14 = 0)
CYLINDER MODE (bit 14 = 1)
A = AUTOMATIC SEEK (DECREMENTAL IF BIT 12 SET OR INCREMENTAL IF BIT 12 CLEARED)
</td><td>The retry count is set into a retry counter on the interface unit on a function order from the controller which has set bits 12 through 15 into a mask register. The register is used to control the action during a data transfer.</td></tr>
</table>

Table 3-1. Disc Subsystem Commands (continued)

CODE	COMMAND	COMMAND EFFECT
22	Read Without Verify [022 | H | UNIT] 0 7 8 9 15	This command operates just like a normal read (05), but does not verify the preceding sector so no address checking or sparing operations occur unless a track boundary is crossed during the operation.
23	Load TIO Register [023 | //////] 0 7 8 15	The controller accepts a word of data it writes into the TIO (Status) register on the interface by a write TIO order from the controller. This command is intended as a service tool.
24	Request Disc Address* [024 | //////] 0 7 8 15	The controller returns two words in the order and format of the address words passed in a seek (02) command. This command is used to determine where an error occurred during a verify command, or any other command which terminates with an error.
25	End [025 | //////] 0 7 8 15	The controller returns to polling upon receipt of this command.
26	Wake Up [026 | UNIT] 0 7 8 15	This command checks whether the specified unit is available (hold bit clear). If not, the command is left pending on the interface and the controller resumes polling of other interfaces.

*When these commands are used in the IOAW portion, bit 15 of the IOCW must be set.

Table 3-1A. Command Code versus Octal Value

COMMAND CODE	OCTAL VALUE	COMMAND CODE	OCTAL VALUE
000	0000XX	013	0054XX
001	0004XX	014	0060XX
002	0010XX	015	0064XX
003	0014XX	016	0070XX
004	0020XX	017	0074XX
005	0024XX	022	0110XX
006	0030XX	023	0114XX
007	0034XX	024	0120XX
010	0040XX	025	0124XX
011	0044XX	026	0130XX
012	0050XX		

Table 3-2. IOP Bus/Interface Unit Signals

SIGNAL	DESCRIPTION
$\overline{\text{IOD00-15}}$	16-bit bidirectional data. Inbound (to memory) transfer active with $\overline{\text{SI}}$ signal low. Outbound (to subsystem) transfer active with $\overline{\text{SO}}$ signal low.
$\overline{\text{DEVNO00-07}}$	8-bit bidirectional device number. IOP addresses the subsystem on this bus; subsystem must perform device number compare before commands can be decoded. Subsystem places its number on these lines, when the subsystem interrupt request is recognized by the IOP interrupt poll.
$\overline{\text{IOCMD00-02}}$	3-bit command. Transfers direct I/O commands to subsystem. The following eight commands can be decoded by the cartridge disc subsystem: a. Set Interrupt b. Control I/O c. Start I/O d. Write I/O e. Reset Interrupt f. Test I/O g. Set Mask h. Read I/O
$\overline{\text{INTREQ}}$	Interrupt Request. Subsystem interrupt request signal to the IOP. The IOP responds with an interrupt priority poll (INTPOLL IN)
$\overline{\text{INTACK}}$	Interrupt Acknowledge. When the subsystem has interrupt priority and is requesting interrupt, the INTPOLL signal from the CPU sets the subsystem interrupt active logic. The $\overline{\text{INTACK}}$ signal from the subsystem informs the IOP of this condition and also informs the IOP that the number of the subsystem interrupting is on the device number ($\overline{\text{DEVNO00-07}}$) lines.

Table 3-3. Power Bus/Interface Unit Signals

SIGNAL	DESCRIPTION
$\overline{\text{PF WARN}}$	Power Failure Warning. This signal precedes a power failure by not less than 500 microseconds and is used to clear the controller and stop a read or write operation.
IORESET	I/ORESET is manually generated with the I/O RESET pushbutton switch on the CPU. This signal is used to initialize the subsystem.
INTPOLL IN	Interrupt poll in. This signal is issued by the IOP in response to a subsystem interrupt request. If the subsystem has interrupt priority and is requesting an interrupt, it stops propagation of the interrupt poll and sends INTACK to the IOP. Otherwise, the poll is propagated to the next subsystem with the INTPOLL OUT signal.
INTPOLL OUT	Interrupt poll out. This signal is used to propagate the interrupt poll when the subsystem is polled for an interrupt request but is not requesting an interrupt.
$\overline{\text{SO}}$	Service Out. A signal issued by the IOP to the subsystem to indicate validity of the following IOP bus lines: a. Direct command ($\overline{\text{IOCMD00-02}}$) b. Device Number ($\overline{\text{DEVNO00-07}}$) c. IOP data ($\overline{\text{IOD00-15}}$)
$\overline{\text{SI}}$	Service In. Subsystem signal sent to IOP to acknowledge all direct commands except SIO. Receipt of SIO at the interface unit is acknowledged to the selector channel when the interface unit issues the $\overline{\text{REQ}}$ signal.

Table 3-4. Selector Channel/Interface Unit Signals

SIGNAL	DESCRIPTION
SR00-15	16-bit bidirectional data.
SETJMP	Set Jump. Allows the SIO Program to sense when a device end type of termination has occurred.
DEVEND	Device End. Transmitted by disc controller to terminate a read or write operation it considers retryable.
CHAN SO	Channel Service Out. Signal from selector channel to subsystem. Indicates servicing of the interface unit is being started by the selector channel. During initialization the interface unit address is read out into the IOP bus. For transfer of data, the appropriate strobe is sent with the CHAN SO signal.
SIO ENABLE	Start I/O Enable Signal from selector channel, required at subsystem to initialize the subsystem for SIO operation.
EOT	End of Transfer. Signal from selector channel to notify subsystem that the word count of the current transfer has reached zero (rolled over).
TOGGLE INXFER	Toggle In Transfer Signal from selector channel used to prepare subsystem for inbound (read) data transfer Clears the subsystem read mode at the end of data chaining, or if no data chaining, at the end of each data transfer sequence.
TOGGLE OUTXFER	Toggle Out Transfer Signal from selector channel used to prepare subsystem for outbound (write) data transfer Clears the subsystem write mode at the end of data chaining, or if no data chaining, at the end of each data transfer sequence.
TOGGLE SIO OK	Toggle Start I/O OK. Signal from selector channel used to set the subsystem in an idle ready state following the completion of a SIO data transfer sequence.
XFER ERROR	Transfer Error. Error signal from selector channel used to halt transfer operation due to parity error or illegal memory address.
REQ	Request. Signal sent from the subsystem to the selector channel each time the subsystem receives a direct SIO command. The selector channel uses REQ to initiate the DRT fetch sequence. If this signal is routed while an SIO program is in progress, it will abort the program.
CHAN SR	Channel Service Request. A priority level signal from the subsystem to the selector channel. CHAN SR is generated to proceed with the execution of an SIO program. Upon receipt of SR, the selector channel responds with CHAN SO and the appropriate strobes required to service the request.
P CMD 1	Program command one. Signal from selector channel to subsystem. Normally the subsystem uses P CMD 1 to strobe in the first word of the control order doubleword which is not used by this subsystem. Used to generate a Service Request to the selector channel.
P STATUS STB	Program Status Strobe. Signal from selector channel used to strobe out the subsystem status word into the IOP bus. This signal is issued when the selector channel receives a Sense or End order I/O command word (IOCW), the resulting status word is loaded into the associated I/O address word (IOAW).
P CONT STB	Program Control Strobe. Signal from selector channel used to strobe the second word of a Control order doubleword into the subsystem and to clear the subsystem command logic. This strobe always follows a P CMD 1 strobe.

Table 3-4. Selector Channel Interface Unit Signals (continued)

SIGNAL	DESCRIPTION
P WRITE STB	Program Write Strobe. Signal from Selector channel used to strobe data into the subsystem for recording purposes. This signal also sets the subsystem data logic.
P SET INT	Program Set Interrupt. Signal from selector channel used to set the interrupt request logic in the subsystem.
P READ STB	Program Read Strobe. Signal from selector channel used to strobe recorded data out of the subsystem onto the channel bus. This signal also sets the subsystem data logic.
CHAN ACK	Channel Acknowledge is the interface units response to CHANSO.

Table 3-5. Interface Unit/Disc Controller Signals

SIGNAL	DESCRIPTION
CLEAR	Clear. This signal is generated by the IO RESET signal of Table 3-3 or bit 0 of a control word in direct mode. This signal is disabled on all but one system when the disc controller is used in a multi-system configuration.
IBUS 0-15	Interface Bus. Sixteen bit data bus used to transmit all information between the interface and controller in both directions.
ENID	Enable Interface Drivers. Enables data transmission on the two-way interface bus to the controller.
ENIR	Enable Interface Receivers. Enables reception of data on the two-way interface bus from the controller.
IFN 0-3	Interface Function Bus. Four-bit bus carrying the coded function commands listed in Table 3-6. Decoded functions are valid only if IFVLD which accompanies them is true.
IF CLK	Interface Clock. Validates data and status word transfers word-by-word by gating the DATA IN, DATA OUT, or WRITE TIO signal held high by the disc controller.
IFN VALID	Interface Valid. Validates functions on the function bus. No function is valid if this line is not true.
FLAG*	**DESCRIPTION**
CMD RDY	Command Ready. Held true while a command to the controller is on the interface bus. Cleared by GET COMMAND from controller.
DATA RDY	Data Ready. Held true while data to or from controller is on the interface bus.
EOD	End of Data. True when the selector channel has completed a block transfer. Not set during data chaining until the entire transfer is complete. Cleared by GET COMMAND from controller.
OVRUN	Overrun. True if there is a word in the data buffer register and the controller tries to send another or true if data buffer register is empty and controller attempts to fetch. Cleared by GET COMMAND from controller.
XFRNG	Transfer No Good. True if the interface or channel selector detects an error condition (other than OVRUN) which prohibits transfer of data.

*Interface unit must be selected by controller to enable flag signals.

Table 3-6. Decoded Function Signals

FUNCTION	DESCRIPTION
$\overline{\text{STINT}}$ (00)	Interrupt Request. On the selected interface unit, sets interrupt request flag to IOP when the controller discovers an error condition or when a disc drive is requesting attention.
$\overline{\text{SELIF}}$ (03)	Select Interface. The $\overline{\text{ENIR}}$ (enable interface receivers) signal gates in a three-bit address on the data bus. If it matches the jumpered address on the interface unit. $\overline{\text{SELIF}}$ sets the XFACE SELECT flip-flop. When set, this interface unit responds to select required functions and its flags to the disc controller are enabled.
$\overline{\text{SRTRY}}$ (04)	Set Retry Counter. The $\overline{\text{ENIR}}$ (enable interface receivers) signal gates in a four-bit retry counter setting on the interface bus. On the selected interface unit, this setting is loaded into the retry counter. The setting is an image of the setting passed to the controller by the Set File Mask disc subsystem command.
$\overline{\text{DVEND}}$ (05)	Device End. On the selected interface unit, the controller so terminates an operation it considers retryable (correctable or uncorrectable data error on read operations, overrun on any data operation). Decrements the retry counter.
$\overline{\text{RQSRV}}$ (07)	Request Service. On the selected interface unit, signals that the controller has finished with its data transfer and it is alright to fetch the next command.
$\overline{\text{DSCIF}}$ (11)	Disconnect Interface. Clears the XFACE SELECT flip-flop. The interface unit will not respond to select-required commands, or gate its flags or data out to the controller.
$\overline{\text{WRTIO}}$ (12)	Write TIO. The $\overline{\text{ENIR}}$ (enable interface reciever) signal gates in a status word which, on the selected interface unit, is clocked into a status register available to the CPU.
$\overline{\text{IFOUT}}$ (13)	Data Out. The $\overline{\text{ENID}}$ (enable interface drivers) signal on the selected interface unit gates the data buffer register contents onto the interface bus. Transfer validation is indicated by IFCLK word-by-word.
$\overline{\text{IFIN}}$ (14)	Data In. The $\overline{\text{ENIR}}$ (enable interface receivers) signal gates the interface bus into the interface unit. This function enables all transfers into the CPU from the controller. Transfer validation is indicated by IFCLK word-by-word.
$\overline{\text{IFGTC}}$ (15)	Get Command. The $\overline{\text{ENID}}$ (enable interface drivers) signal on the selected interface unit is true. This command is used to gate the contents of the data buffer register onto the interface bus. The contents of the data buffer register is a command to the disc controller.

3-22. FUNCTIONAL THEORY.

3-23. The functional-level theory presented here covers only that for the interface unit. Refer to the HP 7905A Disc Drive Installation and Service Manual (part no. 07905-90007) or to the HP 13037A Disc Controller Installation and Service Manual (part no. 13037-90006) for the theory of subsystem electronics not provided here.

3-24. IOP CONTROLLED OPERATION.

3-25. Operation of devices interfaced to the computer via the selector channel starts under control of the IOP which places commands on command lines IOCMD00, 01, and 02 for decoding by the interface unit's direct command decoder. A simplified partial diagram of the direct command decoder is shown in Figure 3-4. These circuits receive and process the coded direct commands from the IOP bus.

3-26. Direct commands are initiated by the CPU and sent via the IOP and IOP bus in the form of a 3-bit I/O command (IOCMD00-02). Decoding of the command word by the command decoder consists of converting the binary value of the bits into an equivalent octal output. Each of the possible eight numbers 0-7 (output 6 of the command decoder is not used on this card) represents a specific direct command. When any direct command except SMSK and SIO is decoded, the command logic issues a service in (SI) signal to the IOP to acknowledge receipt. When the command is SIO, a REQ signal is issued by the command logic to the selector channel and the selector channel should issue SI to the IOP.

3-27. Before the decoding of a direct command (except SMSK) can be carried out, the command decoder must be enabled. When the CPU executes a direct command, the CPU microcode assembles a 12-bit word. This word is sent via the IOP bus to all device controllers. The word consists of the 8-bit device number (DEVNO 0-7), a 3-bit command (IOCMD00-02), and a service out (SO) control bit. (The SO bit is actually received on the power bus.) Tables 3-1 and 3-2 provide a detailed description of IOP and power bus signals received by, and issued from, the subsystem. The 7-bit device number (bit 0 is tied to ground) received on the IOP bus is compared with the wired-in device number. See Figure 3-5. If the numbers compare, the high output of the compare circuit and the high SO signal combine to clear the Priority Latch. The DIR output of the latch is combined with SO to enable the command decoder, Figure 3-4.

3-28. With the command decoder enabled, the code on the IOCMD lines may be decoded as a:

a. SIN (Set Interrupt) command, octal 0. When implemented, this is one of the three ways to set the interrupt request flip-flop.

b. CIO (Control IO) command, octal 1. This command, also called D CONT STB, is accompanied with a control word from the TOS. If bit 0 of the data word is set, Figure 3-6, master reset will clear the interface unit and, if jumper W1 is set to E, a clear is sent to the disc controller. If bit 1 is set, Figure 3-5, it will cause the reset of the interrupt request flip-flop. If bit 2 is set, Figure 3-9, the test mode flip-flop is preset.

c. SIO (Start IO) command, octal 2. This command, which starts an SIO program by sending a REQ and DRT number to the selector channel, is discussed at length later in this section.

d. WIO (Write IO) command, octal 3. The operating system software does not make use of this command, however, it provides a means to load the data buffer register when the interface unit is in the test mode and is thereby useful for diagnostic purposes.

e. RINT (Reset Interrupt) command, octal 4. Resets the interrupt active flip-flop.

f. TIO (Test IO) command, octal 5. Also known as D STATUS STB. This signal switches the output selector logic and enables the data-in bus gates to put the status word on the IOP bus.

g. RIO (Read IO) command, octal 7. The operating system does not use this command, however, the command provides a means to read the contents of the data buffer register when the interface unit is in the test mode and is thereby useful for diagnostic purposes.

3-29. The Set Mask (SMSK) command is received by all device controllers. It provides a means to selectively set or reset the interrupt mask flip-flop, to disable the mask completely, or to enable it at all times by appropriate positioning of a jumper on the interface unit.

3-30. One other function which is performed by the Interface at the request of the IOP, is to respond to an Interrupt Poll signal. See Figure 3-6. Since all device controllers transmit the Interrupt Request signal (INTREQ) to the IOP on a common line, it is necessary to poll the device controllers to determine which are generating the interrupt. Polling is done on a daisy chain basis starting with the device with the highest priority and continuing on through the other controllers in the order of their priority. When the polling signal arrives at the highest priority interrupting device controller, it is blocked from proceeding further and the DEVNO of this device must be gated on the DEVNO lines. An Interrupt Acknowledge signal (INTACK) is also transmitted to the IOP to enable it to load the DEVNO into one of its registers.

3-31. Figure 3-6 shows the interrupt logic elements. Interrupt logic consists of four flip-flops and associated gate logic. These flip-flops are:

a. INT MASK FF

b. INT REQ FF

c. INT LATCH FF

d. INT ACTIVE FF

3-32. A capability by the IOP to directly enable or disable the subsystem interrupt logic is provided by the INT MASK FF. An input is applied to the INT MASK FF from the IOP bus through a preassigned jumper on a connecting pinwheel. This input combined with a direct SMSK command, can either set or clear the INT MASK FF. When set, the output of INT MASK FF enables the INPUT REQ FF output line. A permanent enable level is selected for this subsystem.

3-33. INT REQ FF. There are four ways of setting the INT REQ FF:

a. By a direct interrupt command (SIN).

b. By a program interrupt order (PSET INT).

c. By a decoded Interrupt Request function from the disc controller.

d. By a borrow from the retry counter.

3-34. When one of these conditions is active, the set output of the INT REQ flip-flop generates the INT REQ signal to the IOP. A MASTER RESET signal or a direct CIO (D CPMT STB) command combined with the bit 1 of the data-out bus clears the INT REQ flip-flop.

3-35. An INT POLL IN signal is issued by the IOP to poll the interrupt states of the subsystems. When the INT POLL IN signal is received at the interrupt logic the signal is allowed to propagate through as INT POLL OUT if the interrupt logic is not in a request state. If the interrupt logic is in a request state, the input to the INT LATCH FF is active and the INT POLL IN signal sets the flip-flop. As the clear output of the INT LATCH FF is connected to the input of the INT POLL OUT gate, the gate is disabled. However, due to the time required to set the INT LATCH FF, a partial pulse is allowed through the gate. By the same token, this subsystem may not get a full INT POLL IN signal. This indicates that a higher priority subsystem "upstream" has blocked the INT POLL IN signal. A delay circuit in the interrupt logic of each subsystem maintains the integrity of the I/O priority structure. A complete INT POLL IN signal is required before the INT LATCH FF output is gated to set the INT ACTIVE FF and enable the device address gates. These gates are used to strobe out a device address whenever the IOP "recognizes" the subsystem interrupt. An INT ACK signal is generated when the INT ACT FF is set. This INT ACK signal and the device address on the IOP bus are used by the IOP to identify the subsystem being serviced. The INT ACTIVE FF is cleared by a MASTER CLEAR signal or by a direct RINT command.

3-36. SELECTOR CHANNEL CONTROLLED OPERATION

3-37. Note in Figure 3-4 that direct commands are transmitted directly to the interface unit via the IOP bus. It is the SIO direct command that starts the I/O program. Then the selector channel is used for I/O program control, data transfers, and status transfers.

3-38. First the CPU checks the status of the interface unit with a direct TIO command. The interface unit returns the contents of its status register and the CPU checks the SIO OK bit (bit 0). If the selector channel to which the interface unit is connected is not busy with another transfer, and the interface unit is ready (indicated by bit 0 being set), the CPU transmits the direct SIO command to the interface unit.

3-39. The decoded low SIO command pulls the REQ signal to the selector channel low, sets the SIO Busy flip-flop, and is inverted to gate the device number to the selector channel. The set output of the SIO Busy flip-flop (SIO Busy) sets the Priority Latch (Figure 3-5) and is generally used to initialize the interface unit. The clear output of the SIO Busy flip-flop sets the SIO OK bit of the status word to 0 signifying that the interface unit is busy and drives the INTOK (Interface OK) signal to the disc controller low.

3-40. The selector channel informs the IOP that the SIO instruction has been received by sending Service In (SI); the IOP is released. The selector channel begins fetching and executing the I/O program associated with the disc cartridge subsystem. During operation of the selector channel, the selector channel fetches the I/O program doublewords, decodes them, then transmits the appropriate control signals to the interface unit. Control signals to and from the selector channel are described in Table 3-4.

3-41. DISC CONTROLLER CONTROLLED OPERATION

3-42. In order for the disc controller to select a particular interface and do the other things required to control data transfer operations via the interface, it is necessary for the interface unit to be able to perform certain functions when directed by the controller. When the controller wants an interface unit to perform a function, it transmits a four-bit function code (IFN00-IFN03) along with a IFN VALID indicator on the interface function bus. See Table 3-5 and Figure 3-7. No function decoded by the Function Decode logic is valid unless IFN VALID, which goes active about 200 nanoseconds after the coded function, is present. Most functions are executed either at the beginning or end of this pulse. The exception are three functions involving data transfer which are executed when another pulse called Interface Clock (IFCLK) occurs. The functions which the disc controller can request an interface unit to perform are summarized in Table 3-6.

3-43. The functions decoded by the Function Decoder that have to do primarily with data transfer operations are described in the paragraphs dealing with data transfer functions. These are Command Ready, Data In, Data Out, Get Command, Select Interface, Disconnect Interface, and Request Service.

Table 3-7. SIO Program

SIO PROGRAM	FUNCTION
%040000, %007603	IOCW (CONTROL) IOAW (SET FILE MASK COMMAND)
%040000, %001000	IOCW (CONTROL) IOAW (SEEK COMMAND)
%067776, @ BUFFER	IOCW (WRITE OF TWO WORDS) IOAW (ADDRESS OF SEEK PARAMETERS)
%040000, %004000	IOCW (CONTROL) IOAW (WRITE COMMAND)
%160000, @ BUFFER	IOCW (WRITE OF 4096 WORDS) IOAW (ADDRESS OF DATA)
%067770, @ BUFFER	IOCW (WRITE OF 8 WORDS) IOAW (ADDRESS OF LAST 8 WORDS)
%004000, @ SEEK CMD	IOCW (JUMP ON CONDITION) IOAW (RETRY SEEK AND WRITE)
%040000, %012400	IOCW (CONTROL) IOAW (END COMMAND)
%034000 STATUS	IOCW (SIO END COMMAND) STATUS IS RETURNED HERE

3-44. DATA TRANSFER FUNCTIONS. The disc controller has provision for multiple interface units. As a consequence,it is necessary for the controller to continuously poll the interfaces, when not engaged in data transfers, to determine if one has a command for it.

3-45. The selector channel strobes the command into the data buffer register of the interface unit with a programmed control strobe (P CONT STB) signal. This strobe is also used to set the Command Ready flip-flop, Figure 3-8, the output of which is disabled by the output of the X face Select flip-flop at a gate. The interface unit and the selector channel now wait for the disc controller to fetch the command.

3-46. While polling, the disc controller issues a Select Interface function to the interface unit along with a three-bit interface address on the interface bus. If this interface unit is addressed, the comparison of the address with the address jumpered provides a high input to the X face Select flip-flop which is clocked set by the Select Interface function from the disc controller. The set output of the X face Select flip-flop is an enable signal for the Command Ready flag to the disc controller.

3-47. The disc controller may now sense the status of the Command Ready flip-flop. If it is reset, the interface unit does not have anything for the disc controller and the disc controller issues a Disconnect Interface function and proceeds with the polling of the next unit. The Command Ready flip-flop, however, is set and the disc controller issues a Get Command function and an ENID strobe to the interface unit. The Enable Interface Drivers (ENID) strobe causes the command in the data buffer register to be transmitted to the disc controller. The Get Command function clears the Command Ready flip-flop, initializes certain other logic on the interface unit, and sets the Service Request 2 flip-flop, Figure 3-9. The clear output of the flip-flop is a service request to the selector channel.

3-48. If the command was for a data transfer operation, the disc controller will set up the interface unit so it can accept or provide data when the disc controller is ready. For a write operation, the first data word would be accessed from memory, transmitted to the interface unit, and loaded into the data buffer register. Further operation stops until the disc read head arrives at the sector which is to be written on. The disc controller then begins accepting data.

3-49. The data transfer operation starts with the disc controller setting up a Data Out function to be decoded by the function decoder. This function is one of the four clock signals into the Service Request 2 flip-flop. It is a static signal and will be left active until the data transfer operation is complete. To make the signal useful, each time that the disc controller accepts a data word, an Interface Clock (IFCLK) signal transmitted from the disc controller enables the Data Out function to set the Service Request 2 flip-flop, sending a Channel Service Request (CHAN SR) signal to the selector channel. The flip-flop is reset by the CHAN SO signal which accompanies the write strobe from the selector channel which writes each word into the data buffer register.

3-50. The disc controller does not have time to check that the buffer has been refilled while the write operation is in progress. The controller blindly reads data from the interface unit until a complete sector has been written. The interface unit checks for data overruns and sets the Data Overrun (OVRUN) and/or Transfer No Good (XFERNG) flags if an overrun occurs.

3-51. The Data Ovrun flip-flop (Figure 3-10) will set and pull Flag 7 low on a data transfer under two sets of conditions. These are:

a. The INXFER signal implies that this is a read operation and DATARDY is high implying that the data buffer still has a word that has not been taken by the selector channel with P READ STB at the time of the leading edge of an IFCLK pulse.

b. The OUTXFER signal implies that this is a write operation and DATARDY is high implying that the data buffer does not have a new word from the selector channel put in on a P WRITE STB, at the time of the leading edge of an IFCLK pulse.

3-52. The Transfer No Good flip-flop (Figure 3-11) will set and pull Flag 3 low under three sets of conditions. These are:

a. The PF Warn signal on the power bus goes low or the selector channel reports a Transfer Error signal. Either will set the Xfer Error flip-flop.

b. The OUTXFER signal implies this is a write operation and/or the INFER signal implies this is not a read operation and the DATA IN function from the disc controller calls for a read operation.

c. The INXFER signal implies this is a read operation and/or the OUTXFER signal implies this is not a write operation and the DATA OUT function from the disc controller calls for a write opertion.

3-53. The setting of the Transfer Error flip-flop described in the last paragraph also triggers the Clear Interface Logic one-shot. The Clear IL signal in effect turns off the interface unit. The signal:

a. Clears Inxfer, Outxfer, and SIO Busy flip-flops.

b. Sends a REQ to the selector channel.

c. Sets the End of Data 2 flip-flop routing an EOD flag to the disc controller.

3-54. After the complete sector has been written, the disc controller checks the Data Overrun and Transfer No Good flags to see if the transfer was successful. If successful the controller checks the End of Data flag, Figure 3-12, to see if more data must be written. If more data must be written, the disc controller just resumes reading data from the interface unit. If there is no more data to be written, the controller issues a Request Service function which is relayed to the selector channel by the setting of the Service Request 2 flip-flop, Figure 3-9.

3-55. After all device commands of the SIO program are issued, the program causes the selector channel to execute an END order which issues a Toggle SIO OK signal. This signal clears the SIO Busy flip-flop ,Figure 3-5, and deactivates the interface unit.

3-56. If the data transfer was not successful, the disc controller issues a Device End and a Request Service function to the interface unit. The Device End function sets a Jump Met flip-flop and a Device End flip-flop if the SIO read or write has not already ended (see Figure 3-13). The status of these flip-flops may be sensed by the selector channel.

3-57. When a "device end" occurs in the disc controller, the Device End, Jump Met, and Channel Service Request arrive at the selector channel at the same time. The Device End signal aborts further chained read or write opertions. The Device End flip-flop clears at the end of a read operation when the INXFER flip-flop clears or at the end of a write operation when the OUTXFER flip-flop clears. The Jump Met flip-flop is not cleared until a JUMP SIO order (P SET JMP) is received or until the end of the SIO program.

3-58. INTERRUPT REQUEST FUNCTION. The Interrupt Request output of the Function Decoder or a Borrow signal from the Retry Counter sets the Interrupt Request flip-flop and clears the Transfer No Good flip-flop.

3-59. SET RETRY COUNTER, DEVICE END FUNCTIONS. These functions are included in Figure 3-13. The selector channel, when executing a Jump I/O Order Pair can make a conditional jump depending on whether the Jump Met signal from the interface unit is active (proceed with jump) or inactive (do not jump). A Jump Met flip-flop is provided on the interface unit. The flip-flop is cleared (Jump Met to the selector channel is made inactive) by the SIO Busy signal at the start of an SIO operation, and when the selector channel transmits a PSET JUMP signal. The flip-flop is set when a Device End function from the disc controller is decoded. The Device End function signifies that the disc controller has terminated the data transfer.

3-60. If the disc controller detects a transfer error of some kind during the operation, it inserts the appropriate error code in the status word and terminates the operation by sending a Device End signal or an interrupt to the interface unit. An interrupt which occurs while an SIO program is in progress is considered to be due to an error,and so causes the SIO program to be aborted as well as causing the CPU to be interrupted. The Device End signal is sent if the error is of such a nature that retrying the operation might permit it to be completed correctly. Examples of this type of error include overruns and CRC errors. The SIO Jump command (P SET JMP) allows the SIO program to sense when a device end type of termination has occurred and to count the number of retries which have been attempted. The SIO program can thus retry operations without involving the CPU at all. For those data transfer operations where it is desirable to permit retries, it is necessary to specify a non-zero count in bits 8 through 11 of the File Mask. When the controller executes a Set File Mask command it loads this count into the Retry Counter in the interface unit. Each time that a retryable error is detected during the subsequent data transfer operation, the controller will issue a Device End signal which sets the Jump Met and Device End flip-flops and decrements the retry counter. The SIO program could then sense the indicator and loop back to retry the operation. This sequence continues until the operation is performed without error or the device end signal occurs with the retry counter in a zero state. When the latter occurs, the SIO program is aborted and an interrupt is sent to the CPU.

3-61. WRITE TIO FUNCTION. This function loads a status word (bits 3 through 15) from the disc controller into a 13-bit Status Register. A direct or programmed status strobe will make the 16-bit status word available to IOP and selector channel, respectively. Bits 0, 1, and 2 of the status word are added to the 13-bit contents of the status register and represent the SIO OK bit, test mode bit, and interrupt request bit of the interface unit.

3-62. TEST MODE OPERATION. The Test Mode flip-flop is set by a direct command word from the IOP with bit 2 of the control word set. The flip-flop is clocked by the CIO (D CONT STB) strobe which accompanies the command. See Figure 3-9. The set output of the flip-flop is routed to become bit 1 of the status word. The reset output performs the following functions:

a. Disables an "and" gate to isolate six flag signals from the disc controller. The interface unit may be exercised without regard to device safety or timing constraints.

b. Provides a constant Service Request signal to the selector channel via two Service Request flip-flops.

3-63. SIO PROGRAM OPERATION. Table 3-7 is a typical SIO program consisting of nine SIO doubleword commands. (For a series II Computer System, the SIO program example would contain three additional doubleword commands since a Set Bank doubleword command must precede each unchained read or write command or the first read or write command of a chained set.) There are four control commands, three writes, one jump, and one end. The function of this program is to read a block of 5004 words from a data buffer in memory and store the data on the disc. The IOAW or second word of each control word pair is one of the disc subsystem commands selected from Table 3-1. A general description of program operation is provided to explain subsystem response to the commands. This is followed by a description of how the interface unit, specifically, is affected by the program.

3-64. The first command is a control command. Bits 4 through 15 of a control command IOCW are designated control word #1 and the 16 bits of the IOAW are designated control word #2. With one exception where the Wait flip-flop, Figure 3-14, uses bit 15, the bit arrangement of control word #1 has no importance. Control words #1 of control commands are not otherwise used by the disc cartridge subsystem. The IOAW of the first control command is the disc subsystem command "Set File Mask."

3-65. After the disc controller accepts the Set File Mask command, the controller returns bits 8 through 11 of the command to the interface unit accompanied by a Set Retry Counter function. The interface unit loads bits 8 through 11 of the Set File Mask command into its retry counter. This counter is decremented by one each time a retryable error is detected during a data transfer operation and a retry of the data transfer is attempted. Bits 12 through 15 are set into a register in the disc controller. These bits are assigned functions as follows:

a. If bit 13 is set, track sparing is allowed.

b. If bit 14 is set, the cylinder mode is in effect. Otherwise the surface mode is used.

c. If bit 15 is set and bit 12 is also set, decremental seek is in effect. If bit 15 is set and bit 12 is cleared, incremental seek is in effect. If bit 15 is cleared, seek is not allowed, therefore, the state of bit 12 is of no consequence.

3-66. The next SIO command, also a control word pair, carries the disc subsystem Seek command. This command results in head positioner motion and is passed directly to the disc controller. The command is followed by the issuance of two words; the first contains the cylinder address and the second contains the head and sector address. These two words, are issued as a result of the "write of two words", the third command.

3-67. The fourth SIO command contains the disc subsystem command "Write." This is passed to the disc controller which begins writing in the sector addressed by the disc subsystem Seek command described in the previous paragraph. The disc controller will write the block of 5004 words designated by the two "Write" SIO commands. The first specifies the maximum block of 4096 words but has bit 0, the data chaining bit, set to indicate that the 8 words specified by the second command is part of the same write operation.

3-68. The Jump SIO command which follows has bit 4 of the IOCW set indicating a conditional jump with the condition being the state of the Jump Met flip-flop in the interface unit. If the Jump Met flip-flop is set, an error was detected during the transfer of the 5004-word block and the SIO program will continue at the jump target address specified by the IOAW of the command. The target is the control SIO command containing the disc subsystem Seek command. The retries of the data transfer will continue until the transfer is good or the count in the interface units retry counter decrements past zero and a borrow occurs. If there were no errors, the Jump Met flip-flop would be cleared and the SIO program would continue with the SIO command following the Jump command.

3-69. A control SIO command follows which has the disc subsystem command "Poll" in the IOAW. The command is passed to the disc controller which returns to polling. The command is used to get the controller out of the hang-up condition that might result from a user system that otherwise has no further commands to send it. An End SIO command ends the SIO program.

3-70. The SIO program, Table 3-7, looks like this to the interface unit. When the selector channel begins execution of any control SIO command, the selector channel transmits CHANSO and P CMD 1 signals and places the IOCW on the selector channel bus. CHANSO develops SC ENABLE to gate various signals from the selector channel including P CMD 1 and results in the interface unit pulling low the CHANACK signal to the selector channel (Figure 3-12), the Trailing edge of P CMD 1 sets the Service Request 1 flip-flop resulting in a CHAN SR to the selector channel.

3-71. The selector channel ends the CHANSO and P CMD 1 signals and the interface unit ends the CHANACK signal but still holds the CHAN SR signal high. The selector channel fetches the IOAW, places it on the selector channel bus and transmits the CHANSO and P CONT STB signal. CHANSO develops SC ENABLE to gate various signals from the selector channel including P CONT STB and results in the interface unit pulling the CHANACK signal to the selector channel low.

3-72. In the interface unit, P CONT STB clears the CHAN SR to the selector channel by clearing the Service Request 1 flip-flop which enables CHANSO to clear the Service Request 2 flip-flop. It also clocks the IOAW (which is a disc subsystem command) into the data buffer register by dropping P CONT STB and sets a Command Ready flip-flop. The selector channel drops CHANSO; the interface unit drops CHANACK. When the disc controller polls this interface card, it will discover that the Command Ready flag is set and send a Get Command signal to the interface unit.

3-73. When the disc controller issues the Get Command, the disc controller also enables drivers on the interface card to transmit the command in the data buffer register. The Get Command also sets the Service Request 2 flip-flop which results in a CHAN SR and the selector channel goes into an IOCW fetch operation.

3-74. When the selector channel begins execution of any write SIO command, the selector channel transmits a CHANSO signal followed shortly by a TOGGLE OUTXFER. The CHANSO signal results in a CHANACK signal returned to the selector channel. The TOGGLE OUTXFER is applied to the Outxfer flip-flop which is clocked set by the trailing edge of CHANACK. The clear output of the flip-flop sets the Service Request 1 flip-flop resulting in a CHANSR to the selector channel. This service request will cause a CHANSO cycle which will load the first word into the interface unit's data buffer.

3-75. Data word transfers start and continue word-by-word as follows:

a. Selector channel receives CHAN SR from interface unit and responds with CHANSO, P WRITE STB, and a data word on the selector channel bus.

b. The CHANSO develops a CHANACK returned to the selector channel and enables various signals from the selector channel including P WRITE STB. The strobe clocks the data into the data buffer register, clears the Service Request flip-flop, and sets a Data Ready flip-flop.

c. The disc controller is expecting data as a result of a just prior disc subsystem command calling for a write, write full sector, or initialize or it is expecting parameters as a result of a just prior command requiring parameters (seek, verify, address record, read with offset, or load TIO register). The disc controller activates the Data Out function via the interface units function decoder and holds it activated for the data word or the entire data block.

d. For each word the disc controller accepts, it gates the DATA OUT function at a gate on the DATA OUT line of the function decoder with the interface clock, IFCLK. The Service Request 2 flip-flop is set by the clocked DATA OUT with each word transfer sending a CHANSR to the selector channel for the next data transfer.

3-76. In the SIO program, the first write after the seek command looks like an ordinary write operation to the interface unit. The disc controller, however, uses it for the cylinder, head, and sector addresses it is waiting for. On this controller, parameters are passed by SIO Write, or Read orders. Commands requiring SIO for parameters after them are seek, verify, address record, read with offset, load TIO register. Those requiring SIO Reads for passing parameters are request status, request sector address, request syndrome, request unit allocation and timeout, and request disc address. This latter group requires bit 15 in word #1 set. All other commands should have this bit cleared. The Wait flip-flop which is set by this bit will delay the controller from sending a word to the interface until the INXFER flip-flop is set. See Figure 3-14.

3-77. In the first write after the disc subsystem write command was passed to the disc controller, bit 0 of the IOCW is set signifying data chaining is in effect. The software imposed limit of 4096 words per write command makes two successive write commands necessary to transfer data buffers over 4096 words in length. On the 4096th word, the selector channel sends an EOT signal and a P WRITE STB during the same CHANSO time. The EOT sets the EOD1 flip-flop. Because data chaining is in effect, there will be no TOGGLE OUTXFER at this time.

3-78. In the second write, eight more words are transferred. At the end of the eighth word transfer, an EOT signal from the selector channel along with a TOGGLE OUTXFER accompanies the last P WRITE STB. The EOT signal again sets the EOD1 flip-flop directly, the TOGGLE OUTXFER signal clocks the EOD2 flip-flop. Shortly thereafter, a data out pulse will again return the Data Ready flip-flop to its cleared state. This transition sets the EOD3 flip-flop which provides the EOD flag to the disc controller.

3-79. Because the block of 4096 + 8 words is not an exact multiple of 128 words (the length of a sector), the disc controller is now 8 words into a sector. It will not look at the EOD flag until it comes to the end of the sector. It fills the rest of the sector with the bit pattern of the 5004th word. The output of the EOD2 flip-flop prevents any further service requests to the channel.

3-80. When the sector is full, the disc controller looks at the EOD flag and sends a Request Service function to the interface unit. The Request Service sets the Service Request 2 flip-flop routing a CHANSR to the selector channel. This causes the selector channel to proceed with the next SIO double-word command, the conditional jump.

3-81. If the 5004 data words were transferred without an error occurring, the jump will not be taken and the selector channel will proceed with the next SIO double-word command, the control command delivering the disc subsystem Poll command. When the disc controller receives the command, it returns to a polling (idling) condition while the selector channel completes the SIO program by executing the End command.

3-82. If the disc controller detects an error during the data transfer, it routes a Device End function to the interface unit. This function is transmitted by the disc controller to terminate an operation it consideres retryable (correctable or uncorrectable data error on read operations, overrun on any data operation). The Device End function sets the Jump Met and Device End flip-flops. If the selector channel finds the Jump Met flip-flop set during the execution of the Jump command and the count in the retry counter is non-zero, the jump is taken. If the retry counter is zero, the borrow from the retry counter will cause an interrupt and abort the SIO program by triggering the CLRIL one-shot.

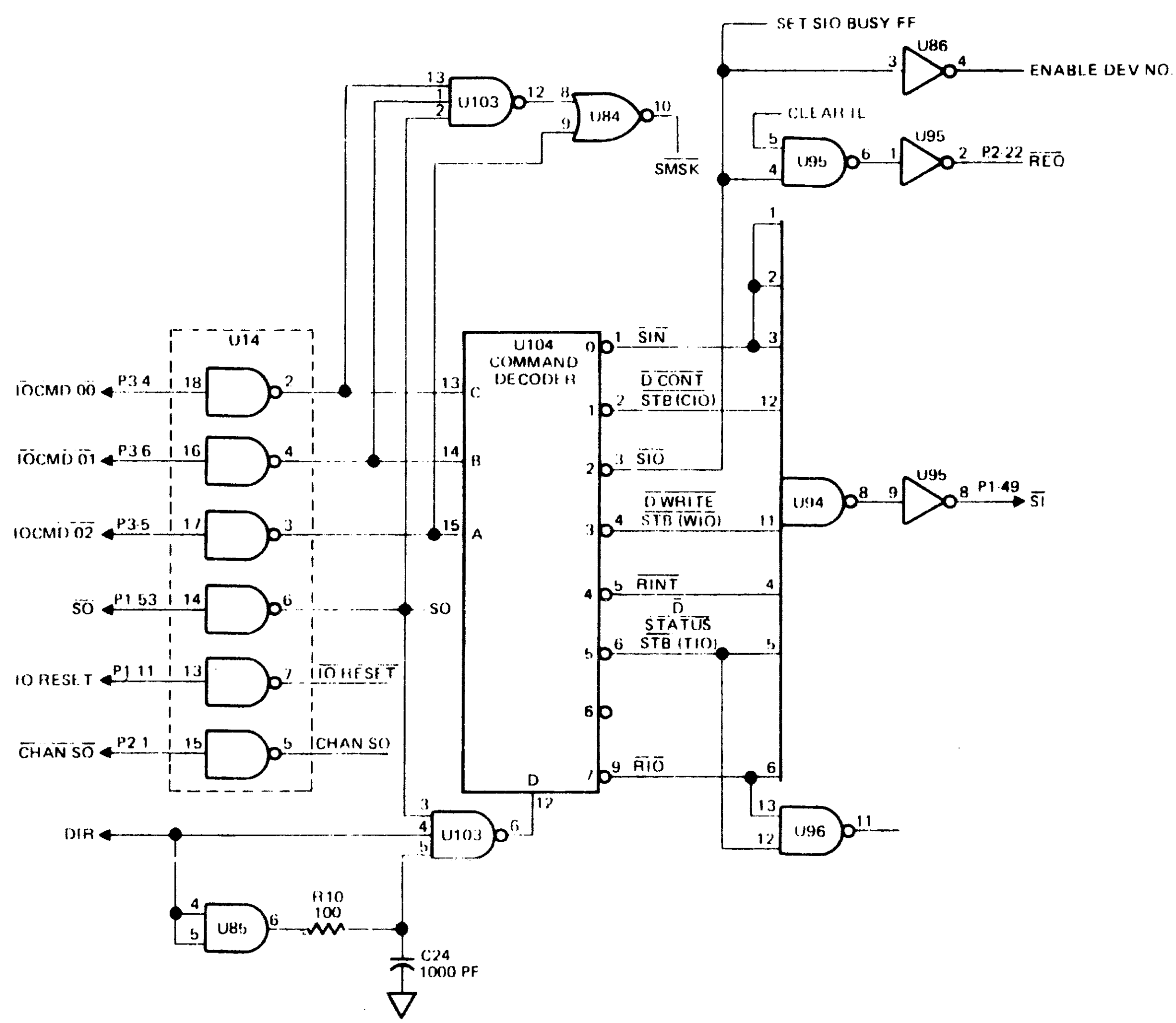


Figure 3-4. Direct Command Decoder

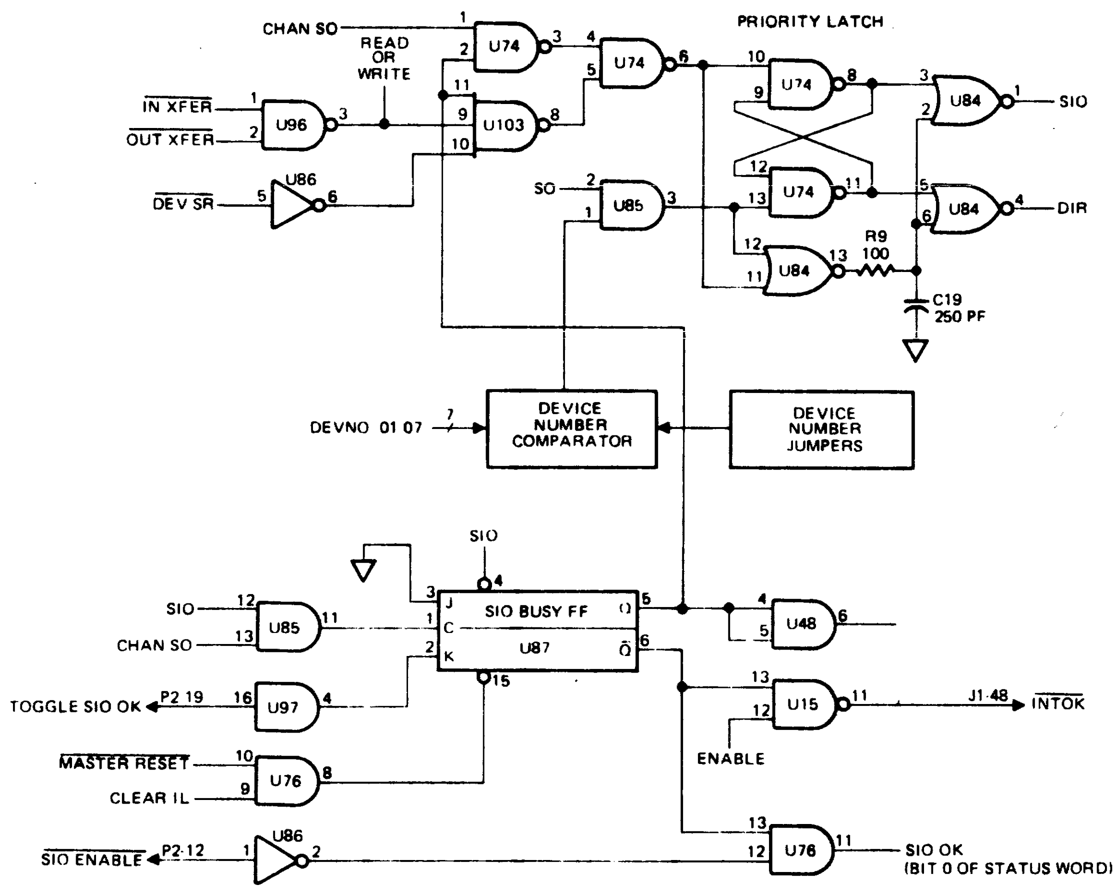


Figure 3-5. Priority Latch and SIO Logic

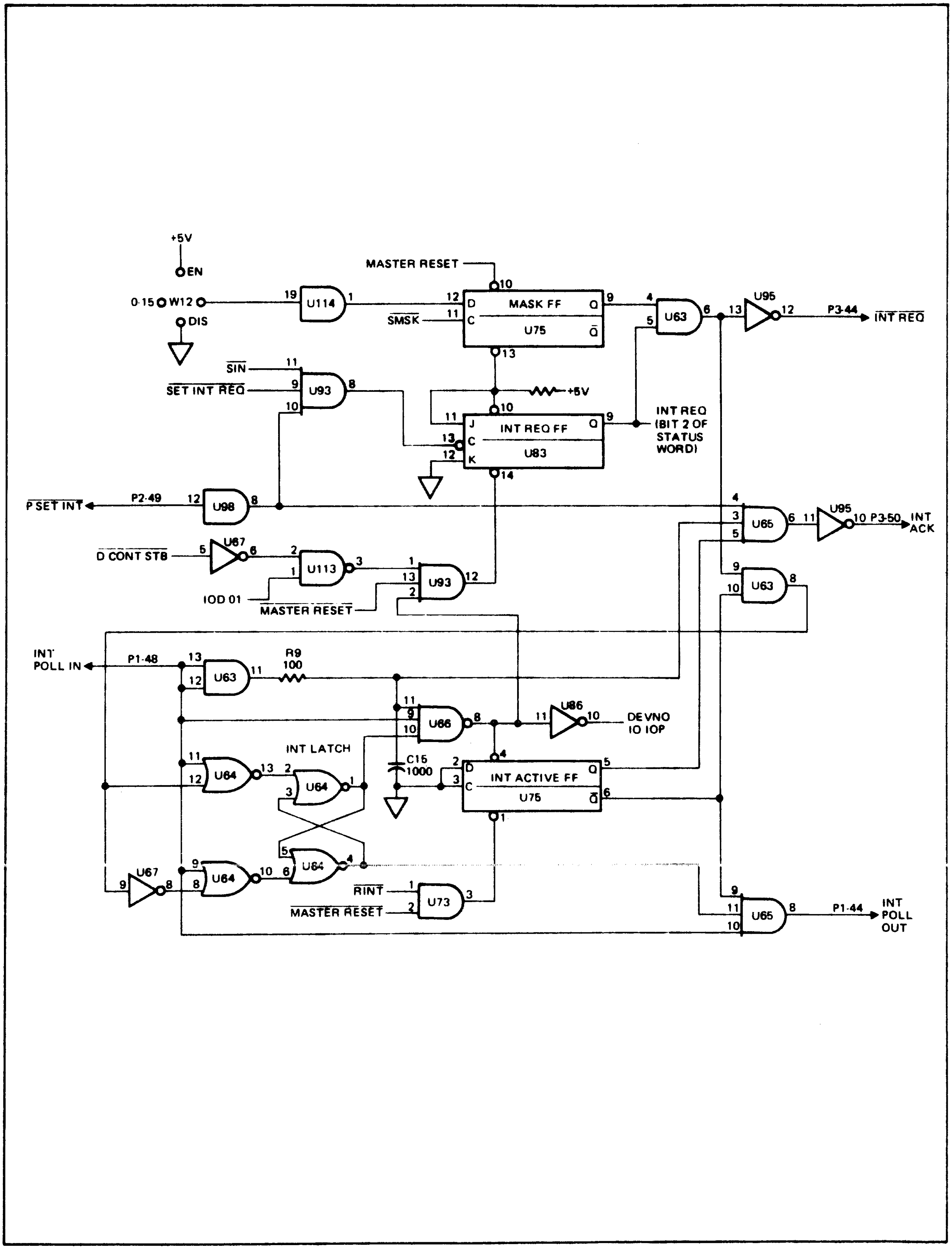


Figure 3-6. Interrupt Logic

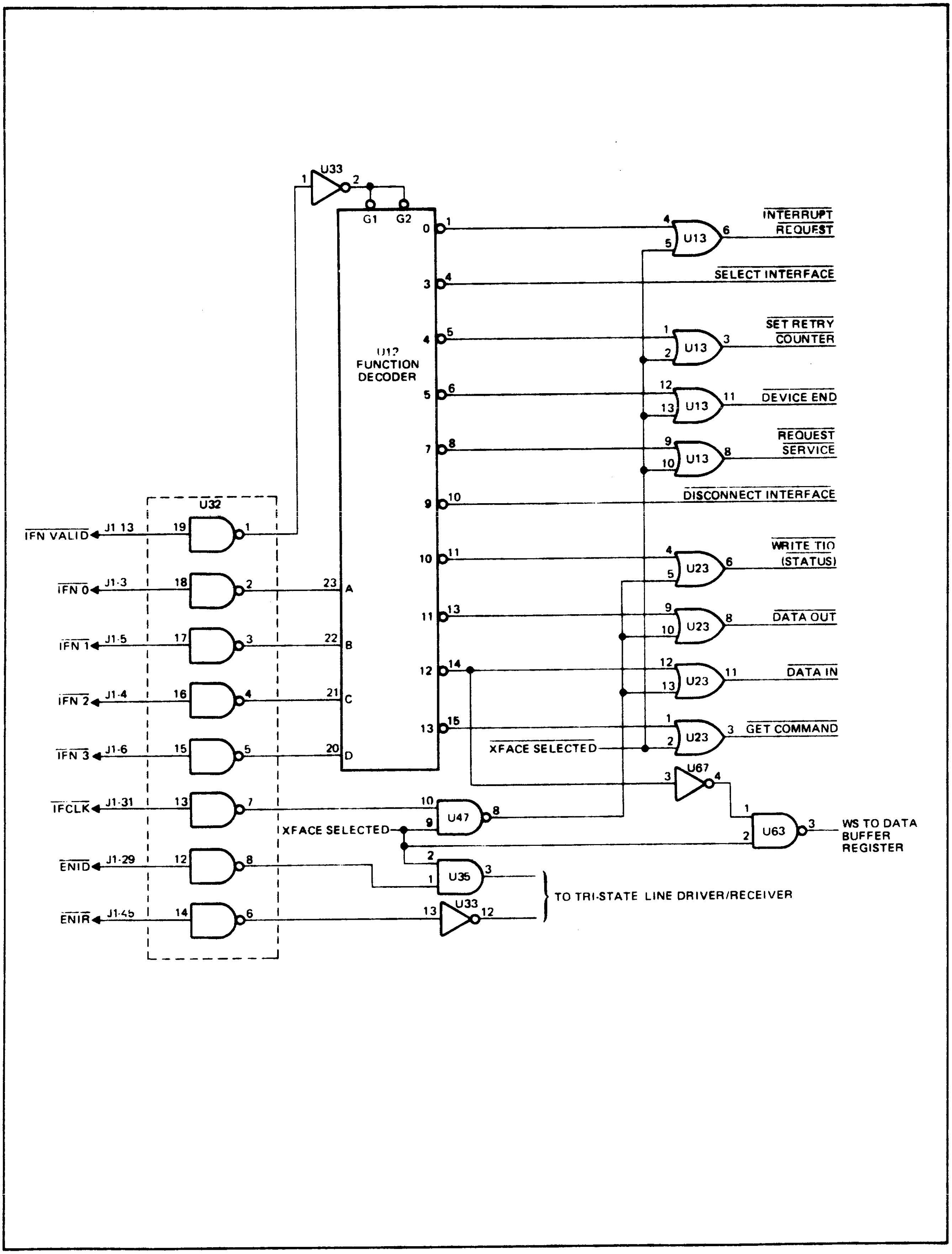


Figure 3-7. Function Decoder

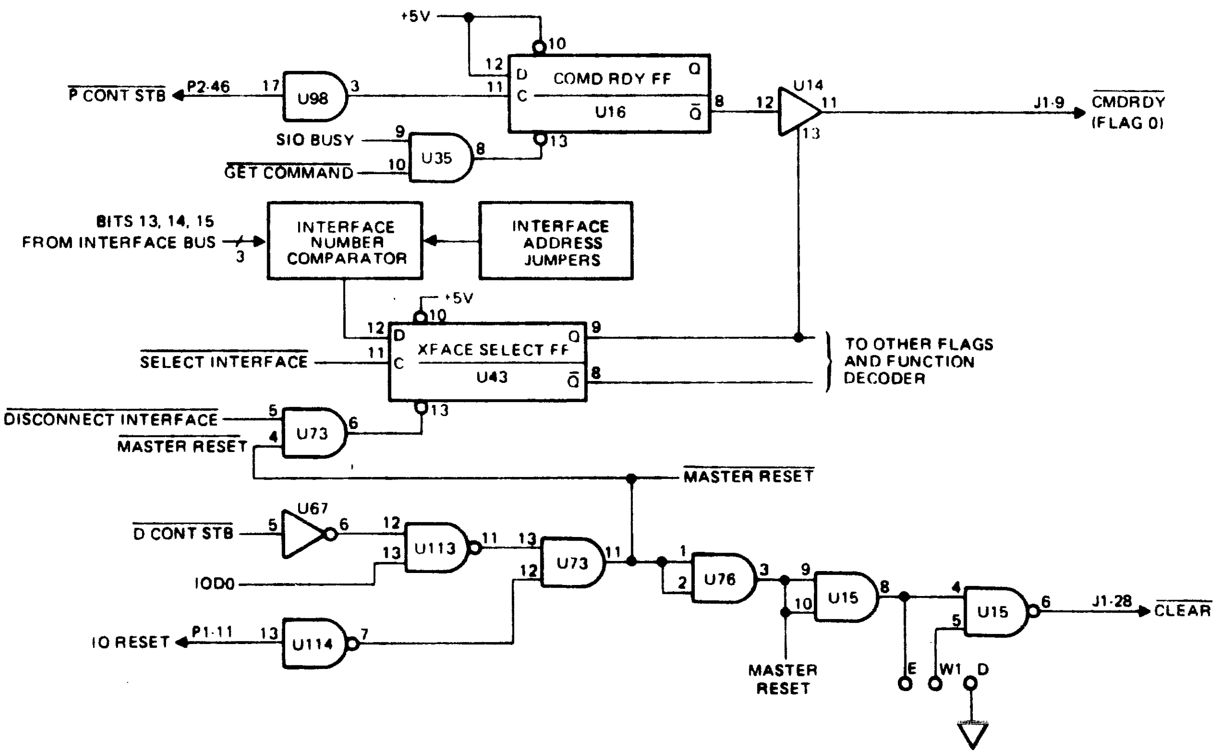


Figure 3-8. Interface Select and Command Ready Logic

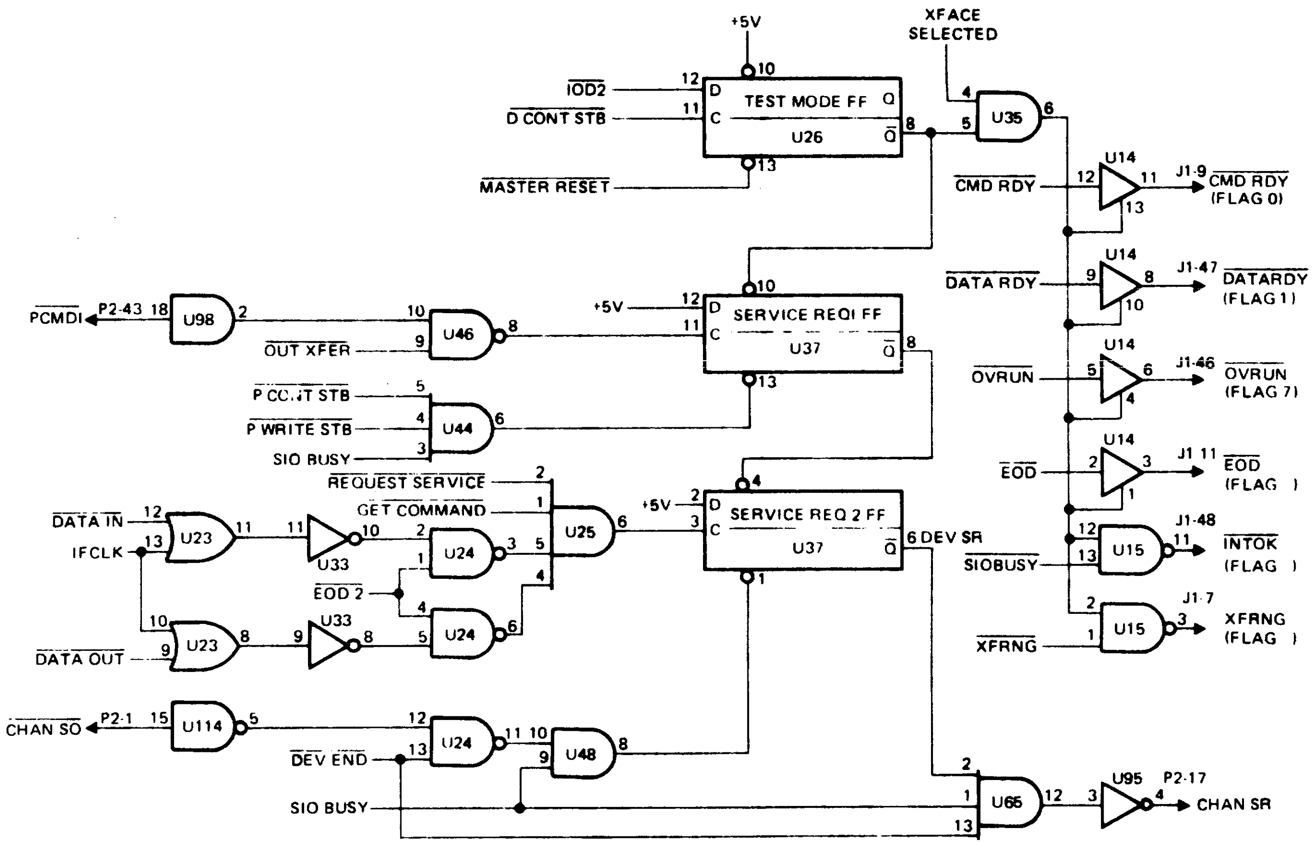


Figure 3-9. Test Mode and Service Request Logic

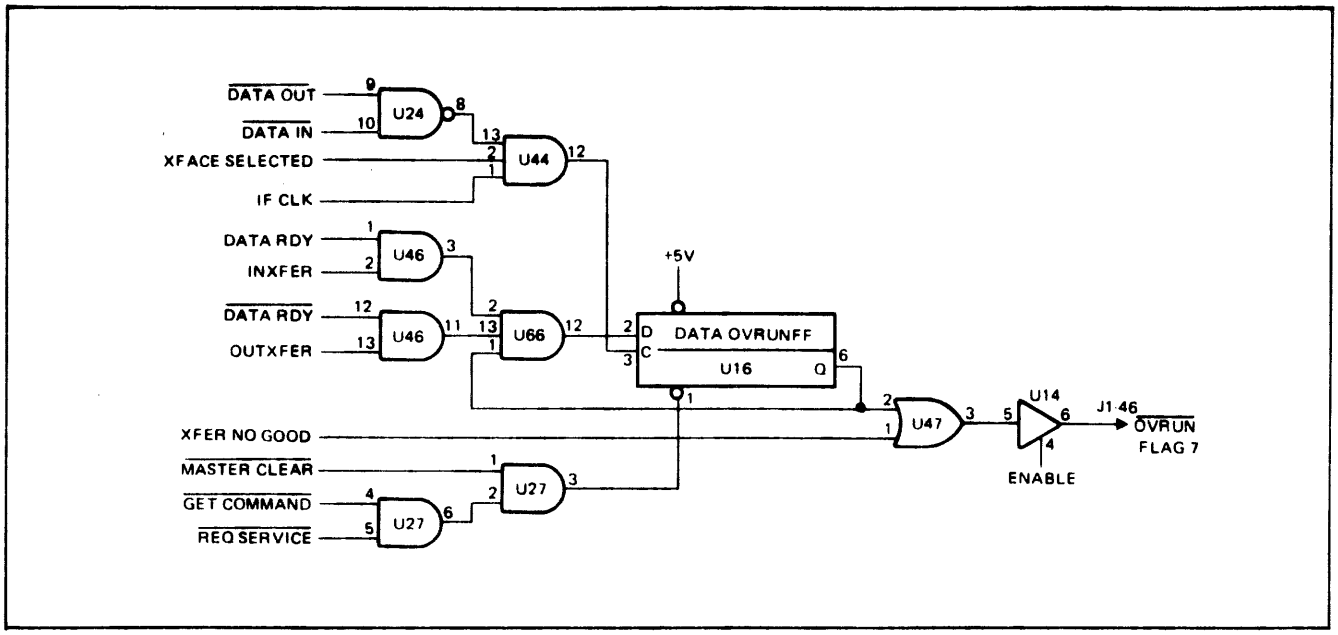


Figure 3-10. Data Overrun Logic

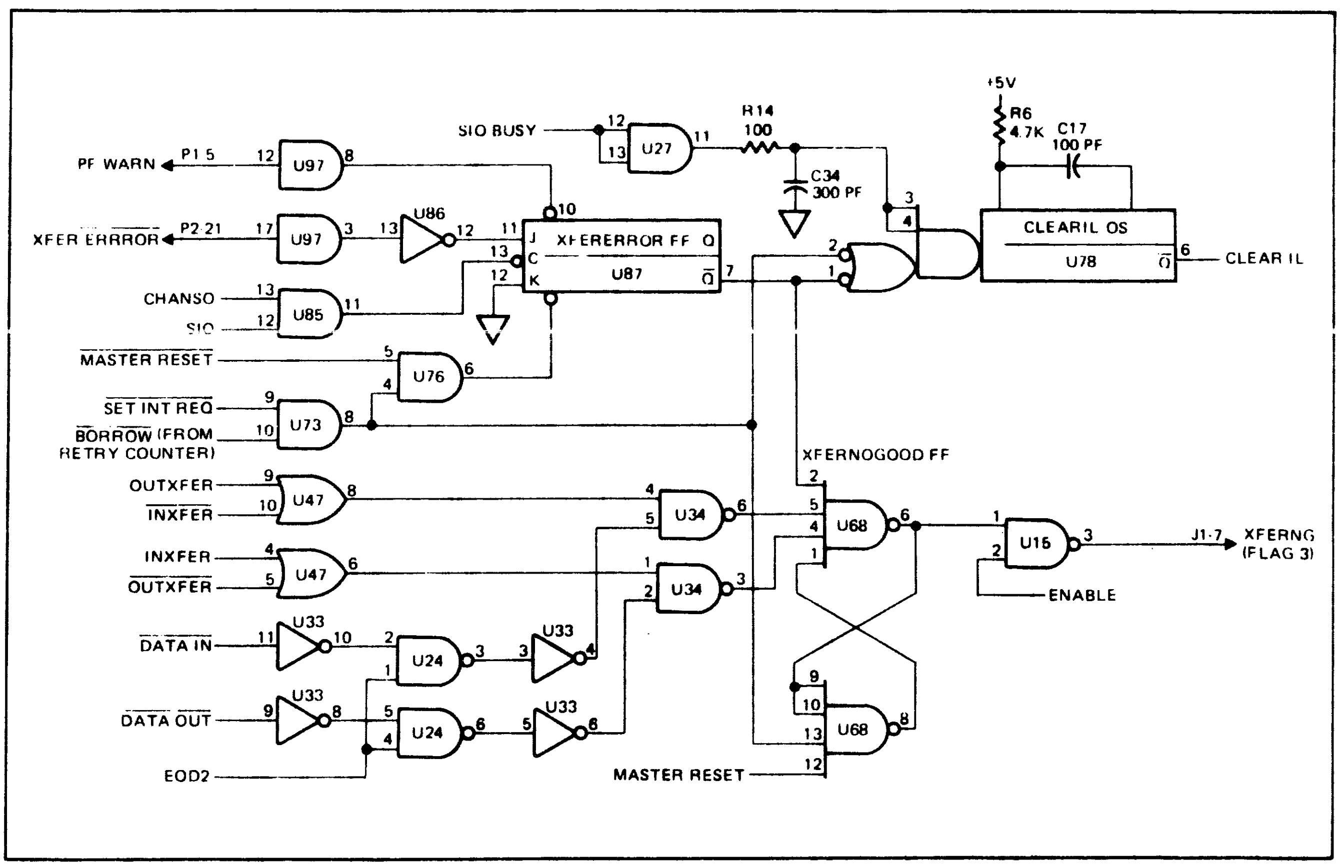


Figure 3-11. Transfer No Good and Error Logic

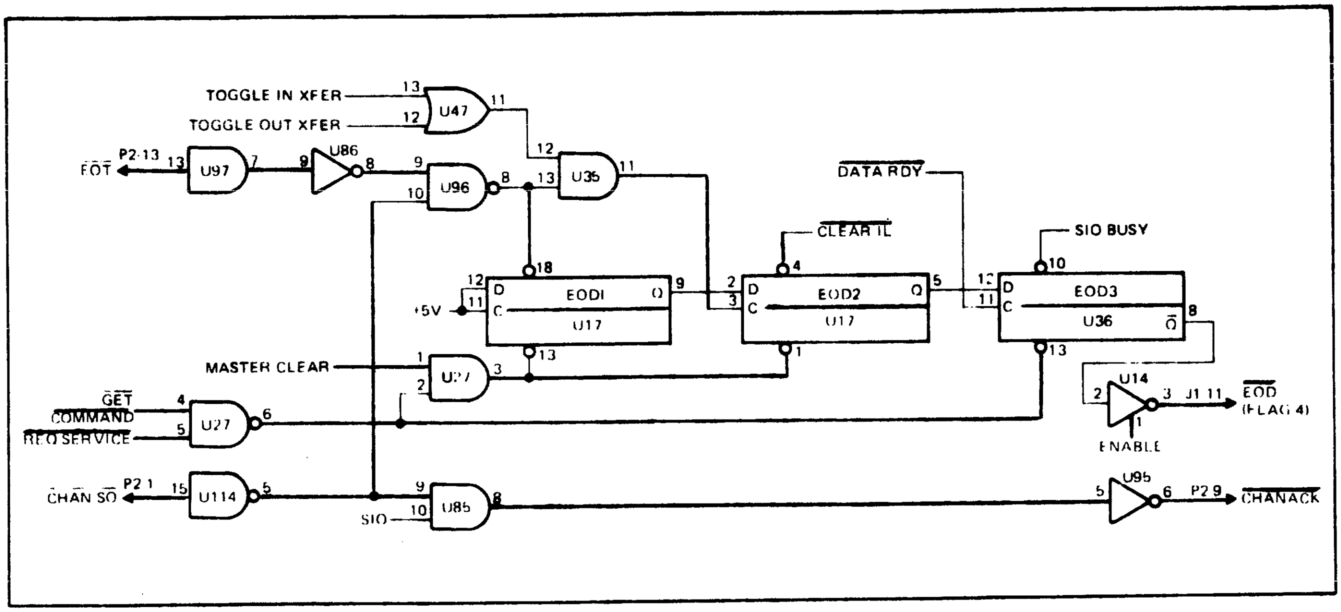


Figure 3-12. End of Data Logic

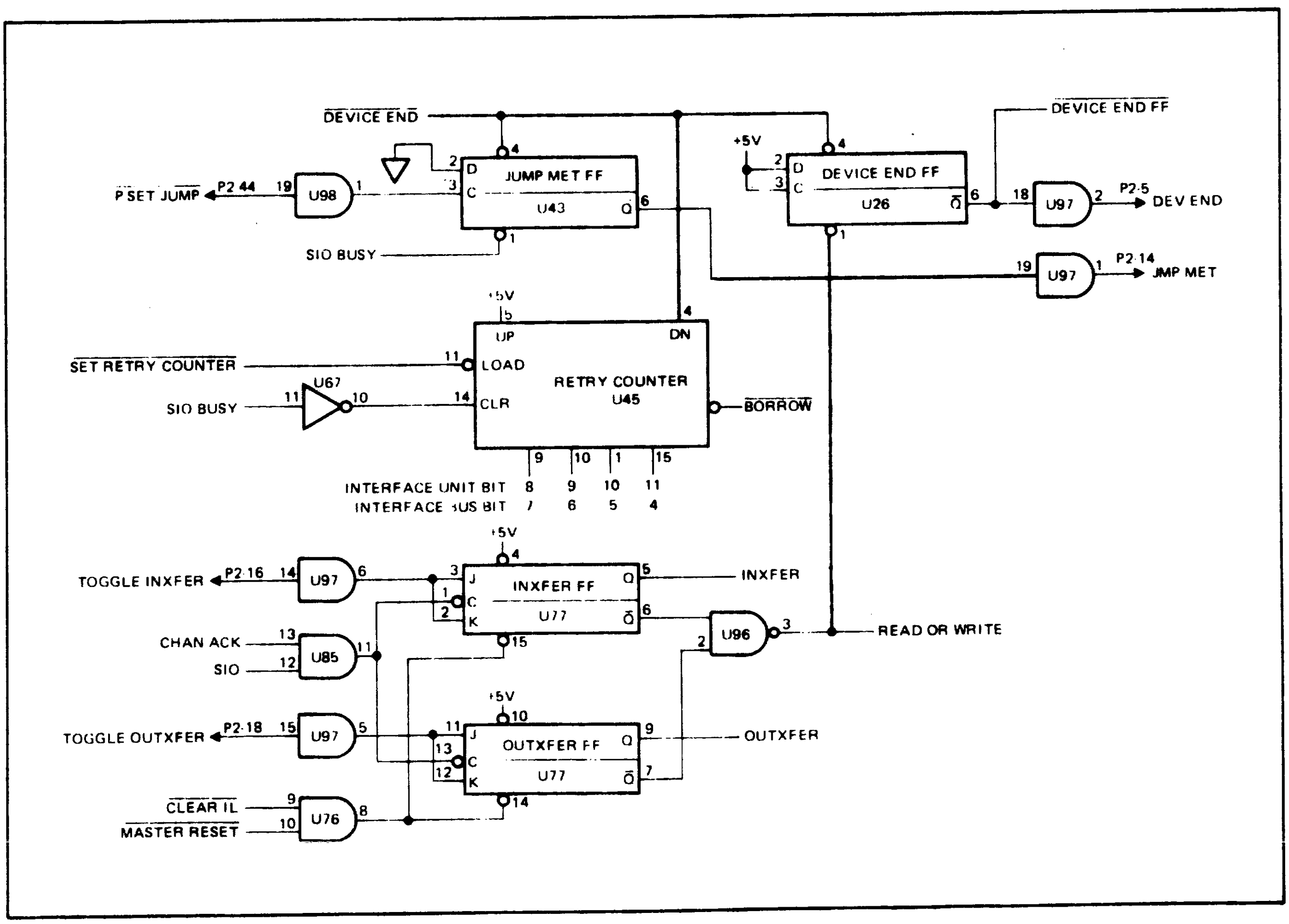


Figure 3-13. Device End and Set Retry Counter Logic

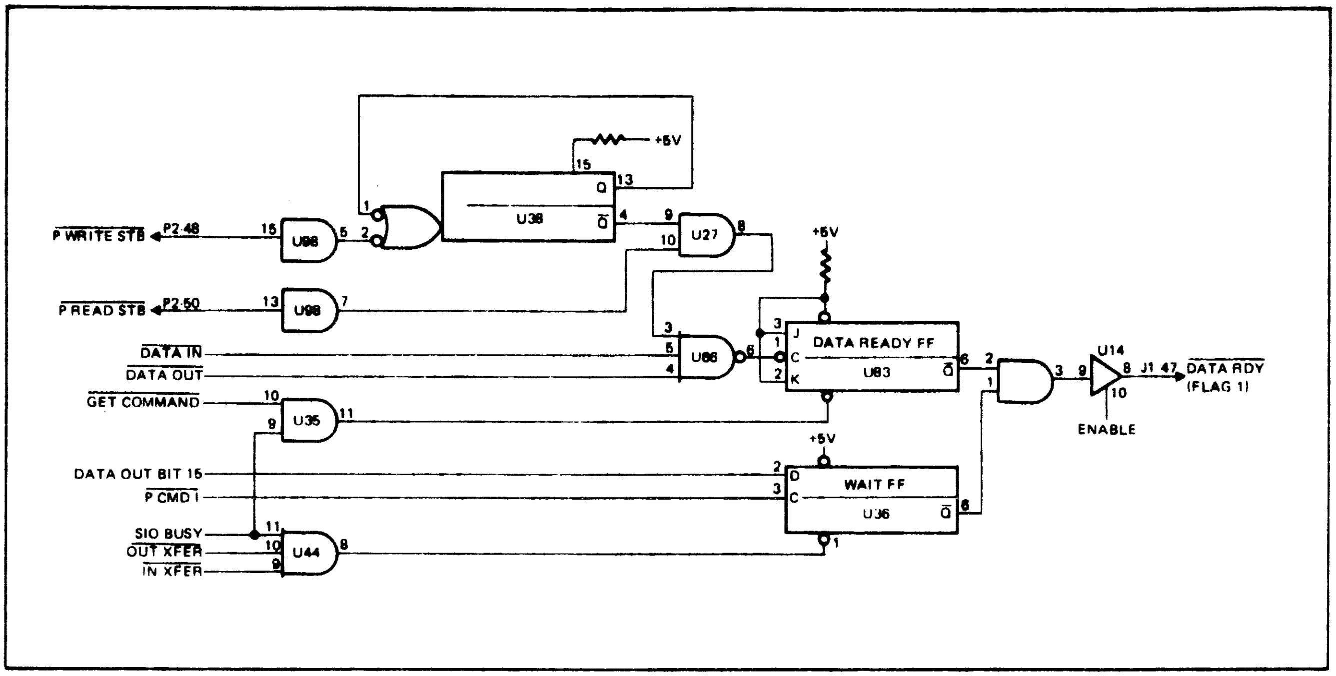


Figure 3-14. Data Ready Logic

MAINTENANCE

SECTION IV

4-1. INTRODUCTION.

4-2. This section includes general servicing information, preventive maintenance instructions, and troubleshooting data for the HP 7905A Cartridge Disc Subsystem. It is assumed that the Service Engineer performing maintenance has a thorough knowledge of the subsystem hardware.

4-3. GENERAL SERVICING INFORMATION.

4-4. The following paragraphs provide general servicing information applicable to the printed-circuit assembly of the cartridge disc subsystem and the 30229-60001 Interface Unit. Refer to the *HP 7905A Disc Drive Installation and Service Manual* for servicing information applicable to the disc drives. Refer to the HP 13037A Disc Controller Installation and Service Manual for information applicable to the disc controller.

4-5. SAFETY PRECAUTIONS.

4-6. When servicing the HP 7905A Cartridge Disc Subsystem, observe the following safety precautions.

WARNING

Dangerous voltages are present in the computer system power control module and cabinet ac power distribution system. Failure to observe all placarded warnings on the computer system hardware could result in injury or death.

CAUTION

Before removing or installing printed-circuit assemblies, ensure that the computer system DC POWER switch is in the STANDBY position. When connecting or disconnecting the interconnecting cable between the disc drive and the disc controller PCA, ensure that the disc power supply power is off. Failure to observe these precautions could result in damage to subsystem components.

4-7. It is assumed that the maintenance personnel will perform proper system (software) shut-down procedures before removing any PCA in the computer system.

4-8. REQUIRED SERVICING EQUIPMENT.

4-9. Oscilloscopes, PCA extenders, voltmeters, logic probes, common hand tools, etc. used for servicing the HP 3000 Computer System are also useful in servicing this subsystem. A list of special equipment, needed to maintain the subsystem and available from the factory, follows.

a. HP 12995A Service Kit for the maintenance of the HP 7905A Disc Drive and the three disc controller PCAs. This kit must include the four-card PCA extender.

b. HP 30372A Service Kit with Option 010 for the HP 30229A Cartridge Disc Interface Kit. This kit is used in maintaining the interface unit PCA.

c. HP 30371A Service Kit with Option 002 for maintenance of the HP 30030A Selector Channel.

d. A Controller Service Unit. A description of this unit and directions for its use in servicing the disc controller is provided in the installation and service manual for the disc controller.

e. A Disc Service Unit. A description of this unit and directions for its use in servicing the disc drives is provided in the installation and service manual for the HP 7905A Disc Drive.

f. The HP 30350A Auxiliary Control Panel, HP 30352A Hardware Maintenance Panel, and interface and power cables needed by the panels.

g. Engineering Supplement Package for the HP 30129A product. This contains factory-type documents such as schematic diagrams, parts lists, software listings, and so forth.

4-10. OPERATING CONTROLS AND INDICATORS.

4-11. Disc drive front panel controls are used when operating the disc drive in the off-line mode for maintenance. Refer to the operating and service manual for the HP 7905A Disc Drive for a list of controls and their functions. There are no operating controls or indicators on printed-circuit assemblies of the HP 7905A Cartridge Disc Subsystem.

4-12. PRINCIPAL SERVICING POINTS.

4-13. Cartridge disc subsystem interface and power cabling connections are shown in Figure 1-1. Pin/signal connections are shown in Tables 4-1 through 4-6 for connections between computer and interface unit (Tables 4-1, 4-2, and 4-3), interface unit and disc controller (Table 4-4), and disc controller and disc drive (Table 4-6). Table 4-5 shows pin data of connector J2 and the signals which may be monitored there.

4-14. The system configuration documentation shows the physical location of the cartridge disc subsystem PCA's. When performing preventive maintenance or troubleshooting, it is essential that these PCA cage locations are maintained and the cables connected as shown. The subsystem PCA's may be placed on extenders for maintenance purposes. The disc controller boards use the special extender provided in the HP 12995A Service Kit. When re-installing a PCA, proceed as follows:

a. Pull the extractor handles on the PCA's to the straight-out position.

CAUTION

Ensure that the plastic extractor handles are moved to the straight-out position before sliding the PCA into final position. Handles will be broken and the PCA cracked if this caution is ignored.

b. Slide PCA, component side up, into the two selected adjacent cage slots.

CAUTION

Do not force or bend the PCA when re-installing. Slide the PCA straight into the cage slot or damage to the PCA may result.

c. Lock the extractor handles into the slots on either side of the PCA cage.

4-15. INTERFACE UNIT PCA JUMPERS.

4-16. The four areas for jumper installation on the interface unit PCA are shown in Figure 2-1. Explanations of jumper functions are given in Table 2-1. Jumpers should be placed in the required positions compatible with the existing HP 3000 Computer System addressing and interrupt structure. Refer to the system configuration documentation for jumper information should it become necessary to modify these jumpers for maintenance. Device number jumpers should not be installed in the same positions occupied by any other device number jumpers on any other subsystem in the computer system.

4-17. PREVENTIVE MAINTENANCE.

4-18. Preventive maintenance of the cartridge disc subsystem consists of periodic inspection and cleaning of the subsystem PCA's, cables and disc drive. Inspect the subsystem PCA's cables, for burned or broken components, wires, and insulation. Ensure that subsystem cables are not subject to excessive bending. The air filters of the HP 29425A Cabinet should be cleaned once a week or when the magnahelix gauge indicates.

4-19. Preventive maintenance procedures for the HP 7905A Disc Drive are provided in the disc drive operating and service manual.

4-20. TROUBLESHOOTING

4-21. Before troubleshooting the cartridge disc subsystem, ensure that the trouble does not lie in another functional area of the system. To isolate the trouble to the cartridge disc subsystem, proceed as follows:

a. First, eliminate the central processing unit (CPU) by running all five sections of the CPU stand-alone diagnostic. Instructions are provided by the Stand-Alone HP 30001A CPU Diagnostic manual, part number 03000-90027. Check that the TIMERS switch on the hardware maintenance panel is set to the ENABLE position during section 3.

b. Then, run the selector channel stand-alone diagnostic using the HP 30033A Maintenance Card furnished as part of the HP 30371A Service Kit listed under Required Servicing Equipment. The service kit also contains replacement boards to aid in troubleshooting the selector channel. Instructions are provided by the Stand-Alone HP 30030A Selector Channel Diagnostic manual, part number 30030-90009.

4-22. Now, only the cartridge disc subsystem components should be suspect. Run the cartridge disc diagnostic. See the Stand-Alone HP 30129A Cartridge Disc Diagnostic manual, part no. 30129-90007 for Series II Computer Systems or 30129-90006 for pre-Series II Computer Systems. The diagnostic should be run such as to thoroughly exercise the I/O circuit areas and the subsystem boards because at times the diagnostic will run for several hours before any errors are reported. Section 6 of the diagnostic program uses direct I/O commands to test data and status paths to and from the interface unit.

4-23. There are many methods or techniques used by persons engaged in troubleshooting when confronted with reports of errors. For troubleshooting the cartridge disc subsystem, consider the following:

a. Note the error or errors reported or make a hard copy of the error printout. Observing the safety precautions set forth earlier in this section, replace the 30229-60001 Interface Unit PCA with the identical PCA from the HP 30372A Option 010 Service Kit. The kit board must be identical in every respect including jumper positioning. Restore power and again run the cartridge disc diagnostic as described in paragraph 4-22.

b. If there are no errors reported, restore the system to operating status. If different errors are reported, check carefully that jumper wires on the Interface Unit PCA from the service kit are indeed identically positional as those of the PCA previously installed. Consider the possibility that the kit board may also be defective. Again swap interface unit assemblies, returning the kit board to the service kit. If the same errors are reported, proceed to step "c."

c. Now, replace all three disc controller boards with the three disc controller boards from the HP 30372A Service Kit. Restore power and again run the cartridge disc diagnostic as described in paragraph 4-22.

d. If the error report is the same, proceed to step "f." If there are no errors reported, perhaps only one of the boards was defective, or, if different errors are reported, perhaps one of the kit boards was defective. At this point, it might be beneficial to replace the kit boards one at a time with the original controller boards. Always try to end up with the original boards installed whenever possible.

e. Refer to the troubleshooting procedures in the installation and service manual for the disc controller.

f. Refer to the troubleshooting procedures in the installation and service manual for the disc drive.

4-24. There may be errors which the diagnostic programs do not report because they cannot detect them. The troubleshooter has two tools left to him under these circumstances, the stand-alone diagnostic Sleuth and the dump analysis routine DPAN.

4-25. System Dump writes the hardware registers and all of memory to magnetic tape in one irrevocable pass. Now DPAN can be used to analyze the dump and print out the analysis on the system lineprinter or, the magnetic tape may be returned to the factory for dump analysis. The information supplied by DPAN can be used to reconstruct a picture of what took place. Examination of the last SIO program executed, the Device Information Table (especially the disc drive entry), and the IOQ table is very important. Figure 4-1 shows the format and contents of those area of the dump analysis associated with the cartridge disc subsystem and the inter-relationships of certain data.

4-26. The information in this paragraph applies only to pre-Series II Systems. See next paragraph for Series II Systems. The SIO programs shown on the left in Figure 4-1 are as they would be generated by the MPE driver IOMDISK1. Also shown is a representation of the Device Information Table (DIT) and the QMISC word from the I/O Queue (IOQ) table. One may now configure Sleuth (product number HP 32212A) to duplicate the SIO program along with other programs for other devices in order to simulate the system environment. Table 4-7, a tabulation of driver parameters, and Figure 4-2, the cartridge disc driver flowchart, are furnished as an adjunct to the dump analysis.

4-27. The information in this paragraph applies only to Series II Systems. See the preceding paragraph for pre-Series II Systems. The SIO programs shown on the left in Figure 4-3 are as they would be generated by the MPE driver IOMDISC1. Also shown is a representation of the Device Information Table (DIT) and several words from the I/O Queue (IOQ) table. One may now configure Sleuth (product number HP 32212A) to duplicate the SIO program along with other programs for other devices in order to simulate the system environment.

Table 4-1. IOP/Power Bus Signal Index

PIN	SIGNAL		PIN	SIGNAL	
1	+5V		31	−20V	
2	+5V		32	−20V	
3	+5V		33	−20V	
4	+V		34	−20V	
5	$\overline{\text{PF WARN}}$		35	+20V	
6	ENTIMER (NOT USED)		36	+20V	NOT USED
7	(SPARE)		37	+20V	
8	(SPARE)		38	+20V	
9	PWR ON		39	+20V	
10	PWR ON ⏚		40	+20V	
11	IORESET		41	$\overline{\text{HSREQ}}$	
12	IORESET ⏚		42	$\overline{\text{HSREQ}}$ ⏚	
13	$\overline{\text{MCUCLKS}}$	NOT USED	43	INTPOLL OUT ⏚	
14	$\overline{\text{MCUCLKS}}$ ⏚		44	INTPOLL OUT	
15	⏚		45	(SPARE)	
16	⏚		46	(SPARE) ⏚	
17	-5V	NOT USED	47	INTPOLL IN ⏚	
18	-5V		48	INTPOLL IN	
19	⏚		49	$\overline{\text{SI}}$	
20	⏚		50	$\overline{\text{SI}}$ ⏚	
21	+15V		51	DATAPOLL OUT ⏚	NOT USED
22	+15V		52	DATAPOLL OUT	
23	+15V		53	$\overline{\text{SO}}$	
24	+15V	NOT USED	54	$\overline{\text{SO}}$ ⏚	
25	-15V		55	DATAPOLL IN ⏚	
26	-15V		56	DATAPOLL IN	NOT USED
27	-15V			$\overline{\text{MSKRTRN}}$	
28	-15V			$\overline{\text{MSKRTRN}}$ ⏚	
29	⏚				
30	⏚				

Note: Power Bus pin numbers match PCA P1 pin numbers.

Table 4-2. Selector Channel Bus Signal Index

PIN	SIGNAL	PIN	SIGNAL
1	$\overline{\text{CHAN SO}}$	26	SR 13
2	⏚	27	SR 12
3	$\overline{\text{SR CLOCK}}$ (NOT USED)	28	SR 11
4	⏚	29	SR 10
5	$\overline{\text{DEV END}}$	30	⏚
6	⏚	31	SR 9
7	$\overline{\text{ACK SR}}$ (NOT USED)	32	SR 8
8	⏚	33	SR 7
9	$\overline{\text{CHAN ACK}}$	34	SR 6
10	⏚	35	SR 5
11	$\overline{\text{DEVNO DB}}$ (NOT USED)	36	⏚
12	$\overline{\text{SIO ENABLE}}$	37	SR 4
13	$\overline{\text{EOT}}$	38	SR 3
14	$\overline{\text{JMP MET}}$	39	SR 2
15	⏚	40	SR 1
16	TOGGLE INXFER	41	SR 0
17	CHANSR	42	⏚
18	TOGGLE OUTXFER	43	$\overline{\text{P CMD 1}}$
19	TOGGLE SIO OK	44	$\overline{\text{SET JMP}}$
20	⏚	45	$\overline{\text{P STATUS STB}}$
21	$\overline{\text{XFER ERROR}}$	46	$\overline{\text{P CONT STB}}$
22	$\overline{\text{REQ}}$	47	$\overline{\text{RD NEXT WD}}$ (NOT USED)
23	⏚	48	$\overline{\text{P WRITE STB}}$
24	SR 15	49	$\overline{\text{SET INT}}$
25	SR 14	50	$\overline{\text{P READ STB}}$

Note: Selector Channel bus pin numbers match PCA P2 pin numbers.

Table 4-3. IOP Bus Signal Index

PIN	SIGNAL	PIN	SIGNAL
1	$\overline{\text{IODPRTY}}$ (NOT USED)	26	$\overline{\text{IOD 04}}$
2	$\overline{\text{IOD PE}}$ (NOT USED)	27	$\overline{\text{IOD 05}}$
3	⏚	28	⏚
4	$\overline{\text{IOCMD 00}}$	29	$\overline{\text{IOD 06}}$
5	$\overline{\text{IOCMD 02}}$	30	$\overline{\text{IOD 07}}$
6	$\overline{\text{IOCMD 01}}$	31	⏚
7	⏚	32	$\overline{\text{IOD 08}}$
8	$\overline{\text{DEVNO 00}}$	33	$\overline{\text{IOD 09}}$
9	$\overline{\text{DEVNO 01}}$	34	⏚
10	⏚	35	$\overline{\text{IOD 10}}$
11	$\overline{\text{DEVNO 02}}$	36	$\overline{\text{IOD 11}}$
12	$\overline{\text{DEVNO 03}}$	37	⏚
13	⏚	38	$\overline{\text{IOD 12}}$
14	$\overline{\text{DEVNO 04}}$	39	$\overline{\text{IOD 13}}$
15	$\overline{\text{DEVNO 05}}$	40	⏚
16	⏚	41	$\overline{\text{IOD 14}}$
17	$\overline{\text{DEVNO 06}}$	42	$\overline{\text{IOD 15}}$
18	$\overline{\text{DEVNO 07}}$	43	⏚
19	⏚	44	$\overline{\text{INTREQ}}$
20	$\overline{\text{IOD 00}}$	45	(SPARE)
21	$\overline{\text{IOD 01}}$	46	⏚
22	⏚	47	(SPARE)
23	$\overline{\text{IOD 02}}$	48	(SPARE)
24	$\overline{\text{IOD 03}}$	49	⏚
25	⏚	50	$\overline{\text{INTACK}}$

Note: IOP Bus pin numbers match PCA P3 pin numbers.

Table 4-4. Interface Bus Signal Index

PIN	SIGNAL	PIN	SIGNAL
1	+5V	26	NOT USED
2	+5V	27	$\overline{\text{IBUS 03}}$
3	$\overline{\text{IFN 00}}$	28	$\overline{\text{CLEAR}}$
4	$\overline{\text{IFN 02}}$	29	$\overline{\text{ENID}}$
5	$\overline{\text{IFN 01}}$	30	NOT USED
6	$\overline{\text{IFN 03}}$	31	$\overline{\text{IFCLK}}$
7	$\overline{\text{XFRNG}}$	32	NOT USED
8	$\overline{\text{IBUS 04}}$	33	⏚
9	$\overline{\text{CMD RDY}}$	34	⏚
10	$\overline{\text{IBUS 05}}$	35	+5V
11	$\overline{\text{EOD}}$	36	+5V
12	$\overline{\text{IBUS 06}}$	37	$\overline{\text{IBUS 08}}$
13	$\overline{\text{IFN VALID}}$	38	$\overline{\text{IBUS 12}}$
14	$\overline{\text{IBUS 07}}$	39	$\overline{\text{IBUS 09}}$
15	⏚	40	$\overline{\text{IBUS 13}}$
16	⏚	41	$\overline{\text{IBUS 10}}$
17	NOT USED	42	$\overline{\text{IBUS 14}}$
18	NOT USED	43	$\overline{\text{IBUS 11}}$
19	⏚	44	$\overline{\text{IBUS 15}}$
20	⏚	45	$\overline{\text{ENIR}}$
21	$\overline{\text{IBUS 00}}$	46	$\overline{\text{OVRUN}}$
22	+5V	47	$\overline{\text{DATA RDY}}$
23	$\overline{\text{IBUS 01}}$	48	$\overline{\text{INTOK}}$
24	NOT USED	49	⏚
25	$\overline{\text{IBUS 02}}$	50	⏚

Note: Interface bus pin numbers match PCA J1 and J3 pin numbers.

Table 4-5. Interface Unit Connector J2 Signal Index

PIN	SIGNAL	PIN	SIGNAL
1		26	
2	+5V	27	OUTXFER
3		28	
4	SIO OK (BIT OF STATUS WORD)	29	INXFER
5	⏚	30	
6		31	WAIT
7	SERVICE REQUEST 2	32	
8		33	⏚
9	DEVICE END	34	
10		35	IFN VALID
11	SERVICE REQUEST 1	36	
12		37	INT MASK
13	COMMAND READY	38	
14		39	INT ACT
15	DATA OVRUN	40	SEEK
16		41	DATA RDY
17	EOD 2	42	XFER ERROR
18		43	XFACE SELECT
19	⏚	44	SO
20		45	SIO BUSY
21	EOD 1	46	INT REQ
22		47	TEST MODE
23	EOD 3	48	CHAN SO
24		49	⏚
25	JUMP MET	50	

Table 4-6. Disc Drive Bus Signal Index

PIN	SIGNAL	PIN	SIGNAL
1	+5V	26	NOT USED
2	+5V	27	$\overline{\text{CBUS 7}}$
3	$\overline{\text{CBUS 0}}$	28	NOT USED
4	$\overline{\text{CBUS 11}}$	29	⏚
5	$\overline{\text{CBUS 1}}$	30	NOT USED
6	$\overline{\text{CBUS 10}}$	31	⏚
7	$\overline{\text{CBUS 2}}$	32	+5V
8	$\overline{\text{CBUS 9}}$	33	⏚
9	$\overline{\text{CBUS 3}}$	34	⏚
10	$\overline{\text{CBUS 8}}$	35	+5V
11	⏚	36	+5V
12	⏚	37	$\overline{\text{TBUS 0}}$
13	$\overline{\text{STROBE}}$	38	$\overline{\text{CBUS 12}}$
14	⏚	39	$\overline{\text{TBUS 1}}$
15	⏚	40	$\overline{\text{CBUS 13}}$
16	⏚	41	$\overline{\text{TBUS 2}}$
17	FORMATTED DATA	42	$\overline{\text{CBUS 14}}$
18	FORMATTED DATA	43	$\overline{\text{TBUS 3}}$
19	⏚	44	$\overline{\text{CBUS 15}}$
20	⏚	45	⏚
21	$\overline{\text{CBUS 4}}$	46	⏚
22	+5V	47	⏚
23	$\overline{\text{CBUS 5}}$	48	⏚
24	NOT USED	49	⏚
25	$\overline{\text{CBUS 6}}$	50	⏚

Table 4-7. Cartridge Disc Software Driver (IOMDISK1 for pre-Series II Systems)

DRIVER REQUEST CODES		IOQ (6) BITS 14:2
0 Read 1 Write 2 Control 3 Fill	If control (%2) then: P1 IOQ (8) - (% 1) - Return hardware status P1 IOQ (8) - (%11) - Device close P1 IOQ (8) - (%12) - File close P1 IOQ (8) - (%13) - File open	

DRIVER RETURN CODES		IOCB(0) BITS 8:8
Qualifying (8:5)	**General (13:3)**	**Overall**
3X - Wait for completion	X0 - Pending	%30
	1 - Successful	%01
0X - Invalid control	X3 - Unusual	%03
10X - Memory management turnaround	XX3 - Unusual	%103
1X - Transmission error	X5 - Irrecoverable errors	%15
4X - SIO failure	X5 - Irrecoverable errors	%45
5X - Unit failure	X5 - Irrecoverable errors	%55
6X - Invalid memory address	X5 - Irrecoverable errors	%65
7X - Invalid disc address	X5 - Irrecoverable errors	%75

TRANSMISSION LOG (TLOG)	IOCB(1) BITS 0:16
Word transfers: Positive Byte transfers: Negative	

MODE	IOQ(3) BITS 2:4
%5 for complete; %13 for call completor.	

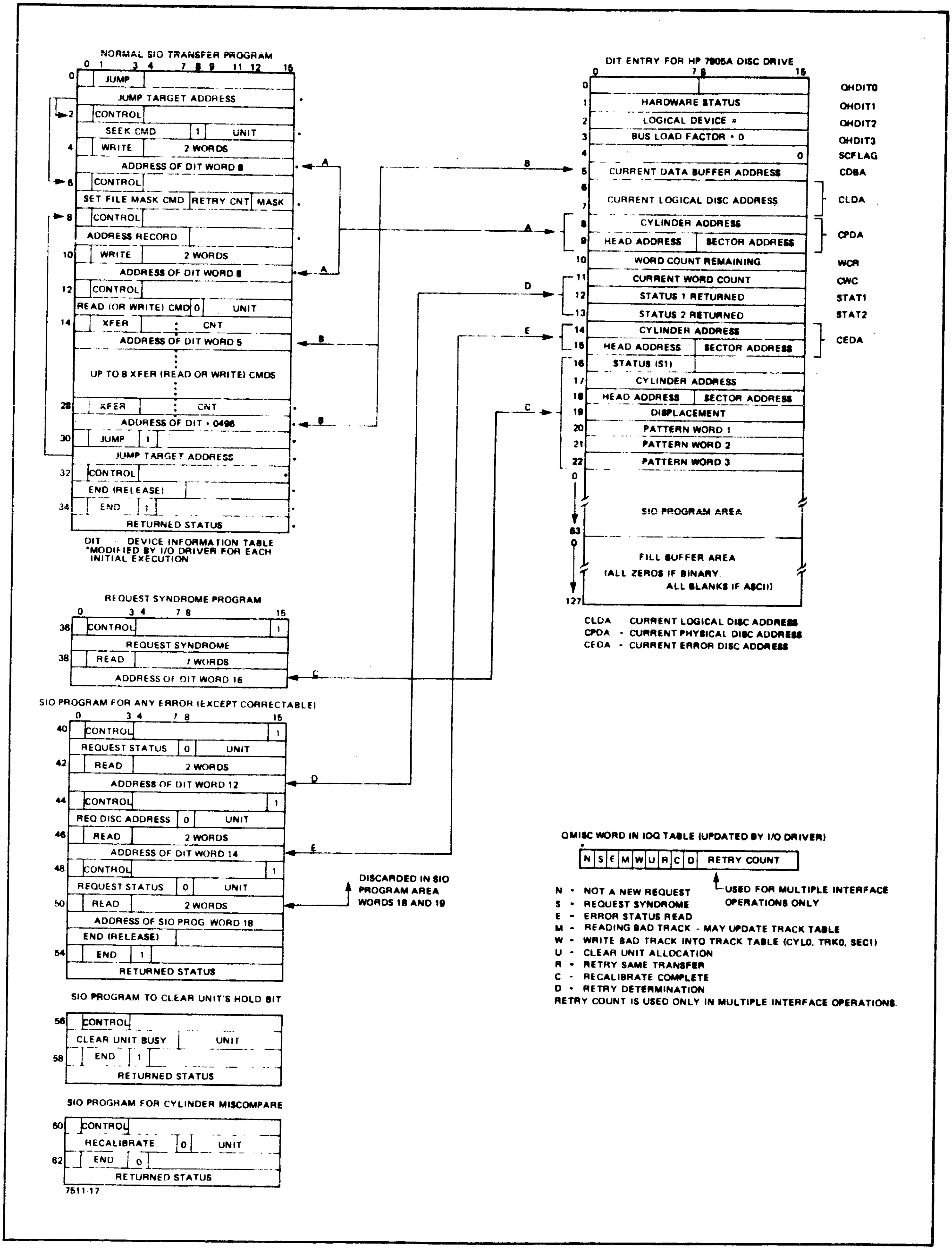


Figure 4-1. System Dump Analysis for pre-Series II Systems

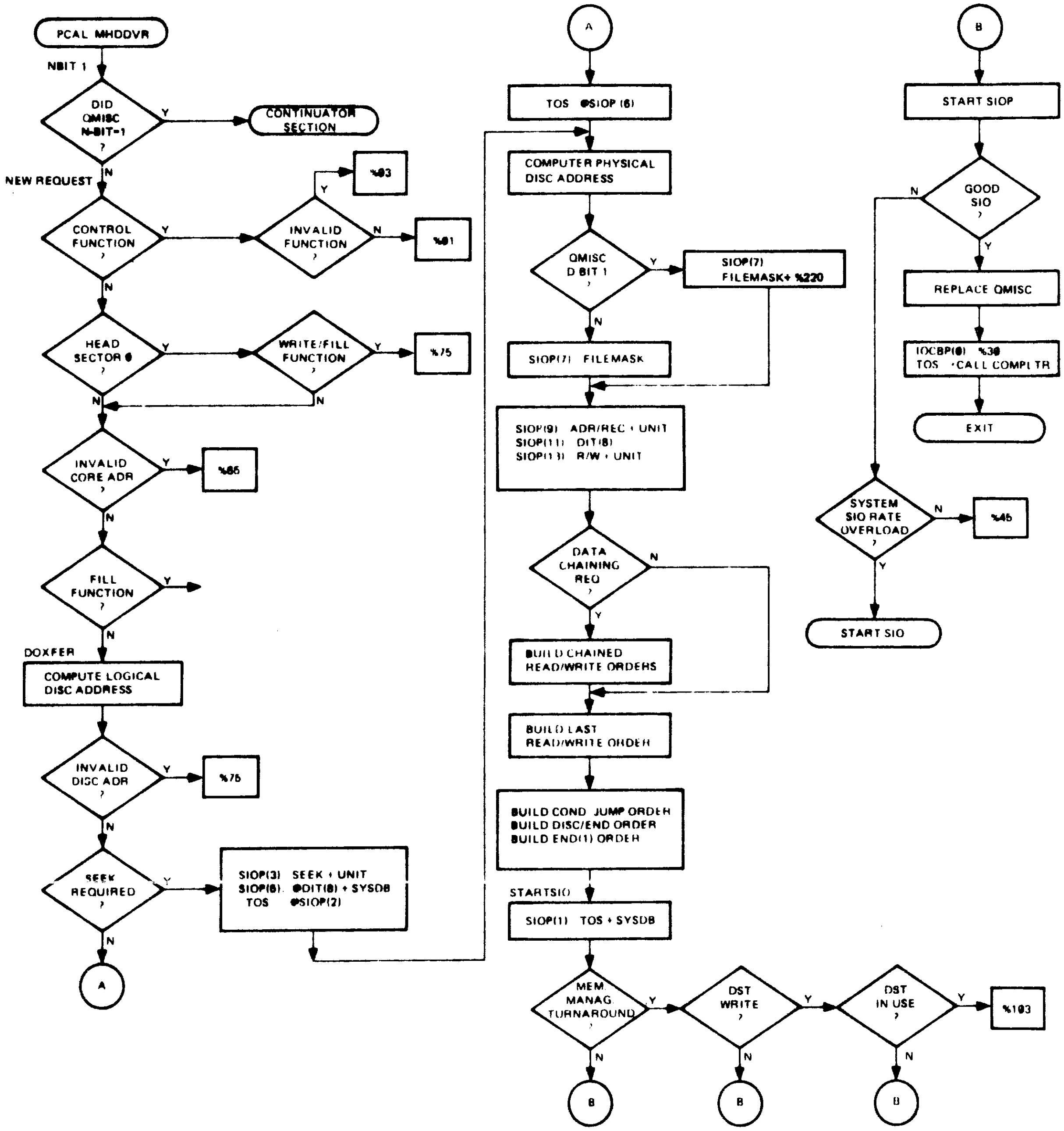


Figure 4-2. Disc Driver Flowchart for pre-Series II Systems (Sheet 1 of 2)

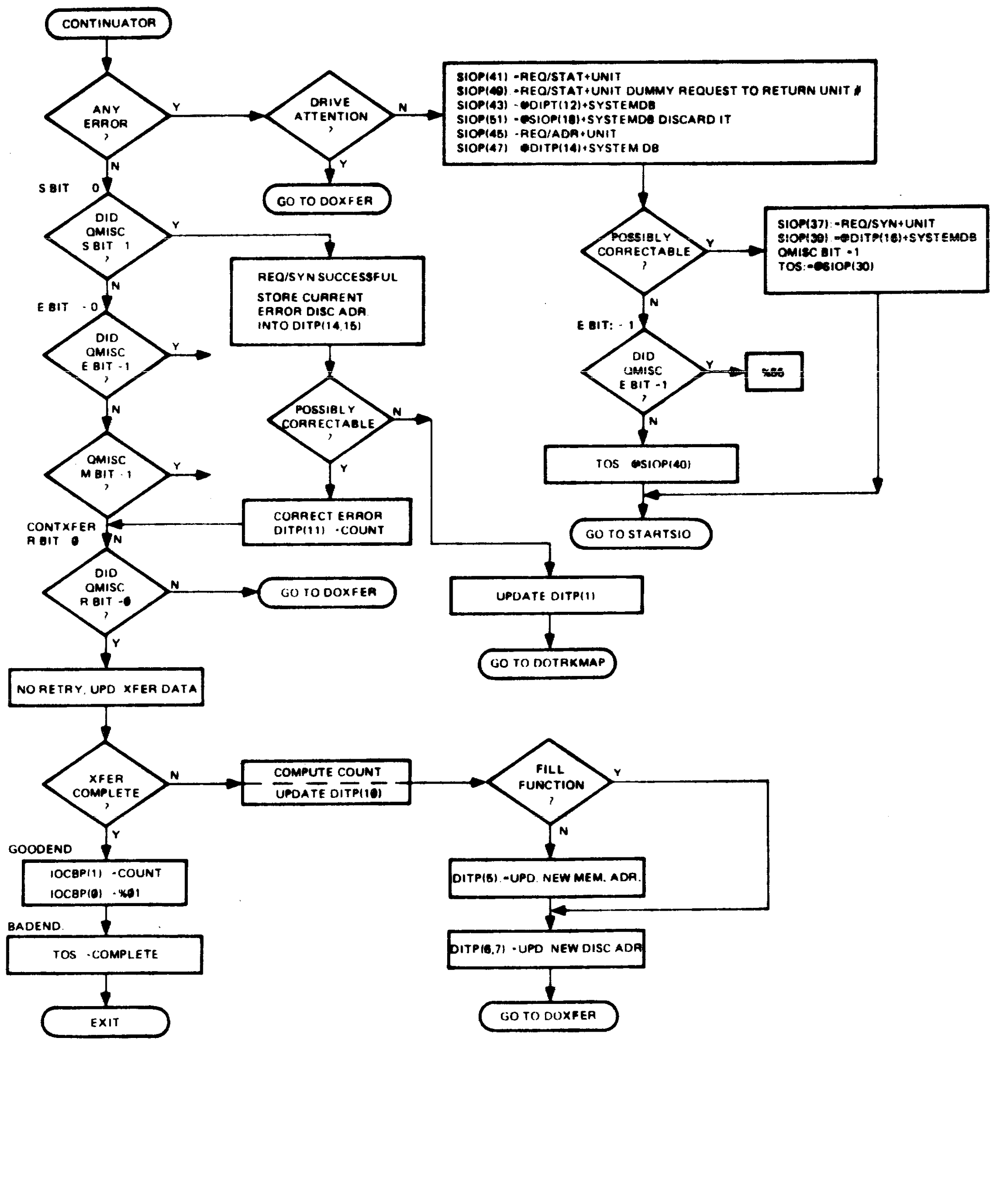


Figure 4-2. Disc Driver Flowchart for pre-Series II Systems (Sheet 2 of 2)

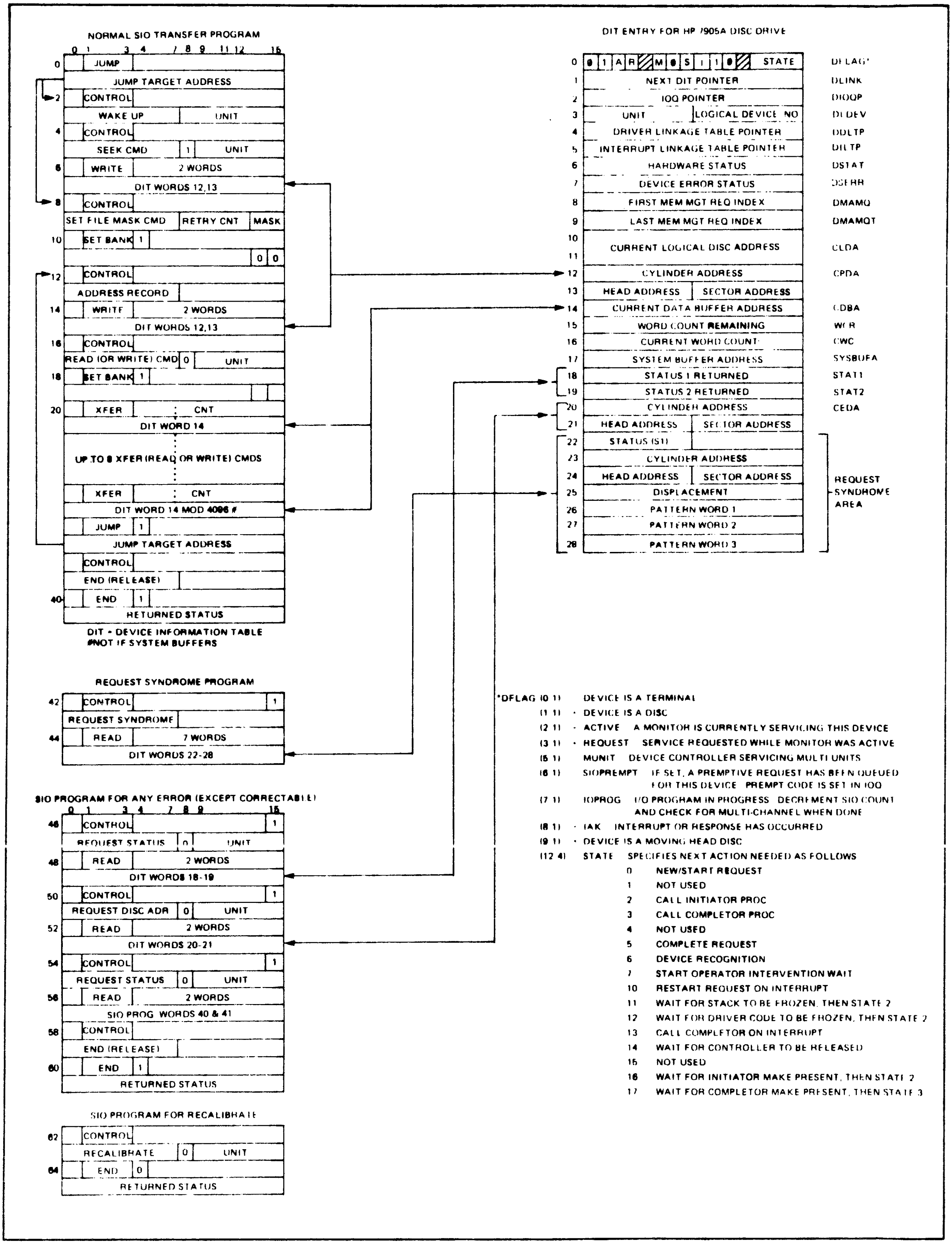


Figure 4-3. System Dump Analysis for Series II Systems (Sheet 1 of 2)

QMISC WORD IN IOQ TABLE

0	1	2	3	4	5	6	7	8–15
D	S	E	M	W	0	0	C	//////

QMISC	(0 1)	D	RETRY DETERMINATION
	(1 1)	S	REQUEST SYNDROME
	(2 1)	E	REQUEST ERROR INFORMATION
	(3 1)	M	UPDATE TRACK MAP
	(4 1)	W	WRITING TRACK MAP
	(7 1)	C	ISSUED A RECALIBRATE

QFUNC WORD IN IOQ TABLE

0–7	8–15
//////	FUNCTION

DRIVER REQUEST CODE	0	READ
	1	WRITE
	2	FILE OPEN
	3	FILE CLOSE
	4	DEVICE CLOSE
	5	FILL WITH ZEROS
	6	FILL WITH BLANKS

QWBCT WORD IN IOQ TABLE

0–15
WORD/BYTE COUNT

QWBCT IS	POSITIVE	WORDS TRANSFERRED
	NEGATIVE	BYTES TRANSFERRED

QPAR1 AND QPAR2 WORDS IN IOQ TABLE

THESE WORDS FORM A DOUBLE WORD DISC ADDRESS FOR ALL TRANSFERS. QPAR1 IS THE MOST SIGNIFICANT WORD. QPAR2 IS THE LEAST SIGNIFICANT WORD.

QSTAT WORD IN IOQ TABLE

0–7	8–12	13–15
PCNB	QUALIFIER	GEN

PCNB PROCESS CONTROL BLOCK NUMBER OF THE PROCESS WHICH MADE THIS REQUEST. ZERO IF NOT ASSOCIATED WITH ANY PROCESS AND THE IOQ IS TO BE RETURNED BY THE SYSTEM.

QUALIFIER (8 5)		GENERAL (13 3)		OVERALL (8 8)
1X	WAIT FOR COMPLETION	X0	PENDING	%10
		1	SUCCESSFUL	%01
0X	INVALID FUNCTION	X4	IRRECOVERABLE	%04
1X	TRACK ERROR		ERROR	%14
3X	TRANSMISSION ERROR			%34
4X	SIO FAILURE			%44
5X	UNIT FAILURE			%54
6X	INVALID DISC ADDRESS			%64
12X	SYSTEM ERROR			%124

Figure 4-3. System Dump Analysis for Series II Systems (Sheet 2 of 2)

FIELD INSTALLATION

APPENDIX A

A-1. INTRODUCTION.

A-1. This appendix contains information that will be needed when adding an HP 7905A Cartridge Disc Subsystem to provide additional mass storage facilities for an HP 3000 Computer System in the field.

A-3. INTERRUPT POLLING

A-4. The interrupt polling sequence for device controllers is recommended by HP Data Systems to be similar to that given in Table A-1. During the installation, the interrupt chain which starts at the INT POLL connector on the rear of the CPU/IOP will have to be opened at the appropriate place in the sequence for including the interface unit PCA of the cartridge disc subsystem in the chain and then again closed.

A-5. CONFIGURING

A-6. Table A-2 contains information needed during system configuration to integrate the cartridge disc subsystem into the Multiprogramming Executive (MPE).

Table A-1. Controller Interrupt Polling Sequence

PRODUCT NUMBERS (by rank)	PRODUCT DESCRIPTION
First 30031A	System clock/console
30032B	Asynchronous Terminal Data
30032B-002	Asynchronous Terminal Control
30032B-001	Asynchronous Terminal Control
30129A	Cartridge Disc (7905A)
30110A	Cartridge Disc (7900A)
30102A	Disc file (ISS)
30055A	Synchronous single-line
30115A	Magnetic tape
30105A	Paper tape punch
30104A	Paper tape reader
30108A/13A/18A	Line printer 200/300 lpm
30109A/28A	Line printer 600/1250 lpm
30050A	Universal interface (TTL)
30051A	Universal interface (differential)
30106A	Card reader 600 cpm
30107A	Card reader 1200 cpm
Last 30226A	Calcomp plotter

Note: When there are duplicate subsystem controllers, they should appear as a group in the sequence.

Table A-2. MPE Configuration Information

HP 7905A DISC DRIVER	
MPE Query	**Response**
TYPE?	0
SUBTYPE?	See subtype list below
REC WIDTH?	128
OUTPUT DEVICE?	0
ACCEPT JOBS/SESSIONS?	NO
ACCEPT DATA?	NO
INTERACTIVE?	NO
DUPLICATIVE?	NO
INITIALLY SPOOLED?	NO
DRIVER NAME?	IOMDISC1‡
DEVICE CLASSES?	SYSDISK#

SUBTYPE LIST	
Subtype	**Use Numeral**
Removable Platter	4
Fixed Platter	5
Cylinder Mode	6
FHD Replacement	7

SUBTYPE PARAMETERS			
Subtype	**Sectors/Cyl**	**Headbase**	**File Mask**
4	96	0	%7426
5	48	%1000	%7425
6	144	0	%7427
7	144	0	%7427

‡IOMDISK1 for pre-Series II # SYSDISK is used as fixed head replacement. Otherwise "DISC, SPOOL" or "DISC".

APPENDIX B

STATUS WORDS

Table B-1. Status Words

STATUS WORD (TIO, SENSE, END)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SIO READY	TEST MODE	INTERRUPT REQUEST	S1 ENCODED TERMINATION STATUS					U UNIT NUMBER % 0-12							

S1 =			OCTAL**
00	=	Normal completion	000
01	=	Illegal opcode	004
07	=	Cylinder compare error	034
10	=	Uncorrectable data error	040
11	=	Head-sector compare error	044
12	=	I/O program error	050
14	=	End of cylinder	060
16	=	Overrun	070
17	=	Possibly correctable data error	074
20	=	Illegal access to spare track	100
21	=	Defective track	104
22	=	Access not ready during data operation	110
23	=	Status word 2 error	114
26	=	Attempt to write on protected or defective track	130
27	=	Unit unavailable	134
37	=	Drive attention (seek complete)	174

STATUS 1 WORD (FIRST STATUS WORD RETURNED ON REQUEST STATUS COMMAND OF DISC SUBSYSTEM. SEE COMMAND 003 OF TABLE 3-1.)

STATUS 1 WORD IS THE SAME AS BITS 3 THRU 15 OF STATUS WORD.

BIT 0 = SPARE TRACK BIT
BIT 1 = PROTECTED TRACK BIT
BIT 2 = DEFECTIVE TRACK BIT

STATUS 2 WORD (SECOND STATUS WORD RETURNED ON REQUEST STATUS COMMAND OF DISC SUBSYSTEM. SEE COMMAND 003 OF TABLE 3-1.)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
STATUS 2 ERROR IF ANY * IS TRUE	ADDRESS OF LAST AVAILABLE SURFACE							ATTENTION	PROTECTED	FORMAT	* FAULT	FIRST STATUS	* SEEK CHECK	* DRIVE NOT READY	* DRIVE BUSY

**Octal representation of bits 1 thru 9 assuming bits 1 and 2 are zeros.