CONTROL DATA CORPORATION

CDC® DISK STORAGE SUBSYSTEM
7054-1/21/41 DISK STORAGE CONTROLLERS
7054-2/22/42 DISK STORAGE CONTROLLERS
7152-1 DISK/TAPE CONTROLLER
7154-1/2/3/4 DISK STORAGE CONTROLLERS
7654-1/21 DISK STORAGE CONTROLLERS
844-2/21/41/44 DISK STORAGE UNITS
10304-1/2 MASS STORAGE EXTENDER OPTION
10333-1 DOUBLE DENSITY OPTION

OPERATION AND PROGRAMMING MANUAL

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PAGE	REV	PAGE	REV	PAGE	REV	PAGE	REV	PAGE	REV
Front Cover	-								
Inside Cover	-								
Title Page	-								
ii	S								
iii/iv	S								
v/vi	P								
vii	S								
viii	P								
1-1	P								
1-2	M								
1-3	P								
1-4	S								
1-5	P								
1-6	P								
1-7	S								
1-8	R								
1-9	P								
1-10	L								
1-11	P								
1-12	S								
1-13	M								
1-14	P								
1-15	P								
1-16	P								
1-17	P								
1-18	M								
1-19	P								
1-20	S								
1-21	P								
1-22	P								
1-23	P								
1-24	P								
1-25	P								
1-26	P								
1-27	P								
1-28	P								
1-29	S								
1-30	P								
1-31	P								
2-1	L								
2-2	P								
2-3	L								
2-4	L								
Comment Sheet	S								
Back Cover	-								

PREFACE

This manual contains reference information for disk storage subsystems using one or more CONTROL DATA® 7X5X Series Disk Storage Controllers to handle CONTROL DATA® 844-2/21/41/44 Disk Storage Units. Section 1 gives programming information for computer systems accessing 7X5X/844 subsystems. Section 2 provides operator's information for these subsystems.

It is assumed that the reader is familiar with peripheral processor (PP) programming techniques used with one or more of the following CDC computer systems.

6000 Series

CYBER 70 Models 72, 73, 74

7000 Series

CYBER 70 Model 76

CYBER 170 Models 172, 173, 174, 175

The Disk Storage Subsystem General Information Manual (publication number 60364400) describes 7X5X/844 subsystem products and discusses subsystem configuration. The reader may wish to reference the following manuals for computer system I/O channel requirements and controller hardware reference information.

Control Data Publication	Publication No.
CYBER 70 Model 72, 73, 74 Input/Output Specifications Manual (applies to 6000 series also)	60352500
CYBER 170 Input/Output Specifications Manual	19983600
7600/CDC CYBER 70 Model 76 Hardware Reference Manual	60367200
Disk Storage Controller Hardware Reference Manual	60364500

CONTENTS

FIGURES

TABLES

PROGRAMMING 1

INTRODUCTION

7X5X and 844-2/21 Disk Storage Subsystems can provide high-speed random-access mass storage for 6000 series, 7000 series, CDC CYBER 70, and CDC CYBER 170 computer systems. 844-41/44 Disk Storage Units function with all of these computer systems except the 7000 series.

This section gives an overview of 7X5X and 844-2/21/41/44 subsystems, describes subsystem commands and associated parameter formats, and provides sample program sequences. The General Information Manual describes products used in these subsystems and explains product interaction in a subsystem environment.

7X5X AND 844-2/21/41/44 SUBSYSTEMS

CONFIGURATION

7X54 and 844-2/21/41/44 subsystems consist of one or two 7X54 Disk Storage Controllers (DSC) and a minimum of two 844 Disk Storage Units (DSU). Each DSC can interface with up to four PP I/O channels (depending upon DSC type) with a maximum of eight DSUs.† Multiaccess DSCs service I/O channels one at a time. Each DSU can connect to one or two DSCs. Figure 1-1 shows possible subsystem configurations.

Standard Options 10304-1 and 10304-2 Mass Storage Extenders increase the maximum number of DSUs which a DSC can handle. Standard Option 10304-1 increases the maximum to 22 DSUs, and Standard Option 10304-2 increases the maximum to 36 DSUs. (Standard Option 10304-2 cannot be installed without 10304-1.) With the addition of two of each of the options, the DSC can handle a maximum of 64 DSUs. (The 844-41/44 DSUs cannot connect to the standard option extenders but may connect to the same controller that is using these extenders for 844-2/21 DSUs.) Each option consists of two independent logical elements, each of which connects to one DSC I/O port, and up to eight DSUs. Figure 1-1 illustrates a possible configuration.

The 10333-1 Double Density Option is installed in 7054-41/42 controllers to permit operation with double density 844-41/44 Disk Storage Units. The option is not installed in 7654 controllers. Double density operation is standard with all 7154 DSCs.

Controlware for the 7X54 DSCs is identified as follows: MA401 for the 7154, MA710 for the 7054, and MA720 for the 7654.

NOTE

MA710 controlware will function in a 7154 with its operation identical to a 7054.

7152-1 DISK/TAPE CONTROLLER

The 7152 consists of a disk controller and a tape controller in one cabinet. The disk controller portion is the same as the 7154 disk controller, except the 7152 has one I/O channel interface and four DSU interfaces. Also, the 7152 has a programmable read only memory (PROM) for autoloading controlware. A recommended minimum subsystem has one 7152 controller, two disk units, and one tape unit.

DSC INITIALIZATION

Since DSCs are software controlled, a PP must autoload a DSC with an appropriate controlware package (nonalterable software) before the DSC can respond to other commands. The start memory load command (used for autoloading) is the only command that a DSC can execute before controlware is loaded.

DISK PACK INITIALIZATION

All disk packs are formatted at the factory. Extensive surface analysis is performed on each disk pack. Bad spots determined by this process are recorded in the factory and utility flaw map sectors.

SUBSYSTEM PERFORMANCE

Table 1-1 gives disk storage subsystem data capacity, access time, and transfer rate. The following paragraphs clarify table 1-1.

Data Organization

Information on a disk pack is divided into cylinders, tracks, and sectors as shown in figure 1-2. A cylinder consists of all the information accessible by all heads in one position. It includes one track for each recorded disk surface in the pack. A track consists of all the information accessible by one head in one position. A track is further divided into sectors. A sector is the smallest addressable area on a disk pack.

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†844-41/44 DSUs cannot be operated with a 7654 DSC.

Figure 1-1. Disk Storage Subsystem Configurations
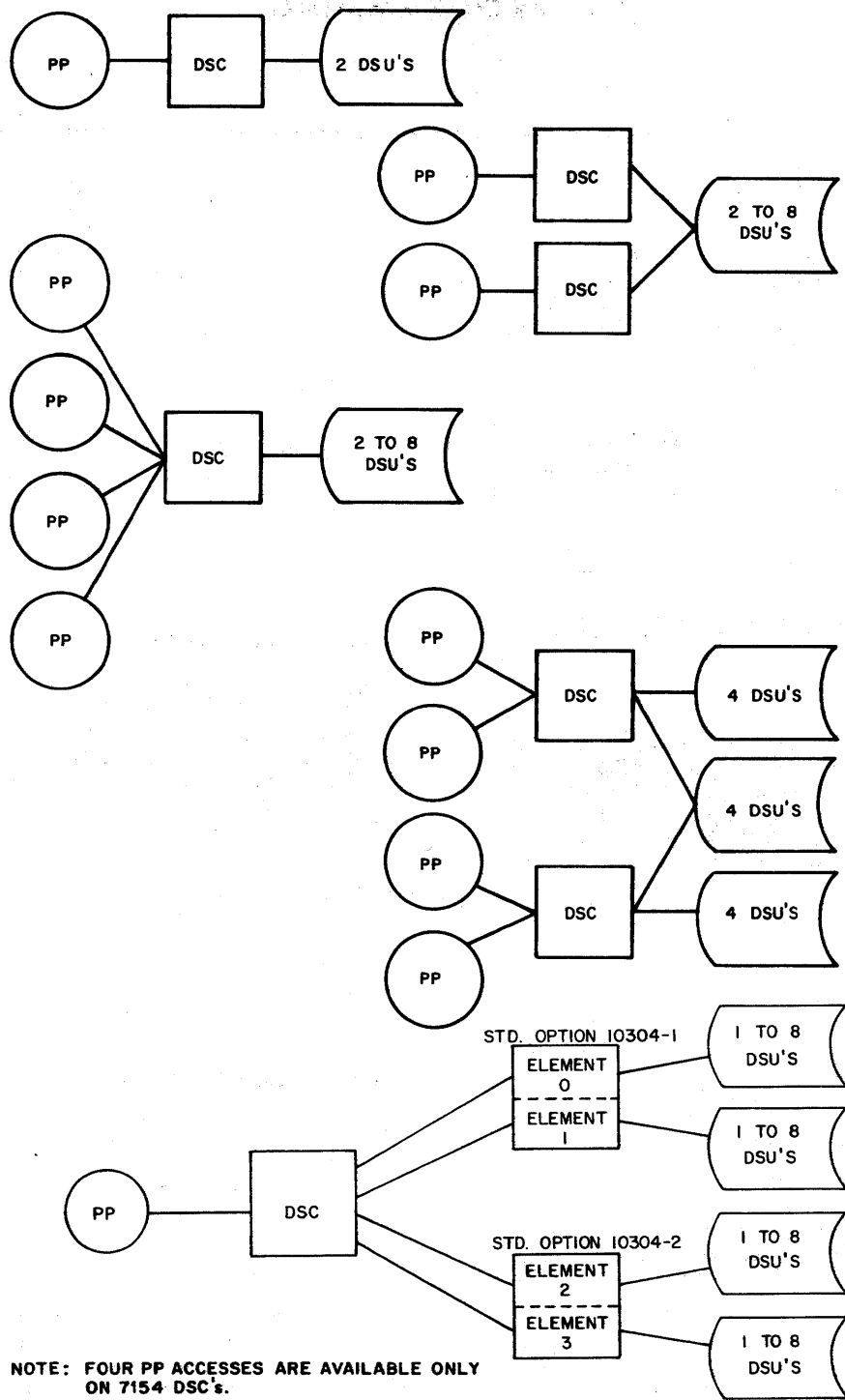
NOTE: FOUR PP ACCESSES ARE AVAILABLE ONLY
ON 7154 DSC's.

TABLE 1-1. DISK STORAGE SUBSYSTEM
PERFORMANCE SUMMARY

Data Capacity (6-bit characters)			
Per Sector	Per Track	Per Cylinder	Per Disk Pack
644	15,456	293,664	118,640,256 †

Access Time (milliseconds)					
Random Seek		Cylinder to Cylinder		Rotational Latency	
Maxi-mum	Average	Maxi-mum	Average	Maxi-mum	Average
55	30	10	6	16.7	8.3

Transfer Rate (millions of 6-bit characters per second)	
1:1 Interlace	2:1 Interlace
0.925	0.462

† 237,280,512 for 844-41 only.
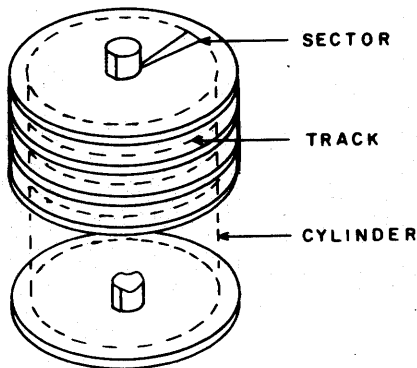
Figure 1-2. Disk Pack Information Divisions

Data Capacity

The on-line data capacity of a disk storage subsystem depends upon the number of DSUs in the subsystem and also upon DSC-determined sector parameters. Each DSC in the 7X54 series drives from 1 to 64 DSUs and specifies a sector length of 644 6-bit characters. The 7152 can drive 32 DSUs.

Access Time

Access time is the time a DSU requires to locate the addressed sector. Before transferring data, a DSU moves the heads to a cylinder and selects one of the data heads. The selected head then transfers data as the appropriate sector passes under (or over) it. Thus, total access time consists of the time required for head movement plus time spent waiting for the appropriate sector to reach the selected head (rotational latency). Head select time is negligible.

Data Transfer Rate

The transfer rates are the average rates at which from 2 to 456 sectors (on the same cylinder) can be transferred. Both rates take into account subsystem overhead time required for addressing, error checking, etc. The 2:1 interlace transfer rate is half the 1:1 interlace rate since the 2:1 mode transfers only half the sectors on a track per disk revolution.

SUBSYSTEM COMMANDS

The following general considerations apply to all subsystem commands.

1. PP Type

    Some command-related procedures vary according to the requesting PP type. The acronym 6TPP (6000-type peripheral processor) refers to PPs in 6000 series, CDC CYBER 70, Model 72, 73, 74, and CYBER 170, Model 172, 173, 174, 175 Computer Systems. The acronym 7TPP (7000-type peripheral processor) refers to PPs in 7000 series and CDC CYBER 70 Model 76 Computer Systems. Statements that apply to both types of PPs use the acronym PP.

2. Bit Positions

    Bit positions are numbered from right to left as follows:

MSB											LSB
11	10	9	8	7	6	5	4	3	2	1	0
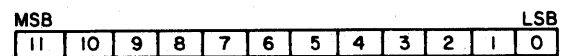
3. Bit Fields

    All numbers placed in specified parameter fields must be right justified and zero filled. Likewise, a DSC right justifies and zero fills all numbers placed in specified status fields.

4. Routine Status

    After processing a 7TPP command, a DSC returns a 12-bit status word to the requesting 7TPP (via the status/control channel) to indicate the status of the current operation. A 6TPP must issue a general status (0012₈) command, followed by a single-word input to receive current status.

5. Interlacing

    Depending upon PP selection (via seek, X:1 interlace commands), a subsystem can store data blocks either in consecutive sectors (1:1 interlace) or in alternate sectors (2:1 interlace). The 2:1 interlace allows a PP one sector time of nonsubsystem related program activity for each sector time of data transfer. When the 2:1 interlace is utilized, the cylinder processing order is as follows:

    • From sector 0, track 0 (the first even sector on the cylinder), the DSC increments to sector 2, track 0, etc.

- From sector 22, track 18 (the last even sector on the cylinder), the DSC increments to sector 1, track 0 (the first odd sector on the cylinder) and processes odd sectors.

- After sector 23, track 18 (the last odd sector on the cylinder) has been processed, the PP must issue another seek command to move processing to another cylinder.

6. Command Listing

Table 1-2 lists subsystem commands in numerical order. All commands processed by a subsystem are 12 bits in length. The upper 3 bits designate the subsystem.

equipment number (0_8). The lower 9 bits comprise a three-octal digit function code.

In table 1-2, commands which must supply parameters to a DSC show the parameter length (in 12-bit words) in the parameter output column. Commands which cause a DSC to return status to a PP show the status length (in 12-bit words) in the status input column.

NOTE

All commands from a 6TPP, except operation complete (0010_8), reserve the DSC.

TABLE 1-2. SUBSYSTEM COMMANDS

Function Code	Parameter Output	Status Input	Command Name	Function Code	Parameter Output	Status Input	Command Name
0000	1 word	-	Connect	0027††	-	-	Gap Sector - Read Checkword
0001	4 words	-	Seek, 1:1 Interlace	0030††	-	-	Read Factory Data
0002	4 words	-	Seek, 2:1 Interlace	0031††	-	-	Read Utility Map
0003	1 word	-	I/O Length	0032††	-	-	Diagnostic Read
0004	-	-	Read	0033††	-	-	Diagnostic Write
0005	-	-	Write	0034††	-	-	Read Flawed Sector
0006	-	-	Write Verify	0035††	-	-	Write Last Sector
0007	-	-	Read Checkword	0036††	-	-	Write Verify Last Sector
0010	-	-	Operation Complete	0037††	-	-	Write Flawed Sector
0011	-	-	Disable Reserve	0040††	-	-	Read Short
0012††	-	1 word	General Status	0041††	1 word	-	Select Strobe and Offset
0013	-	12 words†††	Detailed Status	0042††††	-	-	Clear Coupler Connects
0014	-	-	Continue	0043††††	-	-	Read Coupler Buffer
0015	-	-	Drop Seeks	0046††††	-	-	Write Buffer to Disk
0016	7 words	-	Format Pack	03UU††	-	-	Deadstart from Disk
0017†	-	1 word	On-Sector Status	0414	-	-	Start Memory Load
0020††	-	-	Drive Release				
0021	-	1 word†††	Return Cylinder Address				
0022	1 word		Set/Clear Flaw				
0023††		20 words††	Extended Detailed Status				
0024††	-	-	Gap Sector - Read				
0025††	-	-	Gap Sector - Write				
0026††	-	-	Gap Sector - Write Verify				

† 7TPPs only
†† 6TPPs only
††† 7TPPs must input this status on the data channel
†††† 7154 and 7152 DSCs only

1-4

CONNECT (0000₈)

CONNECT (0000$_8$)

This command and its associated one-word output parameter permits a PP to reserve a DSU without initiating head movement. The DSU remains reserved until the PP issues either an operation complete (0010$_8$), drop seeks (0015$_8$), or drive release (0020$_8$) command. For dual DSC subsystems, a disable reserve (0011$_8$) command received by one DSC can release a DSU previously reserved by a connect command through the other DSC.

Parameter Format

After receiving a connect command, a DSC performs a one-word input to determine the DSU to be reserved. If DSUs are attached directly to the DSC, bits 0 through 2 specify the DSU to be connected. Bits 6 through 11 must be zero filled.

11	6 5	3 2	0
ZERO FILLED	X X X	DSU NO.†	

If Standard Option 10304-1 Mass Storage Extender is a part of the system configuration, DSUs on the extender must be connected through the extender. In this case, bits 0 through 2 specify an element of the extender, and bits 3 through 5 specify the DSU. The addition of Standard Option 10304-2 merely adds more elements and more DSUs which may be connected.

11	6 5	3 2	0
ZERO FILLED	DSU NO.	ELEMENT NO.	

NOTE

Standard Options 10304-1 and 10304-2 do not change the addressing scheme. Although bits 0, 1, and 2 contain the DSU number in the first figure and the element number in the second figure, the address in either case designates a DSC port (physical interface).

SEEK, 1:1 INTERLACE (0001₈)

A PP issues this command and its associated four-word output parameter to condition a DSC for a 1:1 interlace†† data transfer. Upon receipt of this command and its parameter array, a DSC initiates head movement in the addressed DSU unless the DSU already has its heads in motion, is already on-cylinder, or has already been reserved by the other access or the other DSC (dual DSC subsystems only).

A PP can determine if the specified DSU is on-cylinder by checking general status from the DSC [refer to General Status (0012₈) in this section]. When the general status word is zero, the specified DSU is on-cylinder and the seek operation has completed normally. When the selected DSU's heads are in motion, bit 1 (busy) of the general status word is set.

Since the general status word changes only after a DSC processes a command, a PP waiting for a specific seek operation to complete should use the following sequence.

1. Issue seek command and address.

2. Wait for general status to be updated.

3. Go to step 1 if bit 1 of the general status word is set.

4. Continue if status word is zero.

A 7TPP can also use the on-sector status (0017₈) command in conjunction with multiple seek, 1:1 interlace commands to optimize rotational latency in a subsystem [refer to On-Sector Status (0017₈)].

Parameter Format

After receiving a seek, 1:1 interlace command, a DSC performs a four-word input to determine the disk address to be sought.

WORD 1	EXPANDER/DSU NUMBER † ††
WORD 2	STARTING CYLINDER NUMBER
WORD 3	STARTING TRACK NUMBER
WORD 4	STARTING SECTOR NUMBER

SEEK, 2:1 INTERLACE (0002₈)

A PP issues this command and its associated four-word output parameter to condition the DSC for a 2:1 interlace (alternate physical sectors) data transfer.

The parameter format, suggested PP wait sequence, and DSC status related to this command are the same as those listed under Seek, 1:1 Interlace (0001₈). [A 6TPP must use the general status (0012₈) command to determine the current status of a seek, 2:1 interlace operation.]

I/O LENGTH (0003₈)

This command and its associated one-word output parameter specify the number of sectors to be processed by subsequent read (0004₈), write (0005₈), write verify (006₈), or read checkword (0007₈) commands. A DSC retains the current I/O length and applies it to any of these commands. In order to change the current I/O length, a PP must issue a new I/O length command. The sector count can range from 1 to 456$_{10}$ (maximum of one cylinder).

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†DSU number must be from 0 to 3 for a 7152 controller.
††A DSC processes consecutive physical sectors during the transfer.
†††The format for this word is the same as that described under Parameter Format for the connect (0000$_8$) command.

When a 7TPP specifies a 1:1 interlace mode and is processing consecutive data blocks (length specified by I/O length command), a DSC provides one unused sector (gap sector) after each block. This allows PP overhead program activity between data blocks. A DSC resumes processing of the next data block upon receipt of one of the preceding commands during the unused sector's rotational period.

A 7TPP can eliminate the unused sector by issuing a seek, 1:1 interlace command specifying the next sequential sector after processing a data block. However, this procedure requires an additional disk revolution for each data block processed.

An I/O length command from a 6TPP provides no gap sector and is required only for 1:1 interlace transfers on a 7054 DSC. An I/O function is required for each sector to be processed, and lost data status results if the 1:1 interlace is not maintained.

The I/O length command is irrelevant for operations using 2:1 interlace mode or, in the case of 7152 and 7154 DSCs, it is irrelevant for either 1:1 or 2:1 interlace mode.

Parameter Format

After receiving an I/O length command, a DSC inputs the sector count word.

```
11                                    0
┌──────────────────────────────────────┐
│            SECTOR COUNT                │
└──────────────────────────────────────┘
```

READ (0004₈)

This command initiates data transfer from a selected disk sector (specified by a prior seek command) to a PP. On 7152 and 7154 DSCs, the transfer is from the selected disk sector through the coupler buffer memory to the PP. The coupler memory can buffer up to one sector of data from the disk and simultaneously transfer it to the PP at the speed of the channel. (The 7152 and 7154 are the only DSCs that have a coupler buffer memory.)

A read command from a 6TPP must precede each sector to be read. A read command from a 7TPP transfers the number of sectors specified by a preceding I/O length (0003₈) command.

After issuing a read command, a PP must initiate a block input of appropriate length to receive the read data.

As long as either consecutive (1:1 interlace) or alternate (2:1 interlace) sectors are being read, a PP issues another seek command only when data transfer must resume at another cylinder.

WRITE (0005₈)

This command initiates data transfer from a PP to the disk sector specified by a prior seek command. On 7152 and 7154 DSCs, the transfer is from the PP through the coupler buffer memory to the selected

disk sector. The coupler memory can buffer up to one sector of data from the PP at the speed of the channel and simultaneously transfer it to the disk. (The 7152 and 7154 are the only DSCs that have a coupler buffer memory.)

A write command from a 6TPP must precede each sector to be written. A write command from a 7TPP transfers the number of sectors specified by a preceding I/O length (0003₈) command.

After issuing a write command, a PP must initiate a block output of appropriate length to transmit the write data. As long as either consecutive (1:1 interlace) or alternate (2:1 interlace) sectors are being written, a PP issues another seek command only when data transfer must resume at another cylinder.

WRITE VERIFY (0006₈)

This command conditions a DSC to perform a bit-by-bit comparison of data from a PP with data on a disk. A prior seek command specifies the starting sector and interlace mode for the compare operation.

A write verify command from a 7TPP enables the comparison of the number of sectors specified by a preceding I/O length (0003₈) command. A write verify command from a 6TPP must precede each sector to be verified. After issuing a write verify command, a PP must initiate a block output of appropriate length to supply the data to be compared.

READ CHECKWORD (0007₈)

This command conditions a DSC to test for checkword errors in one or more sectors of data already stored on a disk. A prior seek command specifies the starting sector and interlace mode for the check.

A read checkword command from a 7TPP enables checking the number of sectors specified by a preceding I/O length (0003₈) command. A read checkword command from a 6TPP must precede each sector to be tested.

OPERATION COMPLETE (0010₈)

A PP issues this command to release the reserve of the last DSU functioned by the DSC. Other DSUs must previously have been released by a drop seek (0015₈) command. In addition, a 6TPP must issue this command to a multiaccess DSC to release the DSC for use by a 6TPP connected to another access. Do not issue a general status function following this command unless it is intended to reserve the DSC again.

DISABLE RESERVE (0011₈)

A disable reserve command to one DSC permits that DSC to release all DSUs currently reserved to the remaining DSC. A PP should issue this command only after it has determined that one or more DSUs are currently reserved to an inoperative DSC.

1-6

GENERAL STATUS (0012_8)

NOTE

Only 6TPPs use this command to receive the current general status word. A DSC sends the current general status word to a 7TPP on the status/control channel after processing each command. The general status word structure is the same for both types of PPs.

A 6TPP should issue a general status command followed by a single-word input after issuing any other command. Normal command completion results in a zero-filled general status word. If the general status word is nonzero, always examine bit 10 first to determine if the DSC is reserved by another access. If bit 10 is clear, check bit 11 to determine if the previous operation was abnormally terminated. If neither of these bits is set, check the bit or bits which are associated with the previously requested operation.

TABLE 1-3. GENERAL STATUS INTERROGATION

Subsystem Command	Interrogate by 6TPP	Interrogate by 7TPP
Start Memory Load	Yes	No
Format Pack	Yes	Yes
Seek 1:1 Interlace	Yes	Yes
Seek 2:1 Interlace	Yes	Yes
I/O Length	Yes	Yes
Read †	Yes	Yes
Write †	Yes	Yes
Write Verify †	Yes	Yes
Read Checkword †	Yes	Yes
Operation Complete	No	Yes
Disable Reserve	Yes	Yes
Detailed Status	No	No
Continue †	Yes	Yes
Drop Seeks	Yes	Yes
On-Sector Status	N/A	Yes
Connect	Yes	Yes
Read (Gap Sector) †	Yes	N/A
Write (Gap Sector) †	Yes	N/A
Write Verify (Gap Sector) †	Yes	N/A
Read Checkword (Gap Sector) †	Yes	N/A
Drive Release	Yes	N/A
Return Cylinder Address	No	No
Set/Clear Flaw	Yes	Yes
Extended Detailed Status	No	N/A
Read Factory Data	Yes	N/A
Read Utility Map	Yes	N/A
Diagnostic Read	No	N/A
Diagnostic Write	Yes	N/A
Read Flawed Sector †	Yes	N/A
Write Flawed Sector †	Yes	N/A
Read Short	Yes	N/A
Select Strobe and Offset	Yes	N/A
Deadstart from Disk Unit	Yes	N/A
Write Last Sector †	Yes	N/A
Write Verify Last Sector †	Yes	N/A
Clear Coupler Connects	No	N/A
Read Coupler Buffer	Yes	N/A
Write Buffer to Disk	Yes	N/A

†These commands require that general status be interrogated after each sector of data has been processed by the DSC.

Table 1-3 specifies which subsystem commands must be followed by interrogation of general status. A 6TPP issues a general status command to interrogate the status, and a 7TPP inputs the status word on its status/control channel.

The general status word is structured as follows:

NOTE

A bit set to one indicates that its corresponding status exists.

11	ABNORMAL TERMINATION
10	DUAL ACCESS COUPLER RESERVED
9	NONRECOVERABLE ERROR
8	RECOVERY IN PROGRESS
7	CHECKWORD ERROR
6	CORRECTABLE ADDRESS ERROR
5	CORRECTABLE DATA ERROR
4	DSU MALFUNCTION
3	DSU RESERVED
2	MISCELLANEOUS ERROR
1	BUSY
0	NONCORRECTABLE DATA ERROR

Bit 11 - Abnormal Termination

The preceding command terminated abnormally. Either general status bit 8 or 9 specifies whether or not recovery is possible. The PP must examine the detailed status block to determine the cause of the abnormal termination. For all abnormal terminations, the detailed status block should be logged for future use.

Bit 10 - Dual Access Coupler Reserved

The DSC is currently reserved to another I/O channel. When this bit is set, all other general status bits are meaningless.

Bit 9 - Nonrecoverable Error

An error has occurred which is nonrecoverable. Detailed status should be obtained to determine the exact cause of abnormal termination.

Bit 8 - Recovery In Progress

The DSC is ready to respond to one or more continue (0014_8) commands to attempt error recovery.

Bit 7 - Checkword Error

A checkword error has occurred in either the address or data field of a sector. Bits 5 and 6 of general status provide an analysis of the checkword error.

Bit 6 - Correctable Address Error

A correctable read address checkword error has occurred. A continue (0014₈) command causes the data to be processed on a subsequent disk revolution.

Bit 5 - Correctable Data Error

The last sector of data read contains a correctable checkword error. The location of the error and a correction vector are specified in the detailed status block.

Bit 4 - DSU Malfunction

A DSU-related error condition exists. Words 9 through 11 of the detailed status block specify the DSU status at the time of the malfunction.

Bit 3 - DSU Reserved

The specified DSU is currently reserved by the other DSC.

Bit 2 - Miscellaneous Error

After an autoload (0414₈) command, this bit indicates that the controlware loaded is not compatible with the DSC. After all other commands, bit 2 set indicates that detailed status word 3, bits 2 and 3 specify the error condition(s).

Bit 1 - Busy

The specified DSU and/or the DSC are busy.

Bit 0 - Noncorrectable Data Error

The last sector of data read contains an error which cannot be corrected by an 11-bit correction vector.

DETAILED STATUS (0013₈) AND
EXTENDED DETAILED STATUS (0023₈)

These commands cause a DSC to supply a 12- or 20-word detailed status block to the requesting PP. The detailed status block is available immediately upon abnormal command termination and applies to the currently selected DSU.

After an abnormal command termination, a PP should obtain error logging information by issuing a detailed status command followed by a block input of appropriate length. The PP may then attempt error recovery with one or more continue (0014₈) commands or may try a new command.

The detailed status block format is as follows:
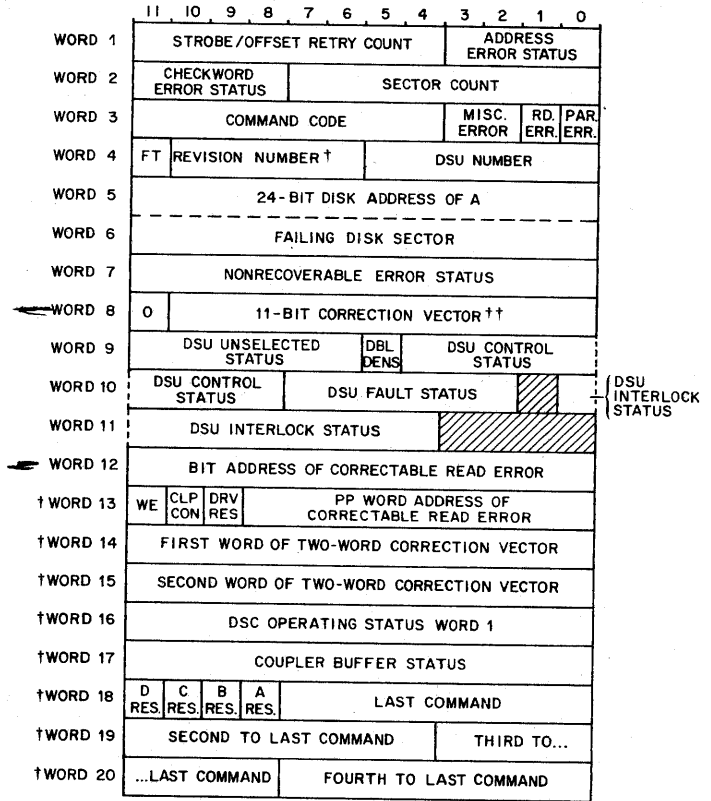
† 6TPPS ONLY
†† THIS MAY ALSO BE THE DSC DIRECTOR ADDRESS.

Detailed Status Interpretation

[NOTE]

In the detailed status block, an individual status bit set to one indicates that its corresponding status condition exists.

Word 1

| Bits 4 through 11 | These bits provide the number of the data strobe/head positioner offset retry attempt just completed (refer to continue (0014₈) command). DSC error recovery allows a maximum of 27₁₀ retries (three retries at each of nine strobe/offset combinations). Retry attempt numbers correspond to strobe/offset conditions shown in table 1-4. |

1-8

TABLE 1-4. REREAD SEQUENCE

Data Reread Attempt Number	Address Reread Attempt Number	Offset	Strobe
1,10,11	1,2,3,	Nominal	Nominal
2,12,13	4,5,6,	Nominal	Early
3,14,15	7,8,9,	Nominal	Late
4,16,17	10,11,12	Reverse	Nominal
5,18,19	13,14,15	Reverse	Early
6,20,21	16,17,18	Reverse	Late
7,22,23	19,20,21	Forward	Nominal
8,24,25	22,23,24	Forward	Early
9,26,27	25,26,27	Forward	Late

Bit 3 The disk address specified by the PP does not compare with the address field read (or read/corrected) from the disk.

Bit 2 An incorrect cylinder number was read.

Bit 1 An incorrect track number was read.

Bit 0 An incorrect sector number was read.

Word 2

Bit 11 A checkword error occurred in reading the address field.

Bit 10 The address field read from the disk sector cannot be corrected by an 11-bit correction vector. Words 5 and 6 contain the address of the failing disk sector.

NOTE

Whenever a correctable address checkword error occurs, a DSC corrects the error with an 11-bit correction vector.

Bit 9 A checkword error occurred in reading the data field.

Bit 8 The data field read from the disk sector cannot be corrected by an 11-bit correction vector. Words 5 and 6 contain the address of the failing disk error.

Bits 0 through 7 These bits specify the number of sectors within the current data block that were successfully processed. This field is not used during pack formatting.

Word 3

Bits 4 through 11 This field contains the lower 8 bits of the PP command causing this detailed status block.

Bit 3 A compare operation for an address field or data field did not complete.

Bit 2 A write verify operation failed, indicating that the data field is in error.

Bit 1 During the last 65,000 read operations on a DSU or port, read errors (excluding flaws) have been detected after at least three head positioning changes. Since errors are detected per port, an error file must be examined to determine the failing DSU if the port drives DSUs through an expander.

Whenever this status bit is set, bit 9 of general status (nonrecoverable error) is also set.

Bit 0 This bit indicates a channel parity error (6TPP, CDC CYBER 170 family only).

Word 4

Bit 11 When this bit is a 1, it indicates that full-track controlware (MA401) is selected. (7152 and 7154 DSCs only).

When this bit is a 0, it indicates that half-track controlware (MA710) is selected (7054, 7152, or 7154 DSCs).

Bits 6 through 10 This field specifies the controlware revision number; this is significant for 6TPPs only.

Bits 0 through 5 This field specifies the DSU number (or port if an expander is connected) associated with this copy of detailed status.

Words 5 and 6

This 24-bit field (which is filled whenever either a positioning error occurs or a defective sector is referenced) contains the address of a failing disk sector. The field format is as follows:

```
          II  IO  9   8   7   6   5   4   3   2   I   0
WORD 5  | C | C | C | C | C | C | C | C | C | T | T | T |
WORD 6  | T | T | S | S | S | S | S | A | B | F | G | U |
```

```
    C = CYLINDER NUMBER
    T = TRACK NUMBER
    S = SECTOR NUMBER
    A = SECTOR FLAW BIT
    B = TRACK FLAW BIT
    F = FACTORY DATA SECTOR
    G = UTILITY MAP
  † U = ZERO FILLED
```

NOTE

If the DSC cannot read the address field of the failing disk sector, it supplies the address from the last seek command. [Refer to Seek, 1:1 Interlace (0001_8).]

Word 7

Bit 11	Either the preceding command/output parameter was invalid, or the command was issued when not expected.
Bit 10	A sector mark was detected by the DSC during a read or write of sector data.
Bit 9	Either the PP did not accept data from the DSC fast enough during a read operation, or the PP did not supply data to the DSC fast enough during a write operation.
Bit 8	The DSC cannot locate the sync pattern or the sync byte in the address field of the selected disk sector.
Bit 7	DSC memory parity error

Bit 6	One or more of the following conditions exist.

1. The DSC's internal composite status bit is set, although none of the conditions normally causing it to be set are present.
2. No error status is available after an error correction attempt.
3. The reseek operation following a head positioning error did not initiate head movement.
4. The DSC has entered an error recovery sequence even though the read/corrected address compares with the address supplied by PP.
5. A DSC director sequence did not complete execution.
6. Word 8 contains the hardware controller director address.

Bit 5	There is no flag bit set to indicate that either the factory or utility flaw map is written.
Bit 4	The DSU address read had a track flaw bit set.
Bit 3	The DSU address read had a sector flaw bit set.
Bit 2	The DSC cannot locate either the sync pattern or the sync byte in the data field of the selected disk sector.
Bit 1	The deadman timer has expired. Refer to 6TPP Deadman Timer Operation in this section.
Bit 0	A maximum of 160_{10} utility flaw entries has been exceeded.

Word 8

Bit 11	Zero filled
Bits 0 through 10	After a correctable read error occurs, this field contains an 11-bit correction vector. In order to

---

† Bit 0 of word 6 is used as the uppermost cylinder bit for controllers having the 10333-1 Double Density Option.

correct the last sector of data received from the DSC, the PP must exclusive OR the correction vector with sector data beginning at the bit location specified by word 12 of the current detailed status block.

If bit 6 of word 7 is set, then word 8 contains the hardware controller director address.

Word 9

> **NOTE**
>
> Words 9, 10, and bits 4 through 11 of word 11 contain status from the selected DSU. The DSC copies this status after any abnormal command termination. Bits identified with an asterisk (*) are dynamic and may not have significance for a PP. Diagnostic programmers should reference appropriate DSU manuals for complete information about these status bits.

Bit 11	Sector alert
*Bit 10	DSU seek error (seek incomplete for 844-4X only)
Bit 9	DSU busy
Bit 8	DSU selected
Bit 7	DSU ready
Bit 6	DSU on-line
Bit 5	Double density drive
*Bit 4	Amplitude monitor 3 (not used)
*Bit 3	Amplitude monitor 2 (not used)
Bit 2	DSU end of cylinder
*Bit 1	Amplitude monitor 1 (not used)
*Bit 0	Track index

Word 10

Bit 11	On cylinder
Bit 10	Seek error (seek incomplete for 844-4X only)
Bit 9	Disk pack is unsafe.
*Bit 8	Sector mark
Bit 7	Seek error (seek incomplete for 844-4X only)

Bit 6	DSU negative voltages are more positive than normal.
Bit 5	DSU positive voltages are more negative than normal.
Bit 4	Current fault
Bit 3	A read and write operation have been attempted simultaneously.
Bit 2	The DSC attempted a data transfer when the DSU was not on-cylinder.
Bit 1	Not assigned (AC write fault for 844-4X only)
Bit 0	The DSU logic temperature is normal.

Word 11

Bit 11	The DSU power supply temperature is normal.
Bit 10	The spindle motor is on.
Bit 9	The DSU power sequencing is not under control of the DSC.
Bit 8	The DSU START switch is ON.
Bit 7	The disk pack brush cycle is in progress.
Bit 6	Heads are loaded.
Bit 5	The sector block is in position to sense the sector disk (control interlock for 844-4X only).
Bit 4	A disk pack is mounted.
Bits 0 through 3	Not assigned

Word 12

Bits 0 through 11	This field contains the bit address of the first bit of a correctable read error detected either in the address or data field of the sector. General status indicates whether the error is in the address or data field. Only errors in the data field are corrected by the PP.

Use the following procedure to correct the read error. Assume that n is the number formed by word 12.

1. Remove bit n plus the next 10 bits from the data field to be corrected. The first bit in the field is bit 0, the second bit is bit 1, and so forth.

2. Perform an exclusive OR operation between the removed 11 bits and the 11-bit correction vector from word 8 of detailed status.

3. Insert the 11-bit result of the exclusive OR operation into the data field where the failing 11-bits were removed.

NOTE

Word 13

Bit 11	During 1:1 interlace write operations, general status is returned when the sector to be written is in the coupler buffer and the disk address has been read and verified. If an error occurs while writing the sector from the coupler buffer to the disk, this status bit will be set. To assure that this error is detected, the next function must be general status. If it is not, there will be no reply.
Bit 10	This bit is only applicable when running multiple PP routines on a shared DSC coupler access. For example, running on-line diagnostic D44 while running another routine. When this bit is a 0, it indicates that the current PP routine issued the first general status function to connect the coupler access. When this bit is a 1, it indicates that the coupler access was connected by a previous PP routine.
Bit 9	Drive access was reserved. Valid only when general status is 0000 or 0002.
Bits 0 through 8	This field contains the first-word address of a two-word correctable read error detected in the data field of the sector.

Use the following procedure to correct the read error. Assume that N is the number formed by word 13.

1. Remove word N from the data field to be corrected. The first word in the field is word 0, the second word is word 1, and so forth.

2. Perform an exclusive OR operation between word N and word 14 of detailed status.

3. Insert the result of the exclusive OR operation into the data field where word N was removed.

4. Remove word N+1 from the data field to be corrected.

5. Perform an exclusive OR operation between word N+1 and word 15 of detailed status.

6. Insert the result of this exclusive OR operation into the data field where word N+1 was removed.

Word 14

Bits 0 through 11	This field contains the first word of a two-word correction vector.

Word 15

Bits 0 through 11	This field contains the second word of a two-word correction vector.

Word 16

This word contains operating status word 1 copied directly from the hardware controller portion of the DSC. Refer to the Disk Storage Controller Hardware Reference Manual listed in the preface for a complete description of these bits.

PP bits and their corresponding hardware controller status bits are as follows:

PP Bit	Hardware Controller Bit	Status
11	02	Checkword error
10	03	Composite status
9	04	Parity error in control logic
8	05	RAP abort
7	06	Lost data
6	07	Sector length error
5	08	Execute
4	09	Double density 844 unit
3	10	Not used
2	11	Compare done
1	12	Compare condition not met
0	13	Correctable error

Word 17

	This field contains 10 bits of coupler status. It is not used on DSCs other than the 7152 and 7154.
Bit 11	Write address = 322
Bit 10	Read address = write address
Bit 9	Read address is less than write address
Bit 8	Buffer memory data mode
Bit 7	Buffer parity error upper
Bit 6	Buffer parity error lower
Bit 5	Memory registers empty
Bit 4	Control logic to PP path selected
Bit 3	Parity enabled
Bit 2	Channel parity error
Bits 0, 1	Not assigned

Word 18

Bit 11	Access D of a multiaccess coupler is connected.
Bit 10	Access C of a multiaccess coupler is connected
Bit 9	Access B of a multiaccess coupler is connected
Bit 8	Access A of a multiaccess coupler is connected

Bits 0 through 7	This field contains the lower 8 bits of the last command processed by the DSC. Since the four-entry command history table is updated after each command is processed, an extended detailed status command (0023₈) appears as the last command processed only if two 0023₈ commands are sent in succession.

With a 7054 DSC, the general status commands sent during 1:1 interlace operations are not placed in the command history table.

Word 19

Bits 4 through 11	This field contains the lower 8 bits of the second to the last command processed by the DSC.
Bits 0 through 3	This field contains the leftmost 4 bits of the lower 8 bits of the third to the last command processed by the DSC.

Word 20

Bits 8 through 11	This field contains the rightmost 4 bits of the lower 8 bits of the third to the last command processed by the DSC.
Bits 0 through 7	This field contains the lower 8 bits of the fourth to the last command processed by the DSC.

CONTINUE (0014₈)

This command permits a PP to step a DSC through a semiautomatic error recovery sequence if the recovery in progress bit in the general status word is set. A PP can use the continue command to attempt recovery during the following commands:

```
0004₈ - Read
0005₈ - Write
0007₈ - Read checkword
0016₈ - Format pack
0017₈ - On-sector status
0030₈ - Read factory data
0031₈ - Read utility map
0035₈ - Write last sector
0034₈ - Read flawed sector
0037₈ - Write flawed sector
0024₈ - Gap sector-read
0025₈ - Gap sector-write
0026₈ - Gap sector-write verify
0027₈ - Gap sector-read checkword
```

NOTE

The following descriptions of the effect of continue commands on a DSC assume that the recovery in progress bit in the general status word is set. When the nonrecoverable error bit is set, the DSC aborts the current error recovery sequence and does not accept further continue commands.

During Pack Formatting

When a DSC is processing a format pack (0016₈) command with bit 9 of output parameter word 2 set, it stops formatting operations when error conditions occur which can set track or sector flaw bits. After taking appropriate action, a PP issues a continue command to restart the formatting operation. A DSC sets track or sector flaw bits after receiving a continue command.

During Other Operations

When a DSC is processing read (0004₈ or 0034₈), write (0005₈ or 0037₈), read checkword (0007₈), on-sector status (0017₈), read factory data (0030₈), read utility data (0031₈), write last sector (0035₈), or gap sector (0024₈, 0025₈, 0026₈, 0027₈) commands, it continually looks for error conditions. The continue command controls recovery from the following types of errors.

- Address field correctable checkword error

- Address field sync error or noncorrectable checkword error

- Seek error

- Data field sync error or noncorrectable checkword error

- Data field correctable checkword error

Address Field Correctable Checkword Error

A continue command causes the DSC to read-skip the address field on the next disk revolution and begin processing the data field.

Address Field Sync Error or Noncorrectable Checkword Error

Each continue command causes a reread attempt on the address field as shown in table 1-4.

NOTE

The number of the last reread attempt appears in bits 4 through 11 of the first word in the detailed status block. [Refer to Detailed Status (0013₈).]

If a reread attempt results in a correctable checkword error, the next continue command causes the DSC to read-skip the address field on the next disk revolution and begin processing the data field. If none of the reread attempts are successful, the DSC sets the nonrecoverable error bit in the general status word.

When the correct cylinder is located, the subsystem verifies the track and sector portions of the address prior to performing data transmission. If the track and sector cannot be verified after one retry, the DSC sets the nonrecoverable error bit in the general status word.

Seek Error

The first continue command causes the DSC to compute the difference between the current and correct cylinders. The heads are then moved accordingly. When this fails to locate the correct cylinder, a second continue command causes a return to zero seek followed by one direct seek. If this procedure also fails, the DSC sets the non-recoverable error bit in the general status word. One recovery attempt is allowed for track and sector miscompares. If this fails, the nonrecoverable error bit in the general status word will set.

Data Field Sync Error or Noncorrectable Checkword Error

Each continue command causes a reread attempt on the data field as shown in table 1-4. If a reread attempt results in a correctable checkword error, a PP should examine the detailed status block for the correction vector and bit address with which to modify the last input block of data (read operations only). If none of the reread attempts are successful, the DSC sets the nonrecoverable error bit in the general status word.

NOTE

Once a DSC has set the recovery in progress bit in the general status word, a minimum of 1 and a maximum of 27 continue commands (and associated block transfers for read or write operations) may be required for recovery from the current error condition. After processing a continue command, a DSC may determine that the error condition is not recoverable and set the nonrecoverable error bit in the general status word. Thus, a PP should ensure that the recovery in progress bit is set before issuing any continue command.

If a PP issues a command other than the continue command while the recovery in progress bit is set, the DSC exits from the error recovery sequence and begins processing the new command.

Data Field Correctable Checkword Error (6TPPs Only)

The 6TPP must correct the faulty data with information from the detailed status block. A continue command causes the DSC to read the next sector of data.

Data Field Correctable Checkword Error (7TPPs Only)

The 7TPP must correct the faulty data with information from the detailed status block. A continue command causes the DSC to read the remaining sectors (if any) of the current data block.

DROP SEEKS (0015$_8$)

This command causes a DSC to release all DSUs reserved to the DSC, except for the DSU that has just returned on-cylinder or on-sector status to the requesting PP. After a drop seeks command, released DSUs are available to all possible DSCs. Before issuing a drop seeks command, a PP should use one of the following procedures to locate a DSU for subsequent operations.

On-Cylinder Check

The PP issues a seek command and its associated output parameter and then checks the general status word. When all bits of the general status word are zero, the DSU specified in the previous seek is on-cylinder. To locate the first DSU to complete its seek, a PP must use the seek/check general status sequence on all DSUs reserved to the PP which are currently moving heads. The PP then issues a drop seeks command and proceeds with the desired operation.

On-Sector Check (7TPPs Only)

After issuing multiple seek commands (and associated output parameters), the 7TPP issues an on-sector status (0017$_8$) command and then interprets the on-sector status word which the DSC returns over the status/control channel [refer to On-Sector Status (0017$_8$)]. When an on-sector DSU has been located, the 7TPP issues a drop seeks command and proceeds with the desired operation.

FORMAT PACK (0016$_8$)

This command and its associated seven-word output parameter cause a DSC to write information fields on a disk pack to prepare the pack for further operations and to record sector and track flaw bits identified in the disk pack utility flaw map. Formatting requires that the disk pack contain the utility flaw map and that sufficient format pack commands be executed to format the entire disk pack before the pack is used for data storage. Since formatting a full pack requires a minimum of 2.5 minutes (844-21) or 5 minutes (844-4X), the output parameter provides start and stop fields which permit a single-format pack command to prepare a minimum of one track. This allows a PP to interleave format pack commands directed to one DSU with I/O commands for other DSUs. (DSC availability for I/O commands is reduced during command interleaving, since a DSC is busy during processing of format pack commands.)

A format pack command causes a DSC to write the following information contiguously into each sector of the specified track(s). Head positioner offset and data strobe remain at nominal settings during pack formatting.

844-2/21 Sector Format

Item	Bit Length
Head gap 1	120 bits
Address sync pattern	300 bits
Address sync byte	6 bits
Address field	24 bits
Address checkword	32 bits
Head gap 2	120 bits
Data sync pattern	78 bits
Data sync byte	6 bits
Data field	3864 bits (644 characters)
Data checkword	32 bits
End of record byte	6 bits
Tolerance gap	134 bits
Total	4722 bits

844-41/44 Sector Format

Item	Bit Length
Address sync pattern	312 bits
Address sync byte	6 bits
Address field	24 bits
Address checkword	32 bits
Data sync pattern	102 bits
Data sync byte	6 bits
Data field	3864 bits (644 characters)
Data checkword	32 bits
End of record byte	6 bits
Tolerance gap	102 bits
Total	4480 bits

Parameter Format

After receiving a format pack command, a DSC inputs a seven-word parameter from the PP to specify format conditions.
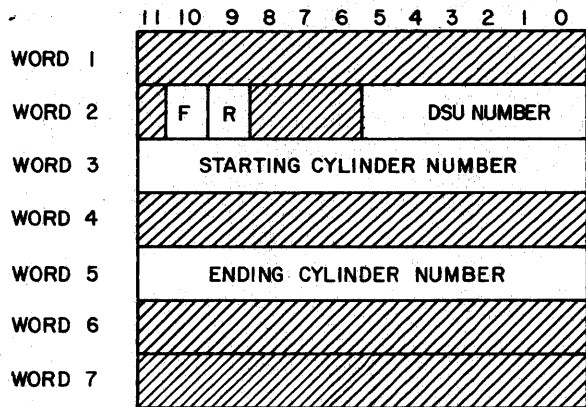
Word 1

Not assigned

Word 2

Bit 11	Not assigned
Bit 10	If this bit is one, words 3 through 6 of the output parameter should be zero, and the DSC will format an entire pack. When this bit is zero, words 3 through 6 determine the portion of the pack to be formatted in response to the current command. In this case, a seek command to the starting cylinder must precede the format pack command.
Bit 9	When this bit is one, a DSC interrupts the format operation and prepares a general status word for each sector and track flaw that exist in the utility flaw map. The DSC sets the flaw bit(s) and resumes formatting when the PP issues a continue (0014_8) command. When this bit is zero, a DSC will set the flaw bit(s) for the tracks and sectors in the utility flaw map and continue formatting. The flaw bit(s) will be set for all sectors contained in the factory flaw map with no provision made for interrupt.
Bits 6 through 8	Not assigned
Bits 0 through 5	If the DSU is attached directly to the DSC, bits 0, 1, and 2 specify the DSU and, bits 3, 4, and 5 must be zero filled. If Standard Option 10304-1 Mass Storage Extender is a part of the system configuration, bits 0, 1, and 2 specify an element of the expander, and bits 3, 4, and 5 specify the DSU attached to an expander.

Word 3

> **NOTE**
>
> When words 3 through 6 are nonzero, bit 10 of word 2 must be zero.

Bits 0 through 11	This field specifies the starting cylinder number. Valid numbers are from 0 to 410_{10} (0632_8). (For 844-4X DSUs only, valid numbers are from 0 to 822_{10}.)

Word 4

Not assigned

Word 5

Bits 0 through 11	This field specifies the ending cylinder number. Valid numbers are from 0 to 410_{10} (0632_8). (For 844-4X DSUs only, valid numbers are from 0 to 822_{10}.)

Word 6

Not assigned

Word 7

Not assigned

Formatting Sequence

The format control octal digit (formed by bits 9 and 10 of output parameter word 2) specifies DSC performance during a format pack operation.

Flaw Bits

> **NOTE**
>
> Refer to Detailed Status (0013_8), words 5 and 6 for the locations of these bits in the address field of a sector.

A DSC sets the sector flaw bit of a sector's address field under the following conditions.

1. Bit 9 of output parameter word 2 is zero, and a checkword error occurred in the sector's data field.

2. Bit 9 of word 2 is one, a noncorrectable checkword error occurred in the sector's data field, and the PP has given a continue command.

3. Detailed status word 6, bit 1 is a one; factory flaw is indicated.

A DSC sets the track flaw bit of all address fields within a track under the following conditions.

1. Bit 9 of word 2 is zero, and a checkword error occurred in an address field within the track.

2. Bit 9 of word 2 is one, a noncorrectable checkword error occurred in an address field within the track, and the PP has given a continue (0014_8) command.

ON-SECTOR STATUS (0017_8) [†]

After initiating seek operations on two or more DSUs, a 7TPP issues an on-sector status command to cause a DSC to look for the first DSU to achieve on-sector status. The 7TPP then checks the status/control channel for a word flag and its associated status word.

During execution of an on-sector status command, the DSC provides either an on-sector status word or a general status word to the 7TPP. An on-sector status word indicates normal command processing and specifies the number of the DSU which will reach its addressed sector in 1390 to 2085 microseconds. A general status word indicates that on-sector status command processing has terminated abnormally or that the DSC is currently reserved to its other access.

The 7TPP determines whether the status word is either on-sector or general by examining bits 11 and 10. When both of these bits are zero, the word is an on-sector status word. When either of these bits is one, the word is a general status word.

The on-sector status word has the following format.

```
 11 10  9  8  7  6  5  4  3  2  1  0
┌──┬──┬─────────────┬───────────────┐
│ 0│ 0│/////////////│  DSU NUMBER   │
└──┴──┴─────────────┴───────────────┘
```
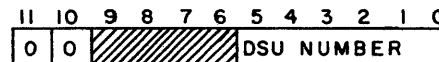
Refer to General Status (0012_8) for the general status word format.

DRIVE RELEASE (0020_8) [††]

This command releases the reservation on the DSU last accessed by the DSC. DSC access reservation is not released. (The DSC updates the general status word, and if a DSU malfunction occurs, detailed status is also updated.)

> **NOTE**
>
> When this command is used on a 7054 DSC, the 6TPP is required to wait 2 microseconds after receiving an inactive before sending the next command.

[†] Only 7TPPs can issue this command.
[††] Only 6TPPs can issue this command.

RETURN CYLINDER ADDRESS (0021₈)

This command allows the PP to determine on which cylinder the read/write heads had been positioned during the preceding seek operation. Before issuing this command, the PP must have reserved the drive with a connect command. The general status word must be zero or busy (0002₈). If the status is busy, the destination address of the read/write heads will be returned.

SET/CLEAR FLAW (0022₈)

This command selectively maintains flaw bits without reformatting the pack. After receiving the command, the DSC performs a one-word block input from the PP. This word should contain bit flags indicating whether to set or clear flaw bits and whether to reference a sector or an entire track. The flags have the following meaning.

Bit 0 - If this bit is a zero, a sector is referenced.

If this bit is a one, an entire track is referenced.

Bit 1 - If this bit is a zero, flaw bits in the address are cleared.

If this bit is a one, flaw bits in the address are set.

To execute this command, the DSU must have successfully executed a seek command immediately preceding issuance of the set/clear flaw command. The seek addresses the cylinder track and sector to be operated upon.

A 24-bit entry will be added to the utility flaw map for a set sector or a set track flaw command, provided it does not already exist. The existing entry will be deleted for a clear sector or clear track flaw command. The utility flaw map contains a maximum of 160₁₀ flaw entries. A general status of busy (0002₈) will be returned while the head is moving to position at the utility map.

GAP SECTOR - READ (0024₈)†

The gap sector commands (0024₈, 0025₈, 0026₈, and 0027₈) permit a gap sector to exist between consecutive data blocks. This feature can be used in either 1:1 or 2:1 interlace with 7152 and 7154 DSCs. With all other DSCs it can only be used with 2:1 interlace.

This feature permits multiple data blocks to be transferred without the loss of a disk revolution between data blocks. These commands must be used in lieu of a seek command to ensure that lost disk revolutions do not occur due to normal seek command processing overhead. In 1:1 interlace (7152 and 7154) the gap sector commands cause the subsystem to process a data transmission command and skip two physical sectors, rather than one. In 2:1 interlace (applies to all DSCs), three physical

sectors will be skipped. The second of the three sectors is a permanent gap sector, and the other two sectors are used during subsequent 2:1 interlace processing. Error recovery procedures and status processing for all data transmission commands using this feature are not affected.

NOTE

To ensure continuous data block transfer, the gap sector commands must be issued only when transferring the last sector of a data block in 2:1 interlace format, because the disk address is updated immediately following the data transfer operation. The PP is responsible for issuing a seek command to position the disk heads to the next cylinder whenever a data block is split between cylinder boundaries.

The gap sector-read command permits use of the gap sector feature during a read operation. With 7152 and 7154 DSCs, this feature can be used in either 1:1 or 2:1 interlace format. On all other model DSCs, this feature can only be used in 2:1 interlace format.

GAP SECTOR - WRITE (0025₈) †

This command permits use of the gap sector feature during a write operation. With 7152 and 7154 DSCs, this feature can be used in either 1:1 or 2:1 interlace. On all other model DSCs, this feature can only be used in 2:1 interlace format.

GAP SECTOR - WRITE VERIFY (0026₈) †

This command permits use of the gap sector feature during a write verify operation. With 7152 and 7154 DSCs, this feature can be used in either 1:1 or 2:1 interlace format. On all other model DSCs, this feature can only be used in 2:1 interlace format.

GAP SECTOR - READ CHECKWORD (0027₈)†

This command permits use of the gap sector feature during a read checkword operation. With 7152 and 7154 DSCs, this feature can be used in either 1:1 or 2:1 interlace format. On all other model DSCs, this feature can only be used in 2:1 interlace format.

READ FACTORY DATA (0030₈) †

NOTE

In the following description, cylinder CCC is cylinder 410 for 844-21 DSUs and cylinder 822 for 844-4X DSUs.

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† This command is for 6TPPs only.

This command permits a 6TPP to read either the factory recorded manufacturing data or the factory recorded flaw map (factory map). Prior to reading, a seek (cylinder CCC, head 0, sector 0 for manufacturing data or cylinder CCC, head 0, sector 1 for the factory map) must be performed. After ensuring that the heads are on cylinder, the PP issues a read factory data command followed by a single sector block input. Data is transferred from the disk to the PP memory, bypassing the subsystem memory.

Factory-recorded manufacturing data is contained in the first 48 bits of cylinder CCC, head 0, sector 0. The first 24 bits comprise a six-digit pack serial number, and the second 24 bits comprise a six-digit factory formatting date. Both entries are in BCD format.

The factory recorded flaw data (factory map) is located at cylinder CCC, head 0, sector 1. The data field contains a list of 24-bit flaw entries. Each entry has the following format.


```
23 22 21        12 11      6 5        0
┌─┬─┬──────────┬──────────┬──────────┐
│A│B│    C     │    H     │    S     │
└─┴─┴──────────┴──────────┴──────────┘
```
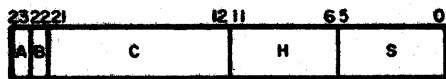
A = SECTOR FLAW
B = TRACK FLAW
C = CYLINDER (0-410)
H = HEAD (0-18)
S = SECTOR (0-23)

If A is a one, it indicates a sector flaw. If B is a one, it indicates a track flaw. The remaining bits give the cylinder, head, and sector location of the flaw. If both A and B are zero, there is a correctable data error at the location given. A flaw bit will be set in the disk address field only for the factory map entries in which A or B is one. The set sector flaw command (0022_8) must be used to set a flaw bit in the address of a sector having a correctable error. An entry of all zeros terminates the factory map.

The read factory data function is not available to a 7TPP; these sectors can be read using a read (0004_8) command.

READ UTILITY MAP (0031_8)†

```
┌──────┐
│ NOTE │
└──────┘
```

In the following description, cylinder CCC is cylinder 410 for 844-21 DSUs and cylinder 822 for 844-41 DSUs.

This command permits a 6TPP to read the utility map (cylinder CCC, head 0, sector 2). The utility map contains all the uncorrectable entries which

comprise the factory map plus all flaw entries set by the set/clear flaw (0022_8) command. The data field contains 24-bit sector and track flaw entries (refer to the factory map description).

To read the utility map, the PP must first perform a seek to cylinder CCC, head 0, sector 2 and assure the heads are on cylinder. The PP then sends a read utility map function followed by a single sector block input. Data is transferred from the disk to the PP memory, bypassing the subsystem memory.

The read utility map function is not available to a 7TPP; these sectors can be read by using a read (0004_8) command.

DIAGNOSTIC READ (0032_8)†

This command allows the PP to read 322 words from the subsystem memory that were previously written by the diagnostic write command. This command should be used for on-line maintenance only. General status will not be updated after this command.

DIAGNOSTIC WRITE (0033_8) †

This command allows the PP to write 322 words into the subsystem memory. This command should be used for on-line maintenance only. General status will be 5000_8 after this command if there was a parity error or if less than 322 words were received. A general status of zero indicates the command completed without error.

READ FLAWED SECTOR (0034_8)†

This command initiates data transfer from a selected flawed disk sector to the PP. The set/clear flaw (0022_8) command can be used to set the sector flaw bit in the address field of the sector to be read.

Operational and error recovery procedures for the read flawed sector command are the same as those for the read (0004_8) command.

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†This command is for 6TPPs only.

WRITE LAST SECTOR (0035$_8$)†

This command is applicable only to 7152 and 7154 DSCs. The operational procedure for this command is identical to the write command (0005$_8$). When writing in 1:1 interlace format, general status is returned to the PP after the address has been read and verified and after the data is in the coupler buffer but before it has been written on the disk. With the write last sector command, general status is returned after the sector is written on the disk. This means that the next physical sector cannot be written without missing a disk revolution. Therefore, the write last sector command should be used only when writing the last sector of a block.

WRITE VERIFY LAST SECTOR (0036$_8$)†

This command is applicable only to 7152 and 7154 DSCs. The operational procedure for this command is identical to the write verify command (0006$_8$). The write verify last sector command should be used only when verifying the last sector of a block. This is because status after this command is returned after the sector is verified and the next consecutive physical sector cannot be verified without missing a disk revolution.

WRITE FLAWED SECTOR (0037$_8$) †

This command initiates data transfer from the PP to a selected flawed sector. The set/clear flaw (0022$_8$) command can be used to set the sector flaw bit in the address field of the sector to be written.

Operational and error recovery procedures for the write flawed sector command are the same as those for the write (0005$_8$) command.

READ SHORT (0040$_8$) †

This command allows the PP to test the error correction logic of the subsystem. The operational procedure for read short is the same as for a read except that 319 rather than 322 12-bit words must be read by the PP.

The PP should use the write command to write a sector containing 319 data words followed by the 32-bit checkword for the 319 words and four zero bits. By modifying bits in the first 319 words, the PP can force checkword errors.

Example 1:

1. Write 322 words of zeros.

2. Perform read short. Because the checkword for an all zeros data field is zero, general status should be zero indicating the data was read without error.

Example 2:

1. Write a sector in which word 1 is 4000$_8$, and all the rest of the words are zero.

2. Perform read short and verify the checkword error is correctable (that is, general status is 4640$_8$ and that applying the correction vector makes the data field all zeros).

Example 3:

1. Write a sector in which word 1 is 4000$_8$, word 2 is 4000$_8$, and the rest of the words are zero.

2. Perform read short and verify that the checkword error is noncorrectable (that is, general status is 4600$_8$).

SELECT STROBE AND OFFSET (0041$_8$) †

This command allows the PP to select the data strobe and carriage offset for ensuing read commands. The intent of the command is to allow the PP to test disk pack margins. Writing at a strobe and offset is illegal and attempting it will result in no reply to the write command. The following sequence should be followed by a read at a strobe or offset position.

1. Perform seek to desired address. When the general status from the seek is zero, go to next step.

2. Perform select strobe and offset command. If general status is zero, go to the next step.

3. Perform read command and then check general status.

4. If general status is zero and the next sequential sector is to be read, go to step 3.

5. If general status is not zero, the standard error recovery sequence can be executed. However, if ensuing sectors are to be read, this sequence must be restarted at step 1.

If a carriage offset is selected, the next command will not be replied to for 10 milliseconds to allow head movement to complete. A seek or connect command always returns the strobe and offset position to nominal. If during a seek or connect it is determined that a unit is at an offset, the next command will not be replied to for 10 milliseconds to allow the heads to return to nominal.

After receiving the select strobe and offset command, the subsystem inputs one word from the PP. The word has the following definition.

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† This command is for 6TPPs only.

Bit 2 set: select forward carriage offset

Bit 5 set: select reverse carriage offset

Bit 7 set: select early data strobe

Bit 8 set: select late data strobe

CLEAR COUPLER CONNECTS (0042_8)†

This command is applicable to 7154 DSCs only. This command is interpreted by the subsystem coupler and is used to clear out hang conditions. It will clear out all connect status information and leave the multiaccess coupler in a clear state, ready for any access to become connected.

READ COUPLER BUFFER (0043_8) †

This command is applicable to 7152 and 7154 DSCs only. This command allows the PP to read the contents of the coupler buffer after any write or write verify command. The coupler buffer contains the last sector (502_8 12-bit words) written by the PP. A general status of zero indicates the command completed without error.

WRITE BUFFER TO DISK (0046_8)†

This function allows the HLP to write data already in the coupler buffer onto the disk at the address loaded in the subsystem processor. This function should be preceeded by a seek command, and if the next sector is a gap sector it should be followed by a seek command. The 0046_8 function is used for recovery when bit 11 of detailed status word 13 is set.

DEADSTART FROM DISK $(03UU_8)$†

This command transfers data from a deadstart sector on DSU UU_8 to the PP, releases the DSU, and then releases the coupler. The total word count of the data written in the deadstart sector will be in the first word. This count (1-502 octal) will determine the length of the block transfer back to the PPU. General and detailed status returned after this command is identical to status returned after seek and read commands.

The deadstart sector is cylinder 410 (841-2) or 822 (844-41), track 0, sector 3. Data in the deadstart sector is protected by a sector flaw bit in the address field. If the deadstart sector is not flawed from the factory, the sector must be flawed either with a set/clear flaw (0022_8) command or with SMM utility program FMT. When the sector is to be flawed on site, the DSU should be checked for alignment first to prevent possible pack interchange problems.

The bootstrap program placed in the deadstart sector must be written with the write flawed sector (0037_8) command.

The following deadstart panel settings may be used for deadstart from disk operations. Variations of this routine may be necessary, depending upon the operating system and hardware configuration.

Location	Instruction	Notes
1	75CC	Deactivate channel CC††
2	2400	Pass
3	2400	Pass
4	2400	Pass
5	2400	Pass
6	77CC	Send deadstart from disk function
7	03UU	(UU is the disk storage unit number)
10	74CC	Activate channel CC
11	71CC	Input data from channel CC
12	XXXX	To PPU memory starting at address XXXX

If channel CC is connected to a 6681 or a 6684, locations 2 and 3 should be set to 77CC and 2100 (deselect 6681 or 6684).

LOAD CONTROLWARE FROM DISK $(01UU_8)$†

This command applies to 7152 controllers only. It transfers data from DSU UU_8 to the subsystem processor memory of a 7152. The drive specified by UU_8 is positioned to cylinder 410 for single density disks or to cylinder 822 for double density disks. Data transfer then begins at track 0, sector 4_8. Consecutive sectors through sector 24_8 transfer from the disk into the subsystem processor memory. UU_8 must be a number from 0 through 3_8.

To load controlware from a disk, refer to the preceding deadstart panel settings and set locations 4 and 5 to 77CC and 01UU, respectively.

START MEMORY LOAD (0414_8)

A PP uses this command for autoloading a DSC through a PPU. It is the only command that a DSC can execute before controlware is loaded. Upon receipt of this command, a DSC prepares for a block transfer from the PP to DSC memory, beginning at DSC memory location 0000.

A DSC controlware block consists of less than 4096 16-bit words. These words are transferred between a PP and DSC memory (figure 1-3). The block transfer terminates when either a 6TPP disconnects the I/O channel or when a 7TPP sends a record flag on the data channel. On 7TPPs, the subsystem initializes itself by issuing a release to all drives; it can now respond to commands issued by the 7TPP.

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† This command is for 6TPPs only.
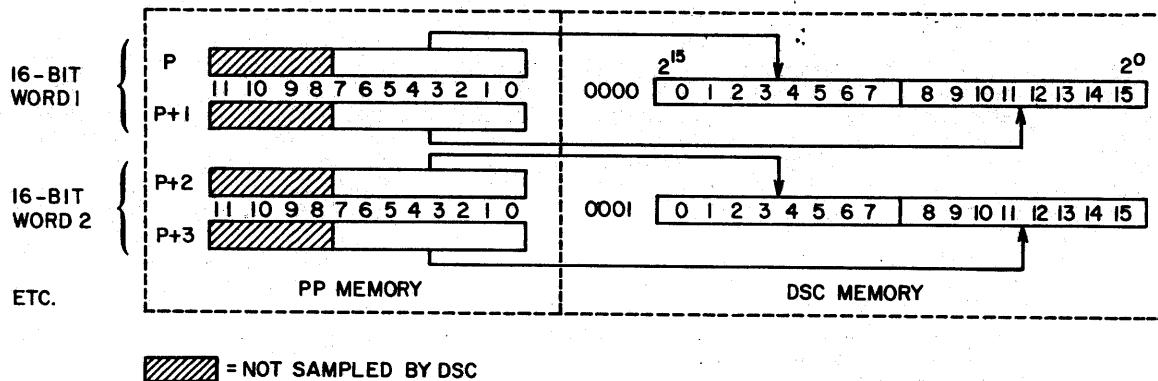†† If CC is channel 1 through 11, this routine does not apply.

Figure 1-3. Start Memory Load Transfer Map

On 6TPPs, the subsystem then calculates a checksum from the loaded data and compares it with the correct value. If it does not compare, the general status function is the only one that will be replied to; it will be 5000_8. If a detailed status is read, bit 0 of word 3 will be set. If MA401 Controlware is loaded in a 7054, general status will be 5004_8 to indicate the controlware is not compatible. If MA710 controlware is loaded into a 7154, instruction modification occurs to handle the 7154 coupler buffer. If there is no checksum error or controlware/DSC incompatibility, all drives are released, and the subsystem will then respond to commands issued by the 6TPP.

PROGRAMMING SEQUENCES

This section describes PP/DSC communication and provides examples of command sequences for typical disk operations.

6TPP/DSC COMMUNICATION PROCEDURE

Commands, output parameters, data, and status pass between a 6TPP and a DSC over a single, 6000 series type I/O channel as the following sequence describes. (Two-digit numbers refer to 6TPP octal operation codes, and four-digit numbers are DSC commands.)

1. (65) The 6TPP checks the I/O channel connected to the DSC to ensure that the I/O channel is inactive (disconnected).

2. (76 or 77) The 6TPP sends a command to the DSC.

| NOTE |

Whenever more than one I/O channel is tied to a multiaccess DSC, the first command sent to the DSC over any I/O channel must be a general status (0012_8) command. The 6TPP must then interpret the general status word to determine if the DSC is currently reserved to the other I/O channel. If a 6TPP issues a command other than a general status command to a DSC currently reserved to the other I/O channel, the DSC does not indicate acceptance of the command until the DSC finishes the current operation.

3. The DSC disconnects the I/O channel to indicate acceptance of the command.

4. At this time, the 6TPP is waiting for the I/O channel to become inactive (65). When the command issued in step 2 requires additional input/output, the 6TPP activates the I/O channel (74) and performs the necessary input/output. All commands except the following require subsequent input/output after command initiation.

Read checkword (0007_8)

Operation complete (0010_8)

Disable reserve (0011_8)

Continue (0014_8), during pack formatting

Drop seeks (0015_8)

Drive release (0020_8)

Clear connects (0042_8)

5. After issuing a command or a command sequence, the 6TPP should monitor the operation's progress or verify the operation's completion with one or more general status commands. If the general status word indicates an error condition, the 6TPP should issue a detailed status (0013_8) command to obtain error information.

6. When an I/O channel is disconnected during an output parameter, data, or status transfer, the 6TPP must issue a new command before communication with the DSC can resume. The 6TPP or the DSC disconnects the I/O channel during an output parameter, data, or status transfer under the following conditions.

   a. The 6TPP disconnects the I/O channel after sending the last word when auto-loading the DSC with a start memory load (0414_8) command.

   b. The 6TPP disconnects the I/O channel after issuing the output parameter associated with one of the following commands.

      Connect (0000_8)

      Seek, 1:1 interlace (0001_8)

      Seek, 2:1 interlace (0002_8)

      I/O length (0003_8)

      Format pack (0016_8)

   c. The 6TPP disconnects the I/O channel after outputting 644 characters (322 12-bit words) of data during execution of the following commands.

      Write (0005_8)

      Write verify (0006_8)

      Continue (0014_8), during write error recovery

      Gap sector - write (0025_8)

      Gap sector - write verify (0026_8)

      Write last sector (0035_8)

      Write verify last sector (0036_8)

      Write flawed sector (0037_8)

   d. The DSC disconnects the I/O channel after successfully processing a read (0004_8), general status (0012_8), detailed status, gap sector-read (0024_8) return cylinder address (0021_8), read factory data (0030_8), read utility map (0031_8), read flawed sector (0034_8), or read coupler buffer (0043_8) command.

   e. The DSC disconnects the I/O channel when an error is detected during processing of a read (0004_8), write (0005_8), or write verify (0006_8) command.

   [NOTE]

   To avoid hanging the 6TPP, the following restrictions govern the disconnect channel d (75) instruction.

      1. A jump if channel d inactive (65) instruction should precede every (75) instruction to ensure that the I/O channel is currently inactive.

      2. A 6TPP should execute a (75) instruction only after having transferred the expected number of words of output parameter, data, or status.

   f. The DSC disconnects the I/O channel if the deadman timer expires.

7. After completing a command or a command sequence, the 6TPP must issue an operation complete (0010_8) command to release the reserve on the DSC.

6TPP COMMAND SEQUENCES

This section describes typical 6TPP disk operations and provides sample command sequences. Refer to 6TPP/DSC communication procedure for general guidelines relating to I/O channel protocol. The following entries deal only with 6TPP/DSC communication and do not cover 6TPP/central memory communication.

Autoloading DSC Controlware

The computer system transfers DSC controlware from cards or magnetic tape to a 6TPP. The 6TPP then uses a start memory load (0414_8) command and a block output to autoload a DSC. The DSC is ready to accept other commands as soon as the I/O channel disconnects after the controlware transfer.

1. Issue a start memory load command and output the controlware block.

2. Issue an operation complete command to release the reserve on the DSC.

PROM Autoload Error Identification (7152)

The 7152 controller has a programmable read only memory (PROM) that allows loading controlware into subsystem processor memory from a disk unit [refer to Load Controlware from Disk ($01UU_8$)].

The following error identification applies to autoloading via PROM.

Breakpoint Instruction Address	Error Code	Reason for Error Code or Reaching Breakpoint
1000		Deadstart master clear started program execution in PROM.
1004		Function was received and stored in location 0010.
	0001	Parity error is on function; function is stored in location 0010.
	0002	PROM received a function other than 01UU, and location 5 does not contain FFD, indicating controlware is not loaded.
	0003	The director sequence to position and read 17 sectors did not complete within 600 milliseconds. Word 0011 has operating status word 1, and word 0012 has disk status.

Breakpoint Instruction Address	Error Code	Reason for Error Code or Reaching Breakpoint
	0004	After the controlware load, either location 5 does not contain FFD, or the checksum is incorrect. The expected checksum is in location 0004, and the actual checksum is in location 0003.

The error codes will be in the A register if selective stop is on.

Manual Loading of Controlware

The 7152 controlware can be loaded off-line from a buffer controller (subsystem processor) maintenance console using the following procedure.

1. Stop, master clear, and channel clear the subsystem processor.

2. Set location $000C_{16}$ in the subsystem processor memory as follows:

   0000 000E EE00 0UUU

   UUU   Output port from the 7152

   EEE   Output port from the mass storage extender; zero if no extender

3. Set P in the buffer controller maintenance console to 1021_{16}.

4. Press GO switch to initiate loading.

Pack Formatting

The 6TPP generates a seven-word format pack output parameter, initiates the format operation, and then monitors the operation to obtain flaw map information.

1. Issue a general status command, input the status word, and ensure that the DSC is not reserved. Zero-filled status indicates that the DSC is ready.

2. Issue a connect command and output the DSU number. Then issue a general status command to ensure that the DSU is reserved to this DSC. If the DSU is reserved to the other DSC, there may be a system problem.

3. Issue a format pack command and output the parameter block to initiate the format operation.

4. Issue a general status function, input the status word, and branch according to the following status conditions.

 * Busy, go to 4

 * Recovery in progress, go to 5

 * Zero-filled status, go to 6

 * Nonrecoverable error, log detailed status and abort this sequence

5. Issue a detailed status command and input the status to obtain sector and track flaw information for the flaw map. Then issue a continue command to restart the format operation and write flaw bits as required. Go to 4.

6. Issue an operation complete command to release the reserves on the DSU and DSC.

Seek/On-Cylinder Check

In preparation for data transfer or data verification operations, the 6TPP initiates head movement (if required) on one or more DSUs. The first DSU to achieve on-cylinder status is then selected.

1. Issue a general status command, input the status word, and ensure that the DSC is not reserved.

2. For each DSU to be positioned, issue a connect command, output the DSU number, issue a general status command, and input the status word. This reserves the DSU or determines that the DSU is reserved to the other DSC.

3. Initiate head movement on each DSU to be positioned by issuing a seek command and then sending an address.

4. Locate the first DSU to achieve on-cylinder status by issuing to each DSU a seek command with address followed by a general status command. Zero-filled status indicates the DSU is on-cylinder.

5. Issue a drop seeks command to release the reserve on all but the last DSU referenced.

6. Continue with data transfer or data verification operation.

Read

After one DSU is on-cylinder, the 6TPP inputs one or more 644-character (322-word) data blocks starting at the sector specified by a prior seek.

1. Use the Seek/On-Cylinder Check sequence to position the DSU to the desired cylinder.

2. Issue a read command and input a sector of data.

3. Issue a general status function, input the status word, and branch according to the following status conditions.

 * Zero-filled status (successful completion), go to 6

 * Any error status, go to 4.

4. Issue a detailed status command and input the status to obtain error correction, error recovery, or error log information. Branch according to the following status information.

 * Correctable checkword error; apply correction vector and go to 6

 * Recovery in progress (more disk revolutions are required), go to 5

 * Other status; log status and either abort this sequence or go to 6

5. After each unsuccessful read attempt (as long as recovery in progress status is active), issue a continue command, input a sector of data, and then issue a general status function. Use detailed status commands to log status, if necessary.

6. Go to 1 if the next sector will be read. Otherwise, issue an operation complete command to release the reserves on the DSU and DSC.

Write

After one DSU is on-cylinder, the 6TPP outputs one or more 644-character (322-word) data blocks starting at the sector specified by a prior seek.

1. Use the Seek/On-Cylinder Check sequence to position the DSU to the desired cylinder.

2. Issue a write command and output one sector of data.

3. Issue a general status command, input the status word, and branch according to the following status conditions.

 * Zero-filled status (successful completion), go to 6

 * Any error status, go to 4

4. Issue a detailed status command and input the status to obtain error recovery and error log information. If recovery in progress status is active, more disk revolutions are required; go to 5. Otherwise, log status and either abort this sequence or go to 6.

5. After each unsuccessful write attempt (as long as recovery in progress status is active), issue a continue command, output data, and then issue a general status function. Use detailed status commands to log status, if necessary.

6. Go to 1 if the next sector will be written. Otherwise, issue an operation complete command to release the reserves on the DSU and DSC.

When writing data in the 1:1 interlace format on a 7154 DSC, a zero general status is returned when the address field has been read and verified and the data is in the coupler buffer. As a result of this, the following errors are not reported in the first general status after a write: lost data, sector length violation, unit fault, or a coupler buffer error (coupler to disk). To prevent these errors from going unreported, there will be no reply to the next function sent by the PP.

Function timeouts must be prevented on the last sector of a block. When writing the last sector of a block in 1:1 interlace format, either the write last sector function must be sent for the last sector or two general status commands must be done after writing the last sector.

1. If a reply to a write command is not received, perform a general status command.

2. If general status is zero, either retry the write command or reseek and retry the write command.

3. If general status is not received, log status and abort the sequence.

4. If general status is not zero, take detailed status. If bit 11 of detailed status, word 13, is set, retry the write of the previous sector. The read coupler buffer command can be used by the 6TPP to obtain the sector of data to be rewritten. If bit 11 of word 13 is not set, log status and abort the sequence.

6TPP DEADMAN TIMER OPERATION

The 6000 system coupler incorporates a deadman timeout feature which prevents the channel from hanging for an extended period of time. The deadman timer is enabled whenever the coupler is reserved by a 6TPP. Each time a function word or a data word is transferred across the channel, the deadman timer is reset to zero and the timeout period is reinitiated. If another function or data word is not transferred within 3.5 to 5 seconds, the timeout period expires, the reserved condition is cleared, and an inactive signal is sent to the PP. The only exception is an operation complete function which disables the deadman timer and clears the reserved condition. Once the deadman timer has expired, the only function which is recognized by the subsystem is a request for general status (0012_8). Any other function is illegal and causes

the channel to hang. In this situation, the PP should execute a timeout and then perform a general status function to determine if the deadman timer has expired. No reply to a general status function indicates that the subsystem is inoperative and requires an autoload of the complete controlware package from the PP.

Expiration of the deadman timer is a nonrecoverable error which voids any I/O or error recovery operation which may have been in progress (that is, the continue function is illegal, and any I/O operation must be preceded by a seek function).

If the deadman timer expires in a dual access configuration, the first PP to request general status will reserve the coupler. The PP which acknowledges the deadman timeout status must inform the other PP that a deadman timeout has occurred.

6TPP 1:1 INTERLACE COMMUNICATION (7054 DSCs ONLY)

The following is an example of a PP driver writing at a 1:1 interlace when the data to be written is already in the PP. The sequence for read, read checkword, and write verify operations are similar. When writing on a single density drive, 30 microseconds can be added safely to this sequence; when writing on a double density drive, 3 microseconds can be safely added to this sequence without creating lost data errors. If the PP has a 500-nanosecond rather than a 1-microsecond memory cycle time, 47 and 20 microseconds, respectively, can be added safely.

Label	Mnemonic	Operand	Comment
WRITE	LDN	5	Load write function.
	FAN	CH	Send function to subsystem.
WRITE 10	IJM	WRITE 20, CH	Jump if reply to function was received.
	ADN	1	Add one to timeout count.
	PJN	WRITE 10	Loop if a 1-second timeout has not expired.
	LJM	ERRPROC 1	Disconnect channel, report the error, and retry the function.
WRITE 20	ACN	CH	Activate the channel.
	LDC	502B	Load word count into A register.
WRITE 25	OAM	BUF, CH	Output the data from location BUF.

Label	Mnemonic	Operand	Comment
	ZJN	WRITE 30	Jump if all words were taken.
	LJM	ERRPROC 2	Save word count, take general and detailed status, and report the error.
WRITE 30	DCN	CH + 40 B	Disconnect the channel if active.
	FNC	12 B, CH	Send the general status function.
WRITE 40	IJM	WRITE 50, CH	Jump if reply function was received.
	ADN	1	Add one to time-out count.
	PJN	WRITE 40	Loop if a 1-second timeout has not expired.
	LJM	ERRPROC 3	Disconnect channel, report the error, and retry the function.
WRITE 50	ACN	CH	Activate the channel.
	LDN	1	Load the word count into the A register.
	IAM	GENSTAT, CH	Input the general status word.
	ZJN	WRITE 60	Jump if word was received.
	LJM	ERRPROC 4	Report the error and retry the function.
WRITE 60	AJM	ERRPROC 5, CH	Disconnect channel, report the error, and retry the write sequence beginning with the seek if channel active.
	LDD	GENSTAT	Load the general status.
	NJN	ERRPROC 6	Jump if there was an error.
	LDC	502 B	
	RAM	WRITE 25 + 1	Update output pointer to the next sector.
	SOD	IOLENGTH	Have all sectors been written?
	ZJN	WRITE 70	If yes, jump.
	LJM	WRITE	Write the next sector.
WRITE 70	LJM	EXIT	Exit write routine.

7TPP/DSC COMMUNICATION PROCEDURE

A 7TPP uses two of its eight bidirectional channels to communicate with a DSC as described in the following sequence. One channel (status/control channel) transfers commands, general status words, and on-sector status words between the 7TPP and the DSC. The other channel (data channel) transfers output parameters, data, and detailed status blocks. In the following sequence, two-digit numbers refer to 7TPP octal operation codes, and four-digit numbers refer to DSC commands.

1. The 7TPP checks for an input record flag on the status/control channel (62), indicating that the deadman timer has expired. If the deadman timer has expired, an output record pulse on the status/control channel is necessary to drop the static resume on the data output channel (74).

2. The 7TPP then checks for an input word flag on the status/control channel (60). If a status word is available, it should be input and considered residue from some previous operation; it is not current status.

3. The 7TPP issues a command to the DSC on the status/control channel (72 or 73). The 7TPP then checks for the output word flag on the status/control channel to drop, indicating that the DSC has accepted the command (65).

4. The 7TPP checks for an input record flag on the status/control channel (65), indicating that the deadman timer has expired. The current procedure must be restarted at step 1 if the timer did expire.

5. The 7TPP then checks for an input word flag on the status/control channel (60), inputs the current general status word (70), and ensures that the DSC is not reserved to the other computer access.

6. When the command issued in step 3 requires output parameters or data to be sent to the DSC, the 7TPP outputs the appropriate number of words on the data channel (72 or 73) and sends a record pulse on the data channel to terminate the transfer (72). When the command issued in step 3 instructs the DSC to send data or detailed status to the 7TPP, the DSC sends the appropriate number of words over the data channel and follows the data with an input record flag.

After a 7TPP executes a block transfer on the input or output data channel (71 or 73), a check should be made for an input record flag on the status/control channel (62) to indicate that the block transfer instruction was terminated by the deadman timer. If the timer did expire, an output record pulse on the status/control channel is necessary to clear the static resume on the output data channel (74).

The following commands require no additional input/output after command initiation.

Read checkword (0007_8)

Operation complete (0010_8)

Disable reserve (0011_8)

Continue (0014_8), during pack formatting

Drop seeks (0015_8)

7. The 7TPP checks for an input word flag on the status/control channel (60) and then inputs the current general status word (70) to verify successful completion of the last command or command sequence. Refer to table 1-3 to find when this status should be interrogated.

8. After completing a command or command sequence, the 7TPP must send a record flag on the status/control channel (74) before the DSC can accept commands from the 7TPP on the other access.

9. After completing operations on one or more DSUs, a 7TPP should issue an operation complete (0010_8) command to release reserved DSUs for use by other 7TPPs.

DSC AUTODUMP

A PP uses a start memory load (0414_8) command to load the DSC with an autodump controlware block.

After the autodump controlware block has been loaded, the DSC can respond only to the autodump discussed in the following paragraphs or to the start memory load command.

Format 2/1 (0001_8)

This command initiates an output block transfer from DSC memory, starting at the DSC location specified in autodump controlware location C_{16} (table 1-5). The length of the transfer (in 12-bit PP words) is 2/1 times the DSC word count specified in autodump controlware location 0, since one 16-bit DSC word fills the lower 8-bit positions of two PP memory locations. (The upper four bits of PP memory locations are zero filled.) Figure 1-4 shows how DSC words are transferred into PP memory in response to an autodump: format 2/1 command.

TABLE 1-5. AUTODUMP CONTROLWARE BLOCK

Autodump Controlware Location	DSC Hex Code	PP Memory Location	PP Octal Code	Notes
0_{16}	0FFF	P P+1	0017 0377	Number of DSC words to be autodumped ($0FFF_{16}=0017$, and $0377_8=4095_{10}$)
1_{16}	0900	P+2 P+3	0011 0000	Test for function
2_{16}	EF01	P+4 P+5	0357 0001	Jump back one location if function not present
3_{16}	1801	P+6 P+7	0030 0001	Select 2/1 format in coupler
4_{16}	0F00	P+8 P+9	0017 0000	
5_{16}	0A00	P+10 P+11	0012 0000	Send function reply
6_{16}	0B00	P+12 P+13	0013 0000	
7_{16}	4800	P+14 P+15	0110 0000	Load A register with two's complement of word count in location 0 (4095_{10} - $0FFF_{16}$)
8_{16}	0906	P+16 P+17	0011 0006	Test for channel active
9_{16}	EF01	P+18 P+19	0357 0001	Jump back one location if channel not active
A_{16}	FC0C	P+20 P+21	0374 0014	Transfer data beginning at location stated in address C_{16} (0000)
B_{16}	BB00	P+22 P+23	0273 0000	Jump forward 0 locations (hang instruction)
C_{16}	0000	P+24 P+25	0000 0000	DSC autodump starting location (0000)

```
      11 10 9 8 7 6 5 4 3 2 1 0
P        ZERO   00    DSC    07
P+1      FILL   08   WORD 1  15
P+2      ZERO   00    DSC    07
P+3      FILL   08   WORD 2  15
ETC.
```

Figure 1-4. Format 2/1 Transfer

PARITY ERROR DETECTION AND PROCESSING

If a 7054-21/41, 7054-22/42, 7152, or 7154-1/2/3/4 DSC is attached to a PP of a CDC CYBER 170 family computer system, the DSC checks parity on all information transferred between the DSC and the PP. An error can occur when the PP sends a command, when the PP sends parameters to the subsystem processor, when the PP sends data to the disk storage unit, or when the subsystem sends information to the PP. These four situations are explained in the following paragraphs.

- Parity error on a command

    The subsystem processor does not reply to a command having a parity error. It clears the parity error status and waits for another command to process. The PP must execute a timeout after sending a command to avoid hanging the channel. Following the timeout, the PP should disconnect the channel and resend the command. If parity errors continue, the operation should be aborted.

- Parity error on a transfer sent to the subsystem processor

    The PP completes its transfer normally. It must then execute a general status command (0012_8). The subsystem processor clears the parity error condition and then prepares the status word in its memory. The subsystem does not reply to any command except 0012_8. General status is 5000_8, and bit 0 of word 3 of detailed status is set to indicate a parity error. The PP should send the command and parameters again before aborting the operation.

- Parity error on data sent to the disk

    The PP completes the transfer normally. It must then execute a general status command. The subsystem processor clears the parity error condition and prepares the status words in its memory. The subsystem does not reply to any command but the general status command. General status is 4400_8, and bit 0 of detailed status word 3 is set to indicate a parity error.

    The PP can send a continue command followed by the data. The subsystem will attempt to write the data on the next revolution. A maximum of three retries with the continue command is allowed.

NOTE

A continue command is not necessary after the 4400_8 general status response. A seek or connect command will stop the recovery sequence.

- Parity error on information sent to the PP

    The PP must check the appropriate bit in the status and control register after the block input. This must be done before the next command is executed. General status will not reflect a parity error during a PP read. Parity is checked in the PP. If an error occurs, the PP should do one of the following.

    1. Resend the command and read the parameters again.

    2. Reseek and read the sector.

    3. Reseek and read the block.

    4. Abort the operation.

SUBSYSTEM TIMING DATA

Tables 1-6 and 1-7 show reply times, parameter/data window times, and total execution times for the subsystem commands. Table 1-6 is for 7152 and 7154 DSCs; the times are based on MA401-A01 controlware and could vary slightly with other controlware versions. Table 1-7 is for the 7054 DSCs and the times are based on MA710-A09 controlware. Again, the times given could vary slightly with other versions of the controlware.

Except where noted in the comments, command reply times assume the previous command has been completed, the subsystem processor is in its idle loop waiting for another command, and the opposite coupler access is not reserved.

The minimum window time for parameters is the shortest amount of time that the controlware can perform the input/output after the command reply. The window times for parameters are dependent on how soon after the reply the PP activates the channel. The channel must be activated prior to the minimum and expected window times for the times to be valid. If the channel is not activated by the maximum window time, the controlware will prepare error status and return to an idle loop. For commands processed by the coupler, the maximum window time is the amount of time that must elapse before the deadman timer expires.

The window times for parameters in rows 5 and 6 are minimum, expected, and maximum times the PP has after the input of general status until the next I/O command must be sent. With a 7152 or 7154 DSC, the PP has a minimum of 35 microseconds after the command reply to execute its IAM/OAM instruction. With a 7054 DSC, the PP has a minimum of 55 microseconds after the command reply to execute its IAM/OAM instruction.

The total execution time is measured from the time the controlware senses the command until it is back in its idle loop testing for the presence of another command. The maximum execution time is usually the result of an error condition. For example, the maximum execution time for commands numbered 8 is 300 milliseconds due to the worst case return to zero seek time. The minimum, expected, and total execution times for commands numbered 5, 6, and 9 are measured from the time the PP falls out of its IAM/OAM instruction until the controlware is back in its idle loop looking for another command.

Figures 1-5 and 1-6 show the 7152 and 7154 DSC timing for the read and write commands, respectively. The figures pertain only to operation at 1:1 interlace.

TABLE 1-6.   7152 AND 7154 SUBSYSTEM TIMING DATA†

Command	Command Reply Minimum/ Expected/ Maximum	Window Times for Parameters/ Data	Total Execution Time Minimum/Expected/ Maximum	Comments
1. Autoload	1/ 1/ 1	13/15/DMT	15 + 2 per DSC word +40 ms	Subsystem coupler performs function
2. Format pack	72/ 80/ 86	5/ 15/196	2.5 min/NA/5 min	Assume full pack format
3. Seek	80/ 90/ 96	13/ 15/163	390/415/10 ms	
4. Connect	80/ 90/ 96	13/ 15/163	345/375/10 ms	
5. Read	25/ 30/35	920/930/940	23/ 25/ 28	Maintaining 2:1 interlace
6. Write/write verify	50/ 55/ 60	620/635/650	20/ 25/ 30	Maintaining 2:1 interlace
7. Read checkword	95/ 105/115	NA	645/ - /1345	Maintaining 2:1 interlace
8. Read/write/ write verify	115/135/160	370/8740/17630	1193/9560/300 ms	Not maintaining interlace
9. Operation complete/ drive release	200/280/290 72/ 80/ 86	NA NA	208/290/1340 208/290/1340	
10. Disable reserve	72/ 80/ 86	NA	110/120/240	
11. Detailed status	150/170/190	266/301/354	461/516/564	
12. Drop seeks	72/ 80/ 86	NA	184/264/2370	One unit released is expected; 63 units released is maximum
13. Return cylinder address	72/ 80/ 86	6/ 8/168	85/100/400	
14. Set/clear flaw	72/ 80/ 86	3/ 13/185	410 ms/775 ms/1150 ms	
15. General status	1/ 1/ 1	1/ 1/DMT	NA	Coupler is reserved (that is, coupler processes command)
16. General status	24/ 31/ 33	4/ 6/126	72/ 82/ 240	
17. General status	18/ 20/ 22	4/ 5/ 6	NA	After 2:1 interlace, I/O command
18. Diagnostic read	75/ 80/ 92	8/ 5/144	590/630/760	
19. Diagnostic write	78/ 83/ 96	5/ 11/140	590/630/770	
20. Select strobe/ offset	80/ 85/ 90	3/ 13/185	110/10 ms/10 ms	
21. Read coupler buffer	75/ 80/ 90	1/ 10/DMT	240/250/DMT	The inactive will follow the data by a maximum of 25 microseconds.
† All times are in microseconds except where noted.				

TABLE 1-7. 7054 SUBSYSTEM TIMING DATA †

Command	Command Reply Minimum/Expected/Maximum	Window Times for Paramters/Data	Total Execution Time Minimum/Expected/Maximum	Comments
1. Autoload	1/ 1/ 1	13/ 15/2.5 sec	15 + 2 per DSC word + 40 ms	Subsystem coupler processes command. Assume full pack format.
2. Format pack	37/ 48/ 52	13/ 18/196	2.5 min/NA/5 min	
3. Seek	50/ 64/ 70	13/ 15/163	410/430/10 ms	
4. I/O length	45/ 50/ 55	3/ 13/185	105/130/310	
5. Read	65/ 70/ 76	620/ 632/645	5/8/10	Maintaining 2:1 interlace
6. Write/write verify	60/ 64/ 72	605/ 620/635	11/15/18	Maintaining 2:1 interlace
7. Read checkword	65/ 70/ 76	N/A	645/ - /1345	Maintaining 2:1 interlace
8. Read/write/write verify	85/ 95/110	370/8740/17,630	1193/9560/300 ms	Not maintaining interlace
9. Read/write/write verify	11/ 12/ 14	10/ 10/ 50	7/ 9/ 10	Maintaining 1:1 interlace
10. Operation complete/drive release	33/ 45/ 48	N/A	208/290/1340	
11. Disable reserve	33/ 45/ 48	N/A	110/120/240	
12. Detailed status	76/ 92/ 98	17/ 20/180	178/207/378	
13. Drop seeks	33/ 45/ 48	N/A	184/264/2370	One unit released is expected; 63 units released is maximum.
14. Connect	45/ 56/ 60	13/ 15/163	355/384/10 ms	
15. Return cylinder address	76/ 92/ 98	6/ 8/168	80/100/400	
16. Set/clear flaw	45/ 50/ 55	3/ 13/185	410 ms/775 ms/1150 ms	
17. General status	1/ 1/ 1	1/ 1/2.5 sec	N/A	Coupler is reserved (that is, coupler processes command).
18. General status	27/ 35/ 37	8/ 10/130	70/88/132	
19. General status	11/ 20/ 26	5/ 6/ 9	34/49/62	After 1:1 interlace, I/O command
20. General status	18/ - / 35 ms	5/ 11/126	N/A	During format or set/clear, flaw command
21. General status	21/ 25/ 28	6/ 7/ 8	88/100/108	After 2:1 interlace, I/O command
22. Diagnostic read	40/ 45/ 56	8/ 5/144	588/630/762	
23. Diagnostic write	45/ 48/ 60	5/ 11/140	588/630/772	
24. Select strobe/offset	45/ 50/ 55	3/ 13/185	105/10 ms/10 ms	

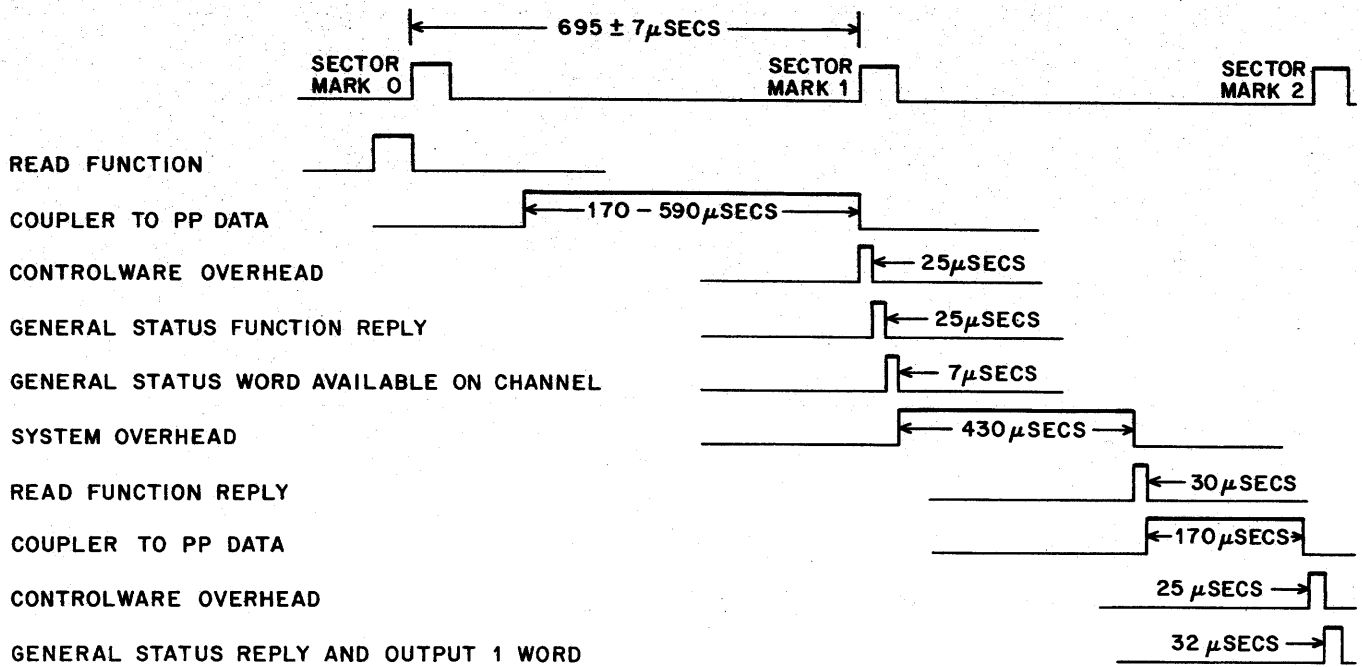†All times are in microseconds except where noted.

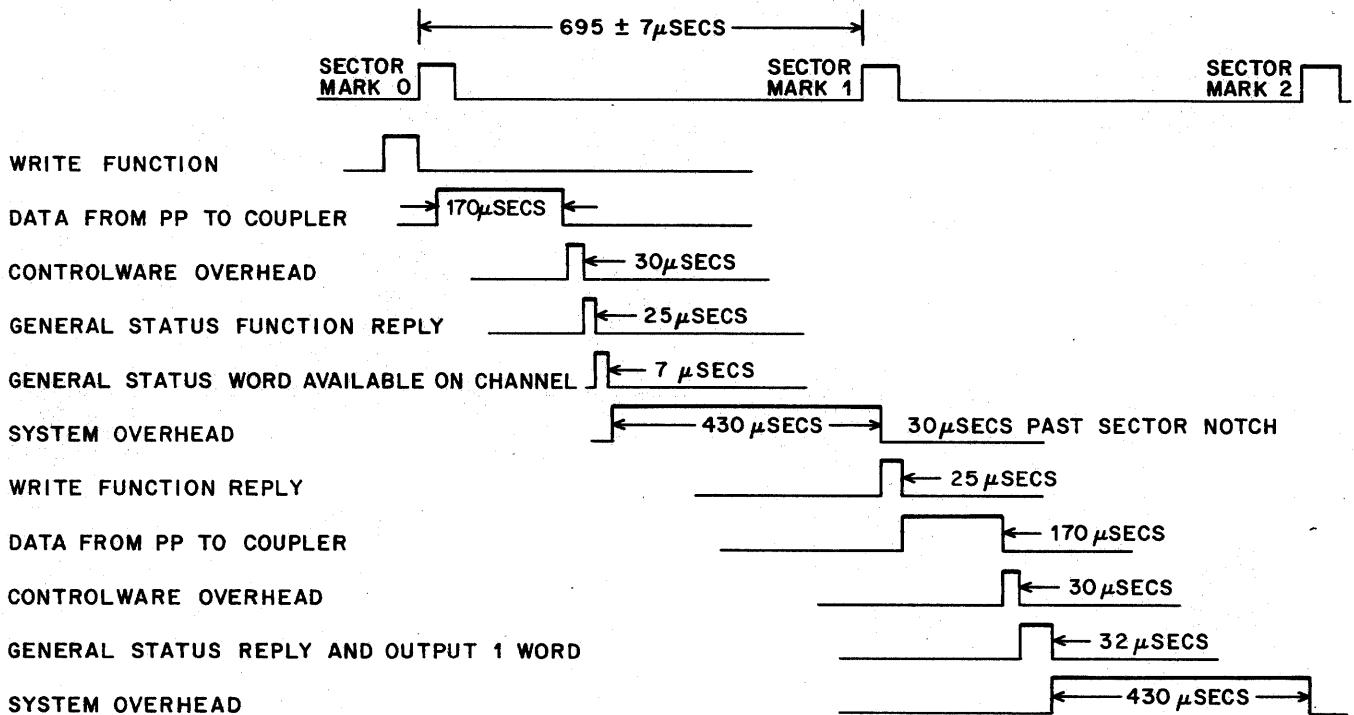Figure 1-5. Read Sequence - 7152 or 7154 at 1:1 Interlace

Figure 1-6. Write Sequence - 7152 or 7154 at 1:1 Interlace

This section lists DSC and DSU operator controls, describes their functions, and provides operational sequences.

CONTROLS AND INDICATORS

Figures 2-1 and 2-2 show the location of controls on a DSC, and figures 2-3 and 2-4 show the location of controls on a DSU. Refer to these figures for locations of the controls and indicators described in the following paragraphs.

DSC POWER ADJUST PANEL

These controls and indcators are located on the front of the DSC. They are for maintenance purposes only and are not to be adjusted by operating personnel.

DSC PWR ON INDICATOR

This indicator is located on the upper right of the DSC and lights when the MAIN POWER circuit breaker and the POWER DISCONNECT switch are both ON.

DSC AUXILIARY OPERATOR PANEL

This panel is located in the DSC logic chassis and is used only for maintenance purposes.
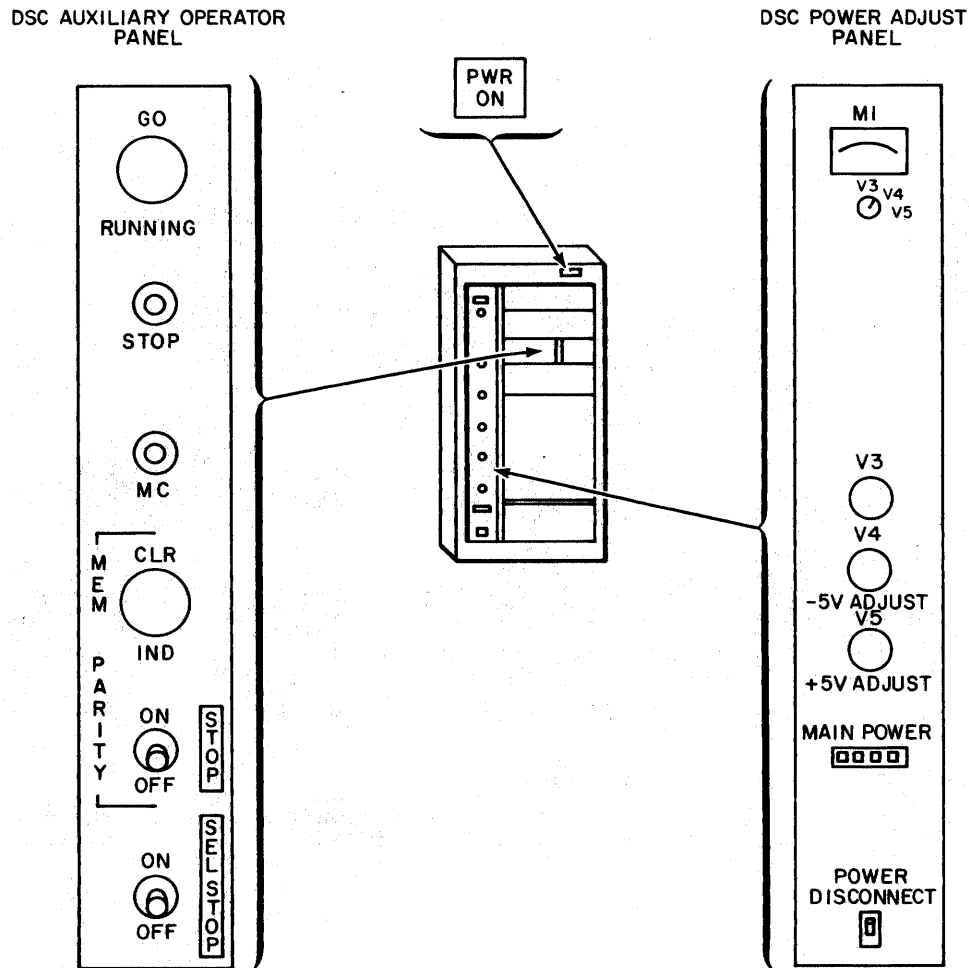
Figure 2-1. DSC Early Unit Controls and Indicators

NOTES:

(1) 30V POWER SUPPLY NOT USED IN 7152 AND 7154 DSC's.

2. THE DISK CONTROLLER PORTION OF A 7152 OCCUPIES THE RIGHT SIDE OF A DOUBLE-WIDE CABINET. A COMMON POWER SUPPLY IS LOCATED BENEATH THE TAPE CONTROLLER ON THE LEFT SIDE OF THE CABINET.

Figure 2-2. DSC Controls and Indicators

| START | READY | FAULT | MAINTENANCE | TEMP | |

MAIN COVER
MAIN COVER LATCH
DUST COVER
DUST COVER LATCH

UNLABELED INDICATOR

DISK PACK

DUST COVER INTERLOCK

2ZZ4A

Figure 2-3.   844-2 DSU Controls and Indicators

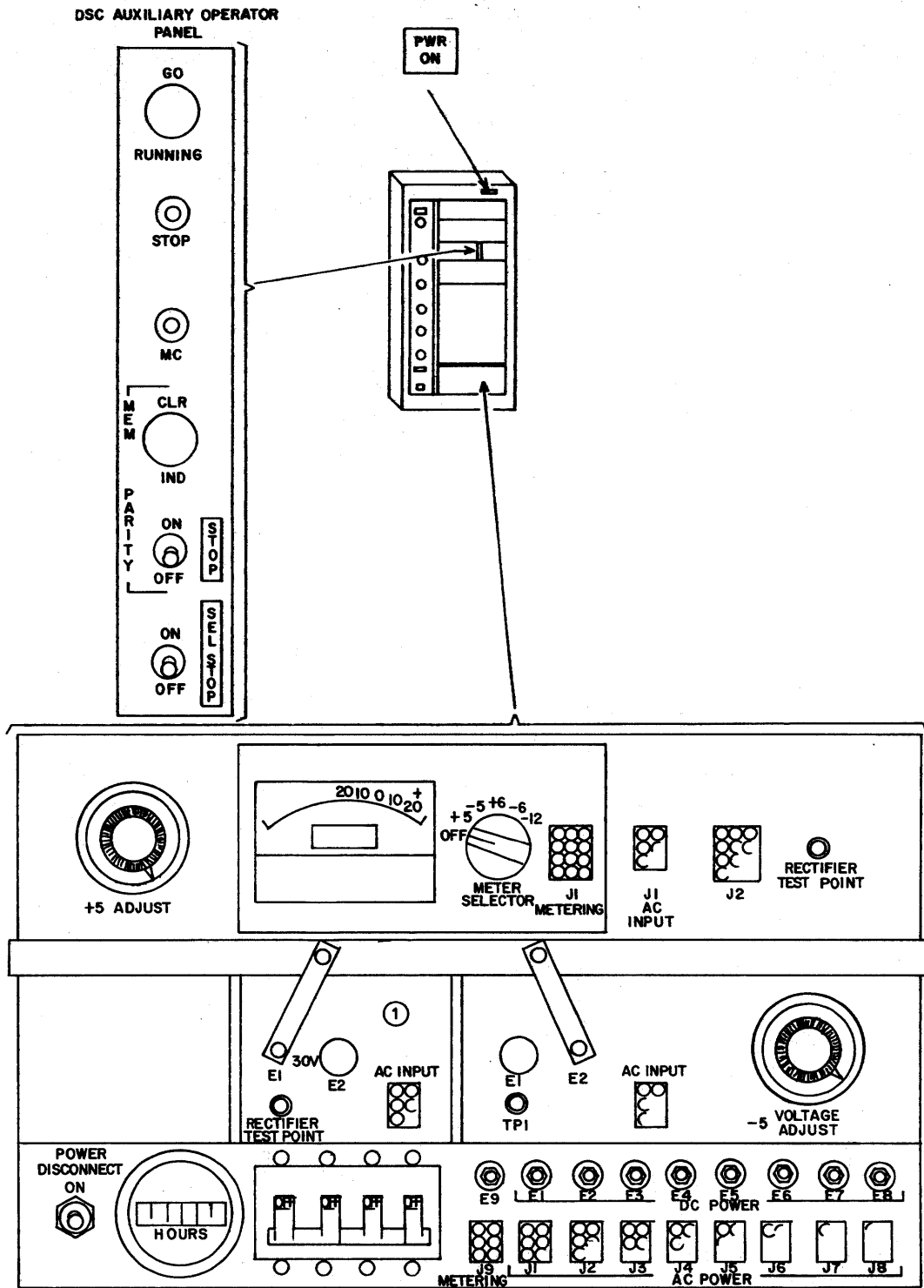| START | READY | FAULT | MAINTENANCE | TEMP | |

UNLABELED INDICATOR

Figure 2-4.   844-21/41 DSU Controls and Indicators

DSU CONTROL PANEL

This panel is located on the center front of each DSU and allows the operator to monitor and control DSU operation. The controls and indicators function as follows:

START — This switch applies power to the DSU and causes the disk pack to rotate, providing all interlocks are properly set.

READY — This indicator lights when the disk pack has reached normal speed, and the heads are loaded.

FAULT — This indicator lights to indicate a fault condition. Pressing the switch causes the indicator to go out.

MAINTENANCE — This indicator lights when a DSC is not controlling the power application for this DSU.

TEMPERATURE (TEMP) — This indicator lights when an over-temperature condition exists in the DSU.

Unlabeled indicator — This indicator lights when the DSU is selected by a DSC. (It is the customer's option to have a number stamped on the lens of this indicator.)

OPERATING INSTRUCTIONS

The following instructions assume that the DSC controlware is loaded and that the subsystem is operational.

DISK PACK EXCHANGING

1. Ensure that the START indicator is not lighted and that the disk pack is not spinning. If the START indicator is lighted, press it to turn off the light and stop the DSU.

2. When the disk pack has stopped, press the main cover latch (refer to figure 2-3) and lift the main cover. The dust cover opens with the main cover.

3. Place a disk pack cover over the loaded disk pack so that it engages the spindle. Turn counterclockwise until the spindle clicks, and lift the cover and disk pack from the DSU.

4. Using its cover as a handle, place the new disk pack slowly over the DSU spindle until it engages the spindle drive unit. Turn the disk pack cover clockwise until it reaches a stop, and lift the disk pack cover from the DSU.

5. Close the main cover, ensuring that it latches. If the cover is not securely latched, the dust cover interlock remains open and prevents power application.

6. Press the START switch. When the disk pack is at operating speed (heads loaded), the READY indicator lights; the DSU is now ready for operation.

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