60459190

CONTROL DATA

CDC® 895 DISK STORAGE SUBSYSTEM

7165-21 MASS STORAGE CONTROLLER
7165-22 MASS STORAGE CONTROLLER
10555-1 UPGRADE OPTION

GENERAL DESCRIPTION
OPERATION
PROGRAMMING
TROUBLESHOOTING

USER'S GUIDE

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LIST OF EFFECTIVE PAGES

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B-1	C
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PREFACE

This manual provides an overview of the CONTROL DATA® 895 Disk Storage Subsystem consisting of a CDC® 895 Disk Storage Unit and a CDC 7165 Mass Storage Controller. The purpose of the manual is to provide operating and programming information for the CYBER channel couplers that are included as part of the 7165 Mass Storage Controller. Also included are general troubleshooting information and a description of the maintenance features and error recovery procedures applicable to the CYBER channel coupler. This information is organized under the following major sections.

- General Description
- Operation
- Programming
- Troubleshooting

The following CDC publications provide additional reference and maintenance information on the various disk storage subsystem devices. All are available from Control Data sales offices or may be ordered from:

Control Data Corporation
Literature and Distribution Services
308 North Dale Street
St. Paul, MN 55103

Title	Publication Number
FA163 Storage Control Unit Hardware Reference Manual	83324380
FA163 Storage Control Unit Hardware Maintenance Manual	83324390
FA163 Storage Control Unit Operator's Sheet	83337310
FV716 Head-of-String Controller Hardware Reference Manual	83337500
FV716 Head-of-String Controller Hardware Maintenance Manual	83337510
FV716 Head-of-String Controller Operator's Sheet	83337560
BZ640 Disk Storage Unit Hardware Reference Manual	83337440
BZ640 Disk Storage Unit Hardware Maintenance Manual	83337450
33800/895 Disk Storage Subsystem Hardware Diagnostic Reference Manual	83337530
33800/895 Disk Storage Subsystem Troubleshooting Guide	83337540

Title	Publication Number
33800/895 Disk Storage Subsystem Installation Manual	83321400
33800/895 Storage Control Hardware Diagnostic Reference Manual	83324410
33800/895 Storage Control Troubleshooting Guide	83324420
FR205-A/B, FV720-A/B CYBER Channel Coupler Hardware Reference Manual	60459170
FR205-B, FV720-B CYBER Channel Coupler Hardware Maintenance Manual	60000021
FR205-A, FV720-A CYBER Channel Coupler Hardware Maintenance Manual	60459180
NOS Version 2 Analysis Handbook	60459300
NOS Version 2 Operations Handbook	60459310
NOS Version 2 Installation Handbook	60459320
NOS Version 2 Reference Set, Volume 3	60459680
NOS Version 2 Reference Set, Volume 4	60459690

DISCLAIMER

This product is intended for use only as described in this document. Control Data cannot be responsible for the proper functioning of undescribed features and parameters.

WARNING

This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of the FCC rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

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APPENDIXES

FIGURES

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GENERAL DESCRIPTION

INTRODUCTION

This section provides a general description of the 895 Disk Storage Subsystem consisting of an 895 Disk Storage Unit and a 7165 Mass Storage Controller. Also included are:

- Information on the physical, electrical, and environmental specifications of the devices comprising these units.
- Typical subsystem configurations.
- A functional description of the CYBER channel coupler.

SUBSYSTEM DESCRIPTION

The major elements of the subsystem are the 895 Disk Storage Unit and the 7165 Mass Storage Controller, which includes two CYBER channel couplers. These are briefly described in the following paragraphs. For additional information on the devices comprising these products, refer to the CDC publications listed in the preface of this manual.

895 DISK STORAGE UNIT

The 895 Disk Storage Unit is a high-speed, large-capacity, disk storage device that connects to a 7165 Mass Storage Controller. These elements control the storage and retrieval of large amounts of data from CYBER 170/180 Model 835, 845, 855, or 990 Computer Systems. Each 895 Disk Storage Unit provides a formatted capacity of 2.4 gigabytes and approximately 9.6 gigabytes of on-line storage per CYBER I/O channel. Two models of the disk storage unit are available, model 895-1 and model 895-2.

- The 895-1 Disk Storage Unit contains four independent disk spindles with fixed (nonremovable) head/disk assemblies in one cabinet. Each disk spindle has a formatted capacity of 611 megabytes. The 895-1 also includes a head-of-string controller† (HSC) that has two separate data paths and dual-access control for up to 16 disk spindles. Dual access allows two CYBER channel couplers to simultaneously transfer data from any two of the disk spindles in the subsystem. Capabilities are provided for multiple overlapped seek operations to be performed concurrently with read or write data operations. Each 895-1 provides control and power circuits for attachment of up to three 895-2 Disk Storage Units.
- The 895-2 Disk Storage Unit contains four additional spindles, each of which has a formatted capacity of 611 megabytes. Up to three 895-2 Disk Storage Units can be connected to an 895-1 to provide additional subsystem storage capacity in increments of 2.4 gigabytes. The dual-access feature is also included as part of the 895-2.

†The term head-of-string controller refers to the controller at the beginning (or head) of a string of disk storage units.

Each disk storage unit appears to the 7165 Mass Storage Controller as four separate, independent disk devices, each with its own device interface. Each of the disk devices has its own dc power supply, control logic, head drive assembly, and drive motor. A failure in one disk device has no effect on the other devices.

7165 MASS STORAGE CONTROLLER

The basic 7165 Mass Storage Controller contains two independent CYBER channel couplers (CCCs) and two storage control units (SCUs). The couplers each provide a path for the transfer of data between peripheral processor channels of a CYBER 170/180 computer and 895 Disk Storage Units via the SCUs. Each CYBER channel coupler can access and control up to 64 disk spindles in a subsystem. A dual-access feature allows the two CYBER channel couplers to simultaneously transfer data from any two disk spindles in the subsystem, thereby enhancing data throughput capabilities. The mass storage controller is composed of two models, the 7165-21 and 7165-22.

- The model 7165-21 consists of two CYBER channel couplers and two storage control units. Each coupler has a single data path to a CYBER 170/180 peripheral processor channel. The storage control units have independent data paths, each with a 7165 device interface to an 895-1 Disk Storage Unit.

- The model 7165-22 consists of two CYBER channel couplers and two storage control units. Each coupler has a single data path to a CYBER 170/180 peripheral processor channel. The storage control units have independent data paths, each with a 7165 device interface to an 895-1 Disk Storage Unit. Each storage control unit has a second access that allows for redundant interconnections between multiple 7165-22 controllers (refer to figure 1-2).

Storage Control Unit (SCU)

The mass storage controller contains two separate but functionally identical storage directors in a single cabinet. Each SD operates independently to direct high-speed data transfers between the CYBER channel coupler and attached disk storage devices. All activities of each SD are controlled by microcode instructions that are loaded from a flexible disk and stored in random access memory (RAM) of the SD.

CYBER Channel Coupler (CCC)

The CYBER channel coupler is the hardware connection between a CYBER 170/180 peripheral input/output (I/O) channel and an 895 Disk Storage Unit. Microcode within the CYBER channel coupler converts CYBER peripheral processor (PP) functions into the commands necessary to control the attached disk storage units. The microcode also converts device status conditions from the attached disk storage units into general and detailed status words that can be read by the PP to determine the overall status of these devices. Semiautomatic error recovery procedures are also provided by the microcode to facilitate error recovery operations.

10555-1 UPGRADE OPTION

The 10555-1 Upgrade Option is a field installable option that adds a second channel to each storage control unit included within the 7165-21 Mass Storage Controller. This allows for redundant interconnection between multiple identically configured 7165 Mass Storage Controllers. This essentially turns a 7165-21 into a 7165-22.

Check with the operating system software to be used with the 7165-895 Disk Storage Subsystem to determine how many channels are supported and how many drives per channel/system are supported.

STORAGE CONTROLLER ADDRESSING

Up to two strings of 895-1's can attach to each storage control unit in a 7165. The 895-1 can attach to two storage control units. The storage control units can be in the same 7165 storage controller or in different 7165 storage controllers. NOS and NOS/VE require that the two storage directors in the same 7165-2X product be connected to all of the same units.

The string controller address (bit 4) is subject to the following limitations:

- If there is only one string (895-1) attached to a storage control unit (7165), bit 4 may be either 0 or 1.
- If there are two strings (895-1's) attached to a storage control unit, the string controller bit must be 0 for one string and 1 for the other string.
- If there is one string (895-1) with two head of string controllers, both controllers must have the same address. (Both head of string controllers cannot be attached to the same storage control unit).
- If there are two strings (895-1's), each with two head of string controllers, the controller bit addresses in one string must be 0's and the controller bit addresses in the other string must be 1's.
- The address associated with the head of string controllers within the same 895-1 cabinet must be identical.

Up to two storage control units may be connected to a CCC, address 0 and/or address 1 (bit 5).

Up to two head of string controllers may be connected to a storage control unit, address 0 and/or address 1 (bit 4).

Up to 16 disk storage units may be connected in a string (bits 3, 2, 1, 0).

The addressing bits to the device level are as follows:

5	4	3 2 1 0
Storage control unit address	String controller address	Disk storage unit device address

Storage Control Unit to Head of String Controller Cable Lengths

Certain restrictions apply to the length of cable that may be used between the Storage Control Unit and the Head of String Controller.

Cable lengths that may be used are 3 to 12 m (10 to 40 ft) and 33 to 61 m (110 to 200 ft).

Cable lengths that are not allowed for a Storage Control Unit to a single Head of String Controller are 15 to 30 m (50 to 100 ft).

In a daisy-chain configuration, the cable lengths allowed from the storage control unit to the first head of string controller are 3 to 12 m (10 to 40 ft) and 33 to 61 m (110 to 200 ft). The cable length from the first head of string controller to the second head of string controller is the sum of the first head of string controller plus the cable length to the second head of string controller plus 3 m (10 ft) (for internal cabling) but cannot equal 15, 18, 21, 24, 27, or 30 m (50, 60, 70, 80, 90, or 100 ft). Refer to SCU to HSC Cable Lengths table 1-1.

Table 1-1. SCU to HSC Cable Lengths

SCU TO SINGLE HSC OR SCU TO HSCA		Then the allowable daisy-chained cables from HSCA to HSCB can be:											
		20	30	40	50	60	80	100	120	140	160	180	200
20	X						X	X	X	X	X		
30	X						X	X	X	X	X		
40	X					X	X	X	X	X			
50													
60													
80													
100													
120	X	X	X	X	X	X							
140	X	X	X	X	X								
160	X	X	X										
180	X												
200	X												

NOTES:

1. All cable lengths are in feet.

2. X indicates lengths to single HSC or combinations of daisy-chained lengths that are allowed. All others are disallowed.

3. Units now using 9 and 54 m (30 and 180 ft) cables may continue to use them even though this chart disallows those combinations.

SUBSYSTEM CONFIGURATIONS

Two different configurations for the disk subsystem are shown in figures 1-1 and 1-2. These depict a minimum and typical subsystem configuration, respectively. NOS and NOS/VE software capabilities presently support a maximum of two active CYBER channel accesses per spindle on the same mainframe. These accesses are defined at the time of installation.

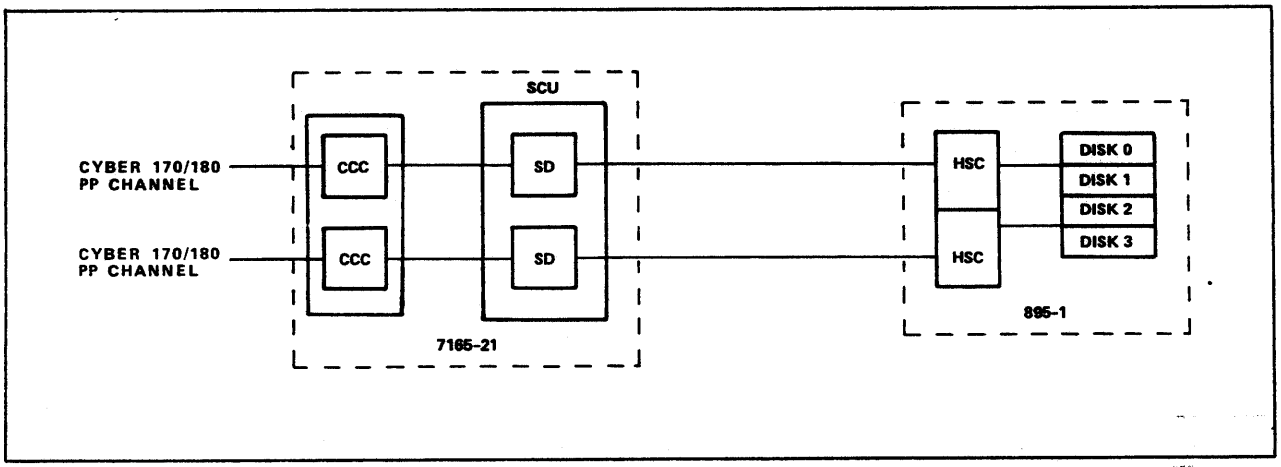


Figure 1-1. Minimum Subsystem Configuration

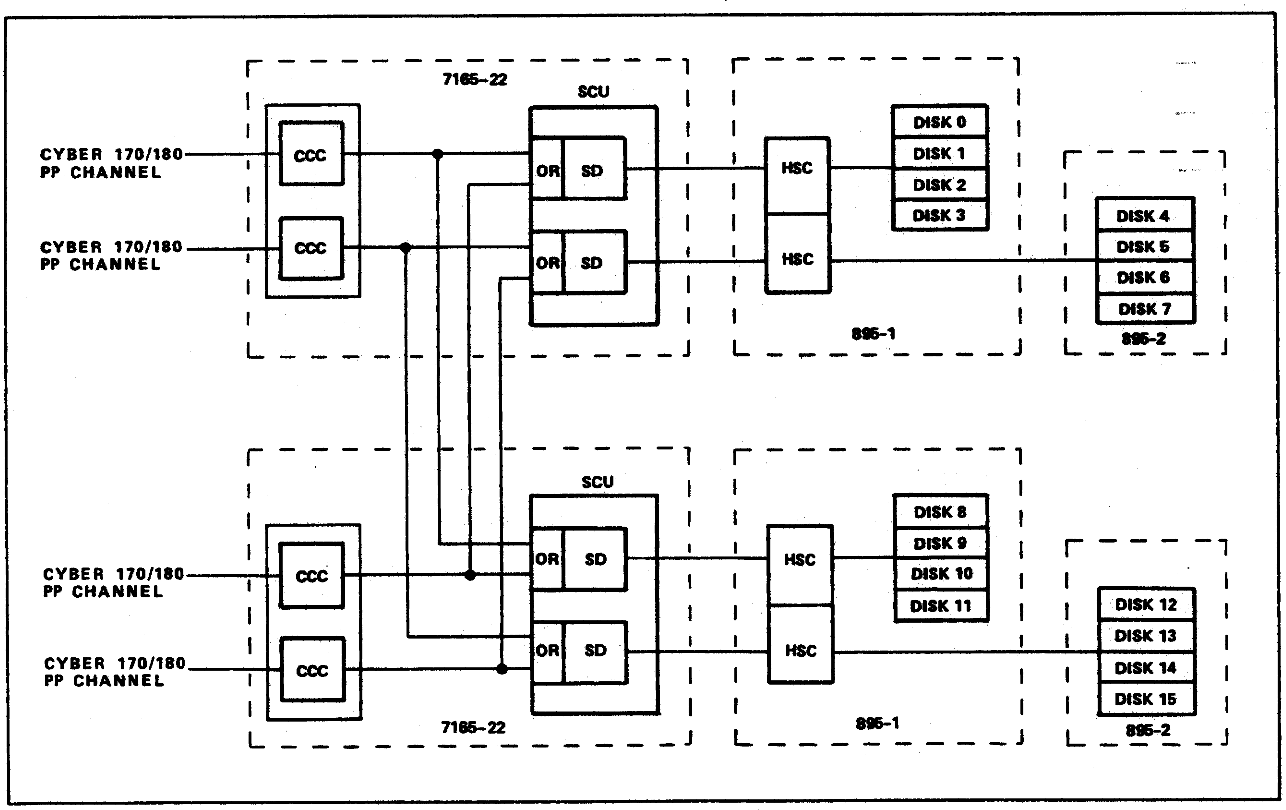


Figure 1-2. Typical Subsystem Configuration

SUBSYSTEM SPECIFICATIONS

The following paragraphs describe the physical, electrical, and environmental specifications for the 7165 Mass Storage Controller and the 895 Disk Storage Unit.

7165 MASS STORAGE CONTROLLER

Power Requirements

Storage controller: 200 to 240 V ac, 60 Hz, 3-phase, at 3 kW

or

200 to 415 V ac, 50 Hz, 3-phase, at 3 kW

CYBER channel coupler: 120 V ac, 50/60 Hz, single-phase, at 1.1 kVA

and

120/208 V ac, 400 Hz, 3-phase, at 0.4 kVA

Environmental Conditions

Temperature

Operating: 15°C to 32°C (59°F to 90°F)

Nonoperating: -40°C to 60°C (-40°F to 140°F)

Relative Humidity

Operating: 35% to 60%

Nonoperating: 5% to 95%

Physical Characteristics

	Storage Controller	CYBER Channel Coupler
Height:	1791 mm (70.5 in)	1676 mm (66 in)
Width:	813 mm (32 in)	737 mm (29 in)
Depth:	1130 mm (44.5 in)	635 mm (25 in)
Weight:	386 kg (850 lb)	159 kg (350 lb)

895 DISK STORAGE UNIT

Storage Characteristics

Recorded data capacity per spindle: 611.7 megabytes

Data tracks per spindle: 13 275

Data cylinders per spindle: 855

Tracks per cylinder: 15

Burst data rate: 24.0 megabits/s (nominal)

Average positioning time: 16.0 ms

Rotational speed: 3600 r/m

Average latency time: 8.3 ms

Power Requirements

895-1 Head-of-String Controller: 180 to 253 V ac, 60 Hz, at 1.0 kW
or
170 to 242 V ac, 50 Hz, at 1.0 kW,
or
325 to 449 V ac, 50 Hz, at 1.0 kW

895-1/895-2 Disk Storage Unit: 200 to 230 V ac, 60 Hz, at 2.0 kW
or
200 to 415 V ac, 50 Hz, at 2.0 kW

Environmental Conditions

Temperature

Operating: 15°C to 32°C (59°F to 90°F)

Nonoperating: -40°C to 60°C (-40°F to 140°F)

Relative Humidity

Operating: 35% to 60%

Nonoperating: 5% to 95%

Physical Characteristics

	895-1 Head-of-String Controller	895-1/895-2 Disk Storage Unit
Height:	1562 mm (61.5 in)	1562 mm (61.5 in)
Width:	610 mm (24 in)	762 mm (30 in)
Depth:	813 mm (32 in)	813 mm (32 in)
Weight:	181 kg (400 lb)	454 kg (1000 lb)

NOTE

The 895-1 head-of-string controller cabinet bolts to the 895-1 Disk Storage Unit cabinet.

CYBER CHANNEL COUPLER FUNCTIONAL DESCRIPTION

The CYBER channel coupler is driven by a CYBER 170/180 peripheral processor, to which it is attached. All communication between the PP and the coupler is initiated by 12-bit I/O function codes from the PP. The coupler replies only to those functions described in section 3 of this manual. The coupler microcode, which is autoloaded into RAM, converts the PP functions into commands for controlling the attached subsystem control units and disk storage devices.

Figure 1-3 shows the major components of the coupler. These include an internal data bus, processor, RAM, programmable read-only memory (PROM), CYBER channel interface, 7165 device interface, 7165 device power control circuit, and transfer logic.

DATA BUS

The internal data bus interconnects the processor, CYBER channel interface, 7165 device interface, and both the RAM and PROM of the coupler. Use of the data bus is divided equally between the processor, CYBER channel interface, and the 7165 device interface.

PROCESSOR

The processor is an internally programmed, 16-bit device that decodes function commands from the PP and issues instructions that allow the functions to be performed. The processor consists of two major sections: a control section and an arithmetic section. The control section processes the function commands and sequences the various instructions. The arithmetic section performs all related arithmetic operations.

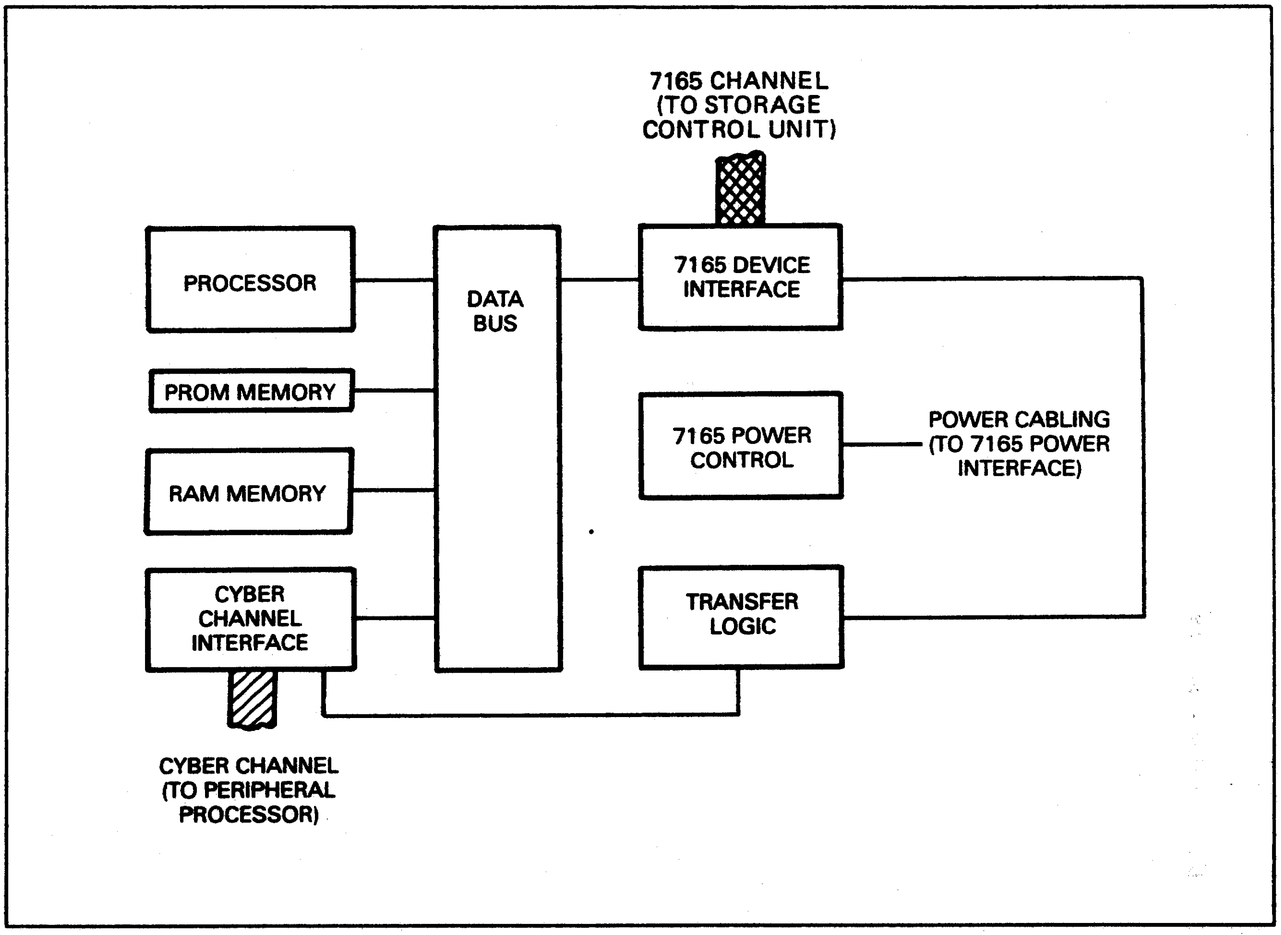


Figure 1-3. CYBER Channel Coupler Block Diagram

RANDOM ACCESS MEMORY

The RAM contains 16 384 words of memory with a maximum read access time of 85 ns. Each word is 16 bits. The addresses available for use are 0000 through 3FFF (hexadecimal). The microcode program is loaded into the RAM from the PP for subsequent use by the processor.

PROGRAMMABLE READ ONLY MEMORY

The PROM contains 4096 words; each word is 16 bits. The addresses available for use are 8000 through 8FFF (hexadecimal). Firmware, consisting of autoload functions and internal coupler diagnostic programs, is permanently coded in the PROM.

CYBER CHANNEL INTERFACE

The CYBER channel interface links the PP to the processor and memory of the coupler. This interface is connected to the coupler via two 19-pin coaxial cables. All functions received from the PP (except the 05xx and 07xx diagnostic functions or functions that contain a channel parity error) are routed to the processor. The processor decodes the function and directs the CYBER channel interface when to respond to the function. No response is sent to the PP if a parity error is detected.

7165 DEVICE INTERFACE

The 7165 device interface contains the receivers, transmitters, and control logic to drive the attached peripheral device. It also provides code translation and block ID generation for tape control units.

7165 DEVICE POWER CONTROL CIRCUIT

Two 7165 device power control switches are provided on the power control panel to power two separate equipment chains. Each switch controls the power sequence to its respective peripheral device in accordance with applicable federal power control standards.

TRANSFER LOGIC

The transfer logic provides the necessary hardware to transfer data from the CYBER channel interface through memory to the 7165 device interface. This is accomplished with buffer registers. During the transfer, data is written into a 512-byte buffer by one interface and read from that buffer by the other interface.

OPERATION

INTRODUCTION

This section provides information on the operating controls, indicators, and operating procedures of the CYBER channel coupler. For similar information on the other devices composing the subsystem, refer to the applicable Control Data publications listed in the preface of this manual.

OPERATING CONTROLS AND INDICATORS

The only operating controls and indicators on the CYBER channel coupler are those that pertain to applying/removing power to the unit. These are shown in figure 2-1 and described in the following paragraphs. There are, however, additional controls and indicators that are used for maintenance purposes only. Because they are not for operator use, they are not described in this manual.

POWER-ON INDICATOR

This indicator lights when the dc power supplies in the coupler are operating.

50/60-Hz POWER DISCONNECT SWITCH

This switch is located on the power distribution panel. In the ON position, it applies 50/60-Hz input power to the coupler blower motor; in the OFF position, it removes power from the blower motor.

400-Hz POWER DISCONNECT SWITCH/CIRCUIT BREAKER

This switch/circuit breaker is located on the power distribution panel. In the ON position, it applies 400-Hz input power to the coupler power supplies; in the OFF position, it removes this power. The integral circuit breaker provides overload protection to the power supplies.

POWER-ON UNIT A AND UNIT B SWITCHES

These switches are located on the power control panel. They apply power to two separate equipment chains in the disk storage subsystem.

OPERATING PROCEDURES

The following paragraphs provide general guidelines for typical operator tasks, including microcode and disk pack initialization.

POWER APPLICATION

Power application to the coupler is controlled by the 50/60-Hz and 400-Hz POWER DISCONNECT switches located on the power distribution panel at the front of the coupler. Power application to the attached subsystem devices is controlled by the POWER ON UNIT A and UNIT B switches located on the power control panel of the coupler. During subsystem installation, the customer engineer performs the cable routing and switch settings required for power sequencing. Thereafter, the operator normally controls application of power to the subsystem from the power control panel of the coupler.

MICROCODE AUTOLOADING

The operator must autoload the microcode used to control the disk subsystem functions into the coupler RAM before the complete function set described in section 3 can be executed. The following functions reside permanently in the coupler processor read-only memory (ROM) to enable autoloading of the microcode.

- 0414 - autoload coupler microcode from PP.
- 06uu - autoload coupler microcode from disk.

These autoload functions are described in detail in section 3 of this manual. The exact autoload procedure depends upon site operating procedures, operating system, computer system configuration, and whether or not the computer system is running. Refer to the appropriate operating system installation handbook for procedures recommended by Control Data.

MICROCODE INITIALIZATION/DISK PACK INITIALIZATION

Refer to Microcode Initialization and Disk Pack Initialization in section 3 of this manual.

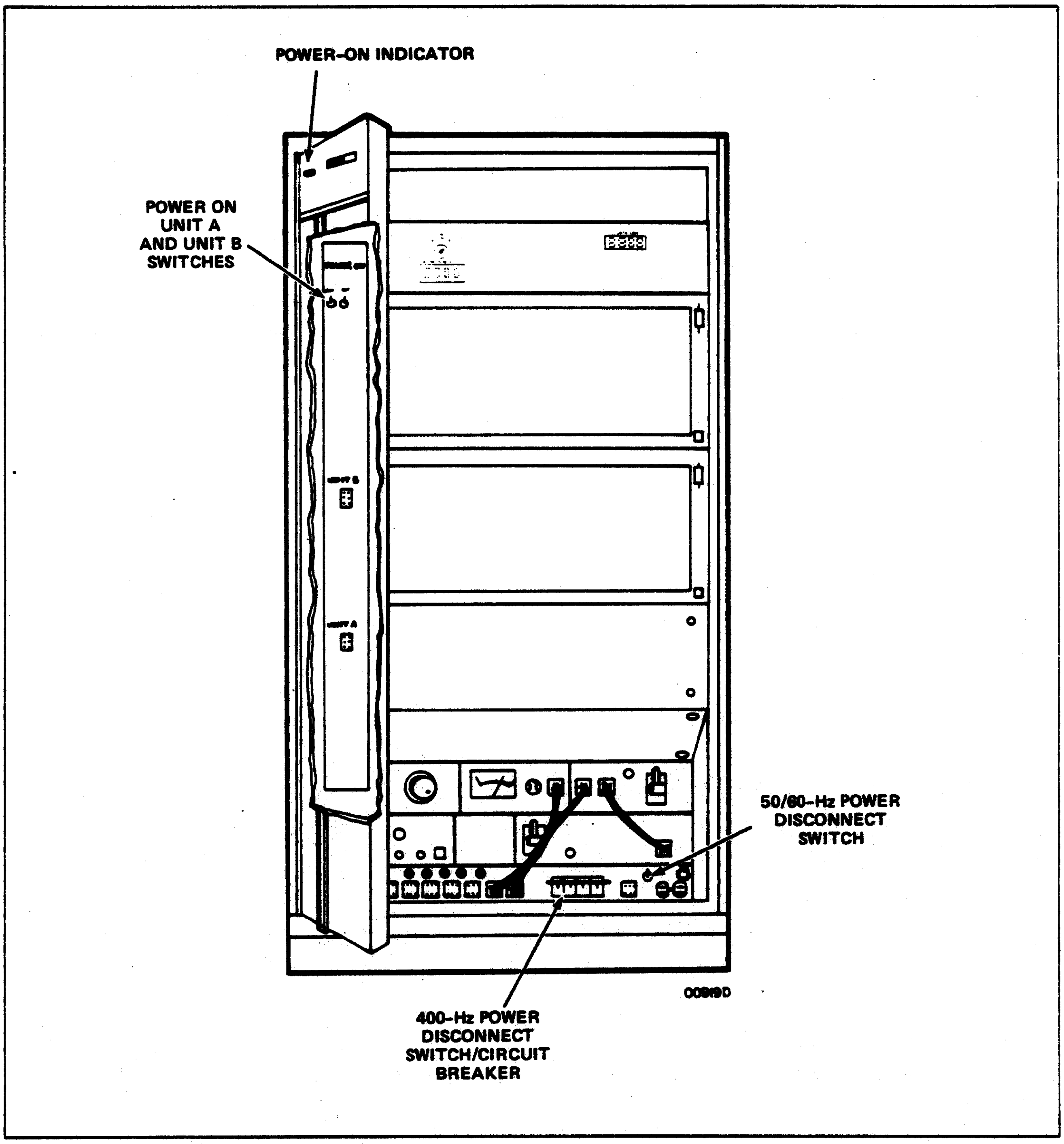


Figure 2-1. Coupler Control and Indicator Locations

PROGRAMMING 3

This section provides information on the disk microcode used with the CYBER channel coupler. The microcode converts CYBER functions into commands necessary to control the attached disk devices. The information in this section is presented under the following major headings:

- Introduction
- Microcode Initialization
- Function Code Descriptions
- Disk Pack Initialization
- Microcode Identification

All numeric values in this section are decimal unless otherwise specified.

The conventions used for the bit values of the 12-bit words from the CYBER PP channel are as follows:

- Most significant bit: bit 11
- Least significant bit: bit 0

All other data words described in this section use the following conventions for bit values.

- Most significant bit: bit 0
- Least significant bit: bit n (n = length of data word)

INTRODUCTION

The CYBER channel coupler is driven by a CYBER 170/180 peripheral processor (PP). Communication between the PP and the coupler is initiated by function codes from the PP. All function codes are 12 bits. Since the coupler is the only equipment on a channel, all 12 bits are used for function bits. The functions have a PP timeout of approximately 1 second (s), which avoids hanging the channel in a full condition due to a hardware logic failure. The coupler replies to all function codes described in this section. Table 3-1 lists the function codes in numerical order.

Certain functions require supporting parameters or data consisting of one or more 12-bit PP words. The PP must activate the channel prior to its input/output of parameters or data; it must disconnect the channel after all outputs of parameters or data. The coupler inactivates the channel after all PP inputs. The microcode terminates all disk data transfer errors to or from the PP in which all words were not transferred. Any other error condition in which the channel remains connected and active for 7 to 10 s is inactivated by the hardware.

Table 3-1. Disk Subsystem Functions (Sheet 1 of 2)

Function Code (Octal)	Function Name	General Status Required
0000	Connect†	Yes
0001	Seek, 1:1 interlace†	Yes
0002	Seek, 1:1 interlace†	Yes
0004	Read	Yes
0005	Write	Yes††
0010	Operation complete	Yes
0011	Disable drive reserve	No
0012	General status	No
0014	Continue	Yes
0016	Format pack†	Yes
0020	Drive release	Yes
0023	Extended detailed status	No
0024	Request extended error log	Yes
0025	Input extended error log	Yes
0027	Read cylinder minus 3	Yes
0030	Read factory data	Yes
0031	Read utility map	Yes
0032	UDI read	No
0033	UDI write†	Yes
0034	Read protected record	Yes
0035	Write last record	Yes
0037	Write protected record	Yes
0043	DMA read	Yes
0044	DMA write	Yes
0047	Scan cylinder	Yes
0060	Path Confidence	Yes
0061	Selective/System reset	No
0070	Run SCU Interface Diagnostics	Yes
0071	Select 895 In-Line Routine and Options	Yes
0072	Verify 895 In-Line Loaded	No
0073	Sense 895 In-Lines	Yes
0074	Change 895 In-Line Parameters	Yes
0075	Start 895 In-Lines	No
0076	Monitor 895 In-Lines	No
0077	Halt 895 In-Lines	No

† When the PP channel deadman timer expires during this function, the coupler prepares a general status of 5000 and sets deadman timout bit (word 18, bit 4) in detailed status.

†† The coupler returns general status before transferring data from coupler memory to disk. If an error occurs during coupler memory-to-disk transfer, the coupler responds only to a 0012 (general status) function. This ensures that coupler memory-to-disk errors do not go undetected.

Table 3-1. Disk Subsystem Functions (Sheet 2 of 2)

Function Code (Octal)	Function Name	General Status Required
0414	Autoload coupler microcode from PP	Yes
06uu	Autoload coupler microcode from disk	No
0770	CCC ID Request	No
33uu	Disk Deadstart from Device	No

MICROCODE INITIALIZATION

A power-on operation, pushbutton master clear, deadstart master clear, or autoload microcode function (either 0414 or 06uu) initializes the coupler and causes the in-line diagnostics to be executed (these diagnostics are described in 0414 - Autoload Coupler Microcode from PP in this section). If the diagnostics execute without error, and an autoload coupler microcode from PP function is not present, a release is issued to all devices addressable by the coupler. The ROM firmware then initiates a jump to an idle loop that looks for functions from the PP.

The coupler microcode must be loaded into RAM before most functions can be executed. ROM firmware, however, can execute the autoload coupler microcode from PP (0414) and autoload coupler microcode from disk (06uu) functions prior to loading microcode. Either of these autoload functions (0414 or 06uu) can be used to load the microcode into RAM.

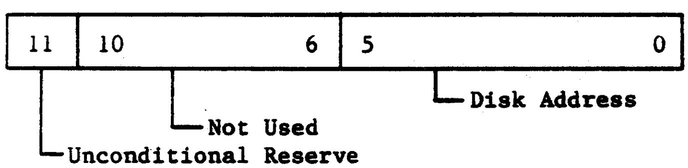
FUNCTION CODE DESCRIPTIONS

The following paragraphs describe each of the function codes listed in table 3-1.

0000 - CONNECT

The connect function and its associated one-word output parameter permit a PP to reserve a disk device without initiating head movement. The device remains reserved until the PP issues either an operation complete (0010) or drive release (0020) function. For a connect function in which bit 11 of the parameter word is set, an unconditional reserve command is issued to the device.

Format of one-word parameter:



NOTE

For configurations that include string switches or dynamic path selection, execution of an unconditional reserve of storage control unit A and device n can abort an unrelated operation on storage control unit B, device n.

0001 OR 0002 - SEEK, 1:1 INTERLACE

The seek function initializes the coupler for a 1:1 interlace for subsequent data transmission on the specified device (consecutive physical sectors are processed during data transmission). When necessary, the seek function also initiates head motion.

A PP can determine if the specified device is on-cylinder by checking general status from the coupler. When the general status word is 0000, the specified unit is on-cylinder, and the seek operation has completed normally. When the selected unit's heads are in motion, general status is 0002.

Since the general status word changes only after the microcode processes a function, a PP waiting for a specific seek operation to complete should use the following sequences.

1. Issue seek function and address.

2. Issue general status function and input status word.

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

4. Continue if status word is 0000.

The subsystem supports seek overlap by allowing the PP to initiate head motion on several devices prior to initiating data transmission on one selected device. Thus, head positioning on other devices can occur concurrently with data transmission to or from the selected device.

The PP must issue a seek function to initially position the heads of the specified device to the required cylinder and to establish the starting track and record numbers for the ensuing data transfer. The PP must issue such functions as read and write for each record that is to be transmitted to or from the PP. The coupler microcode automatically advances the track and record numbers, as required, after each successful transmission of a record of data. The PP must issue another seek function only when:

- A cylinder boundary is detected.

- A nonconsecutive record is to be transmitted.

- I/O functions are to be switched (for example, a read after a write or a write after a read).

Thus, it is possible to issue one seek to a device and transmit one complete cylinder of data without issuing intervening seek functions.

Format of four-word parameter:

	11 — 0
Word 1	Device Number
Word 2	Cylinder Number
Word 3	Record Size/Head Number
Word 4	Record Number

Word	Description
1	Refer to parameter format for 0000 - Connect (in this section).
2	Starting cylinder number.
3	Bits 11, 10, and 9 specify record size; bits 8 through 0 specify the starting track number.

Values of Bits 11	10	9	Bytes/Record	PP Words/Record	Records/Track
0	0	0	483	322	48
0	0	1	15 390	10 260	3
0	1	0	NOS special deadstart record; 483-byte records from a 15 390-byte record.		
0	1	1	2064	1376	18
1	0	0	4128	2752	10

Refer to appendix D for a description of the NOS special deadstart format.

If any other value is set in bits 11, 10, and 9, it is ignored and the record size remains as previously set.

4 Starting record number.

Valid seek address:

Cylinders: 0 through 885
Tracks: 0 through 14

Maximum record size: 15K bytes

Up to two strings of 895 disk devices can attach to each storage control unit in a 7165. The 895 can attach to two storage control units. The storage control units can be either in the same or in a different 7165 Mass Storage Controller.

The head-of-string controller address (bit 4) is subject to the following limitations.

- If there is only one string attached to a storage control unit, bit 4 may be either a 0 or a 1.
- If there are two strings attached to a storage control unit, bit 4 must be 0 for one string and 1 for the other string.
- If there is one string with two head-of-string controllers in the A unit, both controllers must have the same address. (Both head-of-string controllers cannot be attached to the same storage control unit.)
- If there are two strings, each with two head-of-string controllers in the A unit, the controller bit addresses in one string must be 0's and the controller bit addresses in the other string must be 1's.

If a string with less than 16 storage devices is attached to the storage control unit, the full range of 16 addresses must still be reserved for that string.

Device address:

5	4	3 2 1 0
Storage control unit address	String controller address	Access mechanism address

0004 - READ

The read function transfers data from the selected disk record (specified by a prior seek function) through the coupler memory to the PP memory. The coupler can buffer up to 16K of 8-bit bytes of data from the disk and simultaneously transfer it to PP memory at the speed of the channel. The coupler can process only one data transfer at a time, although seek operations initiated on other drives proceed concurrently with a data transfer (seek overlap).

The PP must initiate a single-record coupler block input after issuing a read function to the coupler. A read function is effective for one record of data. The coupler advances the track and/or record numbers, as required, after each successful transmission of a record of data. The data transfer procedure for one record of data is described in section 4 (refer to Disk Error Recovery Procedures). Appendix D describes how to read a NOS special deadstart record.

0005 - WRITE

The write function transfers data from PP memory through the coupler memory to the selected disk record. The coupler can buffer up to 8K words of data from the PP at the speed of the channel and simultaneously transfer it to the disk. The coupler can process only one data transfer at a time, although seek operations initiated on other drives proceed concurrently with a data transfer (seek overlap).

The PP must initiate a single-record block output after issuing the write function. A write function is effective for one record of data. During transmission of the data block, the PP must initiate a single-record block output for each record of data to be written. This procedure must continue until the entire data block has been written. The data transfer procedure for one record of data is described in section 4 (refer to Disk Error Recovery Procedures). The coupler advances the track and/or record numbers, as required, after each successful transmission of a record of data.

0010 - OPERATION COMPLETE

The operation complete function releases the reserve status of the last device referenced by the coupler. This function is identical to the drive release function (0020).

0011 - DISABLE DRIVE RESERVE

The disable drive reserve function is not used and performs no operation.

0012 - GENERAL STATUS

The general status function allows the PP to receive an overall coupler status indication after it has issued one of the subsystem functions. Table 3-1 specifies which coupler function must be followed by a general status function. Normal function completion results in a general status word of 0000.

The 12-bit general status word is structured as follows.

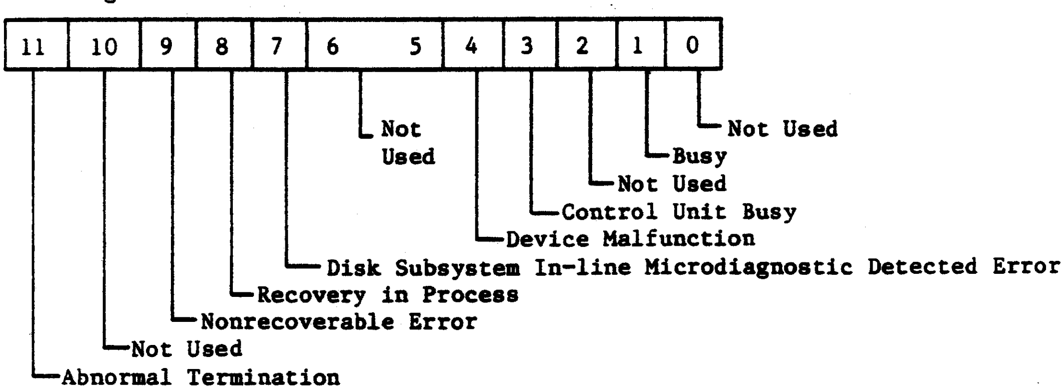


Table 3-2 defines the various general status bits. The status condition exists when the respective bit of the general status word is a 1.

Table 3-2. General Status

Bit	Definition
11	Abnormal termination. Preceding function terminated abnormally. General status bits 9 and 8 indicate whether recovery is possible. Detailed status should be obtained to determine exact cause of abnormal termination. **NOTE** If this bit is set after autoload coupler microcode from PP (0414) and run CCC to SCU interface diagnostics (0070), bits 8 through 0 of general status contain an error code. Detailed status is not updated. Refer to Coupler Internal Diagnostic Error Codes in section 4.
10	Not used.
9	Nonrecoverable error. Coupler detected an error from which no recovery is possible. Detailed status should be obtained to determine exact cause of abnormal termination.
8	Recovery in process. Coupler is ready to attempt error recovery in response to continue (0014) function. Specific status is available from detailed status.
7	Disk subsystem in-line microdiagnostic detected error. A disk subsystem in-line microdiagnostic test has detected an error. Issue function 0073, and input the in-line microdiagnostic sense bytes for detailed description of the detected error.
6	Not used.
5	Not used.
4	Device malfunction. A device or control unit error has occurred. Detailed status reflects actual status at time of malfunction. **NOTE** Drive sense bytes in detailed status words 1 through 16 are not copied during command entry (detailed status word 19 = 2112).
3	Control unit busy.
2	Not used.
1	Busy. Coupler and/or requested device are busy. That is, either the positioner is in motion due to a preceding seek, the drive is reserved by another coupler, or the coupler is processing a format pack or scan cylinder function.
0	Not used.

0014 - CONTINUE

The continue function enables a semiautomatic error recovery sequence to be performed by the coupler. A continue function issued by the PP is valid only after the coupler has returned general status indicating recovery in progress. For read or write functions, the continue function code is sent instead of the read or write function. The data transfer normally done after the read or write function is also done. Refer to Disk Error Recovery Procedures in section 4 for additional information.

0016 - FORMAT PACK

The format pack function writes address and data fields on a pack. It optionally writes the home address and track descriptor record. The PP formats the entire pack before issuing read or write functions to the device. The coupler returns a general status of 0002 during the format operation and a general status of 0000 after the operation completes.

Formatting a home address, track descriptor record, or record destroys any data previously written in records of the track.

After the format pack function is received by the coupler, the coupler performs an eighteen-word block input from the PP to receive the required parameters.

Format pack parameter blocks:

<table>
<tr><th>Word</th><th>11 10</th><th>9 8</th><th>6</th><th>5 0</th></tr>
<tr><td>1</td><td colspan="4">Cylinder</td></tr>
<tr><td>2</td><td>Mode Decode</td><td colspan="2">Operation Decode</td><td>Device Number</td></tr>
<tr><td>3</td><td colspan="2">Record Size</td><td colspan="2">Track (Not Used)</td></tr>
<tr><td>4</td><td colspan="4">Skip Displacement Bytes</td></tr>
<tr><td>5-17</td><td colspan="4">Skip Displacement Bytes</td></tr>
<tr><td>18</td><td colspan="4">Segment Number †</td></tr>
</table>

The following paragraphs describe the bit definitions for the word 2 mode decode and operation decode fields.

† The segment field value equals the displacement between the start of the home address area of the count field and the index. For the home address, the value is 14 and is increased by 6 for each defect pair that causes the home address to be moved.

Word 2, Mode Decode - Bits 11 and 10

These bits decode as follows:

Bit 11 10	Description
0 0	Format one track. Operation decodes of 0 through 3 (hexadecimal) (bits 9 through 6) are legal.
0 1	Format one cylinder. Operation decodes of 2 and 3 (hexadecimal) are legal.
1 0	Format full pack. Operation decodes of 2 and 3 (hexadecimal) are legal.
1 1	Not used.

NOTE

Protected tracks are skipped and must be formatted one track at a time.

Word 2, Operation Decode - Bits 9 through 6

These bits decode as follows:

Bit (Hexadecimal)	Description
0	Write home address (normal track). This operation writes the home address, the track descriptor record, and the appropriate number of records on each track. If track mode is set, parameter words 1 through 18 are used. If cylinder mode is set, only parameter word 1 is used. For cylinder and full pack mode, the skip displacement (SD) bytes written are 0's.

NOTE

Cylinder and full pack mode should not be used. If there is a defect in the home address and the SD bytes are incorrect, writing the home address may not be possible. If not possible, general status is 5000.

1	Write home address (defective track). This operation writes the home address and the track descriptor record. Parameter words 1 through 18 are used.
2	Write track descriptor record. This operation writes the track descriptor record and the appropriate number of records on each track. When applicable, parameter words 1 through 3 are used. The home address is not written.
3	Write records. Parameter words 1 through 3 when applicable are used. The home address and track descriptor record are not written.

Word 3, Record Size - Bits 11, 10, and 9 - Bits 8 through 0

The record size parameter for words 1 through 3 are used when applicable. The home address and track descriptor record are not written. Bits 0 through 8 are not used.

Values of Bits 11	10	9	Bytes/Record	PP Words/Record	Records/Track
0	0	0	483	322	48
0	0	1	15 390	10 260	3
0	1	0	Not used in format function		
0	1	1	2 064	1 376	18
1	0	0	4 128	2 752	10

0020 - DRIVE RELEASE

The drive release function is used to release the reserve on the last drive accessed by the coupler. This function is identical to the operation complete function (0010).

0023 - EXTENDED DETAILED STATUS

The extended detailed status function transfers a 20-word status block from the coupler to the requesting PP as shown in the detailed status format. It is static status that is stored in coupler memory upon abnormal termination of the function. The 24 bytes of sense information identify the conditions that caused the last unit check status to be generated. The sense information also provides secondary information for system error recovery and for diagnosing and isolating storage control unit and device malfunctions.

Detailed status format:

<table>
<tr><th></th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 1</td><td colspan="8">Sense Byte 0</td><td colspan="4">Sense</td></tr>
<tr><td>Word 2</td><td colspan="4">Byte 1</td><td colspan="8">Sense Byte 2</td></tr>
<tr><td>Word 3</td><td colspan="8">Sense Byte 3</td><td colspan="4">Sense</td></tr>
<tr><td>Word 4</td><td colspan="4">Byte 4</td><td colspan="8">Sense Byte 5</td></tr>
<tr><td>Word 5</td><td colspan="8">Sense Byte 6</td><td colspan="4">Sense</td></tr>
<tr><td>Word 6</td><td colspan="4">Byte 7</td><td colspan="8">Sense Byte 8</td></tr>
<tr><td>Word 7</td><td colspan="8">Sense Byte 9</td><td colspan="4">Sense</td></tr>
<tr><td>Word 8</td><td colspan="4">Byte 10</td><td colspan="8">Sense Byte 11</td></tr>
<tr><td>Word 9</td><td colspan="8">Sense Byte 12</td><td colspan="4">Sense</td></tr>
<tr><td>Word 10</td><td colspan="4">Byte 13</td><td colspan="8">Sense Byte 14</td></tr>
<tr><td>Word 11</td><td colspan="8">Sense Byte 15</td><td colspan="4">Sense</td></tr>
<tr><td>Word 12</td><td colspan="4">Byte 16</td><td colspan="8">Sense Byte 17</td></tr>
<tr><td>Word 13</td><td colspan="8">Sense Byte 18</td><td colspan="4">Sense</td></tr>
<tr><td>Word 14</td><td colspan="4">Byte 19</td><td colspan="8">Sense Byte 20</td></tr>
<tr><td>Word 15</td><td colspan="8">Sense Byte 21</td><td colspan="4">Sense</td></tr>
<tr><td>Word 16</td><td colspan="4">Byte 22</td><td colspan="8">Sense Byte 23</td></tr>
<tr><td>Word 17</td><td colspan="2">µ code</td><td colspan="4">µ code Revision</td><td colspan="6">Record Number</td></tr>
<tr><td>Word 18</td><td colspan="4">Not Used</td><td colspan="8">CYBER Interface Status</td></tr>
<tr><td>Word 19</td><td>µ code Data Error</td><td>895 Status Error</td><td>Sequence Error</td><td>Parity Error</td><td colspan="8">Device Interface Status</td></tr>
<tr><td>Word 20</td><td colspan="2">Capacity</td><td>1</td><td>1</td><td colspan="8">CCC Hardware Unique Identifier</td></tr>
</table>

After abnormal termination of a function, the PP should obtain error logging information by issuing a detailed status function followed by a block input of 20 decimal words. If recovery in progress was set in general status, the PP may then attempt error recovery with a continue function (0014); or, it may issue a new function.

The first 16 detailed status words contain the 24 sense bytes copied directly from the device. The first eight sense bytes contain high-level information on the general state of the device following the immediately preceding operation. The format of these sense bytes is shown in table 3-3 and described in detail following the table. Note that sense byte 7 is used to identify the format that is used to present the detailed sense information contained in the remaining 16 bytes (status words 6 through 16). Descriptions for the remaining status words (17 through 20) follow the descriptions of the sense bytes.

Refer to Appendix E for trace information in detailed status.

Table 3-3. Summary of Sense Bytes 0 through 7

Sense Byte	Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
0	Command Reject	Intervention Required	Channel Bus-out Parity	Equipment Check	Data Check	Overrun	0	0
1	Permanent Device Error	Invalid Track Format	End of Cylinder	Message to Operator	No Record Found	File Protected	0	0
2	0	Correctable	First Logged Error	Environmental Data Present	Intent Violation	Imprecise Ending	0	0
3	Controller ID							
4	Dynamic Path Select Function	0	Path Error	0	Device Address			
5	Cylinder Low Address							
6	0	0	Cylinder Address 512	Cylinder Address 256	Head Address			
7	Sense Byte Format				Message Code			

Sense Byte 0

Bit	Description
0	Command reject. Bit 0 is set by: • An invalid command code. • An invalid command sequence. • An invalid or incomplete argument transferred by a control command. • A track formatted without a home address. • An attempt to issue a format write command (other than write home address or write R0) on a defective track. • A write command that violates the file mask. • A record 0 count field of a defective or alternate track that points to itself. • An attempt to write an invalid home address.
1	Intervention required. Bit 1 is set by addressing a device that is not attached to the system.
2	Channel bus-out parity. Bit 2 is set when a parity error is detected during transfer of a command from the channel to the 7165 Mass Storage Controller.
3	Equipment check. Bit 3 is set when an unusual hardware condition occurs in the channel, storage control unit, or device. The condition is further defined in sense bytes 7 through 23.
4	Data check. Bit 4 is set when the storage control unit detects a data error in the information received from the device. If byte 2, bit 1 (correctable) is also set, the data error is correctable, and bytes 15 through 23 provide correction information. Sense byte 7 defines the specific nature of the condition.

Bit	Description
5	Overrun. Bit 5 is set when the storage control unit does not receive a response to a data request within a specified period of time. Detection of an overrun may cause requests for data from the channel to be terminated. When writing, the remaining portion of the record area is padded with zeros. All data overrun conditions are retried by the storage control unit except: • Those that occur after the first record processed by a read multiple count, key, and data command. • Those that occur during a format write operation (unless the data overrun occurred during a format write within the domain of a locate record command). The storage control unit presents an overrun only if the condition occurs more than 10 times in the same CCW chain, or if the overrun occurs during one of the preceding operations not retried by the storage control unit. Command overruns are also retried by the storage control unit and do not cause an overrun to be presented.
6, 7	Not used. Bits 6 and 7 are set to 0.

Sense Byte 1

Bit	Description
0	Permanent error. Bit 0 is set when: • Error recovery procedures initiated by a storage control unit have been exhausted and were unsuccessful. • A retry was not possible or desirable. This bit overrides any other bit settings and indicates that system error recovery procedures are not required.
1	Invalid track format. Bit 1 is set when: • An attempt is made to write data exceeding track capacity. • An index point is detected in the gap that precedes a key or data field. • A previous operation attempted to write data exceeding the track capacity. This operation resulted in a record written into index. This record was encountered during an attempt to execute a read, search, or write command. As long as this record remains on the track, invalid track format may be presented during an attempt to locate a record successfully written on the track. However, a search ID is able to execute on any count field successfully written on the track without invalid track format being presented.
2	End of cylinder. Bit 2 is set when a multitrack read or search operation continues past the end of the cylinder boundary.
3	Message to operator. Bit 3 is set when there is either: • A permanent failure in the other storage control unit in the same storage control unit. • A state-save operation in the reporting storage control unit. Byte 0, bit 3 (equipment check) is also set. A message is sent to the operator console. This bit is also set when the storage control unit has completed sense data logging of a particular error type. Format 0, message 1 or 2, is indicated in byte 7. Byte 2, bit 3 (environmental data present) is also set.
4	No record found. Bit 4 is set when two index points have been detected in the same CCW chain without: • An intervening read operation in the home address area or data area. • An intervening write, sense, or control command.
5	File protected. Bit 5 is set when either a seek command or a read or search multitrack operation violated the file mask.
6, 7	Not used. Bits 6 and 7 are set to 0.

Sense Byte 2

Bit	Description
0	Not used. Bit 0 is set to 0.
1	Correctable. Bit 1 is set when the data check condition indicated by byte 0, bit 4 (data check) is correctable.
2	First logged error. Bit 2 is set along with byte 2, bit 3 when the error rate of temporary seek or data checks has exceeded a predetermined level, and logging mode has been set for the device.
3	Environmental data present. Bit 3 is set when bytes 8 through 23 contain usage or error statistics or error log information. Byte 7 indicates the format for bytes 8 through 23. When set with byte 1, bit 3, the message to the operator is defined by byte 7 (01 equals sense data logged for the device; 02 equals sense data logged for the controller). Refer to byte 2, bit 2 for additional information about this bit.
4 - 7	Not used. Bits 4 through 7 are set to 0.

Sense Byte 3

Formats 1, 2, 6, 7, and 8, byte 3 contains the controller ID. This byte is not used for formats 0, 3, 4, and 5.

In format 7, byte 3 indicates the controller physical identifier of the selected controller, but not necessarily the controller with the check-1 condition:

- If byte 3, bit 0 and byte 11, bit 0 off, or
- If byte 11, bit 1 is off
- Then the other controller on the DDC interface has the check-1.

Bit	Description
0	Bit 0 contains the logical address of the controller.
7	When ON, bit 7 indicates the A2 controller.

Sense Byte 4

Bit	Description
0	Dynamic path select function. Bit 0 is set when the controller has the dynamic path selection function.
1	Not used. Bit 1 is set to 0.
2	Path error. Bit 2 is set when the logical path from the storage control unit to the device has a permanent error, and the path is now unavailable.
3	Reserved.
4 - 7	Device address. Bits 4 through 7 contain the device address.

Sense Byte 5

Bit	Description
0 - 7	Low cylinder address. Bits 0 through 7 identify the low-order cylinder address of the most recent access position.

Sense Byte 6

Bit	Description
0 - 7	High cylinder and head address. Bits 0 through 7 identify the high-order cylinder and head address of the most recent access position.

Cylinder Address	Head Address
Bit 0 = 0	Bit 4 = 8
Bit 1 = 0	Bit 5 = 4
Bit 2 = 512	Bit 6 = 2
Bit 3 = 256	Bit 7 = 1

Sense Byte 7

Bit	Description
0 - 3	Format. Bits 0 through 3 specify the format of sense bytes 8 through 23 as follows:

Values	Format	Description
0000	0	Program or system check.
0001	1	Device equipment check (customer engineer information).
0010	2	Storage control unit equipment check (customer engineer information).
0011	3	Storage control unit check (customer engineer information).
0100	4	Data check without displacement information.
0101	5	Data check with displacement information (format 5 may also be presented on errors that are not ECC correctable, but which require restart displacement information).
0110	6	Usage statistics/overrun errors.
0111	7	Storage control unit to head-of-string controller or controller checks (customer engineer information).
1000	8	Controller equipment check (customer engineer information).

Bit	Description
4 - 7	Message. Bits 4 through 7 describe the specific nature of the error conditions for each of the preceding formats.

Format 0 - Program or System Check

Format 0 is used when sense bytes 0 through 7 completely describe the error or unusual condition caused by a program or system error. For format 0, bytes 8 through 23 are:

Byte	Description
8 - 21	Bytes 8 through 21 are not used. They are set to 0.
22, 23	Bytes 22 and 23 contain the symptom code.

Table 3-4 describes the error messages that apply to format 0.

Table 3-4. Messages for Format 0 - Program or System Check

Sense Byte 7, Bits 4 - 7	Message Code	Message
Byte 1, Bit 3 = 0		
0000	0	No message. No additional information is required.
0001	1	An invalid command was issued.
0010	2	An invalid command sequence was issued to the 7165.
0011	3	The CCW count was less than required for the command.
0100	4	An invalid data argument was used for the command.
0101	5	A diagnostic command was issued when not permitted by the file mask.
0110	6	Retry status was presented and the channel did not indicate chaining.
0111	7	The command code of the CCW returned after a retry sequence did not match the command for which the retry was signaled.
1000	8	MPL device not ready.
1001	9	MPL device permanent seek check.
1010	A	MPL device permanent read check.
1011	B	Defective or alternate track pointer that points to itself.
1100	C	Unconditional reserve.
1101 - 1111	D - F	Not used.

Format 1 - Device Equipment Check

Format 1 is generated when the following occurs.

- A device or controller equipment check is detected. Byte 0, bit 3 (equipment check) is also set. If the error is detected on an asynchronous operation, byte 2, bit 3 (environmental data present) is also set. Byte 1, bit 0 (permanent error) is set, if the internal retries are not successful.
- A permanent device seek check is detected. Byte 0, bit 3 (equipment check) and byte 1, bit 0 (permanent error) are also set. The message code in byte 7 specifies a seek error. If the error occurred on an asynchronous operation, byte 2, bit 3 (environmental data present) is also set.
- Error log information is off-loaded after a successfully retried seek that occurred during error logging. Byte 2, bit 3 (environmental data present) is also set if the message code in byte 7 specifies a seek error, and no other bits are active in sense bytes 0, 1, or 2.
- Byte 19, bit 4 (on-line) is not found in the drive status. Byte 0, bit 1 (intervention required) is also set.

For format 1, bytes 8 through 23 are:

Byte	Description
8	Contents of DDC bus-out.
9	Contents of DDC bus-in. This byte contains the end opcode for message 6 and the response to the command for messages 1 and 8 (table 3-5).
10	Device power status.
11	Device check register.
12	Read/write status 1 checks.
13	Read/write status 2 checks.
14	Not used.
15	Checkpoint log.
16	Expected device 1 status for message 1 or physical cylinder address for messages 7, A, or E.
17	Physical track address (low) read for messages 7, A, or E (table 3-5).
18	Byte 18 is not used.
19	Device status 1.
20	Device status 2.
21	Storage director ID.
22, 23	Symptom code.

Table 3-5 describes the functions of the message bits for format 1.

Table 3-5. Messages for Format 1 - Device Equipment Check

Sense Byte 7, Bits 4 - 7	Message Code	Message
0000	0	No message. No additional information is required.
0001	1	Device status 1 was not as expected.
0010	2	Reserved.
0011	3	Index was missing.
0100	4	Unresettable interrupt.
0101	5	Device did not respond to selection.
0110	6	Drive check 2 or set sector incomplete.
0111	7	Head address miscompare.
1000	8	Invalid device status 1.
1001	9	Device not ready.
1010	A	Track physical address miscompare while oriented.
1011	B	Not used.
1100	C	Drive motor switch was off.
1101	D	Seek incomplete.
1110	E	Cylinder address miscompare occurred.
1111	F	Unresettable offset active.

Format 2 - Storage Control Unit Equipment Check

Format 2 is generated to provide sense information when the microcode detects a storage control unit error condition. For format 2, bytes 8 through 23 are:

Byte	Description
8	Contents of the transfer complete status (XCS) register.
9	Contents of the transfer error status (XES) register.
10	Contents of the check (CHK) register.
11	Contents of the channel transfer complete (CXC) register.
12	Contents of channel control 2 (CC2) register.
13	Contents of the device bus-out (DBO) register.
14	Contents of the device bus-in (DBI) register.
15	Contents of the device tag-out (DTO) register.
16	Contents of the device tag gate (DTG) register.
17	Contents of the device tag-in (DTI) register.
18	Contents of channel status 2 (CS2) register.
19	Not used.
20	Byte 20 indicates microcode-detected check 2 conditions.
21	Storage control unit ID.
22, 23	Symptom code.

Table 3-6 describes the functions of the message bits for format 2.

Table 3-6. Messages for Format 2 - Storage Control Unit Equipment Check

Sense Byte 7, Bits 4 - 7	Message Code	Message
0000 - 0111	0 - 7	Not used.
1000	8	No message. No additional information required.
1001	9	Selective reset occurred while the drive was selected.
1010	A	Failed to latch the First Sync in.
1011 - 1110	B - E	Not used.
1111	F	Microcode-detected check. The message appears in byte 20, bits 4 through 7.

Format 3 - Storage Control Unit Check

Format 3 is generated to report microcontroller control checks detected by the hardware. Bytes 8 through 23 are:

Byte	Description
8	Basic check register.
9 - 20	Vary depending on failure.
21	Storage control unit ID.
22, 23	Symptom code.

Table 3-7 specifies the function of the message bits for format 3.

Table 3-7. Messages for Format 3 - Storage Control Unit Check

Sense Byte 7, Bits 4 - 7	Message Code	Message
0000 - 0111	0 - 7	Not used.
1000	8	Clock stopped check 1.
1001	9	Channel check 1 or SD timeout.
1010	A - F	Not used.

Format 3 - Storage Control Unit Check (Microcode-Detected)

This format 3 is generated to report microcontroller control checks detected by the microcode. This format presents the contents of the following registers to the alternate microcontroller for messages 9 and B through F. For message A, this format is reported by the failing microcontroller. Bytes 8 through 23 are:

Byte	Description
8	Basic check register.
9	Contents of the transfer error status (XES) register.
10	Contents of the check (CHK) register.
11	Contents of the condition register 0 (CR0).
12	Contents of the channel status 2 (CS2) register.
13	Contents of the channel control 1 (CC1) register.
14	Contents of the channel status 2 (CS2) register.
15	Contents of the channel status 1 (CS1) register.
16	Contents of the channel control 3 (CC3) register.
17	Contents of the channel transfer control (CXC) register.
18	Contents of the channel bus-out (CBO) register.
19	Contents of the channel bus-in (CBI) register.
20	Interrupt level.
21	Storage control unit ID.
22, 23	Symptom code.

Table 3-8 specifies the function of the message bits for format 3.

Table 3-8. Messages for Format 3 - Storage Control Unit Check (Microcode-Detected)

Sense Byte 7, Bits 4 - 7	Message Code	Message
0000 - 0111	0 - 7	Not used.
1000	8	Clock stopped check 1.
1001	9	Channel check 1 or SD timeout.
1010	A - F	Not used.

Format 4 - Data Check without Displacement Information

Format 4 is generated when the following occurs.

- Errors that were not correctable by the ECC are detected after retry has been unsuccessful. Byte 1, bit 0 (permanent error) is also set.
- Error log information is off-loaded after an ECC uncorrectable error occurred during error logging. The information was recovered through use of command retry. Byte 2, bit 3 (environmental data present) is also set.
- Data checks are detected while processing a read multiple CKD command.
- ECC uncorrectable data checks were detected in the count, key, or data field. Byte 7 identifies the field in error.

For format 4, bytes 8 through 23 are:

Byte	Description
8 - 12	Record identifier. Bytes 8 through 12 contain the record ID obtained from the count field of the record in which the error occurred. These bytes are unreliable, if the message code in byte 7 is 0, 1, 4, 5. Byte 12 is 0, if the message code is 0 or 4. If an ECC uncorrectable error occurred, these bytes are also unreliable after a space count command.
13	Record number. Byte 13 contains the record number of records in error. These bytes are unreliable if the message code in byte 7 is 0, 1, 4, 5.
14	Controller physical identifier. Byte 14 contains the controller physical identifier.
15	Access offset. If byte 2, bit 3 (environmental data present) is set, byte 15 contains the head offset last used for retrying a data check.
16 - 20	Not used.
21	Storage control unit ID. Byte 21 contains the storage control unit ID.
22, 23	Symptom code. Bytes 22 and 23 contain the symptom code.

Table 3-9 specifies the function of the message bits for format 4.

Table 3-9. Messages for Format 4 - Data Check without Displacement Information (Sheet 1 of 2)

Sense Byte 7, Bits 4 - 7	Message Code	Message
0000	0	An error occurred in the home address area and could not be corrected by the ECC.
0001	1	An error occurred in the count area and could not be corrected by the ECC.
0010	2	An error occurred in the key area and could not be corrected by the ECC.
0011	3	An error occurred in the data area and could not be corrected by the ECC.
0100	4	Data synchronization on the home address area was unsuccessful.
0101	5	Data synchronization on the count area was unsuccessful.
0110	6	Data synchronization on the key area was unsuccessful.
0111	7	Data synchronization on the data area was unsuccessful.
1000	8	An error occurred in the home address area and could not be corrected by the ECC (access offset active).

Table 3-9. Messages for Format 4 - Data Check without Displacement Information (Sheet 2 of 2)

Sense Byte 7, Bits 4 - 7	Message Code	Message
1001	9	An error occurred in the count area and could not be corrected by the ECC (access offset active).
1010	A	An error occurred in the key area and could not be corrected by the ECC (access offset active).
1011	B	An error occurred in the data area and could not be corrected by the ECC (access offset active).
1100	C	Data synchronization on the home address area was unsuccessful (access offset active).
1101	D	Data synchronization on the count area was unsuccessful (access offset active).
1110	E	Data synchronization on the key area was unsuccessful (access offset active).
1111	F	Data synchronization on the data area was unsuccessful (access offset active).

Format 5 - Data Check with Displacement Information

Format 5 is generated when the following occurs.

- Data checks that are correctable by the ECC are detected in the data areas of a record.
- Data checks in data areas that are not correctable by the ECC were successfully retried, but the file mask specified PCI fetch mode.
- Error log information is off-loaded after an ECC correctable error occurred during error logging.
- Data checks are detected while processing a second or subsequent record during execution of a read multiple CKD command.

For format 5, bytes 8 through 23 are:

Byte	Description
8 - 12	Record identification. Bytes 8 through 12 contain the record identification obtained from the count field of the record in which the error occurred. Byte 12 is unreliable after a space count command.
13	Record number. Byte 13 contains the record number of records in error.
14	Controller physical identifier. Byte 14 contains the controller physical identifier.
15 - 17	Restart displacement. If byte 2, bit 3 = 0, bytes 15 through 17 contain the restart displacement. If byte 2, bit 3 = 1, byte 15 contains the head offset, byte 16 contains the storage control unit ID, and byte 17 is not used.
18, 19	Error displacement. Bytes 18 and 19 contain the error displacement.
20 - 23	Error pattern. Bytes 20 through 23 contain the error pattern.

Table 3-10 specifies the function of the message bits for format 5.

Table 3-10. Messages for Format 5 - Data Check with Displacement Information

Sense Byte 7 Bits 4 - 7	Message Code	Message
0000	0	Home address data check - correctable.
0001	1	Count area data check - correctable.
0010	2	Key area data check - correctable.
0011	3	Data area data check - correctable.
0100 - 0111	4 - 7	Not used.
1000	8	Correctable HA data check with offset active.
1001	9	Correctable count area data check with offset active.
1010	A	Correctable key area data check with offset active.
1011	B	Correctable data area data check with offset active.
1100 - 1111	C - F	Not used.

Format 6 - Usage Statistics/Overrun Errors

Format 6 is generated when the following occurs.

- A read and reset buffered log command is executed.
- Usage/error statistics require off-loading due to counter overflow.

For format 6, bytes 8 through 23 are:

Byte	Description
8 - 11	Bytes read or searched. Bytes 8 through 11 contain an accumulated count of the number of bytes processed by the storage control unit during read and search operations. Only key and data fields are counted. Bytes processed during retry operations are not counted.
12 - 15	Not used.
16, 17	Number of seeks. Bytes 16 and 17 contain the number of access moves processed by the storage control unit, but do not include recalibrated or retired seeks.
18	Not used.
19	Command overruns. Byte 19 contains the number of command overruns that occurred on the channel specified in the message table of byte 7.
20	Data overruns. Byte 20 contains the number of data overruns that occurred on the channel specified in the message table of byte 7.
21	Storage control unit ID. Byte 21 contains the storage control unit ID.
22, 23	Not used.

Table 3-11 specifies the function of the message bits for format 6.

Table 3-11. Messages for Format 6 - Usage Statistics/Overrun Errors

Sense Byte 7 Bits 4 - 7	Message Code	Message
0000 - 0111	0 - 7	Not used.
1000	8	Channel A.
1001	9	Channel B.
1010	A	Channel C.
1011	B	Channel D.
1100	C	Channel E.
1101	D	Channel F.
1110	E	Channel G.
1111	F	Channel H.

Format 7 - Storage Control Unit to Head-of-String Controller or Controller Checks

Format 7 is generated to provide sense information when a controller error occurs. This format is also generated to indicate to the system that a path error exists between the storage control unit and the head-of-string controller.

This format indicates an equipment check error if:

- The 895 data path switch is switched to disable after the storage control unit and the head-of-string controller have established initial communication.
- The storage control unit attempts to use the path.

If the storage control unit attempts to use the path before initial communication has been established, and if the data path switch is set to disable, a condition code response results.

For format 7, bytes 8 through 23 are:

Byte	Description
8	DDC interface bus-out. Byte 8 contains the contents of DDC interface bus-out.
9	DDC interface bus-in. Byte 9 contains the contents of DDC interface bus-in.
10	DTI and XES registers. Byte 10 contains the contents of the storage control unit device tag in (DTI) and transfer error status (XES) registers.
11	Connection check/no power. Byte 11 indicates which controllers either sensed a connection check or do not have power on.
12, 13	Check 1 errors, controller 0. Bytes 12 and 13 indicate check 1 errors that occurred in the controller with a logical address of 0.
14, 15	Check 1 errors, controller 1. Bytes 14 and 15 indicate the check 1 errors that occurred in the controller with a logical address of 1.
16, 17	Controller 0 sequencer address. Bytes 16 and 17 contain the controller 0 sequencer address at the time of a connection check alert (CCA).
18, 19	Controller 1 sequencer address. Bytes 18 and 19 contain the controller 1 sequencer address at the time of a CCA.
20	Format and message codes. Byte 20 contains the format and message codes reported in byte 7 when the controller first indicated a path was disabled. Used with message code C.
21	Storage control unit ID. Byte 21 contains the storage control unit ID.
22, 23	Symptom code. Bytes 22 and 23 contain the symptom code.

Table 3-12 specifies the function of the message bits for format 7.

Table 3-12. Messages for Format 7 - Storage Control Unit to Head-of-String Controller or Controller Checks

Sense Byte 7 Bits 4 - 7	Message Code	Message
0000	0	RCC initiated by a CCA.
0001	1	RCC1 sequence was not successful.
0010	2	RCC1 and RCC2 sequence was not successful.
0011	3	Invalid director-to-device (DDC) tag sequence.
0100	4	Extra RCC required.
0101	5	Invalid DDC selection response occurred or timeout.
0110	6	Missing End Op, transfer was complete.
0111	7	Missing End Op, transfer was incomplete.
1000	8	Invalid tag-in on immediate command.
1001	9	Invalid tag-in from extended command sequence.
1010	A	Timeout or deselection.
1011	B	No controller response to selection after a poll interrupt.
1100	C	Controller not available.
1100 - 1111	D - F	Not used.

Format 8 - Controller Equipment Check

Format 8 is generated to provide sense information when controller type 2 and drive check 1 equipment checks occur. For format 8, bytes 8 through 23 are:

Byte	Description
8	DDC interface bus-out. Byte 8 contains the contents of DDC interface bus-out.
9	DDC interface bus-in. Byte 9 contains the contents of DDC interface bus-in. It contains the End Op response code either if sense byte 10, bit 7 is on or if the message code is 3, 4, or 5.
10	DTI and XES registers. Byte 10 contains the contents of the device tag-in (DTI) and transfer error status (XES) registers.
11	Controller fault log A. Byte 11 contains the contents of the controller fault log A.
12	Controller fault log B. Byte 12 contains the contents of the controller fault log B.
13	Controller fault log C. Byte 13 contains the contents of the controller fault log C.
14	Controller fault log D. Byte 14 contains the contents of the controller fault log D.
15	Controller fault log E. Byte 15 contains the contents of the controller fault log E.
16, 17	Controller sequencer address. Bytes 16 and 17 contain the controller sequencer address at the time of the check.
18	Controller fault log F. Byte 18 contains the contents of the controller fault log F.
19	Device status 1 checks. Byte 19 indicates the device status 1 checks.
20	Device status 2 checks. Byte 20 indicates the device status 2 checks.
21	Storage control unit ID. Byte 21 contains the storage control unit ID.
22, 23	Symptom code. Bytes 22 and 23 contain the symptom code.

Table 3-13 specifies the function of the message bits for format 8.

Table 3-13. Messages for Format 8 - Controller Equipment Check

Sense Byte 7, Bits 4 - 7	Message Code	Message
0000	0	No message. No additional information is required.
0001	1	Error correction code hardware failure occurred.
0010	2	Reserved.
0011	3	Unexpected End Op response code received.
0100	4	End Op active with transfer count not 0.
0101	5	End Op active with transfer count of 0.
0110	6	Controller stopped the dynamic path selection cleanup after a channel or system reset.
0111 - 1111	7 - F	Not used.

Word 17 - Bits 11 and 10, Microcode

These bits indicate disk microcode when bit 11 is clear and bit 10 is set.

Word 17 - Bits 9 through 6, Microcode Revision Number

These bits indicate the revision number for the disk microcode.

Word 17 - Bits 5 through 0, Record Number

These are the lower 6 bits of the current record number.

Word 18 - Bits 11 through 8

These bits are not used.

Word 18 - Bit 7, Normal End

This bit indicates that the PP completed the function and disconnected the channel with no channel, memory, deadman timeout, or control package parity errors.

Word 18 - Bit 6, Channel Parity Error

This bit indicates that a channel parity error occurred on PP output data or parameter words.

Word 18 - Bit 5, Memory Parity Error

This bit indicates that a coupler memory parity error occurred during a PP read operation from coupler memory.

Word 18 - Bit 4, Deadman Timeout

This bit indicates that the channel remained active for 7 to 10 s after a PP function transferred data. The coupler deactivates the channel after the timeout expires.

Word 18 - Bit 3, Control Package Parity Error

This bit indicates that a coupler memory parity error was detected.

Word 18 - Bit 2, Transfer Indicator

This bit, in conjunction with bit 7 (the normal end bit), indicates that the channel went inactive either before:

- The length register decremented to 0 during either a UDI write, a UDI read, or a microcode autoload.
- All data was read during a DMA read.

This bit set without bit 7 set indicates either that:

- The length register decremented to 0 during a microcode autoload, and the channel is still active.
- The length register decremented to 0 during a UDI write, and the channel continued to send data.

Word 18 - Bit 1, Character Fill

This bit, in conjunction with bit 7 (the normal end bit), indicates that either the lower 6 or 8 bits of the final data word returned to the PP during a read operation, or the upper 6 or 8 bits of the final data word returned during a read backward operation, are fill bits. This gives the character an undefined value. If only the lower 4 bits of the final read operation word or the upper 4 bits of the final read backward operation word are fill bits, the character fill bit does not set.

Word 18 - Bit 0

This bit is not used.

NOTE

Word 19, bit 11 is generated by the coupler microcode; bits 10 through 0 are copied directly from the CCC to SCU interface status word.

Word 19 - Bit 11, Coupler Microcode-Detected Error

This bit enables bits 7 through 0 to define the error as follows:

Bit	Error
7 - 5	Not used.
4	Request was not received during command retry.
3	Illegal write.
2	7165 device interface failed to complete a sequence, and its internal diagnostic ran.
1	7165 device interface failed to complete a sequence, and its internal diagnostic failed.
0	Full/empty count is incorrect after a direct memory access transfer.

Word 19 - Bit 10, SCU/895 Status Byte Error

This bit enables bits 7 through 0 to contain the following status information from the SCU.

Bit	Information
7	Attention
6	Status modifier
5	Control unit end
4	Busy
3	Channel end
2	Device end
1	Unit check
0	Unit exception

Word 19 - Bit 9, 7165 Sequence Error

This bit indicates that the CCC to SCU interface detected a tag line sequence error on the channel. This bit enables the following information in bits 7 through 0.

Bit	Error
7 - 3	Not used
2	Address miscompare on select sequence
1	No request-in on polling sequence
0	Select-in received on select sequence

Word 19 - Bit 8, Parity Error

This bit indicates that the CCC to SCU interface detected a parity error on data or status. This bit enables the following information in bits 7 through 0.

Bit	Error
7 - 4	Not used
3	Bus-in parity error
2	Read path parity error
1	Memory parity error
0	Write path parity error

Word 20 - Bits 11 and 10, Capacity

These bits indicate the storage capacity of the last device referenced with a connect or seek function.

Bit 11	Bit 10	Device Capacity
0	0	630 megabytes (895)
0	1	100 megabytes
1	0	200 megabytes
1	1	317 megabytes

Word 20 - Bits 9 and 8, Always 1's

Word 20 - Bits 7 through 0, Hardware Unique Identifier

These bits contain the assigned hardware unique identifier (HUI) used to identify each CYBER channel coupler separately at a given site. The HUI is established during initial installation of the coupler.

0024 – REQUEST EXTENDED ERROR LOG

The request extended error log (EEL) function and its associated one-word output parameter direct the coupler to obtain either the extended error log data or the configuration file data from the storage controller and to hold the data in coupler memory. Prior to executing this function, the PP must have executed either a connect (0000) or a seek (0001, 0002) function that resulted in a general status of 0000. This is a requirement of the 895, in order to have a device selected.

After the one-word parameter is accepted by the coupler, the PP must take general status to determine when the requested data was received from the storage controller. While attempting to process this function, the coupler returns a general status of busy (0002) for up to 100 s. If an abnormal termination is returned during this function, the PP should obtain detailed status and analyze it for the cause of the abnormal termination. When a general status of 0000 is returned, this function has completed, and the PP should execute the input EEL function (0025).

Best case execution times (approximate):

Format	Execution Time
Configuration file	2 s
Index track	1 s
Data track	1 s

Parameter format:

Bit	Value
11	This bit is 0.
10	This bit is 0.
9	Values are defined as follows:

Value	Description
0	Bit 5 controls the operation.
1	Request configuration file.

Bit	Value
8	This bit is 0.
7	This bit is 0.
6	Determines the storage director's file as follows:

Value	Description
0	This SD.
1	Other SD in 895.

Bit	Value
5	Values are defined as follows:

Value	Description
0	Request EEL data tracks.
1	Request EEL index track.

Bit	Value
4	This bit is 0.
3 - 0	EEL data track number, from 0 through 17 (octal).

The parameter word is decoded as follows:

- If bit 9 is set (request configuration file), bits 8 through 0 are not used.
- If bit 9 is clear, then bit 5 determines the requested operation as follows:
  - If bit 5 is set (request EEL index track), then bits 4 through 0 are not used.
  - If bit 5 is clear (request EEL data tracks), then bits 4 through 0 determine which of the 16 data tracks to obtain.

  Bit 6 determines the storage director's file.

To execute this function, the PP should use the following sequence.

1. Issue seek or connect function and parameters.
2. Issue general status function and input status word.
3. Return to step 2 if bit 1 (busy) of general status word is set.
4. Go to step 9 if status word is 0000.
5. Process abnormal termination status.
6. Issue detailed status function and input detailed status.
7. Process detailed status and report error.
8. If recoverable error, return to step 1; otherwise, stop.
9. Issue request EEL function (0024) and output parameter.
10. Initialize a delay counter.
11. Issue general status function and input status word.
12. Go to step 17 if status word is 0000.
13. Return to step 5 if bit 11 (abnormal termination) is set.
14. Delay 1 s.
15. Return to step 11, if total delay is less than 100 s.
16. Report exceed time limit and stop.
17. Perform input EEL function (refer to 0025 - Input Extended Error Log, which immediately follows).

0025 - INPUT EXTENDED ERROR LOG

This function initiates the transfer of the requested EEL data to the PP. The bytes are transferred to the PP as 4 leading 0 bits and 8 bits of data per each 12-bit PP word. The input is a maximum of 2054 PP words. If necessary, the coupler deactivates the channel after the last word.

After the data is transferred, the PP must take general status to determine if any coupler errors occurred during the transfer. If the general status is 0000, no errors were detected. If general status bit 11 (abnormal termination) is set, the PP should obtain detailed status and analyze it for the cause of the abnormal termination. If necessary, the EEL data is still available in coupler memory to retry the input EEL function.

The PP data lengths for the various formats are:

Format	Data Length
Configuration file	2054 (maximum)
EEL index track	518
EEL data track	2054

The first six bytes (PP words) are common to all formats. The following bit numbers refer to bit positions in the 895.

PP Bit Numbers	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	X	X	X	X	X	X	X	X
895 Bit Numbers					0	1	2	3	4	5	6	7

Byte	Bit	Description
0	0	If set, SD and/or DP is busy.
0	1	If set, DP is unavailable.
0	2 - 7	These bits are all 0's.
1	0 - 7	If not 0, indicates a floppy disk drive (FDD) load error.
2 - 5	05 0D 81 81	Configuration file ready; bytes 6 through 2053 = data.
	05 0D 84 84	EEL ready. If EEL index, bytes 6 through 517 = index data. If EEL data, bytes 6 through 2053 = EEL data.
	04 rr rt xx	Routine rrr test t error xx occurred. Bytes 6 through 37 = SEWs for this error.

Configuration file format:

The configuration file contains information from the currently loaded 895 floppy disk. The file contains sequential entries of the operational microcode modules on the disk. Each entry is 64 bytes long and is in ASCII format. The number of entries is dependent upon the number of microcode modules installed on the floppy disk when the microcode was last updated.

NOTE

In the following examples, the character ^ represents a blank.

The first entry is in the format of the following example.

```
FLOPPY^DISK^P/N:^72888412(39^^s)
```

The rest of the entries are in the format of the following example.

```
FILE:^72888309XX^^DM000nnnn
LAST^UPDATED:^07/23/84^10:59:00nnnnnn
```

The last valid entry is in the format of the following example.

```
FILE:^CONFIGUR.UR^FLOPPYnnn
LAST^UPDATED:^09/06/84^15:59:00nnnnnn
```

0027 - READ CYLINDER MINUS 3

This function must be preceded by:

- A seek function to cylinder 0.
- The track and record number of the record and cylinder minus 3 value to be read. A description of cylinder minus 3 format follows.

Tracks 0 through 11 contain the full complement of HDA home addresses (refer to table 3-14). Tracks 12 through 14 contain no home address data; they are packed with a data pattern of alternate 1's and 0's.

Table 3-14. Home Address Track/Head Assignments

Track Number	Backup for Cylinders
0	000 through 079
1	080 through 159
2	160 through 239
3	240 through 319
4	320 through 399
5	400 through 479
6	480 through 559
7	560 through 639
8	640 through 719
9	720 through 799
10	800 through 879
11	880 through 886

In addition to home address and to an IBM standard record 0, each of these tracks is formatted into 20 records.

- Each record is 1812 8-bit data bytes.
- Each record contains the home addresses of four cylinders (refer to figure 3-1).
- Each track contains the home addresses of 80 cylinders (except cylinder 11, which contains relevant data for cylinders 880 through 886).

Each 1812-byte record can be disassembled as shown in figure 3-1.

a. Six preamble (identifier) bytes - ´FSCMAP´ in EBCDIC b. Fourteen skip control bytes c. Two segment number bytes d. Three physical address bytes e. One flag byte f. Five logical identifier bytes (CCHHR) g. One key byte h. Two data length bytes i. Fourteen iterations of b through h j. Twenty-eight bytes of 0´s	Composes home address recording for cylinder n Total bytes to this point: 454
k. Fifteen iterations of b through h l. Twenty-eight bytes of 0´s	Composes home address recording for cylinder n+1 Total bytes to this point: 902
m. Fifteen iterations of b through h n. Twenty-eight bytes of 0´s	Composes home address recording for cylinder n+2 Total bytes to this point: 1350
o. Fifteen iterations of b through h p. Forty-two bytes of 0´s	Composes home address recording for cylinder n+3 Total bytes to this point: 1812

Figure 3-1. Disassembly of an 1812-Byte Record

0030 - READ FACTORY DATA

The read factory data function is identical to the read function (0004). It is present for software compatibility. Refer to 0037 - Write Protected Record (in this section) for the location of the pack serial number.

0031 - READ UTILITY MAP

The read utility map function is identical to the read function (0004). It is present for software compatibility. Refer to 0037 - Write Protected Record (in this section) for the location of the utility map.

0032 - UDI READ

The universal device interface (UDI) read function allows the PP to read 322 12-bit words from the coupler memory. This function uses the same hardware path as the status functions. The coupler outputs the 12 rightmost bits of each 16-bit memory word. It can be used to read the data previously written with the UDI write function (0033).

0033 - UDI WRITE

The UDI write function allows the PP to write 322 12-bit words into the coupler memory. This function uses the same hardware as functions that send parameters. The 12-bit channel word is stored in the 12 rightmost bits of the 16-bit memory word. General status is 5000, if there is a channel parity error or if less than 322 words are received by the coupler. A general status of 0000 indicates the function completed without error.

0034 - READ PROTECTED RECORD

The read protected record function is identical to the read function (0004). It is present for software compatibility. Refer to 0037 - Write Protected Record (in this section) for a list of the protected records.

0035 - WRITE LAST RECORD

The operational procedure for the write last record function is identical to the write function (0005). When writing, general status is returned to the PP after the address has been read and verified and after the data is in coupler memory, but before it has been written on the disk. With the write last record function, general status is returned after the record is written on the disk. This means that the next physical record cannot be written without missing a disk revolution. Therefore, the write last record function should be used only when writing the last record of a block.

0037 - WRITE PROTECTED RECORD

The write protected record function allows the PP to write any record in the protected area. The protected areas are cylinder = 885 and tracks = 0 and 1. They are formatted for 483-byte records. The coupler microcode protects the area by checking the seek address. The write protected record function is the only one that can write data fields in the protected area. The write (0005) and write last record (0035) functions are the only ones that can write data fields in the unprotected areas. If the PP attempts a write function into the wrong area, the following occurs.

1. A reply is sent to the function.

2. The data is written into coupler memory.

3. A general status of 5000 is returned, but no write to the device occurs.

The operational and error recovery procedures for the write protected record function are the same as that described for the write last record function (0035). The following records are defined in the protected area.

	Track	Record
Pack serial number	0	0
Utility map	0	1
Disk deadstart record	0	2
Microcode for autoload from disk	1	0 - 25

Pack Serial Number

A utility program must be run to write the pack serial number. The first 24 bits of the record compose a 6-digit pack serial number in hexadecimal format.

Example: Serial number 016852 = 0000 0001 0110 1000 0101 0010

Utility Map

This record contains a list of the tracks that should not be written with the write function (0005) and write last record function (0035). A utility program must be run to scan the pack for defective tracks and to write this record. For details on how to scan the pack, refer to Disk Pack Initialization later in this section.

The data field of the utility map record contains a list of 24-bit entries. Each entry has the following format.

23	22 ... 12	11 ... 6	5 ... 0
1	Cylinder	Track	Record

All tracks that the pack manufacturer has flagged as defective should have an entry in this record. The two protected tracks should also have an entry in this record. The record number is always 0 and the leftmost bit is always a 1 in the entry. Example:

Cylinder 120, track 11 = 1000 0111 1000 0010 1100 0000

The drive releases after data has been transferred to the PP. If the data cannot be read into coupler memory, the microcode will retry the read as long as the function is present.

0043 - DMA READ

The direct memory access (DMA) read function allows the PP to read 322 12-bit words from the coupler memory. It uses the same hardware path as the read function (0004).

The words read are stored in the 8 leftmost bits of the 16-bit words in the 483-word coupler memory buffer. This buffer contains the last record written to the disk, read from the disk, or written by the DMA write function (0044). A general status of 0000 indicates the function completed without error.

0044 - DMA WRITE

The DMA write function allows the PP to write 322 12-bit words into the coupler memory. It uses the same hardware path as the write function (0005).

The words read are stored in the 8 leftmost bits of the 16-bit words in the 483-word coupler memory buffer. A general status of 0000 indicates the function completed without error.

0047 - SCAN CYLINDER

This maintenance function allows the PP to obtain a list of the defective tracks and skip displacement (SD) bytes on a cylinder. This function must be preceded by a seek function (0001) to select the cylinder to scan. The coupler microcode reads the home address of each track and makes an entry for each track that is defective or has nonzero SD bytes. The UDI read function (0032) is used to input the scan results. Each table entry consists of the following sixteen 12-bit words.

If no entry, word 1 is 0. Otherwise, the bits are defined as follows::

Bit	Description
11	Set, if track is defective.
10	Always zero.
9	Set, if home address could not be read due to uncorrectable check word error or no sync byte found error.
8	Cylinder number miscompare. Word 2 contains the cylinder number read.
7	Track number miscompare. Word 3 contains the track number read.
6	Not used.
5 - 0	Track number.

Words 2 through 16 contain 8-bit SD bytes right justifed as follows:

Word	Description
2	Upper 8 bits of skip control to first defect.
3	Lower 8 bits of skip control to first defect.
4	Upper 8 bits of skip control to second defect.
5	Lower 8 bits of skip control to second defect.
14	Upper 8 bits of skip control to seventh defect.
15	Lower 8 bits of skip control to seventh defect.
16	Segment number.†

The record that is read (function 0032), contains fifteen of the above entries. One sixteen word entry for each track of the cylinder in the first 240 words of the 322 word record. The remainder of the record is zero filled.

† The segment field value equals the displacement between the start of the home address area of the count field and the index. For the home address, the value is 14 and is increased by 6 for each defect pair that causes the home address to be moved.

General status should be taken following this function. The general status words returned for this function are:

- 0000, if function completed without error.
- 0002, if coupler busy scanning home address fields.
- 5000 or 5020, if hardware error.

0060 - PATH CONFIDENCE TEST

The Path Confidence test consists of the following operations between the coupler and the controller.

- A seek to cylinder 885 is issued to the last device that was selected by the host. If no device was selected since the last microcode autoload to the coupler, device 00 will be used for the test.
- The coupler will write the last record on cylinder 885, track 1. This track is reserved for microcode.
- The coupler will then read back this record and compare the data with the contents of the write buffer.

After the coupler responds to the Path Confidence Test function (0060) from the host, it will ignore all other functions from the host until the test is completed. At the completion of the test a general status is generated which should be interpreted as follows:

Status	Description
0000	The test completed and no errors were detected.
0002	The device is currently reserved by another channel and a seek or select function should be issued to select another device.
0010	The storage control unit is currently busy from another channel using the other access of the storage control unit. Both A and B accesses of the storage control unit are enabled.
5000	The test failed and other diagnostics should be initiated to determine the problem. Sense bytes are not available from the storage control unit.
5020	The test failed and the failure was detected at the storage control unit. Sense information from the storage control unit is available in detailed status.

The microcode must be loaded into coupler memory for this function and is not meant to isolate failures to any single box or device.

0061-SELECTIVE/SYSTEM RESET

This function sends a selective or a system reset to the 895 disk subsystem, depending on the value of the one word parameter that is to follow the function code on the channel. This function will break chaining from the CCC to the SD and will release the addressed unit in the case of a selective reset and all units in the case of a system reset. The time required to complete this function is 12 msec.

The one word parameter is as follows:

```
MSB                       LSB
 S 0 0 0 0 0 U U U U U U
```

S= If 0, selective reset to the unit whose address is specified in the lower six bits (U U U U U U). If 1, then system reset and the unit number in the lower six bits is not used.

0070 - RUN SCU INTERFACE DIAGNOSTICS

This function allows the PP to run the same SCU interface diagnostics that are run during a full autoload coupler microcode from PP function (0414). The SCU interface UDI diagnostic runs first and is followed by the processor SCU interface interaction tests. The interaction tests include loading and reading transfer registers, loading and reading conversion tables, transmitting fixed data patterns from memory to the transmitters, and transmitting fixed data patterns from the receivers to memory. If the diagnostics run without error, general status is 0000. If not, general status is 5xxx (xxx is an error code, described in section 4).

Error Codes for the maintenance panel display and general status are as follows:

Maint Panel (Hex)	General Status (Oct)	Error Description
8141	5101	Equipment switches set wrong.
8148	5110	Normal end not set in ending status after select sequence.
8149	5111	Normal end not set in ending status after load xfer regs.
814A	5112	Normal end not set in ending status after read xfer regs.
814B	5113	Transfer register data miscompare.
814C	5114	Normal end not set after diagnostic write sequence.
814F	5117	Full/empty count incorrect after diagnostic write.
8150	5120	SCU address incorrect after diagnostic write.
8151	5121	Normal end not set after read block ID.
8152	5122	Block ID wrong after diagnostic write.
8154	5124	Normal end not set after diagnostic read.
8156	5126	Diagnostic read data pattern incorrect.
8157	5127	Transfer register error after diagnostic read.
8158	5130	Block ID wrong after diagnostic read.
816D	5155	SCU I/F sequence did not complete.

0071 - SELECT 895 IN-LINE ROUTINE AND OPTIONS

This function and its three-word parameter allows the PP to select the in-line routines and options. † Detailed descriptions of the tests are provided in section 2 of the 895 Disk Storage Subsystem Hardware Diagnostic Reference Manual (publication number 83337530). When the microdiagnostics are run from a PP, the tests use the default parameters described in the test descriptions; it is not possible to supply the parameters from the PP.

† During in-line tests, diagnostic operation is concurrent with customer use of the subsystem. Off-line tests are standalone diagnostic operations.

The following microdiagnostic tests are selectable from the PP.

- C80, C81, C82, C83, C84, C85, C86, C87, C88, C90, C92, C93, C94, CA0, CA1, CA2, CA6, CA7, CA9, CAA, CAB, CAC, and CAD.

The following subset of tests require caution.

- C90, C92, C93, C94, CA1, CA9, CAA, and CAC.

This function causes the following sequence of commands to be issued to the storage control unit.

- Check SCU to see if available.
- Select in-line routine and options.

The in-line microdiagnostics provide a comprehensive in-line and off-line diagnostic capability for an 895 Disk Storage Subsystem attached to a Storage Control Unit. The Control Data diagnostic hierarchy is:

1. Operating system error reporting/logging.
2. On-line diagnostics.
3. HSC/DSU in-line microdiagnostics.
4. Equipment hardcores/standalones.

In this hierarchy, the in-line microdiagnostics are the second-level HSC/DSU fault detection/isolation diagnostic. Error information consists of error codes and subsequent error words, which are unique to the in-line microdiagnostics. First-level error detection/isolation is a function of the firmware, which resides in the SCU. Error information is in the form of fault symptom codes, which are reported to the CPU.

The in-line microdiagnostics are written in assembly language. They interface to, and operate under, the control of the firmware in a 7165 SCU. The routines themselves reside on a floppy disk. They are loaded into control store and execute in segments. Therefore, each segment must be executed time-independent from the other. The diagnostic routines are organized into two groups, a good machine path (GMP) group and a group of utility programs. Each routine is then subdivided into a series of subtests.

The GMP series of routines are designed to test an HSC/DSU combination in a building block hierarchy. Their purpose is to verify the basic operation of an HSC/DSU combination (that is, its ability to perform seeks, orient, read/write, and so forth).

Executing the in-line microdiagnostics in a linked fashion inhibits selection timeouts. Under this condition the host should time out, if routine execution appears to be hung because in-line microdiagnostics are unable to select the desired test device.

When C80 or C81 are executing, the selection timeouts are not inhibited, and the selection timeout errors are presented. Selection timeout errors 8811CX, 8811D8, RRRTOF are possible and should be retried by the host a number of times before presenting the error to the user.

The approximate best case execution times of the microdiagnostics are:

Unlinked Inlines Using Default Parameters

Routines	Time (seconds)
C80	3
C81	3
C82	4
C83	3
C84	5
C85	10
C86	6
C87	4
C88	3
C90	4
C92	5
C93	3
C94	3
CA0	Variable (a portion is executed during linked series)
CA1	Variable
CA2	3
CA6	Variable
CA7	3
CA9	154
CAA	5
CAB	Variable
CAC	11
CAD	6

Linked Series

Routines	Total Time (seconds)
C80 CA0 C81 C82 C83 C84 C85 C86 C87 C92	35

When the subsystem is being heavily used, the worst case execution time may be up to several hours in length.

The microdiagnostics may be run concurrently with normal operating system activity. Any of the following activities cause the microdiagnostics to abort execution.

- Autoload coupler.
- Disk deadstart.
- Any coupler function that does a system reset.

The following 3 parameter words select routine number, run options and the device address to be tested.

	PP Bits											
	11	10	9	8	7	6	5	4	3	2	1	0
PW1	R	R	R	R	R	R	R	R	R	R	R	R
PW2	0	0	0	B	P	P	P	P	P	P	P	P
PW3	0	0	0	0	D	D	D	D	D	D	D	D

R-R = Routine Number, Ex. $C80_{16}$ = 6200_8

P = 40_8 - Default Mode
42_8 - Loop Linked Series
44_8 - Inhibit Routine Linking
46_8 - Loop Single Routine

B = Set Bypass Selection Timeout

D-D = Actual 8 bit FIPS channel device address

This function also obtains the in-line microdiagnostic sense bytes and prepares general status. A function timeout of 7 s may be required.

General status responses:

Status	Response
0000	Completed without error.
0002	DP busy, delay 1 s and reissue function (0071) and parameters.
0010	SD busy, delay 1 s and reissue function (0071) and parameters.
5000	Coupler error, issue extended detailed status function (0023).
5020	Device malfunction, issue extended detailed status function (0023).
5200	SD/DP detected error, issue sense 895 in-lines function (0073).

0072 - VERIFY 895 IN-LINE LOADED

This function determines if the DP has successfully loaded the selected in-line routine by inputting verify status.

General status responses:

Parameters: None

Status	Response
Input	This one word of verify status is returned with the function (0072) and has the following meanings.
0000	Load completed without error, function (0073) may now be used to input the default routine parameters.
0002	DP still busy loading, delay 1 s and reissue function (0072).
0010	SD busy, delay 1 s and reissue function (0072).
5000	Coupler error, issue extended detailed status function (0023).
5020	Device malfunction, issue extended detailed status function (0023).
5200	SD/DP detected error, issue sense 895 in-lines function (0073).

0073 - SENSE 895 IN-LINES

This function transfers the actual 895 inline diagnostic sense buffer to the host. The transfer will be 54 decimal CYBER Channel words and each word will contain as the 8 LSBS the actual sense byte. The contents of these sense bytes are determined by the previous inline function operation.

Parameters: None

Input: Following function (0071):
- 6 Common Sense bytes

Following function (0072):
- 6 Common Sense bytes
- 18 Run Options and Default Parameter Bytes

Following function (0074):
- 6 Common Sense bytes
- 18 Run Options and Default Parameter Bytes

Following function (0075):
- 6 Common Sense bytes

Following function (0076):
- 6 Common Sense bytes
- 32 Subsequent Error Word Bytes, if Error Detected
- 16 Field Replaceable Unit Error Word Bytes, if Error Detected

Following function (0077):
- Same function (0076)

The following status will be returned to a General Status Function.

Status	Response
0000	Completed transfer without error.
5000	Coupler detected error, issue extended detailed status function (0023).

Common Sense Byte Definitions:

Each sense byte (8 bit) is returned to the PP as the lower 8 bits of each 12 bit PP word. The following definitions refer to the sense byte bit number.

Bit Numbers

PP Word	11	10	9	8	7	6	5	4	3	2	1	0
Sense Byte	NU	NU	NU	NU	0	1	2	3	4	5	6	7

Byte 0 - Common to all diagnostic commands
- Bit 0 - SD/DP interface busy
- Bit 1 - DP unavailable
- Bit 2-7 - Not used

Byte 1 - Common to all diagnostic commands
- Floppy disk error code if not zero

Byte 2-5 - Unique to Channel initiated inlines

05000000 - Invalid request (Control byte not 00, 01, 02, 05, 06, 0700, 0701, 0702, 0703, 07FF, 07FE, 08, 81, 82, or 84).

050DRRRT - Inline routine RRRT completed with no errors.

050ERRRT - Inline routine RRRT executing.

04RRRTXX - Inline routine RRR, Test T, Error code XX, the following 32 bytes are SEWs and the 8 words following are the FRUs.

050E07XX - Parameters, Options modified/loaded.

08XX0000 - SD Diagnostic execution status.

XX Bit 0, 1, 4, 5, 6, 7 - Not used
2 - Channel Config. status/EEL running
3 - Channel Inlines running

If the diagnostic load command control byte was 0700, the following 18 bytes are the selection timeout status, run options, and parameters.

Subsequent Error Word Definitions:

Refer to the Troubleshooting Guide publication number 83337540.

Field Replaceable Unit Word Definitions:

Refer to the Troubleshooting Guide publication number 83337540.

0074 - CHANGE 895 IN-LINE PARAMETERS

This function will allow the host to change the default parameters that were returned during the function (0073). This function will also read the changed parameters back from the SD and verify them. Refer to the CDC 895 Disk Storage Subsystem Hardware Diagnostic Reference Manual publication number 83337530 for parameter selection.

Parameters: The 16 parameter words are defined as follows. The 4 MSBS are always zero.

PW1 = 1H
2 = 1L
3 = 2H
4 = 2L
5 = 3H
6 = 3L
7 = 4H
8 = 4L
9 = 5H
10 = 5L
11 = 6H
12 = 6L
13 = 7H
14 = 7L
15 = 8H
16 = 8L

The XH is the SD parameter byte X high order byte and XL is the low order byte. Refer to the 895 inline reference manual (publication number 83337530) for detailed descriptions of each parameter.

The following status will be returned to a General Status function.

Status	Description
0000	Parameters changed without error.
0010	SD busy, delay 1 s and reissue function (0074) and parameters.
5000	Coupler error, issue extended detailed status function (0023).
5020	Device malfunction, issue extended detailed status function (0023).
5200	Coupler error detected in changed parameters, issue sense 895 in-lines function (0073).

0075 - START 895 IN-LINES

This function starts execution of the previously selected 895 in-line routine with the default parameters or the parameters changed with function (0074).

Parameters: None

The following status will be returned with this function.

Status	Description
0002	Routine started without error.
0010	SD busy, delay 1 s and reissue function (0075).
5000	Coupler error, issue extended detailed status function (0023).
5020	Device malfunction, issue extended detailed status function (0023).
5200	SD/DP error detected. Issue sense 895 in-lines function (0073).

0076 - MONITOR 895 IN-LINE

This function monitors the execution of the selected 895 in-line routine and prepare status for it.

Parameters: None

The following status will be returned with this function.

Status	Description
0000	Completed without error.
0002	Still busy, delay 1 s and reissue function (0076).
0010	SD busy, delay 1 s and reissue function (0076).
5000	Coupler error, issue extended detailed status function (0023).
5020	Device malfunction, issue extended detailed status function (0023).
5200	SD error detected. Issue sense 895 in-lines function (0073).

0077 - HALT 895 IN-LINE

This function instructs the SD to halt the execution of any 895 in-line diagnostic routine.

Parameters: None

The following status will be returned with this function.

Status	Description
0000	SD accepted the halt control byte.
0010	SD busy, delay 1 s and reissue function (0077).
5000	Coupler error, issue extended detailed status function (0023).
5020	Device malfunction, issue extended detailed status function (0023).
5200	SD error detected. Issue sense 895 in-lines function (0073).

0414 - AUTOLOAD COUPLER MICROCODE FROM PP

The CYBER DI will decode the autoload function, light four LED's, stop the processor and cause the FSC DI to go to an idle loop. The CYBER DI will then execute its UDI diagnostic. If its diagnostic runs, it will turn off its LED and start the processor executing at address 8000 hex in ROM. The processor will execute an instruction test. If it runs the processor will turn out its LED and then execute a processor/CYBER DI interaction test. If it executes without error a third LED will be turned off. Following this, the processor will instruct the 895 Channel DI to execute its UDI diagnostic and turn off its LED if successful. The autoload function will then be replied to if all the above diagnostics execute without error. The lower 8 bits of each consecutive word output by the PP are transferred alternately to upper then lower byte positions of consecutive coupler memory locations beginning at address 30 hex. The coupler remains in autoload mode until the PP disconnects the channel.

If a full autoload is being done, processor firmware will do a memory test after the eighth word is received from the channel. If the memory test was successful, the processor firmware will complete the autoload. When the PP disconnects the channel, the processor firmware will calculate a checksum from the data loaded. If there was a memory test error or a checksum error, the processor will stop. The channel will be inactivated by the Deadman Timer. If no error, processor/895 DI interaction tests will be executed. These are part of the downloaded microcode. If the interaction tests fail, the equipment switch is wrong or the microcode number in the binary is wrong, General Status will be 5XXX where XXX is an error code described in section 4. If no error, a release will be issued to all devices addressable by the coupler. General Status will be set to zero. The processor will go to an idle loop which looks for functions from the PP.

06uu - AUTOLOAD COUPLER MICROCODE FROM DISK

NOTE

Microcode must have previously been written on the disk in full track mode (1:1 interlace).

This function starts the coupler executing the same diagnostics as in a full autoload coupler microcode from PP function (0414). If the diagnostics execute without error, processor firmware checks coupler hardware switches to determine which device to load from. If switches 2 and 4 are off, the disk subsystem is selected and the device whose number is in the function is positioned to the factory map cylinder. When the device is on-cylinder, data is read from the disk into coupler RAM.

After the coupler RAM is loaded with microcode data, the coupler firmware calculates a checksum and compares it with the correct value. If there is a checksum error, a function parity error, the microcode number is wrong, or a failure to load coupler RAM from the device, a function reply is not returned to the PP. If the coupler RAM is successfully loaded, a function reply is returned to the PP, the disk device is released, and a jump is made to the coupler ROM idle loop.

0770 – CYBER CHANNEL COUPLER ID REQUEST

This function is used by the operating system to determine if the host CPU is connected to a CYBER channel coupler. The CCC responds to this function with a 6314 (octal) code. This function is available for use before and after microcode is loaded into CCC memory.

33uu - DISK DEADSTART FROM DEVICE

This function positions the selected device to the deadstart record and transfers data from device to coupler to PP. The first word in the deadstart record must specify the number of words to be transferred. When the transfer of data completes, the coupler releases the device. If data cannot be read into coupler memory, the microcode retries the read operation as long as the function is present. The microcode protects the data in the deadstart record by checking the address in the seek function (0001). The write protected record function (0037) is used to write a bootstrap program into the deadstart record. The seek address contains the following deadstart records: Cylinder - 885, track - 0.

DISK PACK INITIALIZATION

Each disk pack track has the same basic format: home address, track descriptor record, and data records. All disk packs are initialized at the factory with a home address and a track descriptor record written on all tracks. Any defective track is flagged, and an alternate track is assigned.

The data records must be written by the user with a utility program.

Cylinder 885 comes from the factory with the alternate bit set in the flag byte of the home address. Tracks 0 and 1 of this cylinder are designated as a protected area by the CCC microcode; they are used by the operating system and during CCC microcode autoloading. Therefore, this cylinder must be formatted in track mode and the home address rewritten for each track, in order to clear the alternate bit. Small records of 483 8-bit bytes (322 12-bit PP words) must be used.

To prevent the director from automatically positioning to alternate tracks, the pack should be scanned, and a utility map containing a list of the defective tracks should be written. The utility map can be read to determine which tracks not to use. The track descriptor record, which contains the alternate track address, should be written to contain its own address. This guarantees that a write to a defective track gives an error, and that no automatic recovery by an attempt to write an assigned alternate track will occur. If a utility map is used, all tracks not listed in the map can be used by the PP.

The following procedure is recommended to initialize a pack.

1. Seek to cylinder x using seek 1:1 interlace function (0001 or 0002). Cylinder x equals cylinder 0, 1, . . . through 885.

2. Scan cylinder using scan cylinder function (0047).

3. Request general status (function code 0012).

4. Repeat general status request, if general status is 0002.

5. Request extended detailed status (function code 0023), if general status is 5xxx, and report detailed status error.

6. Read buffer using UDI read function (0032). Save scan cylinder data.

7. Increment cylinder x by 1. (New cylinder x equals old cylinder x plus 1.)

8. Repeat steps 1 through 7 if x is not greater than 885 (630-megabyte device).

9. Format all tracks on cylinder 885 using format pack function (0016). Use small records of 483 bytes. Use mode decode 0 and operation decode 0 (or operation decode 1 if track is defective). The disk pack is unusable if track 0 is defective.

10. Seek to pack serial number map address.

11. Write pack serial number using write protected record function (0037).

12. Seek to utility map address.

13. Write a list of defective tracks using write protected record function (0037).

14. Format cylinder x using formrt pack function (0016). Cylinder x equals cylinder 0, 1, . . . through 884.

15. Request general status (0012).

16. Repeat general status request if general status is 0002.

17. Request detailed status if general status is 5xxx, and report detailed status error.

18. Increment cylinder x by 1. (New cylinder x equals old cylinder x plus 1.)

19. Repeat steps 14 through 18 if x is not greater than 884.

Defective tracks can be added or deleted by reading the utility map (function 0031), formatting the pack (function 0016), and writing the utility map (function 0037) to reflect the change.

The skip displacement (SD) bytes in the home address provide the displacement (in segments) from the index to the starting segment of the first track defect. The coupler microcode enables the PP to read the SD bytes. The information from the scan cylinder function (0047) can be used to write the SD bytes in the home address of each track.

The SD bytes in the home address include those written at the factory and any additional SD bytes that may have been added by utility programs since the unit left the factory. The coupler microcode also allows the PP to read cylinder minus 3 (function code 0027). This cylinder contains records of the home address skip displacement data at the time of manufacture for the entire disk device.

MICROCODE IDENTIFICATION

The microcode contains the identification information shown in table 3-15.

Table 3-15. Microcode Identification

Coupler Memory Address (Hexadecimal)	Value (Hexadecimal)	Description
38	XXXX	Expected memory checksum.
39	XXXX	Actual memory checksum.
3B	XXXX	Last address to checksum.
3C	A464	Last four digits of microcode part number.
3D	000R	Microcode revision number.

The first two 12-bit words of the binary are loaded into location 30 (hexadecimal). These locations can be checked with the diagnostic load address and length function (X5xx) and the diagnostic read function (X701) (see page 4-1).

DATA TRANSFER PROGRAMMING REQUIREMENTS

The following are programming requirements for data streaming large and small records between the PP and the 895 Disk Storage Subsystem. Small records contain 483 bytes of data (322 12-bit PP words); large records are any that are of greater length.

- A general status request must not be issued from the PP between consecutive read or write functions for large records. The CCC interprets the receipt of a general status request after either a series or a single read or write function as the end of that read or write sequence. The next read or write function after a general status must be preceded by a seek function.

- If the CCC microcode detects a data error during a data stream read or write function, the microcode does not reply to the PP on the read or write function that immediately follows the function on which the error was detected. The CCC stops processing data and loops until it receives a general status request. The microcode expects the PP to time out after not receiving a reply from the read or write function in one revolution time of the disk (approximately 17 ms), and issues a request for general status.

- To remain compatible with current software, the CCC microcode expects a general status request to be issued from the PP between consecutive read or write functions for small records (322-12 bit PP words).

RECOMMENDED READ/WRITE PROCEDURES

A status of 4A or 4E from the SCU results in a general status of 4400. When the continue function is received from the PP, the microcode waits for a Request-In signal from the correct unit and chains into the retry function of the failing command.

The recommended procedures for writing or reading 10 260 12-bit word records on a 895 Disk Storage Unit follow.

A. SEEK OPERATION

1. Issue the seek function (0001) or (0002).
2. Go to step D1 if the function is not replied to within 500 ms.
3. Activate the channel.
4. Output four parameter words with the OAM (73cc) instruction.
5. Go to step D1 if the A register is not 0 after the output.
6. Go to step D1 if the channel is not empty within 1 ms.
7. Disconnect the channel.
8. Perform a general status function (procedure D).
9. If general status is 0002, the storage control unit or drive is busy. Return to step A1.
10. The seek has completed without error. Go to step B1 to write data or to step C1 to read data.

B. WRITE OPERATION

1. Issue a write function (0005).

2. Go to step D1 if the function is not replied to within 20 ms.

NOTE

> If writing consecutive records, this function reply indicates the previous write has completed without error.

3. Activate the channel.

4. Output 10 260 12-bit words with an OAM instruction. To prevent an overrun, the output must start within 20 s after the reply to the write function and must complete within 5200 s.

5. Go to step D1 if the A register is not 0 after the output.

6. Go to step D1 if the channel is not empty within 1 ms.

7. Go to step D1 if the channel error flag is set.

8. Disconnect the channel.

9. Return to step B1 to write the next consecutive disk record.

10. Perform a general status function (procedure D) to determine if the write of the last record was successful.

C. READ OPERATION

1. Issue the read function (0004).

2. Go to step D1 if the function is not replied to within 20 ms.

NOTE

If reading consecutive records, this function reply indicates the previous read has completed without error.

3. Activate the channel.

4. Input 10 260 12-bit words with an IAM (71cc) instruction. To prevent lost disk revolutions between consecutive reads of records, the PP must complete the input within 5200 μs after it receives the first full.

5. Go to step D1 if the A register is not 0 after the output.

6. Go to step D1 if the error flag is set.

7. Go to step D1 if the channel is not inactive within 1 ms.

8. Disconnect the channel.

9. Return to step C1 to read the next consecutive record.

10. Perform a general status function (procedure D) to determine if the read of the last record was successful.

D. GENERAL STATUS FUNCTION

1. Disconnect the channel if active.
2. Issue the general status function (0012).
3. Go to step E1 if the function is not replied to within 500 ms.
4. Activate the channel.
5. Input one word of status with the IAM instruction.
6. Go to step E1 if the A register is not 0 after the input.
7. Go to step E1 if the channel is not inactive within 1 ms.
8. Go to step E1 if the error flag is set.
9. If general status bit 11 is set, go to step 14.
10. If a previous error occurred, such as function timeout, nonzero word count, channel not empty or channel not inactive, go to step E1.
11. If general status is 0000, the previous command has completed without error. Exit this routine.
12. If general status is 0002, and the previous command is a seek, the drive or storage director is busy. Exit this routine.
13. An undefined value for general status has occurred. Go to step E1.
14. Perform general status function.
15. If bit 8 of general status is not set, go to step E1.
16. Either a data field checkword error or an error requiring command retry between the CCC and SCU has occurred. Issue a continue function (0014).
17. Return to step D1 if the function is not replied to within 500 ms.
18. Return to step 3 of the write or read routine being executed when the error occurred.

E. RECOVERY SEQUENCE

1. If a general status function timeout occurred, go to step 6.
2. If the operation has not been repeated x times, issue a seek with an address equal to the first record not successfully read or written. If general status after the seek is 0000, go to either step B1 (if a write) or to step C1 (if a read) to repeat the failing operation.
3. If a reload of CCC microcode has already been done for this operation, go to step 9.
4. Reload CCC microcode. If the reload fails, the CCC is unusable.
5. Issue a seek with an address equal to the first record not successfully read or written. If general status after the seek is 0000, go to step B1 (if a write) or to step C1 (if a read) to repeat the failing operation.
6. Perform read CYBER register file 1 operation (procedure F).
7. If bit 0 of CYBER register file 1 is set, or status could not be read, go to step 3.
8. Go to step 2.
9. The drive is unusable. To provide FRU isolation, run SCU and drive diagnostics.

F. READ CYBER REGISTER FILE 1 OPERATION

1. Issue the read CYBER register file 1 function (X704).
2. Go to step 8 if the function is not replied to within 500 ms (status, see page 4-2).
3. Activate the channel.
4. Input one word of status with the IAM instruction.
5. Go to step 8 if the A register is not 0 after the input.
6. Go to step 8 if the channel is not inactive within 1 ms.
7. Go to step 8 if the error flag is set.
8. Exit to calling routine.

TROUBLESHOOTING 4

This section describes the CYBER channel coupler maintenance features available to aid the user in isolating subsystem malfunctions. Information is presented under the following major headings.

- Peripheral Processor Diagnostic Functions
- Disk Error Recovery Procedures
- CYBER Channel Coupler Maintenance Features
- Extended Error Log

PERIPHERAL PROCESSOR DIAGNOSTIC FUNCTIONS

Seven PP diagnostic functions are decoded by the CYBER channel interface independent of processor instructions and are not part of the microcode or firmware. The operation (op) codes for these functions are in octal notation and described in the following paragraphs.

- X5xx - Load Address and Length
- X701 - Read
- X702 - Write
- X704 - Status
- X710 - Stop
- X720 - Go
- X740 - Master Clear

X5xx - LOAD ADDRESS AND LENGTH

This function allows the PP to activate the channel and output one or two data words. The lower 4 bits (xx) of the function are loaded into the upper four bit positions of the 16-bit address register. The first word sent by the PP is loaded into the lower 12 bit positions to complete the loading of the address register.

The second word sent by the PP is loaded into the lower 12 bit positions of the 16-bit length register; the upper four bit positions are zero-filled.

The channel interface responds only to the first two words sent by the PP, and a hung channel may result if the PP attempts to send additional words. This function also clears register file 1 (status).

X701 - READ

This function allows the PP to activate the channel and input the length count times 2 words. The upper 8 bits of the 16-bit word referenced by the address register are transferred as the lower 8 bits of the first 12-bit channel word; the upper 4 bits are zero-filled. The lower 8 bits of the 16-bit word are transferred in the same manner as the upper 8 bits. The address is incremented, the length is decremented, and the PP input process continues until the length equals 0; the CYBER channel interface then inactivates the channel. The PP may terminate the operation early if desired.

In order for the data to be valid, the address and length must be loaded prior to sending this function. A check for memory parity errors is made at the end of the data transfer, and the results are logged in register file 1 (status).

X702 - WRITE

This function allows the PP to output the desired number of words. Only the address register is loaded by diagnostic function 05xx; the length register is not used.

The lower 8 bits of the first 12-bit word received by the coupler are loaded into the upper eight bit positions of a holding register. The lower 8 bits of the second 12-bit word are loaded into the lower eight bit positions of the holding register. The contents of the holding register are then sent to memory.

This process continues for additional words sent by the PP. The word transfer is terminated by an inactive signal from the channel. To ensure that data is written into the correct memory location, the address register must be loaded prior to every X702 function received by the coupler. If an odd number of words are received from the channel, the lower 8 bits of the last word sent to memory are zero-filled.

X704 - STATUS

This function allows the PP to activate the channel and input one word of status from register file 1. The CYBER channel interface inactivates the channel after it sends the status word. This word contains the following status bits.

NOTE

Bit 11 is the most significant bit.

Bit	Description
11	Normal end
10	Channel parity error
9	Memory parity error
8	Deadman timeout
7	Control package parity error
6	Transfer indicator

Bit	Description
5	Character fill
4	Not used
3	Length is 0
2	DMA complete
1	Processor running
0	Processor abnormal

Bits 11 through 5 reflect the last status sent to memory location 0024 (hexadecimal) following a processor operation. Diagnostic function 05xx clears bits 11 through 5. Only bits 10 through 8 of these bits are valid for diagnostic purposes, as the others are processor-controlled bits. Bits 3 through 0 are dynamic status bits, which indicate the state of the logic at the time the function is received.

X710 - STOP

This function causes the processor to stop running.

X720 - GO

This function allows the processor to start running.

X740 - MASTER CLEAR

This function clears processor and device interface logic.

DISK ERROR RECOVERY PROCEDURES

The PP can initiate standard error recovery procedures after the coupler detects a hardware malfunction. Whenever a malfunction occurs for which error recovery is possible, the coupler notifies the PP via general status (abnormal termination and recovery in progress). The PP should respond by requesting detailed status for subsequent error file logging, after which it should issue a continue function (0014) to initiate the next logical error recovery procedure.

A data transmission operation, including error recovery procedures, should be processed as follows:

1. The PP issues a seek function, which results in the coupler selecting the designated drive and positioning the read/write heads at the specified cylinder. If so directed by the PP, the coupler performs seek operations on other drives concurrently with a data transfer (seek overlap).

2. After issuing all necessary seek functions, the PP waits for a drive to become on-cylinder. The appropriate data transfer function is then issued.

READ FUNCTION ERROR RECOVERY SEQUENCE

A typical read function error recovery sequence is as follows:

1. Issue seek function.

2. Take general status.

3. If bit 1 is set, the control unit or device is busy. Return to step 1 as required.

4. If bit 11 is set, take detailed status for error logging, return to step 1, and abort the operation if errors continue.

5. If general status is 0000, proceed.

6. Issue read function. (If an error occurs and the channel is active, the coupler terminates the block transfer.)

7. Save word count.

8. Take general status.

9. If general status is 0000, the remaining word count is 0, and more records are to be read, return to step 6. If all records have been read, exit the sequence.

10. If bits 11 and 8 are set, take detailed status, issue the continue function, and then return to step 7.

11. If bits 11 and 9 are set, take detailed status for error logging, return to step 1, and abort the operation if errors continue.

12. If remaining word count is not 0, return to step 1 and abort the operation if errors continue.

WRITE FUNCTION ERROR RECOVERY SEQUENCE

A typical write function error recovery sequence is as follows:

1. Issue seek function.

2. Take general status.

3. If bit 1 is set, the control unit or device is busy. Return to step 1 as required.

4. If bit 11 is set, take detailed status for error logging, return to step 1, and abort the operation if errors continue.

5. If general status is 0000, proceed.

6. Issue write function and wait for a reply. If this is the last record of a block of records to be written, do one of the following.

   - o Issue write last record function (0035) instead of write function.

   - o Follow write function with two general status functions.

7. If a function reply is received, go to step 14.

8. Take general status.

9. If general status 0000, return to step 1 and abort the operation if errors continue.

10. If general status is not received, issue zero-word autoload, return to step 1, and abort the operation if errors continue.

11. If general status is not 0000, take detailed status.

12. If bit 11 of detailed status word 18 is set, retry the write of the previous record. Use the DMA read function (0043) to obtain the record of data to be rewritten. Then return to step 1 or 6.

13. If bit 11 of detailed status word 18 is not set, return to step 1 and abort the operation if errors continue.

14. Activate the channel and output 322 words. (If an error occurs and the channel is active, the coupler terminates the block transfer.)

15. Save the word count.

16. Take general status.

17. If general status is 0000, the remaining word count is 0, and more records are to be written, return to step 6.

18. If general status is 0000, the remaining word count is 0, and this is the last record to be written, go to step 22.

19. If bits 11 and 8 are set, take detailed status, issue the continue function, and then return to step 7.

20. If bits 11 and 9 are set, take detailed status for error logging, return to step 1, and abort the operation if errors continue.

21. If remaining word count is not 0, return to step 1 and abort the operation if errors continue.

22. If write last record function was used, then exit sequence.

23. Take general status.

24. If general status is 0000, exit the write sequence.

25. If general status is not 0000, take detailed status for error logging, return to step 1, and abort the operation if errors continue.

CYBER CHANNEL COUPLER MAINTENANCE FEATURES

The following paragraphs describe the maintenance features applicable to the CYBER channel coupler.

CYBER CHANNEL INTERFACE DIAGNOSTIC FUNCTIONS

The CYBER channel interface has two separate paths through which PP data can reach the coupler memory. One path uses the universal device interface (UDI) module and assembles data under microcode control. The other path uses direct memory access (DMA) to assemble data under hardware control. The following function codes are used to test these paths. Also listed is the scan cylinder function used to obtain a list of defective tracks and skip displacement (SD) bytes on a cylinder.

- 0032 - UDI Read
- 0033 - UDI Write
- 0043 - DMA Read
- 0044 - DMA Write
- 0047 - Scan Cylinder

Refer to the descriptions in section 3 for details of operation.

CHANNEL INTERFACE DIAGNOSTICS FUNCTION

The run SCU interface diagnostics function (0070) is used to test the 7165 device interface. This function allows the PP to run the same 7165 device interface diagnostics that are run during a full autoload coupler microcode from PP function (0414). Refer to 0070 - Run SCU Interface Diagnostics in section 3 for details of operation.

COUPLER INTERNAL DIAGNOSTIC ERROR CODES

The coupler generates and returns to the PP various error codes detected by the internal diagnostics. The internal diagnostics are run during an autoload microcode from autoload coupler microcode from PP function (0414), an autoload coupler microcode from disk function (06uu), and a run SCU interface diagnostics function (0070). If the internal coupler diagnostics detect an error, the coupler returns a general status of 5xxx (xxx is the octal error code). The error codes are:

General Status (Octal)	Error Description
5100	Equipment switch settings (SW1-2, SW1-3, and SW1-4 on module A05 of the coupler) do not indicate a valid equipment type.
5121 - 5137	Normal end did not set in the ending status word after a load transfer registers function.
5141 - 5157	Normal end did not set in the ending status word after a read transfer registers function.
5160	Tranfer register data miscompare.
5161 - 5177	Normal end did not set in the ending status word after a diagnostic write sequence.
5200	Full/empty counter is incorrect after a diagnostic write sequence.
5201 - 5217	Normal end did not set after a read block ID function.
5220	Block ID is incorrect after a diagnostic write sequence.
5221 - 5237	Normal end did not set in the ending status word after a diagnostic read function.
5250	Diagnostic read pattern is incorrect.
5251	Transfer register error occurred after a diagnostic read function.
5252	Block ID is wrong after a diagnostic read function.
5253	7165 interface sequence did not complete.
5254	Data stream diagnostic read timeout occurred.
5255	Data stream diagnostic write timeout occurred.
5261 - 5277	Data stream diagnostic read status is not normal end.

General Status (Octal)	Error Description
5300	Data stream diagnostic read block ID is wrong.
5311 - 5327	Data stream diagnostic write status is not normal end.
5330	Data stream diagnostic write block ID is wrong.
5401	System reset error occurred after checksum during autoload from PP function.
5402	CYBER interface status error occurred after an autoload from PP function.
5403	RAM checksum error occurred after autoload.
5404	RAM memory test error occurred before the autoload from PP function started.
5501	Seek or recalibrate sequence timeout from disk device occurred.
5502	Recalibrate or seek error from disk device occurred.
5503	Seek sequence occurred ending status error from disk device.
5504	Search error from disk device occurred.
5505	Read data error from disk device occurred.
5507	System reset sequence error from disk device occurred.
5510	Search/read sequence timeout from disk device occurred.

CYBER CHANNEL PARITY ERROR DETECTION AND PROCESSING

CYBER channel parity errors are detected on all PP functions and all PP read/write operations to the coupler. The following paragraphs describe the types of channel parity errors and their methods of processing.

Parity Error on Function From PP

The coupler does not reply if the PP sends a function with a parity error. The PP must time out the function to avoid hanging the channel. After the timeout, the PP should disconnect the channel and resend the function to the coupler. The operation must be aborted if parity errors continue.

Parity Error on PP Write

After detection of a parity error on a PP write function, the PP completes the write operation in a normal manner. The PP should then send a general status function (0012) to the coupler. The coupler microcode prepares the status words in its memory and returns a general status of 5000 to the PP. The PP should then send an extended detailed status function (0023) to the coupler, and the coupler responds with bit 6 of detailed status word 18 set to indicate a write parity error. The PP should resend the write function and parameters or data to recover from the parity error. The operation must be aborted if parity errors continue.

NOTE

> If parity errors occur during general or extended detailed status functions, refer to Parity Error on Function from PP and Parity Error on PP Read.

Parity Error on PP Read (Parameters or Data)

The PP should test the appropriate bit in the status and control register after the data block input. This must be done prior to sending the next function. The coupler microcode does not detect a parity error on a PP read, and only general status indicates a coupler error. The PP must take one of the following actions after detecting the parity error.

- Resend the function and reread the parameters or data.
- Reseek and read the record.
- Reseek and read the block of records.
- Abort the operation if parity errors continue.

DEADMAN TIMER FEATURE

The coupler hardware incorporates a deadman timeout feature that prevents the PP channel from hanging for an extended period of time. The deadman timer is enabled for all functions that transfer data between the PP and the coupler. Each time a Full or Empty signal is transferred across the channel, the deadman timer is reset to 0, and the timeout period is reinitiated. When the PP inactivates the channel, the deadman timer is set to 0. If a data transfer hangs up, a timeout period of from 7 to 10 s expires and an Inactive signal is sent to the PP.

For read/write functions to the disk, DMA write operations, and DMA read operations, the microcode prevents deadman timeouts. If the data transfer does not complete or the channel is not inactivated for these functions, the microcode inactivates the channel. General and detailed status describe the error.

For the remaining functions that transfer words between the PP and the coupler (connect, seek, format pack, and UDI write), the deadman timer is used. A general status of 5000 and a deadman timeout status in detailed status word 18 are returned for these functions, if the deadman timer unhangs the channel.

EXTENDED ERROR LOG

The 895 Disk Storage Subsystem provides extended error logging capabilities through use of the request extended error log (0024), input extended error log (0025), and read cylinder minus 3 (0027) functions. These functions are described in section 3.

The purpose of the extended error logging system is to store error information that:

- Can be accessed by the customer engineer to speed the diagnosis and repair of intermittent errors.
- Can be used for long-term analysis.

The extended error log (EEL) data resides on a flexible disk storage device in the storage control unit (SCU) cabinet. Data in the EEL is available for transmission via the remote terminal assistance (RTA) port. It can also be transferred via the block multiplexer channel to the host CPU. The format of the EEL data is described in appendix C of this manual.

GLOSSARY

Address Field	Alternative name for count area.
CCA	Connection/check alert.
CCC	CYBER channel coupler.
CCW	Channel command word.
CKD	Count/key/data.
Count Area	The part of a record defining the record status, cylinder/head/record number, and the data length of the record.
CPU	Central processing unit.
CYBER Channel Coupler	Provides the hardware connection between a Disk Subsystem and a CYBER 170/180 Computer System.
Cylinder	All the tracks at a given accessor position.
Disk Storage Device	A rotating mass storage access mechanism.
DMA	Direct memory access.
DP	Diagnostic processor.
Drive	Alternative name for device.
DSU	Disk storage unit.
DTI	Device tag-in.
ECC	Error correction code or circuit.
EEL	Extended error log.
FAT	Format allocation table.
FDD	Floppy disk drive.
FFU	A MALET format utility program for performing maintenance functions on devices connected to the CYBER channel coupler.
FID	Format index directory.
Firmware	The processor program that resides in read only memory (ROM).
FRU	Field replaceable unit.
GMP	Good machine path.

HA	Home address.
HDA	Head/disk assembly.
Head	Defines the unique track at an accessor position.
Home Address	An area at the beginning of a track, following the index point, which defines track status, cylinder number, and head number.
HSC	Head-of-string controller.
HUI	Hardware unique identifier.
IML	Initial microprogram load.
Index Point	Marks indicating the start and end of a track.
I/O	Input/output.
Microcode	A processor program that executes in the coupler and that performs interface and control functions previously performed by hardware logic. It is delivered to the user on prerecorded media in machine executable code form only.
OAM	Output A words from memory.
OP	Operation.
PCI	Program-controlled-interruption.
PP	Peripheral processor.
PRU	Physical record unit.
PROM	Programmable read only memory.
RAM	Random access memory.
Record	All the information at a given cylinder/head/record address; includes a count and a data area.
ROM	Read only memory.
RTA	Remote terminal assistance.
SCU	Storage control unit is the cabinet that contains two storage directors (SD), a diagnostic processor (DP), and a floppy disk drive. The floppy disk contains the microcode for the SDs and the DP.
SD	Skip displacement or storage director.
SEW	Subsequent error words.
Storage Director (SD)	Provides control over the attached disk storage devices; physically connected between coupler and devices.
Track	All the information at a given cylinder/head address.

UDI	Universal device interface.
Utility Map	The record that can be edited and that lists all the tracks that can't be written with the write function (0005).
XES	Transfer error status.

MICROCODE IDENTIFICATION

The microcode binary contains identification information shown in table B-1.

Table B-1. Microcode Identification

Memory Address (Hexadecimal)	Value (Hexadecimal)	Description
38	XXXX	Expected memory checksum.
39	XXXX	Actual memory checksum.
3B	XXXX	Last address to checksum.
3C	A464	Last four digits of microcode number.
3D	000R	Microcode revision number.

The first two 12-bit words of the binary are loaded in location 30 (hexadecimal). These locations can be checked with the load address and length (X5xx) (octal) and read (X701) (octal) functions.

EXTENDED ERROR LOG FORMAT C

This appendix describes the extended error logging capabilities of the 895 Disk Storage Subsystem. The extended error log (EEL) data resides on a floppy disk storage device in the cabinet of the 7165 Mass Storage Controller. Data in the EEL is available for transmission via the remote technical assistance (RTA) port. It also can be transferred to the host CPU via the block multiplexer channels.

EXTENDED ERROR LOGGING SYSTEM

The extended error logging system consists of several utility programs that are stored on the floppy disk drive. They are called in and executed by either the storage control unit, called the storage director (SD), or by the customer engineer via the RTA interface or local terminal connected to the 7165 controller.

The purpose of the EEL system is to store error information that:

- Can be accessed by the customer engineer to speed the diagnosis and repair of intermittent errors.
- Can be used for long-term analysis.

There are five modules that compose the callable utility routines associated with the extended error logging system (EEL, DEEL, REEL, SEEL, WEEL).

Module	Description
DEEL	The module used to display an error record to the RTA interface or terminal.
REEL	The module called by the SD to read error log information from the floppy disk and to transmit the information to the SD (the SD calls this module after receiving a request for information from the host CPU).
SEEL	The module used to summarize error information to the RTA interface or terminal.
WEEL	The module called by either the SD or diagnostic processor (DP) to log error records to the floppy disk.
WEL30	The module called by the DP to log maintenance panel error records to the floppy disk.
EXEL/DXEL	The module used to enable/disable the extended error logging system.

ERROR RECORDING

Error information is generated each time unit check status is posted to the CPU channel. This information is gathered by the SD or, when the SD is hardstopped, by the diagnostic processor (DP).

All error log entries have, as a minimum, 24 bytes of sense information in one of the following IBM-designated formats.

Format	Description
0	System or program checks
1	DSU check 2 errors
2	SD check 2 errors
3	SD check 1, channel check 1, SD timeout errors
4	Data check (without displacement information)
5	Data check (with displacement information)
6	Usage statistics and overrun errors
7	HSC check 1 errors
8	DSU check 1 and check 2 errors
30	Maintenance panel errors

With the exceptions for format 0 which follow, suppression by utility command, and with the limitations listed in Error Buffering in this section, all such error information is logged on the error log of the respective SD.

NOTE

Format 3 entries are reported to the system by the nonfailing SD contained within the same cabinet. However, the nonfailing SD does not log to the EEL any format 3 entries received, because the diagnostic processor has already logged that error for the failing SD.

No entry is made into the error log for the following format 0 program error checks.

Program Error Check	IBM Sense Byte	IBM Sense Bit
Command reject	0	0
Intervention required	0	1
Invalid track format	1	1
End of cylinder	1	2
No record found	1	4
File protected	1	5
Intent violation	2	4
Imprecise ending	2	5

LOG ENTRY STRUCTURE (IDENTIFIER)

The error log entry structure consists of 8 bytes of header information and 24 or more sense/error bytes in the following standard record format.

Bytes	Information
0 - 7	Header ID
8 - 31	Sense information based on device

Refer to section 3 for a detailed description of the contents of the sense bytes. Descriptions of the header ID and of standard error information follow.

HEADER ID

Byte	Bit	Description
0	0, 1	Reserved for extended format codes.
0	2	This bit is 0.
0	3	**Value** / **Description** 0 No duplicate records encountered. 1 Duplicate records encountered.
0	4 - 7	High order of entry stamp.
1, 2		Error log entry stamp. A binary count is used for each SD log. The count is incremented for each new log error written and wraps to 0 from 1 048 575.
3	0 - 3	Month.
	4 - 7	Day (tens).
4	0 - 3	Day (units).
	4 - 7	Hour (tens).
5	0 - 3	Hour (units).
	4 - 7	Minute (tens).
6	0 - 3	Minute (units).

NOTE

All numbers in the data are in hexadecimal base 10, that is, x´0´ (0) to x´9´ (9). The month is an exception; it is represented x´1´ (1) to x´C´ (12).

Byte	Bit	Description
6	4	This bit is 0.
	5 - 7	Channel interface ID:

Value	Description
0 - 7	Interface A to interface H.

Byte	Bit	Description
7		Failing command code.

The following is an example of the header bytes.

Byte \ Bit	0	1	2	3	4	5	6	7
0	0	0	0	D	High 4 Bits Entry			
1	Entry							
2	Stamp							
3	Month				Day			
4	Day				Hour			
5	Hour				Minute			
6	Minute				0	Chan Interrupt ID		
7	Failing Command Code							

STANDARD ERROR INFORMATION

Sense Format 3 – Hardware-Detected and Microcode-Detected Errors

Byte	Description
0 - 7	Header bytes
8 - 15	Common sense bytes
16	Not used
17	XES register
18	CHK register
19	CRO register
20	CS2 register
21	CC1 register
22	CC2 register
23	CS1 register
24	CS3 register
25	CXC register
26	CBO register
27	CBI register
28	Timeout message with FSC 3F2x; otherwise, interrupt level.
29	Storage director identifier
30, 31	Fault symptom code

Storage director before SSM loop:

Byte	Description
32 - 36	SSM loop 80 (ECC status)
37 - 40	SSM loop 88 (ECC status)
41 - 44	SSM loop 90 (useq status)
45 - 50	SSM loop 98 (useq status)
51 - 58	SSM loop A0 (pseq status)

Byte	Description
59 - 63	SSM loop A8 (pseq status)
64 - 68	SSM loop B0 (ALU/shift status)
69 - 72	SSM loop B8 (ALU/shift status)
73 - 78	SSM loop C0 (DATA/CTL status)
79 - 86	SSM loop C8 (ADDR/CTL status)
87 - 91	SSM loop D0 (ADDR/CTL status)
92 - 99	SSM loop D8 (DATA MEM status)
100 - 106	SSM loop E8 (DATA MEM expansion)
107 - 110	SSM loop F0 (breakpoint)
111	SSM loop F8 (halt enable)

Storage director after SSM loop:

Byte	Description
112 - 116	SSM loop 80 (ECC status)
117 - 120	SSM loop 88 (ECC status)
121 - 124	SSM loop 90 (useq status)
125 - 130	SSM loop 98 (useq status)
131 - 138	SSM loop A0 (pseq status)
139 - 143	SSM loop A8 (pseq status)
144 - 148	SSM loop B0 (ALU/shift status)
149 - 152	SSM loop B8 (ALU/shift status)
153 - 158	SSM loop C0 (DATA/CTL status)
159 - 166	SSM loop C8 (ADDR/CTL status)
167 - 171	SSM loop D0 (ADDR/CRL status)
172 - 179	SSM loop D8 (DATA MEM status)
180 - 182	SSM loop E0 (configuration)
183 - 189	SSM loop E8 (DATA MEM expansion)
190 - 199	10 bytes reserved

DP ports at time of error alert:

Byte	Description
200	CLKSTAT (DP port 40)
201	OVSTAT (DP port 5C)
202	PCUSTAT (DP port 24)
203	DEVSTAT (DP port 25)
204	STATPCU (DP port 26)
205	DPCKST (DP port 58)
206 - 215	Ten bytes reserved

SD ports at time of error alert:

Byte	Description
216	CC1 (SD port 15)
217	CSC (SD port 17)
218	DBO (SD port 18)
229	DTG (SD port 19)
220	DTO (SD port 1A)
221	DXC (SD port 1B)
222	MCS (SD port 1C)
223	CS1 (SD port 04)
224	CS2 (SD port 05)
225	CS3 (SD port 06)
226	DBI (SD port 07)
227	DTI (SD port 0A)

Byte	Description
228	ILR (SD port 0B)
229	CC2 (SD port 01)
230	CBI (SD port 12) CXC(3)=1
231	CBO (SD port 12) CXC(3)=0
232	CRO (SD port 03) CC1(5-7)=000
233	CR1 (SD port 03) CC1(5-7)=001
234	CR2 (SD port 03) CC1(5-7)=010
235	CR3 (SD port 03) CC1(5-7)=011
236	CR6 (SD port 03) CC1(5-7)=110
237	XCS (SD port 00) DXC(0,3)=00
238	XES (SD port 00) DXC(0,3)=01
239	CHK (SD port 00) DSC(0,3)=10
240	CK1 (SD port 00) DSC(0,3)=11
241	IRG (SD port 20)
242	OSR (SD port 21)
243 - 255	13 bytes reserved (cache-SMB)

SD regs at time of error alert:

Byte	Description
256 - 383	SD register groups 0 - F (128 bytes)

IAT buffer at time of error alert

Byte	Description
384 - 415	Instruction address trace buffer (32 bytes)

Format 30 Buffer Definition

Format 30 errors are those errors generated by failures on the maintenance panel. Each format 30 record is 64 bytes long and has the following information.

Byte	Description
0 - 7	Header bytes.
8 - 10	Failure code. • Byte 8 is the most significant byte of routine number. • Byte 9 is the least significant nibble of routine number and test number. • Byte 10 is the FF of RRRTFF.
11	Data path being tested at time of failure.
12	Run options at time of failure.
13	Number of FRUs in table (FF indicates FRUs must be obtained manually).
14 - 29	FRU codes (maximum of eight, stored most significant byte and least significant byte).
30	Number of subsequent error words (SEWs) in table.
31 - 62	SEWs (maximum of 16, stored most significant byte and least significant byte).
63	Flag byte.

Bit	Value	Description
0	1	Failure during power up sequence.
0	0	Failure running standalones.
1 - 7	00	Normal standalone execution.
1 - 7	nn	Special burn-in control executing (nn is pass count at time of failure).

LOG STRUCTURE AND CAPACITY

The extended error log consists of an area of reserved tracks on side 1 of the functional microcode diskette (table C-1). Error logging tracks are divided into two blocks: five tracks (0 through 4) for SD1 and five tracks for SD2. Each error log is composed of three parts.

- The format index directory (FID).
- The format allocation table (FAT).
- Data area for error information.

The FID and FAT each occupy one sector. The remainder of the error log is allocated as a series of circular error logs for each type of format (IBM sense formats). A maximum of 63 format types can exist in the log at one time.

The length of each entry in the log is either 32 bytes (8 header bytes and 24 sense bytes) or a multiple thereof. The number of entries per format vary according to requirements. The header bytes appear once per log entry.

The log is maintained so that it always contains the most recently occurring error data for each format type (except when wrapoff or logoff).

Table C-1. Extended Error Log Allocation

Format	Number of Sectors	Number of Bytes	Number of Entries	Entry Length (Bytes)
0	5	1280	40	32
1	15	3840	120	32
2	15	3840	120	32
3	26	6656	16	416
4	18	4608	144	32
5	18	4608	144	32
6	5	1280	40	32
7	10	2560	80	32
8	10	2560	80	32
9 - E	Undefined			
F	4	1024	32	32
10 - 2F	Undefined			
30	2	512	8	64
31 - 3E	Undefined			

FORMAT INDEX DIRECTORY

The format index directory (FID) is the first sector of each storage director's extended error log. The two extended error logs are independent of each other and may contain different parameters. (Presently, both FIDs are the same, but the design allows for future changes.)

The FID is 64 entries of 4 bytes each (256 bytes, 1 sector as shown in table C-2). The first 63 entries are a format xx type of log (xx = 00 through 3E).† To locate the FID entry, the format type is multiplied by 4; the result equals an offset from byte 0 of the FID. The last four bytes of the FID contain the next log number (table C-2), however, only the last three bytes are used in the header area. The first byte of the next log number must be 00, as are all first bytes of unallocated FIDs. The error log for each SD contains its own log record number, which is a sequence number incremented each time a log is generated by the SD for each EEL data record.

Table C-2. Format Index Directory

Format Type	Data Bytes			
00 - 03	01000000	01000A00	01002800	0D004600
04 - 07	01007A00	01009E00	0100C200	0100CC00
08 - 0B	0100E000	00000000	00000000	00000000
0C - 0F	00000000	00000000	00000000	0100F400
10 - 13	00000000	00000000	00000000	00000000
14 - 17	00000000	00000000	00000000	00000000
18 - 1B	00000000	00000000	00000000	00000000
1C - 1F	00000000	00000000	00000000	00000000
20 - 23	00000000	00000000	00000000	00000000
24 - 27	00000000	00000000	00000000	00000000
28 - 2B	00000000	00000000	00000000	00000000
2C - 2F	00000000	00000000	00000000	00000000
30 - 33	0200FC00	00000000	00000000	00000000
34 - 37	00000000	00000000	00000000	00000000
38 - 3B	00000000	00000000	00000000	00000000
3C - 3E	00000000	00000000	00000000	
3F	Next log number 00000001			

†IBM defines up to 16 different format types in byte 7, bits 0 through 3 of the 24 sense bytes. The CDC concept extends this to 63 format types by appending byte 7, bits 0 through 3 to byte 0, bits 0 and 1 of the header ID.

Table C-3 shows the bit definition of each byte in the FID, and they are described in the paragraphs that follow the table.

Table C-3. Definition of FID Bytes

Byte \ Bit	0	1	2	3	4	5	6	7
0	Disable Wrap Flag	Disable Logging Flag	Log(s) Written Flag	Module-32 Record Length per Entry				
1	Reserved for Use by WEEL Routine							
2	FAT Pointer to Next Error Log to Be Written							Wrap Point Flag
3	0	Log Wrapped Flag	Duplicate Suppress Flag	0	Module-32 Offset			

Byte	Bit	Description
0	0	The disable wrap flag. When this bit is set and the log has been filled, error logging stops on this format type. This bit is set and cleared by utility EEL (refer to description of the FAT pointer at byte 2).
0	1	The disable logging flag. When this bit is set, the flag inhibits any additional logs from being written into this format type. This bit is set and cleared by utility EEL.
0	2	The log(s) written flag. This bit is set by utility WEEL (write EEL) when the first log is written to this format type. It remains set until cleared by utility EEL. (This bit is tested by DEEL to determine if this log is empty.)
0	3 - 7	The module count. The module count is the length of this format's entry divided by 32.
1		This byte is used as a scratch register by WEEL and contains no externally useful information.

Byte	Bit	Description
2		The FAT pointer. The FAT pointer is an offset into the FAT; it points to the location of the next FAT and track and sector of the current log entry to be read or written (refer to table C-4 for more information). Bit 7 (wrap point flag) of this byte is set when the entire log has been written. It indicates that the next FAT will point to the beginning of the error log for that format type. When both this bit and byte 0, bit 0 are set, additional error logging is inhibited for this format type. The FAT pointer is updated by WEEL to point to the next FAT entry to be written.
3	1	The log wrapped flag. It is used by DEEL, SEEL, and WEEL to determine the starting position within the specific format buffer.
3	2	The duplicate suppress flag. If not set, this flag indicates that duplicate sectors are to be suppressed.
3	4 - 7	The module-32 offset into the sector of the next log to be written. (There are eight 32-byte log entries per sector for all formats except format 3, which contains 416 bytes.) For example, if the third module is to be written to the log, then module offset is 02. Module offset values are 0 through 7. Module offset is updated by WEEL to point to the next module to be written.

FORMAT ALLOCATION TABLE

The format allocation table (FAT) is the second sector in the error logs for SD1 and SD2. The FAT defines the location on diskette of the next entry in the circular log to be read or written. The FAT for the SD1 error log is on track 0, sector 2. The FAT for the SD2 error log is on track 6, sector 2. FAT consists of 128 two-byte entries (table C-4). The first byte of the FAT entry contains a pointer to the next FAT entry; the second byte contains the track and sector of the current FAT entry.

NOTE

The least significant bit of the FAT pointer is set when the sector pointed to is the first sector of that format type. This is called the wrap point of the error log. Entries into the error log do not cross this wrap point boundary.

The track and sector defined in the FAT is the physical track and sector offset from the beginning of the reserved extended error log area. The upper 3 bits define the track number; the 5 lower bits define the physical sector number (1 through 26; 1 through 1A hexadecimal).

Table C-4. Sample Format Allocation (FAT)

	x0	x2	x4	x6	x8	xA	xC	xE
0x	0203	0404	0605	0806	0107<=>	0C08	0E09	100A
1x	120B	140C	160D	180E	1A0F	1C10	1E11	2012
2x	2213	2414	2615	0B16<=>	2A17	2C18	2E19	301A
3x	3221	3422	3623	3824	3A25	3C26	3E27	4028
4x	4229	442A	292B<=>	482C	4A2D	4C2E	4E2F	5030
5x	5231	5432	5633	5834	5A35	5C36	5E37	6038
6x	6239	643A	6641	6842	6A43	6C44	6E45	7046
7x	7247	7448	7649	784A	474B<=>	7C4C	7E4D	804E
8x	824F	8450	8651	8852	8A53	8C54	8E55	9056
9x	9257	9458	9659	985A	9A61	9C62	7B63<=>	A064
Ax	A265	A466	A667	A868	AA69	AC6A	AE6B	B06C
Bx	B26D	B46E	B66F	B870	BA71	BC72	BE73	C074
Cx	9F75<=>	C476	C677	C878	CA79	C37A<=>	CE81	D082
Dx	D283	D484	D685	D886	DA87	DC88	DE89	CD8A<=>
Ex	E28B	E48C	E68D	E88E	EA8F	EC90	EE91	F092
Fx	F293	E194<=>	F695	F896	FA97	F598<=>	FE99	FD9A

<=> indicates format boundary.

ERROR BUFFERING

A 20-bit internal sequence number is assigned to each entry by the functional microcode and is carried along with the data and written on diskette. The diagnostic processor keeps track of the last sequence number received from each SD (refer to table C-2) and, during the initial microprogram load (IML), transfers the last number written plus 1 to the SD. The sequence number is displayed by the DEEL command and is in the data transferred to the host CPU.

In developing a manual log of reports, the customer engineer can use the sequence number to determine if recording activity has increased suddenly by having number missing from the report.

Because of the basic design of DPOS, a utility routine (WEEL, REEL, EEL, SEEL, DEEL, WEL30) is not interrupted while executing the command received. Therefore, it is possible to lose records if a high number of errors are detected while exercising any of these utilities.

NOS SPECIAL DEADSTART DESCRIPTION D

The NOS operating system bootstrap (OSB) is written on disk in large-record format (15 390 bytes). However, during NOS initialization the data in these large records must be read as small records (483 bytes). The CCC microcode provides this capability when parameter word 3 of the seek function has a record size of 010 in bits 11 through 9. In this mode, the record number in parameter word 4 is a small-record number ranging from 0 to 95. The CCC microcode divides this number by 32 to determine which large record contains the requested data. The unit, cylinder, and track (head) parameters are interpreted as they are. All other aspects of the seek function are the same.

The read function (0004) is issued after the device is on-cylinder. The large record is then read into the CCC data buffer. Using the large-record headers, the CCC microcode reconstructs the two 12-bit small-record headers and passes these headers and the small-record data to the CYBER channel. The next read function returns the next sequential small record. The CCC microcode continues to read sequential large records as required from the disk as long as read functions are present. A new seek function must be issued:

- If nonsequential small records are needed.
- To continue on a different cylinder.

This process continues until a function other than a read/status function is received.

During these seek and read operations, all error conditions and recovery procedures described in this manual are the same as normal seek/read operations.

The small-record header bytes are formed by the following calculations. All numbers are represented in hexadecimal.

Given:

Head = Track number from seek parameters (0 through E)

Record = Small-record number from seek parameters (00 through 5F)

Compute:

Large Record = Record/20

This is the large-record number in the data track (0 through 2).

Offset = Record - (Large Record x 20)

This is the index of the PRU within the large record (0 through 1F).

First Record = ((Head x 60) + (Large Record x 20)) MODULO 2C0

This is the NOS logical small-record number within a NOS logical track (0 through 2C0).

Each of the small records within a large record has a short PRU flag bit in the large-record header. These flags are contained in the following bytes of the large-record header.

PRU Numbers (Offset)	Header Byte	Header Bits
0 - 7	5	0 - 7
8 - B	D	4 - 7
C - F	C	0 - 3
10 - 17	14	0 - 7
18 - 1B	1C	4 - 7
1C - 1F	1B	0 - 3

The small-record headers (three 8-bit bytes) are then formed as follows:

- If the short PRU flag bit is set, then the header is the first 24 bits of the last 60-bit central memory word of this small record.
- If the short PRU flag bit is clear for PRUs 00 through 1E, the header is:

  nn n0 40

  nnn = First Record + Offset + 1.
- If the short PRU flag bit is clear for PRU 1F, the header is:

  xy z0 40

  x is the lower digit of byte 1C; yz is byte 1D of the large-record header.

TRACE INFORMATION IN DETAILED STATUS   E

Trace information will be inserted into the detailed status when the storage director does not have a unit check and there is no sense information to be reported from the storage director. The trace information is made up of memory addresses which is called error recovery subroutines, last function from the host, address of the last control sequence to the disk subsystem, and the parameters of the last seek function. A CCC controlware listing of the same revision of microcode must be used to make the information meaningful.

If the general status is 4400 octal, then the special idle loop is being executed and the subsystem is in a retry situation. Sense bytes 8 and 9 will contain the address from which the idle loop was called indicating the type of function that the disk subsystem is requesting retry. All other sense bytes will be zero, and detailed status words 17, 18, 19 and 20 will contain the same information as described in extended detailed status (0023) function.

If the general status is 5000 octal, indicating that the error was detected by the microcode in the CCC and not by the disk subsystem, in which case there is no sense information from the storage director, then the sense bytes will contain the following:

Byte	Description
4	Drive number from last seek parameters.
5	Low cylinder address.
6	HI cylinder and track number.
8 and 9	Address at which the error was detected.
11 and 12	Calling address of error status subroutine.
14 and 15	Contents of address 28 HEX, (SA).
17 and 18	Contents of address 2B HEX, (EA).
20	Contents of address 29 HEX, (DA).
21	Last function from host except status request.

Examples:

- If general status is 4400 octal and sense bytes 8 and 9 are 0322 HEX., then the disk subsystem is requesting a retry for a data read function. The CCC controlware is in the idle loop waiting for the host to send a continue function so that the retry can be sent to the subsystem.

- If general status is 5000 octal, then sense bytes 4, 5, and 6 will contain the drive number and cylinder and track currently being addressed. Sense bytes 8 and 9 will be the address in the read or write routine where the error was detected, which should be a hint as to the type of error. Knowing the control sequence starting and ending address will help trace the cause of the error in the microcode dump. The last function code in byte 21 will not list general status or detailed status request.

SEEK TRACE TABLE F

The seek trace table is located from 1D00 hex to 1DFF hex. The entries are eight words in length and contain the following information.

Word	Description
0	General Status
1	Drive Number
2	Cylinder Number
3	Track Number
4	Record Number
5	Device Reserve Sequence Initial and End Status from SD
6	Seek Sequence Initial and End Status from SD .
7	CYBER DI Trace Table Pointer

NOTE

The Drive, Cylinder, Track and Record numbers are the parameters received from the CYBER channel with the Seek function. The CYBER DI Trace Table Pointer is saved to correlate the data in the two trace tables. The current pointer for entering data to seek trace table is located at 00F4 hex.

COMMENT SHEET

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