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Systems

IBM 3310 Direct Access Storage Reference Manual

IBM

Preface

This publication is for use as a reference manual by data processing personnel. The purpose of the manual is to enable data processing personnel to become familiar with the characteristics of IBM 3310 Direct Access Storage. It is designed for the reader who already possesses a knowledge of data storage devices and concepts, but requires a source of reference material.

The publication lists the functional characteristics of the 3310, and describes the data format, storage capacity, and data transfer between the 3310 and the using system. The 3310 attaches to the IBM 4331 Processor via the Direct Access Storage Device (DASD) Adapter. The Channel Commands section includes a list of all commands executed by the DASD Adapter to control the 3310, while the Error Recovery Section includes information on error conditions and recovery.

The following publications are recommended for further reading:

- *IBM System/370 Principles of Operation,* GA22-7000.
- The functional characteristics manual applicable to the parent system. Order numbers for functional characteristics manuals can be found in the *IBM System/360 and System/370 Bibliography,* GA22-6822.
- *Fixed Block DASD Installation/Conversion Guide,* GC20-1879.
- *IBM 4300 Processors Principles of Operation for ECPS: VSE Mode,* GA22-7070.
- *IBM 4331 Processor Functional Characteristics and Processor Complex Configurator,* GA33-1526.

Second Edition, March 1979

The 3310 Reference Manual is a major revision and replaces the Introduction to 3310 manual released in January, 1979.

Information in this publication is subject to change.

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A form for reader's comments is provided at the back of this publication. If the form has been removed, comments may be addressed to IBM General Products Division, Technical Publishing, Dept. G26, 555 Bailey Ave., San Jose, CA 95150.

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(Capacity 258, 080, 768 bytes)

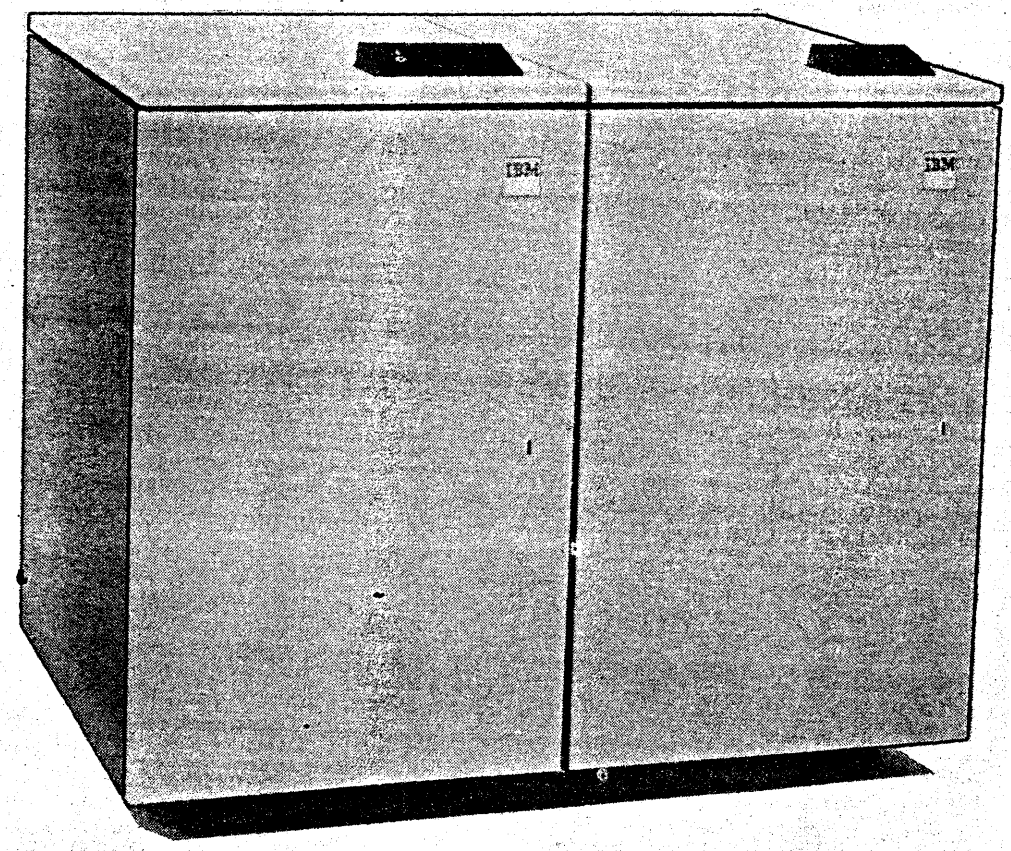


Figure 1-1. IBM 3310 Direct Access Storage (Design Model)

Chapter 1. Introduction

The IBM 3310 Direct Access Storage is a magnetic disk storage subsystem, available in various storage configurations, that can be attached to the IBM4331 Processor via the Direct Access Storage Device Adapter (DASDA). The 3310Direct Access Storage can be used for:

- Data base/data communications.
- Timesharing.
- Systems residence.
- General purpose storage.
- Other applications requiring either random or sequential processing.

The 3310 Direct Access Storage provides:

- A choice of four models.
- On-line storage up to 258,080,768 bytes.
- An instantaneous data transfer rate of 1,031,000 bytes per second.
- An average access time of 27 milliseconds.
- An average rotational delay of 9.6 milliseconds.
- Rotational Position Sensing as a standard feature.
- Error checking and correction of the data field content.

General Description

The IBM 3310 Direct Access Storage operates under control of the using system to which it is attached.

The 3310 can consist of from one to four disk storage devices housed in one or two enclosures (two per enclosure). Each disk storage device contains a sealed unit that houses magnetic storage disks, read/write (R/W) heads, and an actuator that moves the heads. The disk unit is not removable by the user.

In addition, the first disk storage device in a 3310 configuration contains a controller that communicates with the adapter of the using system. The controller receives commands from the system in the form of bus and tag sequences, decodes them, and decides whether a particular command is for itself or if it must be passed to one of the associated disk storage devices.

The eleven read/write heads can be moved to 360 access positions (cylinders). Cylinder 64 is reserved as an alternate cylinder; cylinder 359 is used as a CE cylinder.

Each track is divided into 33 sectors; sectors 0 through 32. Sectors 0 through 31 can be addressed by the system. Sector 32 is a spare. Any given sector is uniquely and completely identified by an identifier (ID) field which contains a flag byte, the cylinder address, head address, and sector number bytes. In addition to the identifier field, the sector contains a data field of 512 data bytes. The basic unit of transfer between the disk storage device and the using system is a fixed block of data of 512 bytes, that is, the data field contained on one sector.

The main characteristics of the device are:

Total No. of primary blocks per disk storage device	126016
Total No. of alternate blocks per disk storage device	352
Total No. of blocks in CE area per disk storage device	352
No. of user access positions (cylinders)	358
No. of blocks per access position	352
No. of moving heads	11
No. of blocks per track	32
Device capacity	64,520,192 bytes

Models of 3310

Four models of the 3310 are available:

- Model A1 - contains a controller and one disk storage device in an enclosure.
- Model A2 - contains a controller and two disk storage devices in an enclosure.
- Model B1 - contains one disk storage device in a separate enclosure. The model B1 must be physically attached to a model A2 from which it derives its power and control functions.
- Model B2 - contains two disk storage devices in a separate enclosure. The model B2 must be physically attached to a model A2 from which it derives its power and control functions.

The drive mounted in the bottom of the Model A2 enclosure always contains the first address in the string.

3310 Subsystem Configurations

The 3310 models, A1, A2, B1 and B2 can be arranged in any of the following subsystem configurations:

Configuration	*Description*
1	Model A1 First enclosure Storage capacity – 64,520,192 bytes
2	Model A2 First enclosure Storage capacity – 129,040,384 bytes
3	Model A2 and Model B1 First and second enclosures Storage capacity – 193,560,576 bytes
4	Model A2 and B2 First and second enclosures Storage capacity – 258,080,768 bytes

A complete four-drive configuration is shown in Figure 1.

Attachment of 3310 to the IBM 4331 Processor

The 3310 direct access storage attaches to the IBM 4331 Processor through the Direct Access Storage Device Adapter (DASDA) of the 4331 Processor. Movements of the read/write heads to particular tracks on the magnetic disk of the disk storage devices and the reading or writing of data, are controlled by command signals from the system via the DASDA to the 3310 direct access storage.

Commands issued by the 4331 Processor are executed by the adapter and transferred to the 3310 in the form of bus and tag sequences to initiate the required action.

Chapter 2. Data Organization

This chapter describes the data organization of each disk storage device in the 3310 Direct Access Storage subsystem. The basic unit of data transfer between the 3310 disk storage devices and the using system is the 512 byte block of data from one addressed sector. This chapter concentrates on the format of the sector.

Each track is divided into 33 sectors (0-32) of 600 bytes. Sector 32 is reserved for use during manufacture as an alternate sector. Cylinder 64 is reserved for alternate sector usage. Cylinder 359 is reserved for diagnostic purposes. This means that there are 126,016 sectors available to the using system as primary blocks.

Sector Format

Each sector has a gross length of 600 bytes and is made up of two basic areas:

- Identification (ID) field which contains the flag byte, sector, head, and cylinder numbers plus cyclic check bytes.
- Data Field which contains the 512 byte data field plus the error correction code bytes.

Identification Field

The sector identification (ID) field contains the physical address of the sector, and consists of a flag byte followed by three address bytes, and two cyclic redundancy check (CRC) bytes.

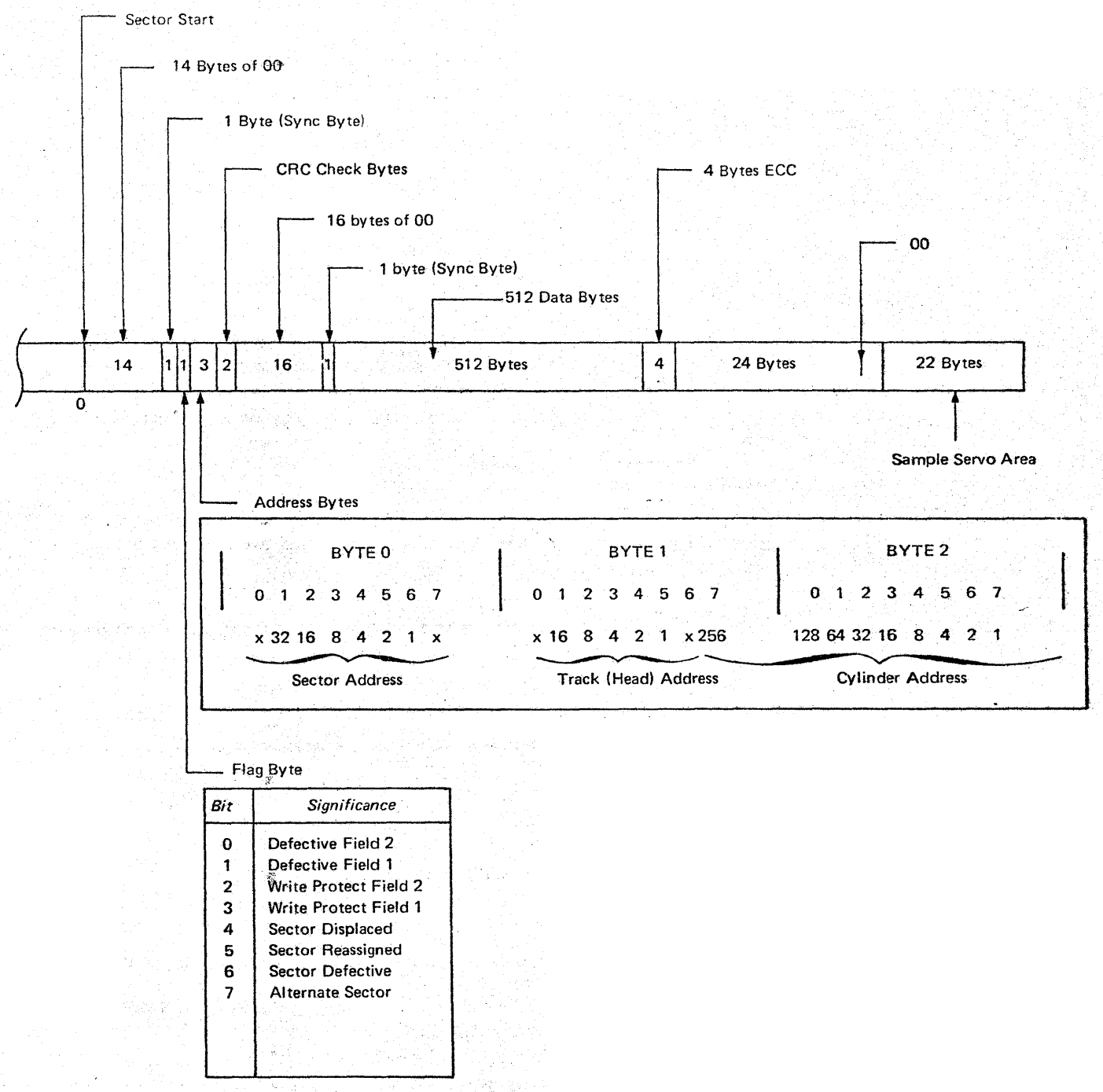
Flag Byte

The flag byte indicates to the using system the condition of the sector. Bits in the flag byte have the following significance.

Bit 0 Defective Field 2
Bit 1 Defective Field 1
Bit 2 Write Protect 2
Bit 3 Write Protect 1
Bit 4 Sector Displaced
Bit 5 Sector Reassigned
Bit 6 Sector Defective
Bit 7 Alternate Sector

On the 3310 disk storage devices, the descriptor flag byte bits have the following meaning:

Bits 4-7:
0000 = Good primary sector
0001 = Available alternate sector
0010 = Defective logical sector number 32
0011 = Defective alternate sector
0100 = not used
0101 = Alternate assigned sector; primary sector not displaced (note)
0110 = Secondary defective sector not in displaced area
0111 = not used
1000 = Good primary sector, displaced
1001 = not used
1010 = Defective sector, factory displaced (sector renumbered 32)
1011 = not used
1100 = not used
1101 = Alternate assigned sector, primary sector displaced
1110 = Secondary defective area in displaced area
1111 = not used



Bit	*Significance*
0	Defective Field 2
1	Defective Field 1
2	Write Protect Field 2
3	Write Protect Field 1
4	Sector Displaced
5	Sector Reassigned
6	Sector Defective
7	Alternate Sector

Figure 2-1. Sector Format

Note: *The combination alternate, reassigned, and the first field write protected is an indication of a factory-flagged sector. This sector should not be overwritten.*

The flag byte can be read using Diagnostic commands.

Address Bytes

The three address bytes are located immediately after the flag byte and contain sector address information. This information is defined in terms of sector number, head number, and cylinder number. The relationship between the address bytes and the relative block numbering used by the system is described in Chapter 3, I/O Operations. The sector address as written on the disk can be read by the system by using the Diagnostic Control command. Refer to the description of the command in Chapter 4.

CRC Bytes

The two CRC bytes are used for error detection, and are located immediately after the address bytes.

Data Field

Within each sector, the data field contains a block of 512 bytes. Each field is followed by 4 bytes of error correction code (ECC). The data for this field is transferred to or from the system under control of the byte count in the CCW. If, on a write data operation, the byte count becomes less than 512 bytes, the data field is padded to the end of the field with zeros.

ECC Bytes

Validity checking of the recorded data is accomplished by adding four bytes of information to each data block. These four bytes allow error detection and provide the basis for error correction.

They contain the syndrome bits (check bits) which allow correction of single error bursts with a maximum length of three bits. Such error areas may be found anywhere within the total 516 byte record (including the error correction code itself). A single burst of errors of up to 14 bits in length is detectable.

When the 3310 is transferring data to or from the IBM 4331 Processor via the Direct Access Storage Device Adapter (DASDA), correctable errors are automatically corrected. The appropriate error counter is stepped to indicate that an error had occurred. In error logging mode, correctable errors are flagged to the system through sense bytes.

Staggered Sector Addressing

Large volumes of data are sometimes required to be read or written on sequential sectors and tracks. In these cases, after all the sectors remaining on the first track have been written the next sequential head is selected and writing continues on the next track. It requires a maximum of eight sector periods for the read/write heads to stabilize after a head change; therefore, to ensure that data transfer can continue with the minimum interruption, sector numbers on each succeeding track are shifted by eight sectors (see Figure 2-2). This avoids the requirement to wait for a full disk rotation before restarting the read or write operation.

Note: *Sector 32 is not included in the staggered addressing. Sector 32 is always the sector immediately before the index pulse, unless it has been displaced (see Defective Sector Handling).*

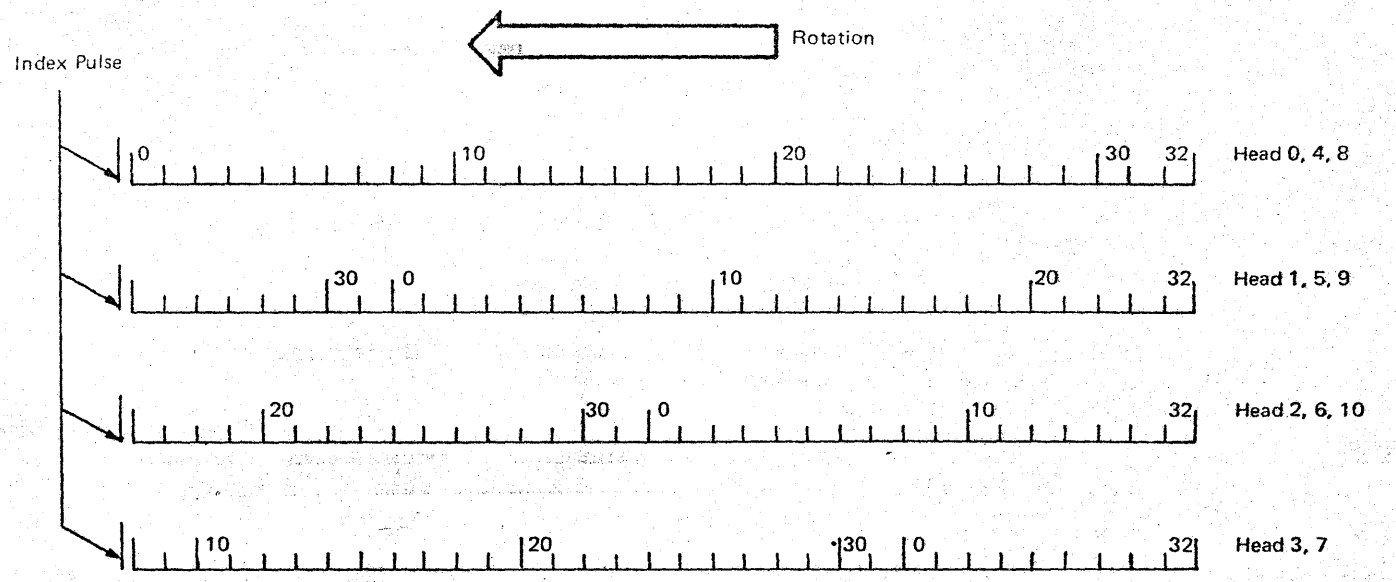


Figure 2-2. Staggered Sector Concept

Defective Sector Handling

When the storage disks are manufactured, a detailed surface analysis is made. The location of small surface defects (which could cause a loss of data) are noted and avoided when the disk is formatted by using alternate storage sectors.

While each track contains 33 sectors, only 32 are used. The extra sector is used as an alternate if a defective sector is found on the track. If more than one defect is found on a track, additional alternate storage sectors are placed on cylinder 64, reserved for this purpose.

The above operation is performed automatically by the 3310 and the DASDA, and is transparent to the user.

Should a new defect be found with the file in use (indicated by permanent error, data check, and check data error), the user must flag the defective sector and reassign it to an alternate. Utility programs for this purpose are described in *DOS/VS Utilities*, Order No. GC33-5381-3.

The Locate command with the Format Defective Block subcommand is used to assign an alternate block as follows:

1. Seek to cylinder 64 using the head that detected the defective sector, and search for the first available sector on track 64.
2. Save the alternate sector address and seek to the defective sector.
3. Rewrite the ID field of the defective sector (moved by 64 bytes if necessary) with the flag byte showing the sector defective and reassigned, and address bytes that contain the address of the alternate sector.
4. Seek to the alternate sector, write the ID field with the flag byte showing alternate assigned sector, and write the address bytes pointing back to the defective sector. Note that the above is purely a relocation of sector address, no data field is written.

Chapter 3. I/O Operations

This chapter describes the Input/Output operations used with the 3310. Additional information about the processing unit and channel program control of I/O Operations is found in the *IBM 4300 Processors Principles of Operation for ECPS: VSE Mode*, GA22-7070.

Device Addresses

Up to four IBM 3310 Direct Access Storage subsystems can be attached to the Direct Access Storage Device Adapter (DASDA) of the IBM 4331 Processor. Each 3310 string can contain up to four disk storage devices.

The eight bits in the unit address byte derived from the Start I/O instruction identify the 3310 subsystem and the individual disk storage device as follows:

Bit Number	*Assignment (Hex)*	
0	ignored	
1	4	3310 subsystem address
2	2	
3	1	
4	0	Not used
5	0	Not used
6	2	Disk Storage Device Address*
7	1	

* **Note:** *If the 3310 string has only 2 devices, bit 6 is not used (set to zero).*

Data Addressing

Each disk storage device in the 3310 subsystem appears to the using system as consisting of 126,016 512-byte blocks consecutively numbered from 0 to 126,015. The blocks are addressed in terms of the displacement, in blocks, from the start of the device (that is, from block 0). The displacement is called the Physical Block Number (PBN).

Address Conversion

In the DASDA to which the 3310 controller and disk storage devices are attached, the block displacement is translated into cylinder, head, and sector numbers which are then compared to the address bytes on the disk to locate the correct sector before data transfer begins.

Logical Block Addressing in Data Sets

The logical blocks of a data set are recorded on the disk storage device in one or more *data extents*, each of which consists of a number of consecutively numbered physical blocks starting with a specified block. All channel commands chained to the Define Extent command must operate within the limits defined by the data extent.

Figure 3-1 shows an example of a data set consisting of two extents, the second of which is defined here. Note that the block number given in bytes 4-7 of the parameters of the Define Extent command (location of the first block of the extent) is relative to the start of the device, but the block numbers in bytes 8-11 and 12-15 (first and last blocks of the extent) are relative to the start of the data set.

Details of these and other channel commands are given in Chapter 4.

Access and Data Transfer Time

The total time required for access and data transfer is a combination of the following:

Access Time is measured from the receipt of an access command, up to (and including) the settling of the heads at a cylinder location.

Head Switching Time is the time needed to switch from one read/write head to the next sequential one.

Rotational Delay is the time required for a data record to reach the required read/write head. The magnetic storage disks rotate at 3125 revolutions per minute (nominal). The time required for a specific record to reach the heads is a maximum of 19.1 milliseconds. Half a revolution, 9.6 milliseconds (the average delay) is generally used for timing purposes.

All 3310 disk storage devices use rotational position sensing. This permits the disk storage device to disconnect from the channel during the time required to bring the correct record to the read/write head. Other disk storage devices can be used by the adapter during this period.

- Zero Track Access time:

Head switching time	4.8 milliseconds

- Access times:

One cylinder	9 milliseconds
Average	27 milliseconds
Maximum	46 milliseconds

- Rotational delay:

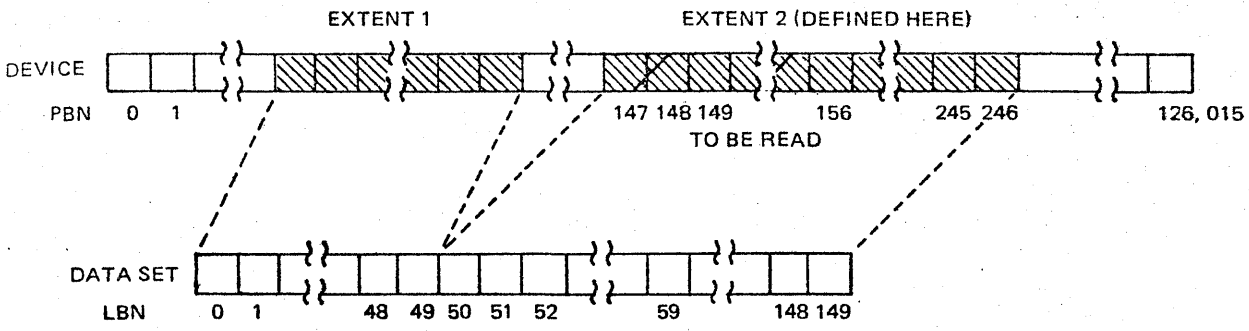
Minimum	0 milliseconds
Average	9.6 milliseconds
Maximum	19.1 milliseconds

Data Integrity

The 3310 and its associated controller provide data integrity by error detection and correction.

When attached to the IBM 4331 Processor, the 3310 and the DASDA (Direct Access Storage Device Adapter) provide data integrity in the following ways:

- Validity checking of ID and data fields.
- Automatic error retry.
- Error logging.



PBN: PHYSICAL BLOCK NUMBER
LBN: LOGICAL BLOCK NUMBER

CHANNEL PROGRAM — CHANNEL COMMAND WORD

Bit	0 — 7	8 — 31	32 — 37	38 — 40	47 — 48	63
	CODE	DATA ADDRESS	FLAGS	000	NOT USED	COUNT
DEFINE EXTENT	X'63'	X' 00 20 00'	01000	000	0 - - - 0	16
LOCATE	X'43'	X' 00 24 28'	01000	000	0 - - - 0	8
READ	X'42'	X' 00 30 00'	00000	000	0 - - - 0	4096

CC (Chain Command)

(EXTENT PARAMETERS)

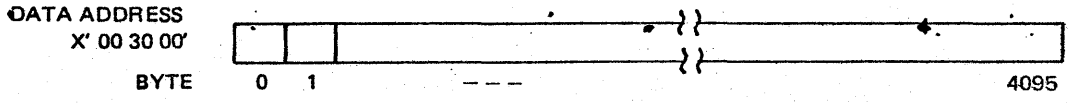
DATA ADDRESS X' 00 20 00'	MASK	UNUSED	BLOCK SIZE (BYTES)	PBN OF FIRST BLOCK IN EXTENT
	X'00'	X'00'	512*	147
BYTE	0	1	2 — 3	4 — 7

LBN OF FIRST BLOCK DATA SET	LBN OF LAST BLOCK DATA SET
50	149
8 — 11	12 — 15

(LOCATE PARAMETERS)

DATA ADDRESS X' 00 24 28'	OPERATION	AUXILIARY INFO	BLOCK COUNT	LBN OF FIRST OF SUCCESSIVE BLOCKS
	X'06'	X'00'	8	50
BYTE	0	1	2 — 3	4 — 7

(READ BUFFER)



* If this field is specified to be all zero, the default block size is 512 bytes.

Figure 3-1 Example of Data Set Addressing

Data Verification after Write Operations

Validity checking of the recorded data is accomplished by adding 4 bytes of information to each data area of a 512-byte record. These four bytes allow for error detection and provide the basis for the error correction capability.

Validity checking of the ID field occurs in the 3310 controller using the CRC bytes attached to the ID field (in both read and write operations).

Data can also be verified explicitly by employing the Write Data with Verify specification in the Locate command. In this case the DASDA will reorient to the beginning of the blocks just written. The data will then be read whereby the ECC code is again generated as during writing. Thereafter the written ECC is compared with the generated ECC and if both are equal, the data has been successfully verified. If an error is detected the read operation is retried 8 times. If thereafter the compare result of the ECC bytes is still unequal, the write operation will be retried 4 times and if the error persists, unit check, permanent error, and check data error will be presented.

Error Retry

Error retry is initiated automatically without requiring an I/O interrupt to recover from:

- Seek Malfunctions.
- Data Checks.
- Data Overruns.

If the retry turns out to be successful, the current command (Locate, Read, or Write) will be completely executed before retry mode is reset. The corresponding error counter is stepped by one.

Seek Error Retry

Seek errors are detected by an ID mismatch from the disk storage device, or if track unavailable or no home is indicated after execution of a Recalibrate.

The 3310 will perform a recalibration and reseek to the desired cylinder (head) if a physical address mismatch is detected during seek verification.

Seek verification may be executed after:

1. An access executed due to a Locate command.
2. An implicit seek (cylinder advance), or
3. A head switch.

Implicit seeks or head switches are performed if track or cylinder boundaries have to be crossed during Read or Write operations.

Seek verification is accomplished by comparing the track address (CCH) read from the disk storage device with the cylinder and head address bytes derived from the command that initiated the seek for that device. Any mismatch indicates that the access mechanism is not properly positioned. Seek Error Retry is invoked to cause repositioning of the access over the correct track.

The erroneous operation will be retried up to ten times. If the disk storage device is in Seek Error Logging Mode, Format 1 Sense Bytes are generated when the error appears the first time (with Sense Byte 2, Bit 3 active). After ten unsuccessful retries Format 1 Sense Bytes are generated with Unit Check set in the Unit Status Byte.

Data Check Retry

Data checks are detected by CRC check or ECC check from the disk storage device. The DASDA automatically attempts recovery by two methods, either by error correction via the error correction code or by retry. The details depend on the operation, as follows:

Read Operation: When a data check is detected during a read operation, the DASDA checks whether the data check is correctable. If so, correction occurs using the correction code pattern against the affected data field. If the data check is not correctable, the read operation is retried eight times, If the 8th retry is also unsuccessful, permanent error and check data error are indicated.

Write Operation: During a write operation the recovery action depends on whether or not verification has been specified. If write *without verify* has been specified, the DASDA does not detect any data checks and simply continues with the next command. If verify has been specified, the data blocks are read back after writing, whereby the ECC is generated once more just as occurred during the preceding write operation, and therefore the written ECC and the ECC which is generated during the read back operation should be identical. If the ECCs do not match, the read verify operation is repeated up to 8 times. If the error still exists, the write operation is retried up to four times. If the 4th attempt is also unsuccessful, permanent error and check data error are indicated.

Data Overrun Retry

When Data Overrun has been indicated during data transfer (outbound: DASDA buffer empty, inbound: DASDA buffer full) the DASDA will repeat the reading or writing of the interrupted ID or block of data.

If the Data Overrun persists after 32 retries, Format 0 sense bytes are generated with Unit Check set in the Unit Status Byte.

Error Logging (Logging Mode)

In the IBM 4331 Processor, each disk storage device is allocated a specific control block (Drive Information Block) which includes usage and error counters. These counters are described in Chapter 7.

When an error counter overflows before the corresponding usage counter, it may mean that too many errors are occurring on a disk storage device, even though the errors are being corrected automatically on retry. The disk storage device is therefore set into Error Logging Mode. (The usage and error counters are also offloaded and reinitialized, see Chapter 7).

Whenever a disk storage device in Logging Mode encounters a successfully retried error of the same type that caused it to enter Logging Mode, 24 sense bytes of environmental data (Sense Byte 2, Bit 3 active) are collected by the microcode.

The next SIO addressing this disk storage device is not executed. Instead, initial status indicates Unit Check. The operating system will then issue a Sense command to fetch the environmental data and will reissue the SIO. The sense command will retrieve sense data in the appropriate format depending on the error causing the logout:

- Format 1, if the error is a seek error.
- Format 4, if the error is a data check retried.
- Format 5, if the error is a correctable data check (sense byte 2, bit 7 will also be on in this case).

Logging Mode terminates if:

1. The disk storage device logged error data four times, or
2. A second disk storage device enters Logging Mode before the first has finished. When this happens, Logging Mode is reset for the first disk storage device. Only one disk storage device at a time may be in Logging Mode.

Chapter 4. IBM 4331 Processor Channel Commands

The following channel commands are executed by the DASD Adapter of the IBM 4331 Processor and result in actions at the 3310 Direct Access Storage:

Command Type	*Command Name*	*Hex Code*
Control	No-operation	03
	Define Extent	63
	Locate	43
Read	Read	42
	Read IPL	02
Write	Write	41
Test *	Test I/O	00
Sense	Sense I/O	E4
	Sense	04
	Read and Reset Buffered Log	A4
	Read Device Characteristics	64
Diagnostic	Diagnostic Control	F3
	Diagnostic Sense	C4

Note: *Any other command bit configurations are considered invalid*

* Test I/O is an I/O instruction, not a channel command.

No Operation (Hex 03)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0000 0011 Hex 03	Not checked for validity; should not exceed addressing capacity.			SLI flag (bit 2) should be on			Must be non-zero; zero count causes a program check.	
Chaining and Special Requirements: None								

No-op command causes no action to be taken by the addressed device.

Status: Channel end and device end are presented during initial selection.

Define Extent (Hex 63)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0110 0011 Hex 63	Specifies storage location of the first byte of the parameters.			Used at the discretion of the programmer.			Sixteen	
Chaining and Special Requirements: If not the first Define Extent command in the chain, it must be permitted by previous Define Extent (see mask bits).								

Sixteen bytes of data are transferred from the system to the DASD Adapter. These 16 bytes represent parameters which define the size and location of the data extent and, thereby, the bounds within which subsequent chained commands may operate. The inhibit mask is included in the 16 bytes and either allows or prohibits an operation (see Mask Byte).

Parameter Definition

Byte 0: Mask Byte.
Bytes 1–3: Must be zero.
Bytes 4–7: Define the offset, in blocks, from the beginning of the device to the first block of the extent.
Bytes 8–11: Define the relative displacement, in blocks, from the beginning of the data set to the *first* block of the extent.
Bytes 12–15: Define the relative displacement, in blocks, from the beginning of the data set to the *last* block of the extent.

Note: *The entire extent defined by bytes 4-15 must lie within the limits of the addressed device, otherwise the Define Extent command is rejected.*

Byte 0 (Mask Byte) allows control over the following operations through the mask bits as defined below:

Bits 0 and 1
- 00 = Inhibit format write operations
- 01 = Inhibit all write operations
- 10 = Unassigned (must not be set)
- 11 = Allow all write operations

Bits 2 and 3: Unassigned, must be zero.

Bit 4 (Defines the area in which the extent resides.)
- 0 = The extent resides in the data area
- 1 = The extent resides in the CE-area (see Note).

Bit 5 (Controls diagnostic commands.)
- 0 = Inhibit diagnostic commands
- 1 = Allow diagnostic commands

Bit 6 (Controls additional define extent commands.)
- 0 = Inhibit additional define extent commands
- 1 = Allow additional define extent commands

Bit 7: Unassigned (must be zero).

Note: *The CE area is a separate linear addressable space of 512-byte blocks. This area may be accessed by making bit 4 active. The contents of bytes 4-15 will then be ignored. The parameters will be set implicitly so that the data set is identical to one extent that covers the whole CE area (parameters 0, 0, 351).*

Command Reject is set if:
1. Any of the unassigned bits or codes of the mask are set.
2. Less than 16 bytes are specified.
3. Invalid parameters are specified.
4. A previous define extent in this command chain did not have bit 6 of the mask byte set.

Status: Channel end and device end are set at the end of the data transfer. Unit check is presented at this time if command reject is set.

Locate Command (Hex 43)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0100 0011 Hex 43	Specifies storage location of first byte of the parameters.			Used at the discretion of the programmer.			Eight	
Chaining and Special Requirements: Must be preceded by a Define Extent or Read IPL command in the same command chain.								

Eight bytes specifying the location and the amount of data to be processed are transferred from the system to the DASD Adapter.

Byte Specification

Byte	*Assignment*
0	Operations Byte
1	Replication Count
2 and 3	Block Count
4 through 7	Relative displacement of data within the data set

Byte 0: contains subcommands defining the type of record orientation and operation to be performed when the block has been reached:

Bits 0–3: must be zero
Bits 4–7 (in Hex):
- 1 = Write Data
- 2 = Read Replicated Data
- 4 = Format Defective Block
- 5 = Write Data with Verify
- 6 = Read Data

Byte 1: used only for Read Replicated Data. Byte 1 specifies the range of blocks that contain replicated data. For example, if a two-block unit is replicated five times, then the replication count is 10. If the replication count is not an integral multiple of the block count, the Locate command is terminated with channel end, device end, unit check, with command reject presented in sense byte 0.

Byte 2 and 3: specify the number of sequential blocks to be processed by the command immediately following the Locate command. The block count must not be zero or the Locate command is rejected.

Byte 4-7: contain the displacement, in blocks, of the first block to be processed from the beginning of the data set.

Command Reject is set when:
1. Less than 8 bytes are specified.
2. The Locate command is not preceded by a Define Extent or a Read IPL command in the same chain.
3. The replication count is not an integral multiple of the block count.
4. The block count is zero.

File Protected is set when the relative displacement is not within the data extent.

Status: Channel end and device end will be presented at the end of the operation (see subcommands). Unit check will only be present if command reject, operation incomplete, equipment check, or file protected is set.

Locate Subcommands (Operations byte bits 4-7)

Format Defective Block (Hex 4)

This subcommand rewrites the ID of the block specified by the relative displacement with the address of the first available alternate block under the same head. The flag byte is rewritten to include the defective and reassigned bits. The ID of the alternate block is written with the address of the defective block and the flag byte rewritten to include the reassigned bit.

Status: Channel end and device end are presented once both IDs have been written. Channel end, device end, and unit check are presented if all the alternate space on the track has been exhausted.

Write Data (Hex 1)

This subcommand prepares the DASD Adapter to write one or more blocks of data, as specified by the block count in bytes 2 and 3, by initiating an access to the first block to be processed.

Status: Channel end and device end are presented when the logical block address, converted to a physical block address, has been reached.

Note: *No actual writing takes place.*

Write Data And Verify (Hex 5)

This subcommand is the same as for Write Data except that on the subsequent Write command the written data will be verified by reading (without transferring data to storage) all the blocks written.

Status: Channel End and Device End are presented when the data has been written and verified.

Read Replicated Data (Hex 2)

This subcommand prepares the DASD Adapter to read one or more blocks of data, as defined by the block count, from a range of replicated data. This is done by initiating an access to the first block of any unit of replicated data.

Status: Channel end and device end are presented when the block has been reached but no actual reading occurs.

Read Data (Hex 6)

This subcommand prepares the DASD Adapter to read one or more blocks of data, as specified by the block count, by establishing the correct orientation. An access to the first block to be processed (as defined by bytes 4-7, the relative displacement) is initiated.

Status: Channel end and device end are presented as soon as that block is reached, but no actual reading occurs.

Read Command (Hex 42)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0100 0010 Hex 42	Specifies storage location where first data byte is to be transferred.			Used at the discretion of the programmer.			Specifies number of bytes to be read.	
Chaining and Special Requirements: Must be command chained from a Locate command or data chained from a previous Read command.								

The Read command reads the block Identifier Field (ID) from the device to verify correct positioning, and transfers the following 512 byte block to storage. This process is repeated until either the channel command word (CCW) count from the Read command, or the block count from the preceding Locate command, reaches zero. If the CCW count is the first to reach zero, the DASD Adapter ends the data transfer but continues to read to the end of the block so that the ECC, which is written for 512 bytes, can be verified.

Command Reject is set if:

1. The read command is not command chained from a locate command.
2. The immediately preceding Locate command did not specify Read Data or Read Replicated Data.

Note: *Data chaining within a 512 byte block causes permanent overrun.*

Retry: Data errors occurring in the block ID or the data are handled internally. Only if the error is permanent is data check and permanent error set.

Command or service overruns are also handled internally except when caused by data chaining within a 512-byte block (where the overrun is permanent).

Status: Channel end and device end are presented when the ECC bytes following the data have been checked and no errors detected. If errors are detected, the DASD Adapter automatically attempts recovery by retry. If the errors are uncorrectable, data check and permanent error are presented with channel end and device end.

Read Initial Program Load (Hex 02)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0000 0010 Hex 02	Specifies storage location where first data byte is to be transferred.			Used at the discretion of the programmer.			Specifies number of bytes to to be read.	
Chaining and Special Requirements: Must be the first command in the chain or data chained from another Read IPL.								

The Read IPL command transfers the data from block zero of the device to storage. The DASD Adapter executes an implicit Define Extent command with an extent of maximum allowable size, an offset of zero, and a mask byte of all zeros. It then orientates to block zero on the disk storage device and reads, at maximum, the entire block.

When used for system IPL, the CCW specifies a count of 24 bytes:

Bytes	0–7	IPL Program Status Word (PSW)
	8–15	IPL Channel Command Word (CCW1)
	16–23	IPL Channel Command Word (CCW2) (if required)

Command Reject is set if:

1. The Read IPL command is not the first command in the chain.
2. The Read IPL command is not data chained from another Read IPL command.

Write Command (Hex 41)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0100 0001 Hex 41	Specifies storage location of first byte of data to be transferred.			Used at the discretion of the programmer.			Specifies number of bytes to be written.	
Chaining and Special Requirements: Must be command chained from a Locate command or data chained from a previous Write.								

The Write command transfers data from the using system to the disk storage device where this data is recorded. When the command is received, the block ID is read to verify correct orientation, and the following data block is written. This procedure is repeated until either the CCW count in the Write command or the block count in the Locate command becomes zero. The Count field specifies the number of bytes to be written with this CCW, and the Data Address specifies the location.

Note: *If the CCW count reaches zero before the block count, the DASD Adapter causes zeros to be written to the end of the current block and in all succeeding blocks until the block count reaches zero. If the CCW count is greater than the block count, the operation is terminated when the block count reaches zero.*

Chaining: The Write command must be command chained from a Locate command or data chained from a Write command. Data chaining within a 512-byte block must be avoided or unpredictable overruns or chaining checks may occur.

Error Correction Code: For each block, the 3310 generates and appends four bytes of ECC information to the data field. The ECC check bytes provide a data check of the written data.

Command Reject is set if the Write command is chained from the Locate command and the adapter is not in the write state for this device.

Status: Write Without Verify (operation byte of the Locate command = Hex 01); channel end and device end are presented after the ECC bytes have been written for the last block.

Write With Verify (operation byte of the Locate command = Hex 05); the DASD Adapter reads back all the blocks written without transferring any data, and compares the ECC bytes. Successful completion is indicated with channel end and device end.

Command Retry: If errors are encountered in this readback check, the DASD Adapter will retry the write operation. If the error persists, unit check with permanent error (sense byte 1 bit 0) and check data error (sense byte 2 bit 0) will be indicated.

Test I/O (Hex 00)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0000 0000 Hex 00				Used at the discretion of the programmer.				
Chaining and Special Requirements: None								

Test I/O determines the status of a disk storage device. It is the result of a programmed instruction or a self-initiated sequence by the using system. To the DASD Adapter, it is a command byte of zeros and is treated as an immediate command. The execution of this command transmits one status byte to the using system in the initial selection sequence.

Status Byte: The status byte presented can contain one of the following:

- The available pending status bits.
- A busy condition.
- All zeros.

Sense I/O (Hex E4)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 1110 0100 Hex E4	Specifies storage location where sense bytes are to be transferred.			Used at the discretion of the programmer.			Seven	
Chaining and Special Requirements: None								

The Sense I/O command transfers 7 bytes of I/O identification data to the using system. These bytes contain information relating to type and model number of the DASD Adapter and device. This information is stored as follows:

Byte 0	Always Hex FF.
Bytes 1 through 3	Storage adapter number
Bytes 4 and 5	Device type number.
Byte 6	Device model number.

If the disk storage device is available and not busy, then the execution of the Sense I/O command must be accomplished even if the device is in the not-ready state.

Status: Channel end and device end are presented after the transfer of the sense bytes.

Sense Command (Hex 04)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 0000 0100 Hex 04	Specifies storage location where sense bytes are to be transferred.			Used at the discretion of the programmer.			Twenty-four	
Chaining and Special Requirements: None								

The Sense command transfers 24 bytes of sense information to storage. These bytes identify the nature of the error or unusual condition that generated the last unit check.

Status: Channel end and device end are presented after the transfer of the sense data.

Note: *The sense information is reset after the transfer of the sense data. It is also reset whenever an initial status byte of zero is presented in response to any command other than No-op or Test I/O.*

Contingent Connection: A contingent connection state is maintained with a disk storage device for which unit check is presented. The purpose is to preserve the sense data relevant to the unit check until a Start I/O with a command, preferable a Sense command, but not No-op or Test I/O is issued. When in the contingent connection state, the 3310 controller will respond with busy condition to commands issued to any of its attached devices.

Read and Reset Buffered Log (Hex A4)

Byte 0	1	2	3	4		5	6	7
Command Code	Data Address			Flags	000	Not Used	Count	
Binary 1010 0100 Hex A4	Specifies storage location of first error byte or usage data.			Used at the discretion of the programmer.			Twenty-four	
Chaining and Special Requirements: None								

The Read and Reset Buffered Log command transfers 24 bytes of usage and error information pertaining to the addressed device to storage. The format of this information is identical to the 24 bytes of sense information that is created upon the usage or error counter overflow. The usage/error statistics relate to the logical disk storage device that is addressed by the Start I/O instruction. The usage/error information is reset to zero after data transfer is complete.

The Read and Reset Buffered Log command also allows end-of-day off-loading of the buffered log.

Read Device Characteristics (Hex 64)

Byte 0	1	2	3	4		5	6	7
Command Code	Data Address			Flags	000	Not Used	Count	
Binary 0110 0100 Hex 64	Specifies storage location where data is to be transferred.			Used at the discretion of the programmer.			Thirty-two	
Chaining and Special Requirements: None								

The Read Device Characteristics command transfers 32 bytes of device characteristics information from the DASD Adapter to the using system.

Bytes	*Contents*	
0	Operation modes X'30'	
1	Features X'08'	
2	Device class X'21'	
3	Unit type X'01' X'01'	
4–5	Physical record size (bytes)	X'0200'
6–9	Number of blocks per cyclical group	X'00000020'
10–13	Number of blocks per access position	X'00000160'
14–17	Number of blocks under movable heads	X'0001EC40'
18–21	Reserved	
22–23	Reserved	
24–25	Number of blocks in CE area	X'0160'
26–27	Reserved	
28–29	Reserved	
30–31	Reserved	

Byte 0, Operation Modes

Bit Number	*Meaning*
0	reserved
1	not used
2	0 = byte mode, 1 = burst mode
3	1 = data chaining
4–7	reserved

Byte 1, Features

Bit Number	*Meaning*
0	reserved
1	removable media
2	shared device
3	reserved
4	movable access mechanism
5	reserved
6–7	reserved

Diagnostic Control (Hex F3)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 1111 0011 Hex F3	Specifies storage location of first byte of diagnostic control parameters.			Used at the discretion of the programmer.			Twelve or greater	
Chaining and Special Requirements: See description below.								

The Diagnostic Control command transfers 12 bytes defining the exact operation to be performed, from storage to the DASD Adapter.

The bytes are:

Byte	*Meaning*
0	sub-command ID
1	must be X'00'
2–3	must be X'0008'
4–5	block count
6	must be X'00'
7	3310 ID handling flag
8–9	cylinder address
10	head
11	logical sector address

Sub-command ID

X'04' Format ID
X'06' Space ID and Read Data
X'0A' Read ID

Refer to the description of the individual subcommands for the meaning of byte 7 - 3310 ID handling flag.

Logical Sector Address: All Diagnostic Control commands use a 4 byte logical sector address. Two bytes are used for cylinder address, one byte for head address, and one byte for sector address. The positions of logical sector 0 are shifted by eight sectors for each consecutive head, to allow for head switching time. Sector 32 however, is always the sector before the index pulse unless it has been displaced, see Defective Sector Handling in Chapter 2. Orientation for Diagnostic Control commands is done on the sector counter, that is, counting from index point to index point.

Command Reject is set if:

1. The subcommand code is other than hex 04, 06, or 0A.
2. Bytes 1, 3, or 6 are not as specified.
3. For the subcommand Format ID, the preceding Define Extent did not allow Format Write.
4. The CCW count is less than 12.
5. Any of the other conditions given under the individual subcommands.

Status: See the individual subcommands.

Access errors are retried by the DASD Adapter. If they are permanent, the DASDA sets equipment check and permanent error in the sense data and terminates the operation.

Format ID (Subcommand ID Hex 04)

After the parameters have been verified, the subcommand causes the ID of the block specified by bytes 8-11 to be rewritten and the data field of the block to be filled with zeros.

Byte 7, the 3310 ID Handling Flag, specifies how and where the ID is written as follows:

Bits 0–2

- 000 = Write a normal ID
- 100 = Write an ID into the alternate area with the *alternate* flag on
- 110 = Write an ID into the alternate area with the *alternate and defective* flags on
- 001 = Write an ID into the sector behind the addressed one (next sequential) with the *displaced* flag on (see note)
- 010 = Write an ID with sector number 32 into logical sector 32 with the *defective* flag on (sector specification must be 32)
- 011 = Write an ID into the addressed sector with sector number 32 and the *defective* and *displaced* flags on

Bits 3–6: reserved (must all be zero)

Bit 7:

- 0 = No function
- 1 = Write the ID into the moved position (applies only when bits 0-2 have the patterns 110, 010, and 011).

Note:

1. *If bits 0-2 are equal to 001 the next sequential sector is formatted, that is, the sector defined by the contents of bytes 8-11 plus 1.*
2. *The Format ID command will not automatically be verified. A Read ID should follow to check the ID and if it fails, the Format ID should be retried. If the error is permanent and the prime area is addressed, a format defective block procedure should be invoked.*

Command Reject is set if:

1. The ID Handling Flag byte is invalid.
2. Bytes 8-11 contain an invalid logical sector address (alternate not specified) for the device.
3. Alternate specified, and bytes 8-11 contain an invalid alternate logical sector address for the device.
4. Bytes 8-11 address a block in the CE area but the Define Extent mask bit 4 is not set.
5. Bytes 8-11 do not address a block in the CE area but the Define Extent mask bit 4 is set on.

Status: Channel end, device end, and unit check are presented at the end of the data transfer if command reject is detected or if equipment check is set.

Space ID and Read Data (Subcommand ID Hex 06)

The Space ID and Read Data subcommand orients to the block specified in bytes 8 - 11 and prepares the DASDA to space over the Block ID and to read the data field. The actual spacing over the ID and reading the data field is performed on a subsequent Diagnostic Sense command X'C4'. Only one block is processed and the block count in bytes 4 and 5 is ignored.

3310 ID Handling Flag: Only bit 2 of byte 7 has any significance for this subcommand. If bit 2 = 1, the data is to be read from the sector behind the one addressed. All other bit combinations are ignored.

Command Reject is set if bytes 8-11 do not contain a valid logical sector address for the device.

Status: If any sense bit in bytes 0, 1, and 2 is set, then channel end, device end and unit check are set. If not, then channel end and device end are presented when the block is reached.

Note: *This subcommand may typically be used for recovering the data field of a block when the block ID has a permanent data check.*

Read ID (Subcommand Hex 0A)

The Read ID subcommand prepares the DASDA to read one or more block IDs and accesses the first block. The number of block IDs that are read is determined by the block count in bytes 4 and 5.

The actual operation of reading the block IDs and transferring the data to the using system, is performed on a subsequent Diagnostic Sense command. The format of the bytes is identical to the block ID field written on the disk storage device. The block IDs processed are physically continuous.

Command Reject is set if the address in bytes 8-11 is not a valid logical sector address.

Status: If any sense bit in bytes 0, 1, and 2 is set then channel end, device end, and unit check are set. If not, channel end and device end are presented when the block is reached.

Diagnostic Sense (Hex C4)

Byte 0	*1*	*2*	*3*	*4*		*5*	*6*	*7*
Command Code	*Data Address*			*Flags*	*000*	*Not Used*	*Count*	
Binary 1100 0100 Hex C4	Specifies main storage location where data is to be transferred.			Used at the discretion of the programmer.			Specifies number of bytes to be transferred.	
Chaining and Special Requirements: Must be command chained from Diagnostic Control.								

The Diagnostic Sense command transfers diagnostic information from the 3310 controller to storage. The number and meaning of data bytes transferred is determined by a preceding Diagnostic Control command.

Command Reject is set if the command is not chained from a Diagnostic Control command.

For Format ID Diagnostic Control Subcommands

No data transfer occurs.

Status: Channel end and device end are presented in the ending status.

For Space ID and Read Data Diagnostic Control Subcommands

After orientation, allows the controller to space over the block ID field and transfer the 512-byte data field.

Retry: If a data error is detected during reading the data field, the operation is retried. If the retries are unsuccessful, data check is set in the sense data.

Status: If any sense bit in bytes 0, 1, or 2 is set, channel end, device end, and unit check are set. At successful completion of the data transfer, channel end and device end are presented.

For Read ID Diagnostic Control Subcommands

After orientation, reads the 4 byte ID field and transfers it to storage. This process is repeated until either the block count or the CCW count reaches zero. Access boundaries are ignored and the controller continues reading IDs from the same track.

The block IDs are read from the disk as raw data, refer to the description in Chapter 2, Data Organization.

Retry: If a data error is detected in reading a block ID, the operation is retried. If the error is permanent, the data check and ID data check sense bits are set.

Status: If any sense bit in bytes 0, 1, or 2 is set, channel end, device end, and unit check are set. If not, channel end and device end are presented at the completion of the data transfer.

Status: Channel end and device end are presented on completion of data transfer.

Chapter 5. Error Recovery

This chapter describes the error conditions that may occur within the 3310 and its associated adapter, and the recovery action procedures that should be used for each error condition.

Error Condition Table

The error condition table (Figure 5-1) summarizes error conditions that are identified in sense bit configurations set by the using system in sense bytes 0, 1, and 2. Each of these unique configurations requires a specific recovery action to be invoked by the system. Error logging requirements are also listed.

Byte	*Bit*	*Format*	*Name*	*Description*	*Recovery Action No. (see Figure 5-2)*	*Log*
0	0	0	Command Reject	Programming error (see Note 1).	2	No
0 1	0 6	0	Command Reject Write Inhibit	A Write command has been received with the device in the Read Only state.	1	No
0	1	1	Intervention Required	Device is offline.	3	No
0	2	0	Bus Out Parity	Bus out parity error has occurred.	3	Yes
0	3	1	Equipment Check	Equipment is malfunctioning.	4	Yes
0 1	3 0	1	Equipment Check Permanent Error	Equipment malfunction (including access error). Controller retry is exhausted or undesirable.	1 1	Yes
0 1	4 0	4	Data Check Permanent Error	Uncorrectable data check. Controller retry is exhausted.	1	Yes
0 1	5 0	0	Overrun Permanent Error	Controller retry is exhausted on an overrun condition.	1	Yes
1	5	0	File Protected	A locate argument has violated the define extent specifications.	2	No
2	3	6	Environmental Data Present (see Note 3)	Statistical usage/error log information is present.	3	Yes
2 1	0 0	4	Check Data Error Permanent Error	Permanent data check during a write-verify operation. Controller retry is exhausted.	1	Yes
0 1	0 7	0	Command Reject Operation Incomplete	Alternate area is exhausted.	1	No
0 2	4 3	5	Data Check Environmental Data Correctable	Logging mode data check.	21	Yes
0 2	4 3	4	Data Check Environmental Data Uncorrectable	Logging mode data check.	21	Yes

Notes

1. *Command Reject is posted for any of the following conditions:*
   a. *An Invalid command code.*
   b. *An Invalid command sequence.*
   c. *The Invalid or incomplete argument has been transferred by a control command.*
   d. *The Write portion of the inhibit mask, transferred by a Define Extent command, has been violated.*
   e. *The Alternate area is exhausted.*
2. *Detection of an overrun immediately stops data transmission. During writing, the remaining portion of the data block is padded with zeros.*
3. *During error logging mode, Data Check may be posted in conjunction with Environmental Data Present. In all cases, Environmental Data Present dictates the action to be performed.*

Figure 5-1. Error Condition Table

Error Recovery Action

The 3310 recovery action table (Figure 5-2) specifies the actions to be taken by the using system for each sense byte configuration shown in the error condition table.

Action No.	*Action*
1	Print console error message for operator and/or customer engineer notification.
2	Exit with programming error or unusual condition indication.
3	a. Repeat the operation once. b. If the error condition persists, do action 1.
4	a. Repeat the operation. b. If the error condition persists after 10 retries, do action 1.
21	**Initial status indicates unit check, and the next Start I/O command that addresses the disk storage unit is not executed. The user system issues a Sense command to fetch the environmental data, creates a log record entry, and then reissues the Start I/O command.** Logging mode terminates when: a. The disk storage unit logged environmental data four times. b. A second disk storage unit enters logging mode before the first has finished. When this occurs, logging mode is reset for the first disk storage unit, since only one disk storage unit may be in logging mode at any one time.

Figure 5-2. Recovery Action Table

Chapter 6. Sense Data

The 3310 uses 24 sense bytes for identifying completely any condition that causes a unit check status to be generated. These sense bytes provide secondary information that may be required for system error recovery, or to aid the customer engineer to diagnose and isolate disk storage device and controller failures. The sense bytes also:

- Indicate a usage or error counter overflow.
- Logout error information if an error retry is successful during logging mode (see Logging Mode.).

Sense Information Summary

Sense bytes 0 through 7 contain high-level sense and condition data and have the same meaning for all formats (see Sense Formats, following). A summary of the sense information for bytes 0 through 7 is shown in Figure 6-1.

Byte	Bit							
	0	1	2	3	4	5	6	7
0	Command Reject	Intervention Required	Bus Out Parity (Not Used)	Equipment Check (Note 2)	Data Check (Note 2)	Overrun	Not Used	Not Used
1	Permanent Error (Note 1)	Not Used	Not Used	Not Used	Not Used	File Protected	Write Inhibited	Operation Incomplete
2	Check Data Error	Correctable Data Check	Not Used	Environmental Data Present	Not Used	Not Used	Not Used	Only Logging Required
3	Physical Cylinder Address (High Order)							
4	Physical Cylinder Address (Low Order)							
5	Physical Head Address							
6	Physical Sector Address							
7	Format Number (bits 0-3 hex)				Message Code (bits 4-7 hex)			

Notes:

1. *Set by ERP'S*
2. *Usually indicates a 3310 malfunction if byte 7, bits 0–3 equal '1', '4', or '5'.*

Figure 6-1. Sense Data Summary (Bytes 0 through 7)

Sense byte 7

Message Code (bits 4-7 hex.) Format Number (bits 0-3 hex.)

Hex	Format 0 (Programming or System Checks)	Format 1 (Device Equipment Checks)	Format 4 (Uncorrectable Data Checks)	Format 5 (Correctable Data Checks)	Format 6 (Usage and Error Statistics)
0	No Message	No Message	ID Field Data Check	No Message	Read and Reset Buffered Log
1	Invalid Command	Transmit Target Error	Data Field Data Check		Overflow of Blocks Read Counter
2	Invalid Sequence	Microcode Detected Errors	Not Used		Overflow of Data Checks Retried Counter
3	CCW Count Less Than Required				Overflow of Correctable Data Checks Counter
4	Invalid Parameters		ID Field No Sync Byte Found		Overflow of Blocks Written with Verify Counter
5	Block Not Within the Valid Extent	Unexpected Status at Initial Selection	Data Field No Sync Byte Found		Overflow of Check Data Errors Counter
6	Not Used	Cylinder Address Error	Not Used		Overflow of Access Motions Counter
7	Not Used				Overflow of Access Errors Counter
8	Not Used		Not Used		
9	Not Used	File Status Not as Expected During Read IPL or Retry	Not Used		
A	Not Used	Seek Error at Seek Verification	Not Used		
B	Not Used	Seek Error at Recalibration	Not Used		
C	Space in Alternate Area Exhausted	No Interrupt from Drive	Not Used		
D	Data Overrun		Not Used		
E	Not Used		Not Used		
F	Not Used		Not Used		

Figure 6-2. Format Messages Summary (Sense Byte 7)

Sense Bytes 0 through 2

Sense bytes 0 through 2 are only generated when a unit check occurs. These bytes describe the error condition and identify the action needed to effect error recovery (see Error Recovery section). The unit check information generated can be any of the following.

Sense Byte 0

Bit 0: Command Reject is set when an unknown command is received, or when a command violates the required sequence or prerequisite. For example:

- The Define Extent mask prohibits the operation.
- A Read or Write command is not chained from a Locate command.
- Replication count is not an integral multiple of block count.

Bit 1: Intervention Required is set when the addressed disk storage device has no power or is not attached.

Bit 3: Equipment Check is set when a hardware error is detected in the disk storage device or the adapter in the using system.

Bit 4: Data Check is set when an error is detected in the data received from the disk storage device, and when the automatic retry by the adapter in the using system is unsuccessful. A data check indicates that read ID fields cannot be read without CRC checks or data fields read without ECC checks. The affected ID or data field is defined in a format 4 message.

Bit 5: Overrun: When a data request of the adapter in the using system is not granted within a specified time limit, a potential overrun condition is detected that causes automatic retry attempts. If the overrun condition exists on the final retry, overrun is posted and data transfer is stopped. The remainder of the record is padded with zeros if a Write command is being executed.

Sense Byte 1

Bit 0: Permanent Error is set when an error persists after the adapter in the using system has exhausted its automatic retry attempts.

Bit 5: File Protected is set when a Locate or Diagnostic Control command violates the logical extent limits established by the Define Extent command. Writing is then suppressed.

Bit 6: Write Inhibited is set if writing is attempted on a record when the ID field has one of the write protect flags (field 1) set to On.

Bit 7: Operation Incomplete is set when an operation ends prematurely. For example, when Format Defective Block is specified and all alternate space is exhausted.

Sense Byte 2

Bit 0: Check Data Error is set when an error is detected during the automatic read-back check operation that follows writing when Verify has been specified, and retry attempts by the adapter in the using system have been unsuccessful.

Bit 1: Correctable Data Check indicates that the indicated data check or check data error is correctable. This bit is only set when the device is in logging mode.

Bit 3: Environmental Data Present is set when sense bytes 8 through 23 contain usage or error counter information (log statistics).

Bit 7: Only Logging Required is set if an error occurs that should be logged to preserve data without invoking error recovery actions, when the disk storage device is used with emulation. The operation performed is similar to that done for Environmental Data Present.

Sense Bytes 3 through 6

Sense bytes 3 through 6 contain the physical address being accessed at the time the error was detected. The content of these sense bytes are as follows:

- Bytes 3 and 4 contain the physical cylinder address.
  Sense byte 3 contains the high order cylinder address of the most recent seek operation. Sense byte 4 contains the low order cylinder address of the most recent seek operation.
- Byte 5 contains the physical head address.
  Sense byte 5 identifies the head that was last used, which is usually the head address of the most recent seek or, when head switching was involved, the update of that address.
- Byte 6 contains the physical sector address.
  Sense byte 6 contains the sector address that identifies the sector defined by relative displacement in the most recent byte command.

Sense bytes 3, 4, 5, and 6 are unpredictable in Format 6.

Sense Byte 7

Sense byte 7 identifies the format of sense bytes 8 through 23.

- Bits 0 through 3 identify the format of sense bytes 8 through 23.
- Bits 4 through 7 provide an encoded message that describes the error condition. The codes are related to format and are described in the following pages.

Sense Formats

Sense bytes 8 through 23 contain format dependent information. The formats used by the 3310 are as follows:

- Format 0, for programming or system checks.
- Format 1, for device equipment checks.
- Format 4, for data checks not providing correction information.
- Format 5, for data checks providing correction information.
- Format 6, for usage and error statistics.

Each of the formats concerned with the 3310 is summarized in Figures 6-3 through 6-9. Figure 6-2 contains a summary of the applicable messages for each of the formats. If the indicated format is 2 or 3, refer to the 4331 Processor Functional Characteristics (see Preface).

Logging Mode

Logging mode occurs when the error counter of a disk storage device overflows before the corresponding usage counter overflows (refer to Chapter 7 for more information on Usage, Error, and Overflow counters). Usage, error, and overflow counters are then offloaded and initialized.

If a disk storage device is in logging mode, and encounters a successfully retried error of the same type that caused it to enter logging mode, then 24 sense bytes of environmental data (Sense byte 2, bit 3 active) are collected by microcode.

The following formats are used when logout occurs due to an error condition.

- Format 1, if the error is a seek error.
- Format 4, if the error is a data check retried.
- Format 5, if the error is a correctable data check.

Bytes 8 through 23

Byte	Format 0	Format 1		Format 4	Format 5	Format 6
		Not Message 'A' (No Seek Check)	Message 'A' (Seek Check)			
8	Not Used	Control Interface Bus Out	Actual Seek Address (Cylinder)	Not Used	Not Used	Number of Blocks Read (see Note 3)
9		Control Interface Bus In	Actual Seek Address (Cylinder)			
10		Control Interface Tag Bus	Actual Seek Address (Head)			
11		Controller Status				Number of Correctable Data Checks
12		Controller Error Byte 1	Not Used			
13		Controller Error Byte 2				Number of Data Checks Retried
14		Controller Error Byte 3				Not Used
15		Drive Sense				Number of Blocks Written with Verify (see Note 4)
16	Number of Good Blocks Transferred	Diagnostic Sense 1		Number of Good Blocks Transferred	Number of Blocks Transferred Including Error Block	
17		Diagnostic Sense 2				
18	Relative Block Number of First Failing Block	Diagnostic Sense 3		Relative Block Number of First Failing Block (see Note 1)	Error Displacement	Number of Check Data Errors Recovered
19		DCIA – File Sense Register	Not Used			Number of Access Motions (Seeks)
20		DCIA – File Control Register	Not Used		Error Pattern	
21		Microcode Detected Errors (see Note 2)				Number of Access Errors
22	Not Used	Fault Symptom Code		Fault Symptom Code	Not Used	Number of Service Overruns
23						Not Used

Notes:

1. *These bytes contain the number of blocks from the beginning of the data set that the first block to be processed is displaced.*
2. *The Microcode error condition is encoded as follows:*

Hex		Hex	
0	*Not used*	8	*Not used*
1	*No Tag Valid on Read/Write operation*	9	*Not used*
2	*No normal or check end on Read/Write operation*	A	*Incorrect drive selected*
3	*No response from controller on control operation*	B	*Busy condition (seek incomplete) missing after seek start was issued*
4	*Not used*	C	*No block found*
5	*CRC compare logic check during feed back of CRC bytes*	D	*Control Bus In parity check*
6	*More than one controller selected or non-selected*	E	*Always active bit on Bus In.*
7	*Preselection check*	F	*Unresetable interrupt*

3. *These bytes provide an accumulated count of the number of blocks (512 bytes) processed by the adapter in the user system in Read operations.*
4. *The blocks written have automatic verification through a read back check.*

Figure 6-3. Sense Data Summary (Bytes 8 through 23)

Format 0 Format 0 is generated for programming or system checks.

Byte	Bit							
	0	1	2	3	4	5	6	7
8	Not Used							
9	Not Used							
10	Not Used							
11	Not Used							
12	Not Used							
13	Not Used							
14	Not Used							
15	Not Used							
16	Number (in Hex) Good Blocks Transferred							
17	Number (in Hex) Good Blocks Transferred							
18	Relative Block Number (in Hex) of First Failing Block							
19	Relative Block Number (in Hex) of First Failing Block							
20	Relative Block Number (in Hex) of First Failing Block							
21	Relative Block Number (in Hex) of First Failing Block							
22	Not Used							
23	Not Used							

Figure 6-4. Sense Data (Bytes 8 through 23) - Format 0.

Format 0 Messages **Message 0:** No message is generated if no additional information is required.

Message 1: Invalid Command is generated when a command that is not in the command set is issued to the adapter of the using system.

Message 2: Invalid Sequence is generated when an invalid sequence of commands has occurred. This includes the following:

- Define Extent prerequisites are not satisfied by a Write command, any Diagnostic command, an additional Define Extent command.
- A Locate command is not preceded by a Define Extent, or a Read IPL command in the same command chain.
- A Read command is not chained from a Locate command.
- A Read command is chained from a Locate command and the adapter in the using system is not read-oriented for this device.
- A Write command is not chained from a Locate command.
- A Write command is chained from a Locate command and the adapter of the using system is not write oriented for this device.
- A Device Reserve or a Device Release command that is preceded by a Define Extent in the same command chain.
- A Diagnostic Control command that is not preceded by a Define Extent command.
- A Diagnostic Sense command that is not preceded by a Diagnostic Control command.

Message 3: CCW Count less than Required is generated when the CCW count for a:

- Define Extent command is less than 16.
- Locate command is less than 8.
- Diagnostic Control command is less than 12.

Message 4: Invalid Parameters is generated when parameters of a command are invalid. This includes:

- Define Extent parameters are invalid for the addressed device.
- Locate block count parameter contains a value of zero.
- Locate operation byte contains an unused operation code.

Message 5: Block not within the Valid Extent is generated if any block specified by the block count is outside the parameters of a Locate command.

Message C: Space in Alternate Area Exhausted is generated when, at the execution of a Format Defective Block operation, the space in the alternate area has been exhausted.

Message D: Data Overrun is generated when a response to a data request signal is not received by the adapter of the using system within the specified time, after ten Data Overrun retries have proved to be unsuccessful.

Notes:

1. *Except for Message 5 and Message D, all messages of format 0 are set in conjunction with Sense Byte 0, Bit 0 (command reject).*
2. *Message 5 is set with Sense Byte 1, bit 5 (file protected).*
3. *Message D is set with Sense Byte 0, bit 5 (overrun) and Sense Byte 1, bit 0 (permanent error).*

Format 1 (No Seek Check) Format 1 is generated for device equipment checks and is available in two forms; No Seek Check, and Seek Check. If message A is indicated in the message bits, use the Format 1 (Seek Check) Sense data.

Byte	Bit							
	0	1	2	3	4	5	6	7
				Control Interface Bus Out				
8	Bus Out 0	Bus Out 1	Bus Out 2	Bus Out 3	Bus Out 4	Bus Out 5	Bus Out 6	Bus Out 7
				Control Interface Bus In				
9	Bus In 0	Bus In 1	Bus In 2	Bus In 3	Bus In 4	Bus In 5	Bus In 6	Bus In 7
				Control Interface Tag Bus				
10	Tag Bus 0	Not Used	Not Used	Not Used	Tag Bus 4	Tag Bus 5	Tag Bus 6	Tag Bus 7
				Controller Status				
11	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Device Interrupt	Sector Found
				Controller Error Byte 1				
12	Tag Bus Parity Error	Bus Out Parity Error	Bus In Parity Error	CSRVD Too Late	Sector Count Error	Not Used	Device Interrupt	Not Used
				Controller Error Byte 2				
13	Sync Byte Error Bit 0	Sync Byte Error Bit 1	Reserved	Bus/In Out Parity	Serial Parity Check	Gap Counter Check	Sector Index Check	CRC/ECC Hardware Check
				Controller Error Byte 3				
14	Bit Ring Error	Sync Out Error	PLA Clock Error	Write Gate Check	Not Used	Not Used	Continuity Check, Sel'd DSD Cable	Continuity Check, DSD Ctl Bus Cable
				Drive Sense				
15	FHD Not Select	Brake * Applied	Track * Unavailable	Command * Error	Data * Unsafe	Seek Incomplete	Home	Not * Ready
				Diagnostic Sense 1				
16	On Track	Linear Region Normal and Even	Index and Sector Pulses Missing	Out Direction	Not Out Drive	Not In Drive	Tag Parity Error	Velocity Profile Error
				Diagnostic Sense 2				
17	Behind Home	Two Missing Clocks	Not Missing Clocks Error Latch	Coil Current Low	Missing Servo Signal	Off Data Track	Not Missing PES	Counter 5 In Sync
				Diagnostic Sense 3				
18	Not Shift	Not (Off Track and Write)	Inside AGC Window	Not AGC Freeze	Demod Pulsing	Not (Read and Write)	Not (Servo Protect and Write)	Illegal Move
				DCIA — File Sense Register				
19	Select Active	Tag Valid	Normal End	Index Alert	Check End	CE Alert	Error Alert	File Bus—In Parity CK
				DCIA — File Control Register				
20	Not Used	Not Used	Sync—In Check	File Counter Overflow	Tag Gate	Response	Select Hold	Recycle
				Microcode Detected Errors				
21	Not Used	Not Used	Error Code 32	Error Code 16	Error Code 8	Error Code 4	Error Code 2	Error Code 1
22				Fault Symptom Code				
23				Fault Symptom Code				

Bytes 15—18 are DSD (disk storage device) sense and status bytes. The bits marked with an asterisk (*) are error conditions that cause an interrupt when seek incomplete is reset. The remaining bits of these bytes indicate the DSD status at the instant the sense operation took place.

Figure 6-5. Sense Data (Bytes 8 through 23) - Format 1 (No Seek Check)

Format 1 (Seek Check) If message A is not indicated in the message bits, use Format 1 (No Seek Check) Sense data.

Byte	Bit 0	1	2	3	4	5	6	7
8	Actual Seek Address (Cylinder)							
9	Actual Seek Address (Cylinder)							
10	Actual Seek Address (Head)							
11	Controller Status: Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Device Interrupt	Sector Found
12	Not Used							
13	Not Used							
14	Not Used							
15	Drive Sense: FHD Not Select	Brake* Applied	Track* Unavailable	Command* Error	Data* Unsafe	Seek Incomplete	Home	Not* Ready
16	Diagnostic Sense 1: On Track	Linear Region Normal and Even	Index and Sector Pulses Missing	Out Direction	Not Out Drive	Not In Drive	Tag Parity Error	Velocity Profile Error
17	Diagnostic Sense 2: Behind Home	Two Missing Clocks	Not Missing Clocks Error Latch	Coil Current Low	Missing Servo Signal	Off Data Track	Not Missing PES	Counter 5 In Sync
18	Diagnostic Sense 3: Not Shift	Not (Off Track and Write)	Inside AGC Window	Not AGC Freeze	Demod Pulsing	Not (Read and Write)	Not (Servo Protect and Write)	Illegal Move
19	Not Used							
20	Not Used							
21	Microcode Detected Errors: Not Used	Not Used	Error Code 32	Error Code 16	Error Code 8	Error Code 4	Error Code 2	Error Code 1
22	Fault Symptom Code							
23	Fault Symptom Code							

Bytes 15–18 are DSD (disk storage device) sense and status bytes. The bits marked with an asterisk (*) are error conditions that cause an interrupt when seek incomplete is reset. The remaining bits of these bytes indicate the DSD status at the instant the sense operation took place.

Figure 6-6. Sense Data (Bytes 8 through 23) - Format 1 (Seek Check)

Format 1 (Seek Check) If message A is not indicated in the message bits, use Format 1 (No Seek Check) Sense data.

Byte	Bit 0	1	2	3	4	5	6	7
8	Actual Seek Address (Cylinder)							
9	Actual Seek Address (Cylinder)							
10	Actual Seek Address (Head)							
11	Controller Status: Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Device Interrupt	Sector Found
12	Not Used							
13	Not Used							
14	Not Used							
15	Drive Sense: FHD Not Select	Brake* Applied	Track* Unavailable	Command* Error	Data* Unsafe	Seek Incomplete	Home	Not* Ready
16	Diagnostic Sense 1: On Track	Linear Region Normal and Even	Index and Sector Pulses Missing	Out Direction	Not Out Drive	Not In Drive	Tag Parity Error	Velocity Profile Error
17	Diagnostic Sense 2: Behind Home	Two Missing Clocks	Not Missing Clocks Error Latch	Coil Current Low	Missing Servo Signal	Off Data Track	Not Missing PES	Counter 5 In Sync
18	Diagnostic Sense 3: Not Shift	Not (Off Track and Write)	Inside AGC Window	Not AGC Freeze	Demod Pulsing	Not (Read and Write)	Not (Servo Protect and Write)	Illegal Move
19	Not Used							
20	Not Used							
21	Microcode Detected Errors: Not Used	Not Used	Error Code 32	Error Code 16	Error Code 8	Error Code 4	Error Code 2	Error Code 1
22	Fault Symptom Code							
23	Fault Symptom Code							

Bytes 15–18 are DSD (disk storage device) sense and status bytes. The bits marked with an asterisk (*) are error conditions that cause an interrupt when seek incomplete is reset. The remaining bits of these bytes indicate the DSD status at the instant the sense operation took place.

Figure 6-6. Sense Data (Bytes 8 through 23) - Format 1 (Seek Check)

Format 1 Messages

Up to sixteen messages are defined and printed in the EREP summary statistics.

Message 0: No message is generated if no additional information is required.

Message 1: Transmit Target Error is generated when a readback check of the disk storage device target register detects that the target register was improperly loaded on a Set Sector operation.

Message 2: Microcode Detected Errors is generated if errors are detected by the microcode as defined in Sense Byte 21.

Message 5: Unexpected Drive Status at Selection is generated when the subsystem receives a status that is not an expected condition during device selection . The following unexpected conditions may be found:

- Device not attached (no tag valid).
- Device offline.
- Device unsafe.

Message 6: Cylinder Address Error is generated after a readback of a target cylinder number ranging from 0 to 255 (required address) by Diagnostic Interface Wrapback detects that the disk storage device was improperly loaded on a seek operation.

Message 9: File Status not as Expected during Read IPL or Retry is generated when the adapter of the using system does not receive the expected file status during the internal rezero of the Read IPL command or during execution of Command Retry requiring the use of Set Sector.

Message A: Seek Error at Verification is generated when seek verification detects a wrong cylinder or head address.

Message B: Seek Error at Recalibrate is generated if after the execution of a Recalibrate during Seek retry no home indication is detected, or track unavailable is indicated.

Message C: No Interrupt from Device is generated when the adapter of the using system does not receive an interrupt from the disk storage device within a specified time. This condition can only occur on an internal seek or recalibrate while the disk storage device remains connected with the adapter.

Format 4 Format 4 is generated for data checks that do not provide correction information.

Byte	Bit 0	1	2	3	4	5	6	7
8	Not Used							
9	Not Used							
10	Not Used							
11	Not Used							
12	Not Used							
13	Not Used							
14	Not Used							
15	Not Used							
16	Number (in Hex) of Good Blocks Transferred							
17	Number (in Hex) of Good Blocks Transferred							
18	Relative Block Number (in Hex) of First Failing Block							
19	Relative Block Number (in Hex) of First Failing Block							
20	Relative Block Number (in Hex) of First Failing Block							
21	Relative Block Number (in Hex) of First Failing Block							
22	Fault Symptom Code							
23	Fault Symptom Code							

Figure 6-7. Sense Data (Bytes 8 through 23) - Format 4

Format 4 Messages

These messages are printed in the EREP summary statistics.

Message 0: ID Field Data Check is generated when a CRC data check occurs in an ID field. In this case the Format Defective Block procedure should be applied to the defective block.

Message 1: Data Field Data Check is generated when an ECC data check occurs in the data field.

Message 4: ID Field No Sync Byte Found is generated when synchronization on the ID area was unsuccessful.

Message 5: Data Field No Sync Byte Found is generated when synchronization on the Data area was unsuccessful.

Format 5

Format 5 is generated for data checks that provide correction information. It is only offloaded to the system when Error Logging Mode is on.

Byte	Bit 0	1	2	3	4	5	6	7
8	Not Used							
9	Not Used							
10	Not Used							
11	Not Used							
12	Not Used							
13	Not Used							
14	Not Used							
15	Not Used							
16	Number of Blocks (in Hex) Transferred including Error Block							
17	Number of Blocks (in Hex) Transferred including Error Block							
18	Error Displacement							
19	Error Displacement							
20	Error Pattern							
21	Error Pattern							
22	Not Used							
23	Not Used							

Figure 6-8. Sense Data (Bytes 8 through 23) - Format 5

Format 5 Messages

Message 0: No message is generated if no additional information is required.

Format 6

Format 6 is generated when either a counter overflow occurs or in response to a Read and Reset Buffered Log command. Then, the Usage/Error statistics need to be offloaded to the operating system. The counter information is reinitialized after offloading. The Usage/Error statistics have to be offloaded before the machine is powered off. The values given in Format 6 bytes are in hexadecimal.

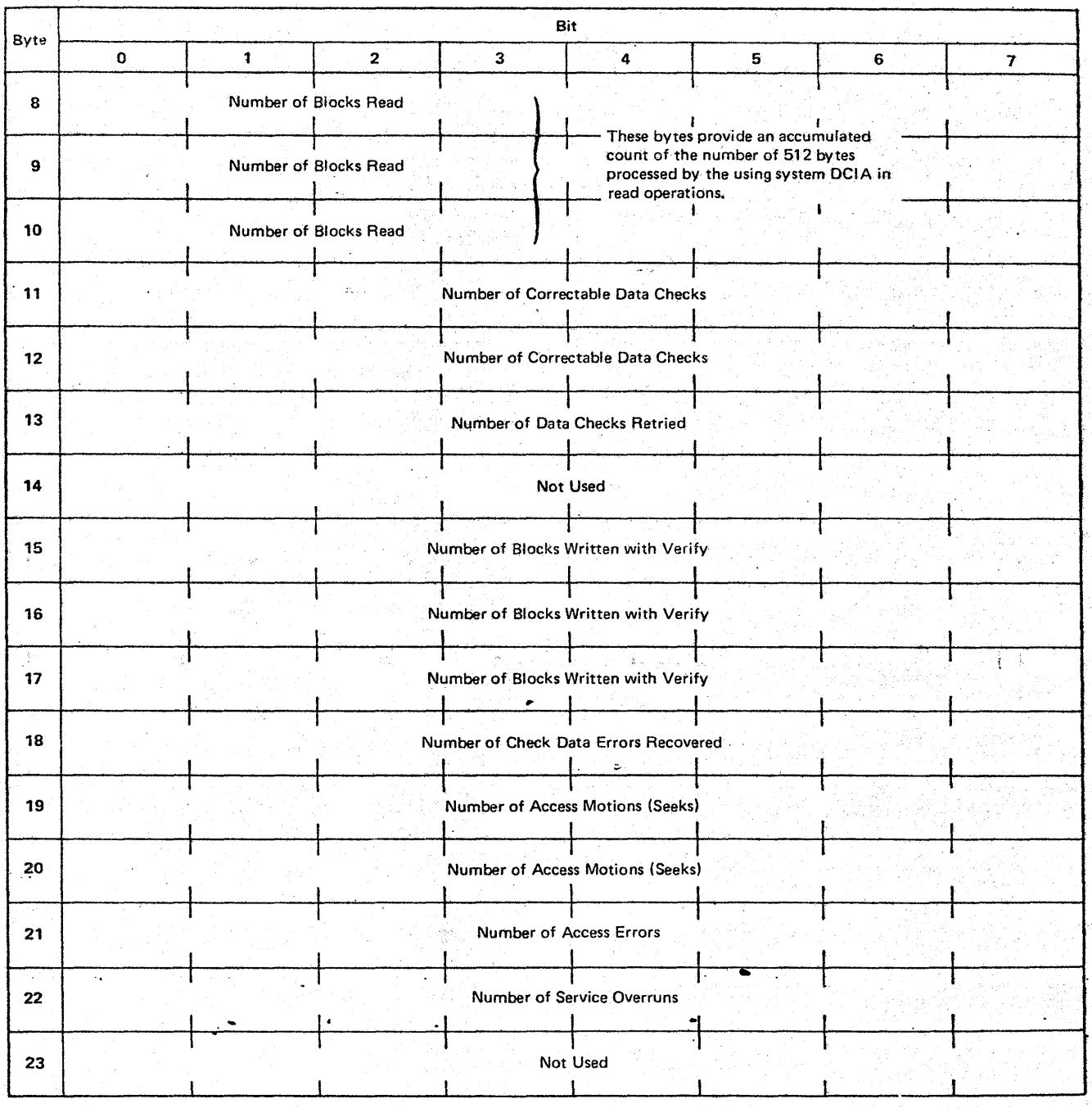


Figure 6-9. Sense Data (Bytes 8 through 23) - Format 6

Format 6 Messages

These messages are generated under the following conditions:

- Usage/Error statistics require offloading to the system:
  - Due to a counter overflow.
  - In response to a Read and Reset Buffered Log command.
- The command information is reinitialized after offload.

Usage/Error statistics have to be offloaded prior to the execution of Power Off.

Eight messages are defined. They are printed in the EREP summary statistics as listed below:

Message 0:	Read and Reset Buffered Log
Message 1:	Overflow of Blocks Read counter
Message 2:	Overflow of Data Checks Retried counter
Message 3:	Overflow of Correctable Data Checks counter
Message 4:	Overflow of Blocks Written with Verify counter
Message 5:	Overflow of Check Data Errors counter
Message 6:	Overflow of Access Motions counter
Message 7:	Overflow of Access Errors counter

Chapter 7. Usage, Error, and Overrun Counters

In the IBM 4331 Processor, each disk storage device is allocated a specific control block in storage (Drive Information Block) which includes among other things the Usage and Error Counters.

An additional Data Overrun counter is shared by all disk storage devices serviced by a DASDA and resides in a different area of storage.

Ussage, error, and overrun counters are stepped by the DASDA functional and error handling microcode.

When a usage counter overflows, a counter overflow flag will be set for the respective disk storage device. The next SIO addressing the disk storage device with counter overflow active will get unit check in the initial status, causing the operating system to issue a Sense command to the corresponding disk storage device. Sense byte 2, bit 3 - environmental data present will be on, and the counters will be offloaded as sense data bytes 8-23 in Format 6. The counters are then re-initialized.

When an error counter overflows before the corresponding usage counter overflows, it may mean that too many errors are occurring on a disk storage device even although these errors are being corrected on retry. The microcode therefore sets the disk storage device in Error Logging Mode in addition to offloading and re-initializing the usage and error counters as described above. Error logging is described in Chapter 3.

Offload and reinitialization of these counters is also done if a Read and Reset Buffered Log command is issued to the disk storage device.

Usage Counters

Three usage counters are provided:

Blocks Read

This three-byte counter is initialized to hex '000000'. Each time a 512 byte block of data is read a one is added to the counter. The counter overflows when the count exceeds the number 16,777,215 (decimal).

Blocks Written

This three-byte counter is initialized to hex '000000' and each time when a 512-byte block is written a one is added to the counter. The counter overflows when the count exceeds 16,777,215 (decimal).

Access Motions

This two-byte counter is initialized to hex '0000'. Each time a seek is initiated a one will be added to the counter. Overflow occurs when the count exceeds 65,535 (decimal).

Error Counters

These counters count errors which are removed during microcode retry. Four error counters are provided:

Data Checks Retried

This one-byte counter is initialized to hex '00'. Each time a data check disappears during retry or is retried successfully, a one is added to the counter. Overflow occurs when the count exceeds 255 (decimal).

Check Data Errors

This one-byte counter is initialized to hex '00'. Each time an incorrectly written block was detected by verify and invoked retry, a one will be added to the counter. Overflow occurs when the count exceeds 255 (decimal).

Access Errors

This one-byte counter is initialized to hex '00'. Each time a seek error (physical address mismatch) is retried successfully, a one is added to the counter. Overflow occurs when the count exceeds 255 (decimal).

Correctable Data Checks

This two-byte counter is initialized to hex '0000'. Each time when a correctable data check is eliminated by correction, a one is added to the counter. Overflow occurs when the count exceeds 65,535 (decimal).

Service Overrun Counter

This one-byte counter is shared by all disk storage devices served by one DASDA. It is initialized to hex '00'. Each time a data overrun occurs a one is added to the counter, except in retry mode.

When the counter overflows (increased beyond 256) it will be set to hex 'FF' and further updates will be inhibited. After the Usage , Error and Overrun Counter offload, the service overrun counter will be reinitialized to hex '00'.

Controls and Indicators

The operator controls for a maximum configuration of the 3310 Direct Access Storage are shown in Figure 1.

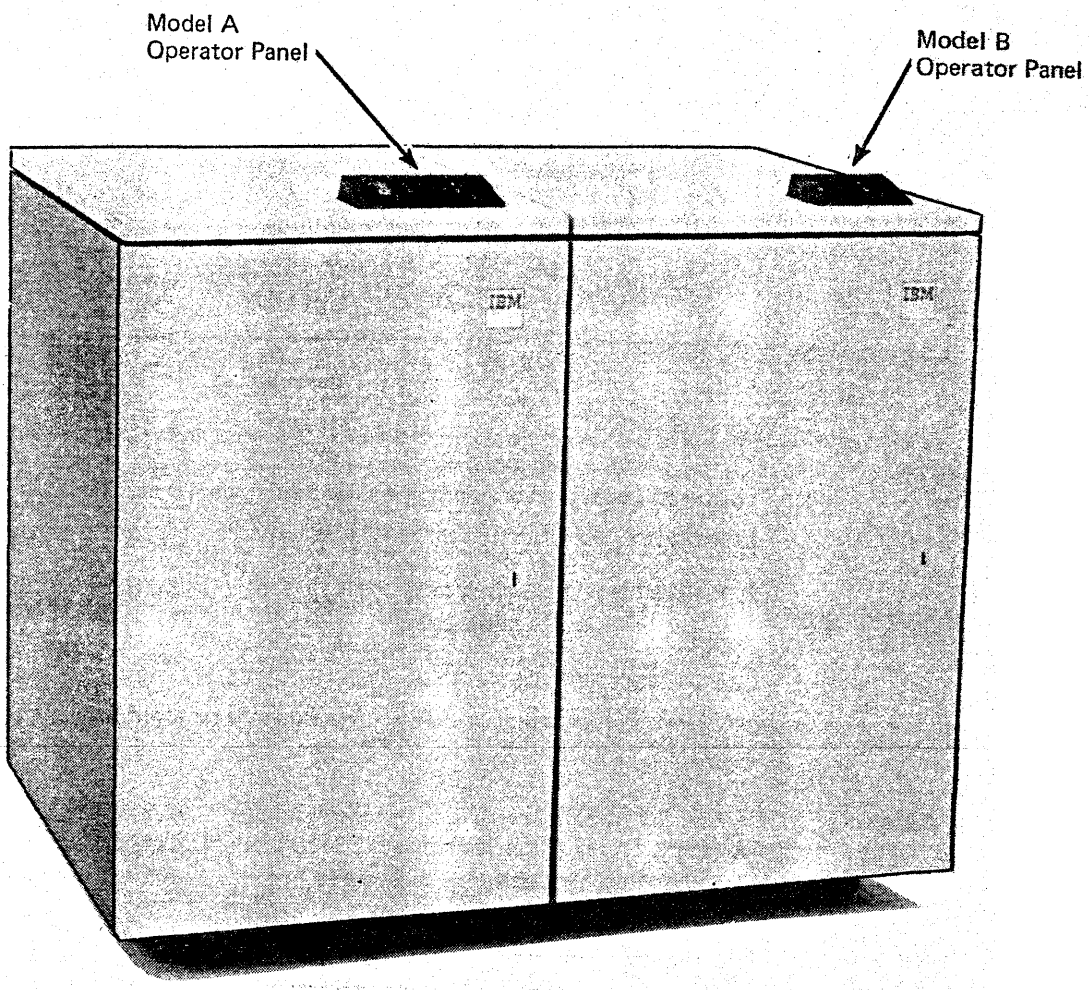


Figure 8-1. 3310 Direct Access Storage Unit Controls (Design Model)

Model A Operator Panel

The 3310 Model A2 operator panel contains the Master Power switch (⊜) and a spindle Start (◇)/Stop (▽) switch for each device in the enclosure. When a Model A1 (single spindle) is installed, there is only one Start/Stop switch on the panel. Above each Start/Stop switch is an Access Ready (⏻) indicator.

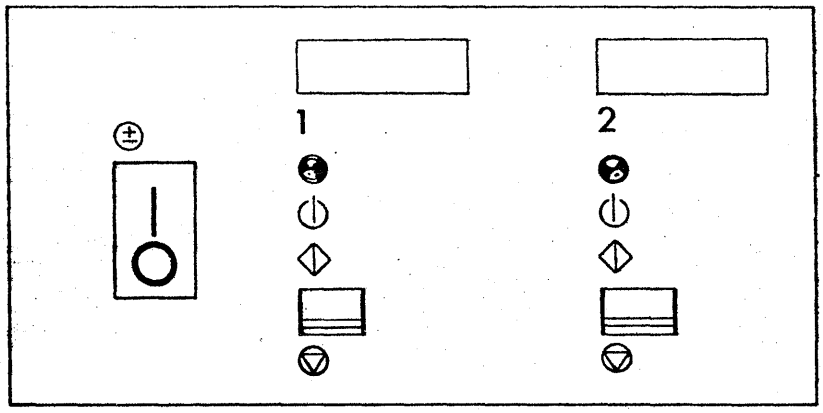


Figure 8-2. 3310 Model A Operator Panel (Design Model)

Power-On Sequence

The normal power-on sequence for a 3310 subsystem is as follows:

1. Set Master Power switch to On (|).
2. Set spindle power switch to Start (◇) for drive number one, then in turn, for each of the other drives in the string.

Power-Off Sequence

Set Master Power switch to Off (○). Power is removed from all the drives in the 3310 subsystem.

Model B Operator Panel

No Master Power switch is used as the 3310 Model B is always attached to a Model A. The operator panel contains either one or two spindle Start/Stop switches depending on the number of spindles in the enclosure.

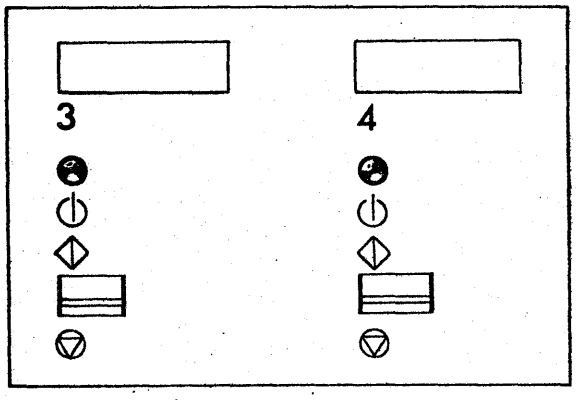


Figure 8-3. 3310 Model B Operator Panel (Design Model)

Abbreviations

AGC - Automatic Gain Control
CCW - Channel Command Word
CRC - Cyclic Redundancy Check
DASDA - Direct Access Storage Device Adapter
DS - Data Set
DSD - Disk Storage Device
ECC - Error Correction Code
ECF - Error Correction Function
EREP - Environmental Recording, Editing, and Printing
ERP - Error Recovery Procedure
ID - Identifier Field
I/O - Input/Output
IPL - Initial Program Load
LBN - Logical Block Number
PBN - Physical Block Number
PSW - Program Status Word
RPS - Rotational Position Sensing
R/W - Read/Write
SLI - Suppress Length Indicator

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