GA32-0061-0
File No. 4300-07/S370-07

Systems

IBM 3880 Storage Control Model 11 Description

IBM

GA32-0061-0
File No. 4300-07/S370-07

Systems

IBM 3880 Storage Control Model 11 Description

IBM

The following warning applies to the IBM 3880 Storage Control Model 11 used in the U.S.A.:

Federal Communications Commission (FCC) Statement

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 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.

First Edition (March 1982)

Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems, consult the latest *IBM System/370 and 4300 Processors Bibliography* GC20-0001, for editions that are applicable and current.

It is possible that this material may contain reference to, or information about, IBM products (machines and programs), programming, or services that are not available in your country. Such references or information must not be construed to mean that IBM intends to announce such products in your country.

Publications are not stocked at the address given below; requests for IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be addressed to IBM Corporation, General Products Division, Department 61C, Tucson, Arizona, U.S.A. 85744.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation whatever. You may, of course, continue to use the information you supply.

Preface

This publication describes the IBM 3880 Storage Control Model 11. It is intended for use by programmers and is intended to provide reference material related to channel command words, sense bytes, and error recovery procedures.

The manual is organized as follows:

- Introduction--describes the basic units, lists the highlights and special features, describes the operation of subsystem and the input/operations between the processor, channel, and storage control.
- Commands--describes each command of the count, key, data command set.
- Error Recovery Procedures--describes the recovery procedures for the devices that attach to the 3880 Model 11.
- Operator Panel--describes the switches and indicators associated with the operation of the 3880.
- Sense Bytes--describes all the sense bytes for the 3330s and 3350s that attach to the 3880 Model 11.

Related Publications

Programmers should be familiar with the information contained in *IBM System/370 Principles of Operation*, GA22-7000, and *IBM 4300 Processors Principles of Operation*, GA22-7070.

Information about IBM 3880 Models 1 to 3 and the IBM 3330s and 3350s can be found in:

- *IBM 3880 Storage Control Description*, GA26-1661
- *Reference Manual for IBM 3330 Series Disk Storage*, GA26-1615
- *Reference Manual for IBM 3350 Direct Access Storage*, GA26-1638

Contents

Introduction

The IBM 3880 Storage Control Model 11 is a high-performance paging and swapping subsystem for use with the MVS/SP Release 1.3 operating system and the program product Data Facility/Device Support. The 3880 Model 11 has two storage directors and an 8 megabyte high-speed, electronic storage unit, called subsystem storage. A large portion of subsystem storage is the cache and is used to store active page data for quick access. A smaller portion of the storage is the directory and is used to locate the data stored in the cache.

Storage Directors

Storage Director 1

Storage director 1 is the paging storage director and is the only storage director with access to cache. The paging storage director attaches to a 1.5, 2.0 or 3.0 megabyte per second channel and to one string of two, four, six, or eight 3350 devices.

> **Note:** When attached to 2.0 megabyte per second channel, the paging storage director operates up to 1.5 megabyte per second data rate.

The paging storage director manages data by:

- Determining which pages should be in cache
- Determining which pages to remove from cache
- Copying pages from 3350 to the cache and from cache to 3350
- Copying pages from cache to the processor
- Performing error recovery procedures (ERPs) within the subsystem storage

Storage Director 2

Storage director 2 is the nonpaging storage director. It does not have access to cache. The nonpaging storage director attaches to a 1.5, 2.0, or 3.0 megabyte per second channel and to any combination of up to four strings of 3330s and 3350 devices.

Subsystem Storage

Subsystem storage has a capacity of 8 megabytes and is logically divided into two areas: cache and directory. Cache is the larger area and is used for storing pages (4096 bytes each); the smaller area is the directory and is used to keep track of the pages that are in cache.

Processor Attachment

The 3880 Storage Control Model 11 attaches to the following IBM systems through a block multiplexer channel:

- System/370 Model 158 and 168
- Processors 3031, 3032, 3033, 3081, and 4341 Model Groups 1 and 2

Dynamic sharing of the Model 11 paging storage director by two or more systems is not supported. However, the attachment of two or more systems is supported for backup.

Channel Attachment

The Model 11 must attach to a block multiplexer channel. It is recommended that channels attached to the paging storage director be exclusive paths and that the paging storage director not be shared with a nonpaging channel.

DASD Attachment

The paging storage director attaches one string of up to eight 3350 devices. The 3350s must operate only in native mode; that is they cannot emulate a 3330 device. If the attached 3350 has the string feature installed, it must be manually switched to the paging path during paging operations.

The nonpaging storage director can attach up to four strings of 3330s or 3350s in any combination. The string switch feature can be used on devices attached to the nonpaging storage director.

Channel Switching Features

Two channel features are available with the 3880 Model 11:

- The Two Channel Switch—Pair feature allows each storage director and its attached devices to be shared by two channels.
- The Two Channel Switch—Pair, Additional allows each storage director and its attached devices to be shared by four channels. The Two Channel Switch—Pair feature is a prerequisite for this feature.

The channels may be attached to the same or different processing units and, with appropriate programming or operator action, individual devices may be reserved for the exclusive use of any of the channels.

Channel switching and device reservations are controlled by the channel programming. Three special commands are associated with channel switching: Device Reserve, Device Release, and Unconditional Reserve.

Two Enable/Disable switches are added to the operator panel for the two channel switch pair feature and four are added for the two channel switch pair, additional feature.

Remote Attachment Features

There are two remote attachment features available on the Model 11.

- The Remote Attachment feature is used in conjunction with the Two Channel Switch—Pair feature.
- The Remote Attachment, Additional feature is used in conjunction with the Two Channel Switch—Pair, Additional feature.

The remote attachment features remove the Enable/Disable switches from the 3880 operator panel and relocate them to a remote location. This allows the operator to reconfigure the system from a central point. Some systems, such as System/370 Models 158, and 168, provide a remote configuration control panel for the switches. If the system is not equipped with such a panel, the customer must provide a suitable panel for mounting the switches.

Addressing

Each storage director and device is assigned an I/O address at the time of installation and is indicated by an eight-bit binary number in an I/O instruction. The address consists of three parts: the storage director address, the controller address, and the device address. The complete I/O address is specified in bytes 2 and 3 of the I/O instruction and has the following format:

Bit Function

0-1 Storage director address

2-4 Storage director and controller address or controller address

5-7 Physical device address

Storage director 1 must be installed to accept 32 logical device addresses. Storage director 2 may be installed to accept 8, 16, or 32 logical device addresses as required by the device configuration. The addresses are installed by the customer engineer through use of switches on the 3880 interface card. See the Appendix for the device addresses that can be used on both storage directors.

Condition code 3 (not operational) is set in the PSW if an attempt is made to address a storage director, controller, or device string that is non-existent, powered off, or disabled by the string switch feature.

If an addressed device in a properly selected string is non-existent or powered off, unit check is presented in the initial status.

3330, 3333, and 3350 Addressing

Only one string of 3350 devices can attach to storage director 1 (paging storage director). Up to four strings of 3330 and/or 3350 devices can attach to storage director 2.

The bit assignments for 3330, 3333, and 3350 attached to storage director 2 are as follows:

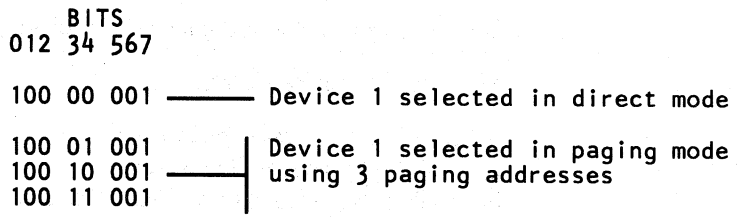
Bits 0 to 2 Storage director address
Bits 3 to 4 3333 or 3350 A2/C2 address
Bits 5 to 7 Physical device address

The paging storage director employs a similar addressing structure but uses two addresses called "base address" and "paging address." Base addresses are used in direct mode and the format is the same as that used by storage director 2. Paging addresses are used in paging mode and are formatted as follows:

Bits 0 to 2 Storage director address
Bits 3 to 4 Address and mode
- 00 Addressed device in direct mode
- 01 Paging address 1 in paging mode
- 10 Paging address 2 in paging mode
- 11 Paging address 3 in paging mode

Bits 5 to 7 Physical device address

The physical configuration of the paging storage director permits only one string of up to eight DASDs to be attached and the address plug for the controller must be zero. Address bits 3 and 4 are normally the controller address of DASD. However, the paging addressing scheme permits the data of one physical DASD to be addressed using any one of four different addresses. One address is reserved for direct mode activity such as formatting and pack maintenance. The other three addresses (paging) are used in paging mode to gain access to data in the cache. For example, the data on device 1 is accessed when the incoming address is:



Thus, if there are eight 3350s attached, there can be up to 32 addresses associated with the paging storage director.

Subsystem Operation

The paging storage director (storage director 1) operates in two modes: direct and paging. The nonpaging storage director (storage director 2) operates only in direct mode.

Direct Mode

When either storage director receives a channel program using a base address, the program is executed in direct mode. All data transfers that occur as the result of the

channel program are between channel and DASD and do not involve cache. DASD remains connected to the channel throughout the operation and is not available to another channel until ending status is presented.

Paging Mode

Only the paging storage director operates in paging mode. All channel programs using a paging address are executed in paging mode. All data transfers that occur as the result of the channel program are between the channel and cache and do not involve DASD.

Cache Operations

When the paging storage director receives a data request, it searches the cache for the data. If the data is found, it is called a "read hit" and the requested data is transferred to channel.

If the requested data is not in cache, it is called a "read miss." The paging storage director, using channel command retry, disconnects from channel and accesses DASD for the data. After the data is in cache, the paging storage director disconnects from DASD and reconnects to channel and transfers the requested data to channel to complete the operation.

When the channel transfers data, the paging storage director stores it in cache. If the data is already in cache, this is called a "write hit" and the data block is updated. If the data is not in cache, it is called a "write miss" and the directory is searched for an available slot. When one is found, the data is stored in cache and an entry made in the directory to indicate that the data is modified. If an available slot cannot be found, the paging storage director begins searching for data blocks that can be deleted from cache or copied on to DASD.

Deleting From Cache

Deleting data from cache is removing it from cache without transferring to DASD. Data that is not modified and blocks that are being discarded are deleted by overlaying the block with new data.

The blocks to be deleted are selected by a least recently used algorithm. The block least recently used is checked for possible deletion. If it has not been modified, the block is marked as invalid and it becomes a free slot. If the block has been modified, it is not invalidated and the next least recently used block is examined.

If no unmodified blocks are found, the allocating of space must wait until some modified blocks are copied onto DASD.

Copying On DASD

Copying the data blocks onto DASD is controlled by the paging storage director and is performed only when the number of available slots falls below a predetermined availability threshold. The purpose of the threshold is to maintain a buffer of free slots and unmodified data blocks that have not been used recently. (The availability

threshold is determined by the microcode and cannot be changed.) The number of available slots should equal or exceed the value specified by the availability threshold. When the number of available blocks falls below this threshold, the least recently used modified blocks are copied onto DASD and marked as unmodified. The copying of data blocks onto DASD continues until the number of available slots exceeds the availability threshold.

Input/Output Operations

Input/output operations, initiated by I/O instructions in the system control program (SCP), are controlled by commands retrieved from processor storage by the channel. Arithmetic and logical operations are performed while the processing unit is in the problem state; for I/O operations, the processing unit must be in the supervisor state.

The processing unit is changed from problem to supervisor state when a supervisor call instruction is executed or when an I/O interrupt occurs. The status of the system at the time of the change is stored in the program status word (PSW).

In the supervisor state, the processing unit can execute the following I/O instructions:

- Start I/O - This instruction initiates the I/O operation if the addressed channel, storage director, and disk drive are available.
- Start I/O Fast Release - This instruction initiates an I/O operation if the addressed channel is available. The storage director and disk storage units are assumed to be available. If not, an I/O interrupt occurs to indicate an unavailable condition.
- Halt I/O - This instruction terminates the operation in progress at the addressed channel and the storage director is disconnected from the channel.
- Halt Device - This instruction terminates the operation in progress at the storage director without interfering with other I/O operations at the channel. This instruction should be used instead of Halt I/O to terminate operations on a device attached to an IBM block multiplexer channel.
- Test I/O - This instruction sets the condition code in the program status word to indicate the status of the addressed channel, subchannel, storage director, and disk storage.
- Clear I/O - This instruction discontinues the operation with the addressed device and stores the status of discontinued operation in the channel status word (CSW).

After the specified instruction has been executed, the processing unit can return to the problem state and continue the interrupted program by reloading the program status word originally stored when the program entered the supervisor state.

A detailed description of the formats and functions of the I/O instructions can be found in *IBM System/370 Principles of Operation*, GA22-7000 and *IBM 4300 Processor Principles of Operation*, GA22-7070.

Channel Operation

After successful execution of an I/O instruction, the channel independently selects and governs the storage director and drive addressed by the instruction. Reserved processor storage locations contain information and instructions that enable the channel to perform those functions necessary to complete the operation.

Channel/Storage Control Timing

Under expected normal conditions the 3880 may add up to 160 microseconds to initial selection time and may delay up to 124 microseconds before propagating the requested channel selection tag because of a withdrawal of the request.

During non-streaming read, write, or search data transfer operations, the 3880 may drop each inbound tag after keeping it up for a minimum period of time as shown below. The inbound tag may drop even if a response from the channel is not received. The minimum tag duration for Model 11 attached devices is shown in the following table.

Disk Storage	Minimum Inbound Tag Duration (Nanoseconds)
3330/3333	1045
3350	730

The 3880 may issue as many as three inbound tags before an outbound tag is received. The 3880 may raise an inbound tag while the corresponding outbound tag is still active.

If the duration of a corresponding channel outbound tag is less than 80 nanoseconds, a channel overrun condition is detected.

Following the signaling of a stop, the channel may still receive one or more data transfer requests.

For additional information about the channel interface, refer to *IBM System/360 and System/370 I/O Interface Channel to Control Unit Original Equipment Manufacturers' Information*, GA22-6974.

Channel Address Word

Issuing a Start I/O or Start I/O Fast Release instruction causes the channel to fetch the channel address word from processor storage location 72. Bits 0 through 3 of the channel address word (CAW) form the subchannel key for all commands associated with the I/O instruction. The subchannel key establishes the right of access (that is, whether the data can be stored or fetched) to the particular processor storage locations.

The command address in bits 8 through 31 designates the address of the first channel command word. The three low-order bits of the command address must be zero to specify the channel command word on doubleword boundaries.

A detailed description of the channel status word can be found in *IBM System/370 Principles of Operation*, GA22-7000 and *IBM 4300 Processor Principles of Operation*, GA22-7070.

Channel Command Word

The channel fetches the first channel word (CCW) from the address specified in the channel address word. The CCW specifies the operation to be performed, the processor storage location to be used, and the action to be taken when the operation is completed.

The channel, if available, when it receives the channel command word, attempts to select the device specified in the I/O instruction by sending the address to all attached control units. If the addressed device is attached to the channel and has power on, the command code portion of the CCW is sent to the storage director, which responds with an initial status to the channel.

At this point, the Start I/O instruction is finished, releasing the processing unit to perform the next instruction. The results of the attempt to initiate execution of the command are indicated by the condition code in the program status word. If the I/O operation was not started, new status information containing the reason for this condition is usually set in the channel status word.

A detailed description of the channel command word can be found in *IBM System/370 Principles of Operation*, GA22-7000 and *IBM 4300 Processor Principles of Operation*, GA22-7070.

Channel Status Word

The channel status word (CSW), stored at processor storage location 64, informs the program of I/O device status or the conditions under which an I/O operation was terminated. The CSW is formed or changed during I/O interruptions and instruction execution. Status stored in the CSW remains unchanged until a subsequent interrupt occurs or a new I/O instruction is processed.

A detailed description of the channel status word can be found in *IBM System/370 Principles of Operation*, GA22-7000 and *IBM 4300 Processor Principles of Operation*, GA22-7070.

Program Status Word

The program status word (PSW) is 64 bits in length and includes the instruction address, condition code, and other control fields. The PSW is used to control instruction sequencing and to hold and indicate the status of the processor in relation to the program being executed.

Bit 12 of the PSW determines whether the processor is operating in basic control (BC) or in extended control (EC) mode.

The two modes determine the allocation of bit positions within the PSW, the use of permanently assigned locations in processor storage for storing the interruption code, instruction length code, and the controlling of I/O interruptions for channels 0

through 5. The BC mode of operation (specified when bit 12 is 0) is provided all processors. The EC mode (specified when bit 12 is 1) is available only with the extended control feature.

When an I/O interrupt occurs, the current program status word is stored, and a new program status word is loaded. By storing the current PSW during an interruption, processor status is preserved for subsequent inspections by the program. Loading a new PSW causes the state of the processor to be initialized or changed to branch to a new instruction sequence. If at the conclusion of an interrupt routine, an instruction is executed that restores the old PSW as the new PSW, the system is restored to the state existing prior to the interruption, and the interrupted routine continues.

A detailed description of the channel status word can be found in *IBM System/370 Principles of Operation*, GA22-7000 and *IBM 4300 Processor Principles of Operation*, GA22-7070.

Status Presentation

Initial Status

The initial status byte is zero for Test I/O instructions and for all non-immediate commands unless one or more of the following conditions exist:

- Control unit busy is indicated for one of the following reasons:
  - A write operation is still in progress after chaining has been terminated.
  - The storage director is disconnected during command chaining when a storage control error recovery procedure is in progress.
  - The storage director is performing a format defective block, check data, or format ID operation.
  - The storage director is executing a Diagnostic Load command or a diagnostic test.
  - A status condition is pending in the storage director for other than the addressed device.
  - A system reset is in progress.
  - The storage director is maintaining a contingent connection to some device other than the addressed device.
  - A storage director initiated connection is preferred over a channel initiated connection because presentation of consecutive device busy or zero status to the channel exceeds the number of devices that can be attached to the storage director.
  - The storage director is in a long connection with another channel.

- The storage director is initiating a seek operation after having disconnected from the channel.
- The storage director is accumulating sense data for a previously presented unit check and a Start I/O or Test I/O is received for the device in the contingent connection.

- A status condition is pending in the storage director. The pending status is presented as initial status and the busy bit is included in the status byte unless a Test I/O instruction was being executed. The busy bit indicates that the device is busy because of the outstanding status. The pending status is then cleared unless it is stacked by the channel. After the status is cleared, the device must be readdressed to determine whether it is available.
- The device is busy to the channel interface. In this case, the busy bit appears alone in the initial status byte. The device is busy to the interface if channel end occurred without device end for the device, and device end was not generated, or if the device is reserved by another interface.
- A status condition is pending in the device. The pending status is presented as initial status and the busy bit is included in the status byte unless a Test I/O instruction was being executed. The pending status is then cleared unless it is stacked by the channel.
- A unit check condition exists at the storage director or device. In this case, unit check is presented as initial status unless the command was one of the sense commands. A zero initial status byte is presented for the sense commands.
- Initial status indicates command retry.
- Invalid parity is sensed in the command code.

Immediate commands (commands not requiring data transfer) present channel end and device end in initial status.

Pending Status

A pending status condition can exist for either the storage director or a device. Status is pending for the storage director if:

- A Halt I/O or Halt Device instruction was signaled after a command was issued but before channel end status was accepted. The ending status for the operation is pending after the operation is complete.
- A Halt I/O or Halt Device instruction was signaled during a Test I/O instruction before the status was accepted by the channel. The status for the addressed device remains pending in the storage director.
- Busy, channel end, or unit check status was stacked by the channel.
- Zero status in response to a Test I/O instruction was stacked by the channel.
- Control unit busy status was presented to the channel. (Control unit end is pending.)
- Device end status from a Diagnostic Control command is stacked.

If device end status for a not ready-to-ready interrupt is stacked in a multichannel environment, the status is pending in the storage director, but the storage director does not appear busy for all devices. Status pending for the storage director (except for control unit end) causes the storage director to appear busy for all devices except the device for which the status condition exists. Unless it is busy, the storage director will request service to clear the pending status. Status is cleared when presented to, and accepted by the channel.

Status is pending for a device if:

- Channel end is presented alone.
- Busy status was presented.
- The device has gone from a not ready status to a ready status.
- Device end status from a Seek or Set Sector command is stacked.

Status pending for a device causes the storage director to request service when both the storage director and device are not busy. The status is cleared when presented to, and accepted by, the channel.

Device end status is the only condition that can be pending in a device.

Priority of Pending Status Conditions

When presented via polling, the priority of pending status conditions is:

1. Status pending in the storage control (except control unit end)
2. Unsuppressible status
3. Suppressible device end status
4. Control unit end status

   Note: During a contingent connection, control unit end has first priority.

Address Associated with Pending Status

All status conditions (except control unit end) are associated with a specific device address. When there is no contingent connection, control unit end may be cleared by addressing any of the devices attached to the storage director. However, during a contingent connection, control unit end is associated with the specific address for which the contingent connection is being maintained.

When presented via polling, the address associated with control unit end status is always the lowest non-busy device address within the range of addresses recognized by that storage director whether or not the device exists.

> **Note:** Generally, when all of the device addresses within a specified address range on the storage director do not exist, the system control program (SCP) I/O generation does not include non-existent device addresses. When the SCP receives an interrupt, like control unit end, from a non-existent device the interrupt is ignored. For 3880, the lowest non-existent address should be generated to ensure that the SCP will recognize the address returned with control unit end status.

Suppressible Status

All status conditions are suppressible except (1) device end status associated with channel end for which chaining has been indicated and (2) the device end status associated with unchained Diagnostic Control commands.

Contingent Connection

A contingent connection is established in the storage director after the channel accepts a status byte containing unit check. It lasts until a command other than Test I/O or No Operation receives an initial status byte of zero for the storage director and device address that generated the unit check, or a selective or system reset occurs.

During the contingent connection state, the storage director is busy to all addresses other than the address for which the contingent connection state was established.

Commands

The command set of the 3880 Model 11 supports the count, key, and data format used for 3330 and 3350 disk storage operations.

The command set is executed in two modes: direct and paging. In direct mode, no data is transferred into or out of cache. Both the paging storage director (storage director 1) and the nonpaging storage director (storage director 2) retrieve data from or store data on DASD.

In paging mode, data is transferred into or out of cache and only the paging storage director has access to the data. The nonpaging storage director can never access the data in cache.

Four new commands have been added and are executed only by the paging storage director. They are Discard Block, Set Paging Parameters, Sense Subsystem Counts, and Sense Subsystem Status. Discard Block and Set Paging Parameters are executed only in paging mode. The other two commands are executed only in direct mode. All the other commands can be executed by either storage director.

A description of each command follows. The commands are grouped according to type (control, search, read, write, and diagnostic) and are in alphabetical order within each group. The descriptions of the commands include an explanation of the status conditions associated with its execution as well as its chaining requirements. Also described are the differences in command execution between direct mode and paging mode.

Control Commands

Control commands do not involve a transfer of data records between storage director and main storage. However, in many cases control information is transferred from main storage to the storage director. This information may include an order code specifying some further action to be taken by the storage director or device, or it may contain parameters defining the types of operations that are allowed or data areas which may be accessed.

The data address field of the channel command word designates the location containing the required additional information.

The following table lists the control commands. The commands marked with an single asterisk (*) are accepted in paging mode.

COMMAND	COMMAND CODE
Discard Block*	8F
No Operation* (No-Op)	03
Recalibrate	13
Restore	17
Seek*	07
Seek Cylinder*	0B
Seek Head*	1B
Set File Mask	1F
Set Paging	8B
Parameters*	
Set Sector*	23
Space Count	0F
Transfer-In-Channel (TIC)	X8**

*Accepted in paging mode.

** The x is not significant.
The data address should not exceed storage capacity.

Discard Block

Command Code 0 7	Data Address 8 31	Flags 32 37	 39	Not Used 40 47	Count (Decimal) 48 63
1000 1111 '8F'	Specifies the starting address in main storage of the parameter bytes	Used at the discretion of programmer	00		2 to 322

Function

This command is executed only by the paging storage director. The Discard Block command indicates which data blocks the paging storage director may invalidate in cache.

Chaining Requirements

The Discard Block command must be chained from a Set Paging Parameters command or another Discard Block command. If it is not, the command is rejected with unit check in the status.

Status

Initial status is normally zero. If all the command parameters are valid and the chaining requirements are met, channel end is presented and the paging storage director disconnects. After the discard operation is completed, the paging storage director presents device end to the channel.

Description

Direct Mode

This command is not accepted in direct mode.

Paging Mode

After the presentation of the initial status to channel, the parameter bytes are transferred to the paging storage director. The parameter bytes have the following format:

- Byte 0 contains the control flags. If bit 0 is a 1 (discard all), all data blocks in cache are discarded. If bit 0 is a zero, only the blocks specified in byte 1 are discarded. Bits 1 to 7 are not used.
- Byte 1 contains the discard block count. The minimum count is 0 and the maximum is 64.
- The remaining bytes (the number of remaining bytes depends upon the block count) contain a five-byte entry in the form CCHHR. Each entry is a logical block identifier that indicates the block to be discarded.

After the parameter bytes are transferred, they are checked for validity by the paging storage director. The operation is terminated if:

- Bits 1 to 7 of byte 0 are not zero
- The discard block count is greater than 64
- The discard all bit (byte 0, bit 0) is a 1 and the discard block count is greater than 0.
- The channel transfers less than the expected number of parameter bytes (2 to 322).

When this occurs, the ending status contains channel end, device end, and unit check.

If the channel transfers more than the expected number of parameter bytes, only the expected number are accepted. No error condition is reported.

If the parameter bytes are found to be valid, the paging storage director presents channel end and disconnects from the channel.

If the discard all bit is set and no previous Set Paging Parameters command in the chain had the guest operating system bit set, all blocks in the cache are invalidated by initializing all directory entries. When the initialization is completed, the paging storage director presents device end to channel.

If the discard all bit is set and a previous Set Paging Parameters command had the guest operating system bit set, no data is discarded from cache. Channel end and device end are presented and no further processing occurs. If the paging storage director requires this command with the discard all bit on, it will present unit check in the initial status for all Search ID Equal commands received in paging mode until the Discard Block command with discard all is received from the host operating system. If the paging storage director does not require Discard Block with discard all on, normal operation continues.

If discard all is not on, the five-byte logical block identifiers are used as follows:

- A physical block identifier is generated by adding the most recent base cylinder address transferred by the Set Paging Parameters command to the CC portion of the logical block identifier.
- The physical block and logical block identifiers are checked for validity. If they are invalid, the operation is terminated and unit check and device end are presented channel.
- If the block identifiers are valid, the cache directory is searched for the block specified. When a match is found, the entry is marked invalid and the block becomes available for allocation. If no match is made, no action is taken nor any error reported.

When all the block identifiers have been processed, the paging storage director reconnects and presents device end.

If the discard all bit is not specified and the discard block count is zero, the Discard Block command has the effect of a No-Op command.

Programming Note: A Discard Block must not specify the discard of a block which has been accessed by a Read Data command that preceded Discard Block in the same chain. Certain exception conditions can occur that may cause the re-execution

of the entire chain. If this occurs, the Read Data command will access the DASD copy of the data block. If the cache copy of the data block had been modified, the DASD copy may not be valid.

No-Operation

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 0011 '03'	Not checked for validity, should not exceed addressing capacity	SLI flag (bit 34) must be on	00		Must be nonzero to avoid a program check

Function

The No-Operation (No-Op) command is used to maintain channel connection during I/O operations.

Chaining Requirements

None in direct mode. In paging mode, the command must be the first command in the chain or must be chained from a Read Data, Write Data, or Discard Block command.

Status

Channel end and device end are presented in initial status.

In paging mode, the command is rejected with unit check in the status if the chaining requirements are not met.

Description

Direct Mode

The No-Op command is processed as an immediate command. (Channel end and device end are signaled immediately upon receipt of the command code.) It causes no action at the addressed device.

The No-Op command resets track orientation information in the storage director. Indiscriminate usage of the No-Op command within CCW chains may cause records or parts of records to be skipped. For example, a No-Op inserted between a Read Count command and a Read Data command may cause the data area of the following record to be read. Also, a No-Op inserted between a command that reads the data area of N-1 and a command that must process the count area of record N, may skip one or more records and process the count area of a subsequent record.

Paging Mode

In paging mode, the command is processed as in direct mode. However, the chaining requirements must be met or it is rejected with unit check.

Recalibrate

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0011 '13'	Not checked for validity, should not exceed addressing capacity	SLI flag (bit 34) must be on	00		Must be nonzero to avoid program check

Function

The Recalibrate command causes the addressed drive to seek to cylinder zero, head zero.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end is presented as ending status and device end is presented after the access is positioned at cylinder zero, head zero.

Description

Direct Mode

The Recalibrate command is processed similarly to a seek command and the file mask must be set to allow seeks. Since this command is not processed as an immediate command and there is no data transfer involved, the suppress length indicator (SLI) flag must be on to avoid an incorrect length indication.

Paging Mode

In paging mode, the command is rejected with unit check, channel end, device end in the status.

Restore

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0111 '17'	Not checked for validity; should not exceed addressing capacity	SLI flag (bit 34) be on	00		Must be nonzero to avoid program check

Function

The Restore command causes no action at the addressed device.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are normally presented as ending status immediately after initial status.

Description

Direct Mode

The Restore command causes no action to be performed at the addressed device. It is maintained primarily for compatibility with other IBM direct access storage devices. Since this command is not processed as an immediate command and there is no data transfer involved, the SLI flag must be on to avoid an incorrect length indication.

Execution of a Restore command resets track orientation information in the storage director.

Paging Mode

In paging mode, the command is rejected with unit check, channel end, and device end in the status.

Seek

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 0111 '07'	Specifies the main storage location of the seek address	Used at the discretion of programmer	00		6

Function

The Seek command transfers the seek address from the channel to the storage director.

Chaining Requirements

None in direct mode. In paging mode, the command must be chained from a Read Data or Write Data command.

Status

Initial status is normally zero. Channel end and device end are presented after the seek address has been transferred. In paging mode, unit check is presented in initial status if the chaining requirements are not met. See the following description for other status conditions.

Description

Direct Mode

The Seek command transfers the six byte seek address from the channel to the storage director. The storage director saves the address to allow positioning of the access mechanism at a later time. If the address indicates that no access motion is required, the proper head is selected before channel end and device end status are presented.

The storage director checks the seek address for validity (see the following chart). If the seek address is not valid, channel end, device end, and unit check are presented in the ending status if the Seek command was the first one in a CCW chain. Otherwise, unit check status is presented alone.

The format for the seek address is:

Bytes 0 and 1 contain zeros
Bytes 2 and 3 contain the cylinder address
Bytes 4 and 5 contain the head address

VALID SEEK ADDRESS	3330-1	3330-11	3350
Bytes 0, 1, and 4 must be:	0	0	0
Bytes 2 and 3 are not greater than:	410	814	559*
Byte 5 is not greater than:	18	18	29
CE cylinders are:			1024 and 1025

* Unless the file mask indicates CE cylinders.

If access motion is required, it is not initiated until a Set Sector, read, search, write, or Space Count command is received in the same chain or until the CCW chain ends normally. If more than one Seek command is received in the CCW chain before access motion is initiated, only the last Seek command will cause access motion.

If the CCW chain ends normally and the last Seek command has not been initiated, the storage director initiates the seek after disconnecting from the channel. If the device is addressed by another command before the seek is completed, device end is not generated, but busy status is presented.

The Seek command does not have to be preceded by another CCW in order to be executed. However, if a Set File Mask command has been issued, the file mask must be set to allow seeks. See the Set File Mask command.

Execution of the Seek command resets track orientation information in the storage director.

Paging Mode

The paging storage director saves the address for a directory search or to position the access mechanism at a later time. The command is rejected with unit check if the chaining requirements are not met.

Seek Cylinder

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 1011 '0B'	Specifies the main storage location of the seek address	Used at the discretion of programmer	00		6

Function

The Seek Cylinder command transfers the seek address from channel to the storage director. This command performs the same functions as the Seek command.

Chaining Requirements

None in direct mode. In paging mode, the command must be chained from a Read Data or Write Data command.

Status

Initial status is normally zero. Channel end and device end are presented after the seek address has been transferred. In paging mode, unit check is presented in the status if chaining requirements are not met. See the following description for other status conditions.

Description

Direct Mode

The Seek Cylinder command transfers the six byte seek address from the channel to the storage director. The storage director saves the address to allow positioning of the access mechanism at a later time.

If the seek address indicates that no access motion is required, the proper head is selected before channel end and device end status are presented.

The storage director checks the seek address for validity (see the following chart). If the seek address is not valid, channel end, device end, and unit check are presented in the ending status if Seek Cylinder was the first command in a CCW chain. Otherwise, unit check status is presented alone.

The format for the seek address is:

Bytes 0 and 1 contain zeros
Bytes 2 and 3 contain the cylinder address
Bytes 4 and 5 contain the head address

VALID SEEK ADDRESS	3330-1	3330-11	3350
Bytes 0, 1, and 4 must be:	0	0	0
Bytes 2 and 3 are not greater than:	410	814	559*
Byte 5 is not greater than:	18	18	29
CE cylinders are:			1024 and 1025

* Unless the file mask indicates CE cylinders.

If access motion is required, it is not initiated until a Set Sector, read, search, write, or Space Count command is received in the same chain or until the CCW chain ends normally. If more than one Seek Cylinder command is received in the CCW chain before access motion is initiated, only the last Seek Cylinder command will cause access motion.

If the CCW chain ends normally and the last Seek Cylinder command has not been initiated, the storage director initiates the seek after disconnecting from the channel. If the device is addressed by another command before the seek is completed, device end is not generated, but busy status is presented.

The Seek Cylinder command does not have to be preceded by another CCW in order to be executed. However, if a Set File Mask command has been issued, the file mask must be set to allow seeks. See the Set File Mask command.

Execution of the Seek Cylinder command resets track orientation information in the storage director.

Paging Mode

The paging storage director saves the address for a directory search or to position the access mechanism at a later time. The command is rejected with unit check if the chaining requirements are not met.

Seek Head

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 1011 '1B'	Specifies the main storage location of the seek address	Used at the discretion of programmer	00		6

Function

The Seek Head command transfers the seek address from channel to the storage director.

Chaining Requirements

None in direct mode. In paging mode, it must be chained from a Read Data or Write Data command.

Status

Initial status is normally zero. Channel end and device end are presented after the seek address has been transferred. In paging mode, the command is rejected with unit check if the chaining requirements are not met.

Description

Direct Mode

The Seek Head command transfers the six byte seek address from the channel to the storage director. The storage director selects the drive and the proper head. Regardless of the value of the seek address cylinder bytes (bytes 0 through 3), no access motion is initiated.

> **Note:** Although the cylinder bytes are not used, they must contain a valid address.

The storage director checks all six bytes for validity (see the following chart). If the seek address is not valid, channel end, device end, and unit check are presented in the ending status.

The format for the seek address is:

Bytes 0 and 1 contain zeros
Bytes 2 and 3 contain the cylinder address
Bytes 4 and 5 contain the head address

VALID SEEK ADDRESS	3330-1	3330-11	3350
Bytes 0, 1, and 4 must be:	0	0	0
Bytes 2 and 3 are not greater than:	410	814	559*
Byte 5 is no greater than:	18	18	29
CE cylinders are:			1024 and 1025

* Unless the file mask indicates CE cylinders.

The Seek Head command does not have to be preceded by another CCW in order to be executed. However, if a Set File Mask command has been issued, the file mask must be set to allow seeks. See the Set File Mask command.

Execution of the Seek Head command resets track orientation information in the storage director.

Paging Mode

The paging storage director saves the head portion of the seek address for a directory search or to position the access mechanism at a later time. The cylinder address is determined from the most recent Set Paging Parameters, Seek, or Seek Cylinder command.

Set File Mask

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 1111 '1F'	Specifies the main storage location of the mask byte	Used at the discretion of programmer	00		1

Function

The Set File Mask command transfers one byte of data (the mask byte) from main storage to the storage director.

Chaining Requirements

The Set File Mask command cannot be issued more than once in the same CCW chain and cannot follow a Space Count command in the same chain.

Status

Initial status is normally zero. Channel end and device end are presented after the mask byte has been transferred to the storage director.

Description

Direct Mode

The mask byte transferred by this command defines the write and seek operations that can be used in the CCW chain and defines command retry-PCI interaction. The following chart describes the significance in the mask.

Bits 0 and 1	Function
00	Inhibits Write Home Address and Write R0 commands.
01	Inhibits all write commands
10	Inhibits all format write commands
11	Permits all write commands

Bit 2	Function
0	This bit must be zero or unit check, channel end, and device end are presented in initial status.

Bits 3 and 4	Function
00	Permits all seek commands
01	Permits Seek Cylinder and Seek Head commands
10	Permits Seek Head commands
11	Inhibits all seek commands

Bit 5	Function
0	Inhibits Diagnostic Write and Diagnostic Write Home Address commands and seeks to CE tracks only. **Note:** Bit 5 is used for diagnostic purposes only. Use of this bit for any other purpose may yield unpredictable results.
1	Permits Diagnostic Write and Diagnostic Read Home Address commands and seeks to CE tracks only.

Bit 6	Function
	This bit must be zero or unit check, channel end, and device end are presented in initial status.

Bit 7	Function
0	Not PCI fetch mode
1	PCI fetch mode. The storage director presents unit check if command retry is used to recover from ECC uncorrectable errors.

Any attempted violations of the file mask cause unit check status to be presented to the channel.

The mask is reset to all zeros at the end of the CCW chain or by a system or selective reset. Therefore, a Start I/O instruction following a reset (without a new Set File Mask command being issued) permits the program to execute all seek and write commands except Write Home Address, Write R0, and Diagnostic Write.

Execution of a Set File Mask command resets track orientation information in the storage director.

Paging Mode

In paging mode, the command is rejected with unit check, channel end, and device end in the status.

Set Paging Parameters

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1000 1011 '8B'	Specifies the main storage location of the parameter bytes	Used at the discretion of programmer	00		10

Function

The Set Paging Parameters command transfers 10 parameter bytes from main storage to the paging storage director.

Chaining Requirements

The command must be the first one in the chain or it must be chained from a Read Data, Write Data or Discard Block command.

Status

Initial status is normally zero if chaining requirements are met. If they are not met, the command is rejected with unit check in the status.

Description

Direct Mode

This command is not used in direct mode. If Set Paging Parameters is received in direct mode, the command is rejected with unit check in the status.

Paging Mode

Following the presentation of zero initial status, the parameter bytes are transferred to the paging storage director and a validity check is made. If an error is detected, ending status is presented with unit check, channel end, and device end. If the parameter bytes are valid, they are stored for future reference and channel end and device end are presented to channel.

The parameter bytes have the following format:

- Byte 0 - attributes
- Byte 1 - block count
- Bytes 2 and 3 - base cylinder address
- Bytes 4 and 5 - not used
- Byes 6 through 9 - seek address (CCHH)

Byte 0 - Attributes

Byte 0 has the following format:

- Bit 0 - sequential read
- Bit 1 - read once
- Bit 2 - guest operating system
- Bits 3 to 7 - must be zero

Bit 0 - Sequential Read: When this bit is a 1, it indicates that the Read Data command(s) that follow this command will reference contiguous block addresses (CC HH R). The number of blocks is specified in byte 1.

Bit 1 - Read Once: When this bit is a 1, it indicates that any blocks transferred from cache to channel as the result of Read Data commands chained from this command are not to be read again without an intervening update of the block.

Bit 2 - Guest Operating System: When this bit is a 1:

- It indicates that the channel program was generated by a guest operating system rather than the host operating system.
- It permits the paging storage director to determine whether or not to discard all data in the cache when a Discard Block command with discard all attribute is received.
- It indicates that the base cylinder address in bytes 2 and 3 is valid.
- It permits the paging storage director to treat the remainder of the chain as though it were issued by a guest operating system.

If another Set Paging Parameters command with this attribute off is received in the same chain, the previous setting of this attribute is maintained.

Byte 1 - Count: If sequential read is specified in byte 0, this byte specifies the number of contiguous blocks to be referenced by the Read Data commands that are chained to the Set Paging Parameters command. The byte must have a value between 1 and 255. If sequential read is not specified, this byte must be zero.

If the combination of the count and the cylinder address specified by the most recent Set Paging Parameters, Seek, or Seek Cylinder command received in this chain, specify a set of blocks that are in more than one cylinder, Seek or Seek Head commands must be inserted within the sequence of Read Data commands to establish new physical cylinder addresses whenever cylinder boundaries are crossed.

Bytes 2 and 3 - Base Cylinder Address: These bytes are used if the guest operating system attribute bit is a 1 and a Discard Block command is chained from this command. The contents of these bytes are then added to the CC portion of the logical block identifier to generate the physical block identifier. (See Discard Block command.) The contents of these bytes are ignored if the guest operating system bit is 0, or a Discard Block command is not in the command chain.

Bytes 6 Through 9 — Seek Address (CCHH)

These bytes specify the address which is the target of the next Search ID Equal command in the chain. This address must be the actual physical address because the paging storage director does not use the base address to adjust this address. Bytes 6 and 7 contain the cylinder address (CC) and bytes 8 and 9 contain the track address (HH).

Set Sector

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0010 0011 '23'	Specifies the main storage location of the sector argument	Used at the discretion of programmer	00		1

Function

The Set Sector command transfers one byte of information (a relative angular track position) from main storage to the storage director.

Chaining Requirements

None in direct mode. In paging mode, the command must be chained from a Set Paging Parameters, Seek, Seek Cylinder, Seek Head, Read Data or Write Data command.

Status

Initial status is zero. Channel end is presented after a valid angular position argument is received. Device end is presented when the angular position is reached.

In paging mode, the command is rejected with unit check in the status if chaining requirements are not met. If the chaining requirements are met and the parameters are valid, channel end and device end are presented after the data transfer.

Description

Direct Mode

The Set Sector command, used on block multiplexer channels, allows the storage director to disconnect from the channel during rotational delay. The storage director checks the byte transferred by the Set Sector command for validity. For 3330s and 3350s, the byte must contain a value between 0 and 127 or it may be 255.

If the argument is not valid, the command is not executed; and channel end, device end, and unit check are presented as ending status.

If the Set Sector command is executed with an argument of 255, the storage director presents channel end and device as ending status. No operation is performed and track orientation is destroyed.

If the Set Sector command is executed with an argument of zero, the storage director attempts reconnection just before index.

All valid Set Sector arguments, except 255, are adjusted by the storage director to compensate for channel reselection delay.

The Set Sector command does not guarantee record orientation. The search commands must still be used for this purpose.

Indiscriminate use of the Set Sector command with multitrack search may result in missing the desired record. A Set Sector (sector 0), Read Home Address and search multitrack sequence will avoid this problem.

See the Rotational Positional Sensing section for additional information on the use of the Set Sector command.

Paging Mode

In paging mode, the paging storage director receives the one-byte sector argument from channel but does not use it. If more than one byte is received, only a single byte is accepted. If the sector argument is valid, channel end and device end are presented in ending status. No disconnection from channel occurs.

If the sector argument is not valid, the command is rejected and unit check, channel end, and device end are presented to channel.

Space Count

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 1111 'OF'	Specifies the main storage location of the key data lengths of the record to be recovered	Used at the discretion of program-mer	00		3

Function

The Space Count command provides a means of recovering or bypassing a defective R0 count area, or provides a means of bypassing a bad count area of any record other than R0.

Chaining Requirements

The Space Count command can not be chained from a Write Home Address, Write R0, Write CKD, Write Special CKD, or Erase command. It cannot be followed by any type of write command, Erase, Set File Mask, Read IPL, Device Reserve, or Device Release command in the same chain.

Status

Initial status is normally zero. See the following description for ending status presentation.

Description

Direct Mode

The Space Count command is used for data recovery. It can be used to bypass or recover a defective R0 count area, or to bypass a defective count area.: If chained from a Read, Write, Search, or Space Count command, the command:

1. Orients at the start of the next count area
2. Spaces over the count area
3. Receives key and data length from channel
4. Sets end-of-count area internal orientation state indicator
5. Presents channel end and device end to channel

Note: If the track is flagged as defective, the Space Count should always follow a Search ID Equal command to provide consistent results.

Using the above: command chain (a) may used to recover key and data areas of record (N≠0). Command chain (b) may be used to recover record N+1.

```
(a)  Set Sector                    (b)  Set Sector
     Search ID (record N-1)              Search ID (record N-1)
     TIC*-8                              TIC*-8
     Space Count**                       Space Count**
     Read KD                             Read CKD
```

* Transfers to the address of the TIC command minus 8.
** Must specify correct key and data lengths or a data check normally occurs.

If the command is not chained to a Read, Write, Search, or Space Count command, the command:

1. Searches for index
2. Clocks through gap 1, home address and gap 2
3. Spaces over R0 count area
4. Receives key and data length from channel
5. Sets end-of-count area internal orientation state indicator
6. Presents channel end and device end to channel

Using the above: (a) Space Count followed by a Read Key and Data command recovers or bypasses a bad R0 count area; (b) Space Count followed by a Read CKD reads R1.

The three bytes of data transferred from channel are used as the key length (first byte) and the data length (last two bytes). If the CCW count is greater than three, only three bytes are transferred. If the CCW count is less than three, the number of bytes specified is transferred and a value of zero is assumed for bytes not transferred.

Paging Mode

In paging mode, the command is rejected with unit check, channel end, and device end in the status.

Transfer-in-Channel

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
XXXX 1000 'X8'	Specifies the main storage location of the next CCW	Ignored	00		Ignored

Function

The Transfer-in-Channel (TIC) command provides chaining capabilities for CCWs not located in adjacent main storage locations.

Chaining Requirements

The TIC command cannot be the first CCW designated by the channel address word. One TIC command cannot transfer directly to another TIC command.

Status

No unit status is presented. The channel status portion of the CSW is stored if either of the special requirements is violated, or if the data address portion of the CCW does not specify an address on a doubleword boundary.

Description

The TIC does not initiate any I/O operation at the channel, and the storage director and device are not signaled when the command is executed. The purpose of the TIC command is to provide chaining capabilities for CCWs not located in adjacent doubleword locations in main storage.

To address a CCW on integral boundaries for doublewords, the TIC command must contain zeros in bits 29 through 31.

The contents of bit positions 0 through 3 and 32 through 63 are ignored.

Search Commands

In direct mode, search commands cause the storage director to compare data from the device with data from the main storage. During the execution of the search commands, the channel operates in write mode and the device operate in read mode. The storage director compares the data from main storage with the data coming from the device. When the search requirement has been satisfied, the storage director returns a status modifier bit with channel end and device end. This causes the channel to skip the next CCW in the chain and fetch the next command from a storage location 16 positions higher than the current CCW. This is normally done by chaining a Transfer-In-Channel (TIC) command to the search command. The following is an example of this procedure:

Search ID Equal

TIC*-8

Read Data

As long as the search is unsuccessful, the TIC command following the search command causes the search to be repeated. When the search is successful, the status modifier bit causes the TIC command to be skipped and the Read Data command to be executed.

In paging mode, only the Search ID Equal command can search the cache. The device is never searched in paging mode.

The following chart lists the search commands.

	COMMAND CODE	
COMMAND	MULTITRACK OFF	MULTITRACK ON
Search Home Address Equal	39	B9
Search Identifier (ID) Equal*	31	B1
Search Identifier (ID) Equal or High	71	F1
Search Identifier (ID) High	51	D1
Search Key Equal	29	A9
Search Key Equal or High	69	E9
Search Key High	49	C9

*Accepted in paging mode.

Search Home Address Equal

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0011 1001 '39' Multi-track: 1011 1001 'B9'	Specifies the main storage location of a cylinder number (CC) and a head number (HH)	Used at the discretion of programmer	00		4

Function

The Search Home Address Equal command causes the storage director to compare the four bytes of home address data from main storage with four bytes of home address data from the drive.

Chaining Requirements

None

Status

Initial status normally zero. Channel end and device end are presented if the comparison is not equal. Channel end, device end, and status modifier are presented when the comparison is equal.

Description

Direct Mode

The execution of a Search Home Address Equal command causes the storage director to search for index. When index is detected, the storage director compares the cylinder and head numbers from processor storage with the cylinder and head numbers from the track home address.

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than four bytes, only the first four bytes are used. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the comparison was equal.

If the CCW count was less than four bytes, comparison of main storage and track data continues until the CCW count reaches zero. Channel end and device end status are presented after the home address and correction code bytes have been read and checked. Status modifier is also presented if the comparison was equal.

The validity of the data is verified by the correction code bytes following the home address area.

Paging Mode

In paging mode, the command is rejected with unit check, channel end, and device end in the status.

Search Identifier Equal

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0011 0001 '31' Mulit-track: 1011 0001 'B1'	Specifies the main storage location of a five byte record identifier (CC HH R)	Used at the discretion of programmer	00		5

Function

The Search Identifier (ID) Equal command causes the storage director to compare the five bytes (CC HH R) from main storage with five byte count area ID from the drive.

Chaining Requirements

None in direct mode. In paging mode, the command must be chained from a Set Paging Parameters, Seek, Seek Cylinder, Seek Head, Read Data, or Write Data command. A Set Sector command may be inserted between the required command and the Search ID Equal command.

Status

Initial status normally zero. In direct mode channel end and device end are presented if the comparison is not equal. Channel end, device end, and status modifier are presented when the comparison is equal.

In paging mode, the command is rejected with unit check in the status if the chaining requirements are not met.

If the paging storage director requires a Discard Block command with the discard all attribute specified, Search ID Equal is rejected with unit check. If it had been previously determined that there is no cache space available, this command is rejected with unit check.

Description

Direct Mode

The execution of a Search ID Equal command causes the ID from main storage to be compared with the count area ID of the next record encountered on the track (including R0).

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than five bytes, only the first five bytes are used. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the comparison was equal.

If the CCW count was less than five bytes, comparison of main storage and track data continues until the CCW count reaches zero. Channel end and device end status are presented after the home address and correction code bytes have been read and checked. Status modifier is also presented if the comparison was equal.

The validity of the data is verified by the correction code bytes following the count area.

Paging Mode

The paging storage director receives the five-byte argument from channel. The argument is in the form CCHHR and is called logical block identifier. Only the head (HH) address is checked for validity. If it is valid, the HH portion is compared with the HH portion received with the most recent Set Paging Parameters, Seek, Seek Cylinder, or Seek Head command.

In multitrack format, the HH bytes must have a value between 0 and 29. If any other value is used, the command is rejected with unit check, channel end, and device end.

If no errors are detected, ending status containing channel end, device end, and status modifier is sent to channel. The logical block identifier argument is saved for later use in a data transfer operation by the paging storage director.

Search Identifier Equal or High

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0111 0001 '71' Multi-track: 1111 0001 'F1'	Specifies the main storage location of a five byte record identifier (CC HH R)	Used at the discretion of programmer	00		5

Function

The Search Identifier (ID) Equal or High command causes the storage director to compare the five bytes (CC HH R) from main storage with five byte count area ID from the drive.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented when the ID from the drive is not higher. Channel end, device end, and status modifier are presented if the ID on the drive is equal or higher than the ID from main storage.

Description

Direct Mode

The execution of a Search ID Equal or High command causes the ID from main storage to be compared with the count area ID of the next record encountered on the track (including R0).

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than five bytes, only the first five bytes are used. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the if the comparison is equal or high.

If the CCW count was less than five bytes, comparison of main storage and track data continues until the CCW count reaches zero. Channel end and device end status are presented after the count area and correction code bytes have been read and checked. Status modifier is also presented if the comparison was equal or high.

The validity of the data is verified by the correction code bytes following the count area.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Search Identifier High

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0101 0001 '51' Multi-track: 1101 0001 'D1'	Specifies the main storage location of a five byte record identifier (CC HH R)	Used at the discretion of program-mer	00		5

Function

The Search Identifier (ID) High command causes the storage director to compare the five bytes (CC HH R) from main storage with five byte count area ID from the drive.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented when the ID from the drive is not higher. Channel end, device end, and status modifier are presented if the ID on the drive is higher than the ID from main storage.

Description

Direct Mode

The execution of a Search ID High command causes the ID from main storage to be compared with the count area ID of the next record encountered on the track (including R0).

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than five bytes, only the first five bytes are used. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the drive ID was higher than the drive ID from main storage.

If the CCW count was less than five bytes, comparison of main storage and track data continues until the CCW count reaches zero. Channel end and device end status are presented after the count area and correction code bytes have been read and checked. Status modifier is also presented if the drive ID is higher than the ID from main storage.

The validity of the data is verified by the correction code bytes following the count area.

Paging Mode

In paging mode, the command is rejected with unit check, channel end, and device end in the status.

Search Key Equal

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0010 1001 '29' Multi-track: 1010 1001 'A9'	Specifies the main storage location to which the key is compared.	Used at the discretion of programmer	00		Equal to the length of the argument

Function

The Search Key Equal command causes the storage director to compare the key data from main storage with the key area read from the track.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end, device end, and status modifier are presented if the key from main storage compares equally with the key from the track. Channel end and device end are presented if the comparison is not equal.

Description

Direct Mode

The execution of a Search Key Equal command causes the key data from main storage to be compared with the next key area encountered on the track (excluding R0).

> **Note:** When this command is chained from a search ID or a Read Count command, the key compared is in the same record as the ID or count area. The Search Key Equal command bypasses R0 unless it is chained from a command that searched the ID of R0.

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than the key length (KL), the search operation is completed when the key area is read. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the if the comparison was equal.

The validity of the data is verified by the correction code bytes following the key area.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, device end in the status.

Search Key Equal or High

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0110 1001 '69' Multi-track: 1110 1001 'E9'	Specifies the main storage location to which the key is compared.	Used at the discretion of programmer	00		Equal to the length of the argument

Function

The Search Key Equal or High command causes the storage director to compare the key data from main storage with the key area read from the track.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end, device end, and status modifier are presented if the key from the drive is equal or higher than the key from main storage. Channel end and device end are presented if the key from the drive is lower than the key from main storage.

Description

Direct Mode

The execution of a Search Key Equal or High command causes the key data from main storage to be compared with the next key area encountered on the track (excluding R0).

> **Note:** When this command is chained from a search ID or a Read Count command, the key compared is in the same record as the ID or count area. The Search Key High command bypasses R0 unless it is chained from a command that searched the ID of R0.

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than the key length (KL), the search operation is completed when the key area is read. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the if the comparison was equal or high.

If the CCW count is less than KL, comparison of main storage and track data continues until the CCW count reaches zero. Channel end and device end status are presented after the key area correction code bytes have been read and checked. Status modifier is also presented if the comparison was equal or high.

The validity of the data is verified by the correction code bytes following the key area.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Search Key High

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0100 1001 '49' Multi-track: 1100 1001 'C9'	Specifies the main storage location to which the key is compared.	Used at the discretion of program-mer	00		Equal to the length of the argument

Function

The Search Key High command causes the storage director to compare the key data from main storage with the key area read from the track.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end, device end, and status modifier are presented if the key from the drive is higher than the key from processor storage. Channel end and device end are presented if the key from the drive is not higher.

Description

Direct Mode

The execution of a Search Key High command causes the key data from main storage to be compared with the next key area encountered on the track (excluding R0).

> **Note:** When this command is chained from a search ID or a Read Count command, the key compared is in the same record as the ID or count area. The Search Key High command bypasses R0 unless it is chained from a command that searched the ID of R0.

If the multitrack bit is off, the search is confined to one track. The search continues (as long as the channel repeats the command) until index is sensed again. When index is detected, channel end, device end, and unit check status are presented to the channel.

If the multitrack bit is on, the head number automatically increments when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied or until the head number advances beyond the end of the cylinder (head 18 for 3330 and head 29 for 3350). Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is greater than the key length (KL), the search operation is completed when the key area is read. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the if the comparison was high.

If the CCW count is less than KL, comparison of main storage and track data continues until the CCW count reaches zero. Channel end and device end are presented after the key area correction code byte have been read and checked. Status modifier is also presented if the comparison was high.

The validity of the data is verified by the correction code bytes following the key area.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Commands

Read commands transfer data from disk storage to main storage. Data is placed in main storage in an ascending order of addresses, starting with the address specified in the data address field of the channel command word.

Some read commands can operate in either single-track or multitrack mode. The commands are identified in the following chart.

The Read Data command is the only read-type command accepted in paging mode. Data is transferred from cache to the channel. The Read command never accesses the device in paging mode.

	COMMAND CODE	
COMMAND	MULTITRACK OFF	MULTITRACK ON
Read Count	12	92
Read Count, Key, and Data	1E	9E
Read Data*	06	86
Read Home Address	1A	9A
Read Initial Program Load	02	
Read Key and Data	0E	8E
Read Multiple Count, Key, and Data	5E	
Read Record Zero (R0)	16	96
Read Sector	22	

*Accepted in paging mode.

Read Count

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0010 '12' Multi-track: 1001 0010 '92'	Specifies the main storage location where the first byte of count data is to be transferred.	Used at the discretion of programmer	00		8

Function

The Read Count command transfers the count area of a record from the drive to the channel.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after reading the count area correction code bytes.

Description

Direct Mode

The count area transferred by this command is the next count area (excluding R0) encountered on the track. The eight bytes transferred are the cylinder number (2 bytes), head number (2 bytes), record number (1 byte), key length (1 byte), and the data length (2 bytes).

The validity of the data is verified by the correction code bytes following the count area. If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Count, Key, and Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 1110 '1E' Multi-track: 1001 1110 '9E'	Specifies the main storage location where the first byte of count data is to be transferred.	Used at the discretion of programmer	00		Specifies the number of count, key and data bytes to be read

Function

The Read Count, Key, and Data command transfers the count, key, and data areas of a record from the drive to the channel.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after reading the data area correction code bytes.

Description

Direct Mode

The count, key, and data areas of the record read by this command are from the next record (excluding R0) encountered on the track. The validity of each of the count, key, and data areas is verified by the correction code bytes following the data area. If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel.

If the data error is correctable, the correctable sense bit is set along with the pattern and displacement bytes of the error so that the system error recovery procedures can correct the error.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 0110 '06' Multi-track: 1000 0110 '86'	Specifies the main storage location where the first byte of data is to be transferred.	Used at the discretion of programmer	00		Specifies the number of bytes to be read

Function

In direct mode, the Read Data command transfers the data area of a record from the drive to the channel. In paging mode, the Read Data command transfers a block of data from cache to the channel.

Chaining Requirements

None in direct mode. In paging mode, the command must be chained from a Search ID Equal command.

Status

Initial status is normally zero. Channel end and device end are presented after reading the data area correction code bytes. In paging mode, the command is rejected with unit check, channel end, and device end if the chaining requirement is not met.

Description

Direct Mode

The data area read by this command is either:

- The data area of the record following the next count area (excluding R0) encountered on the track.
- The data area of the record specified by a CCW that has been command chained from the count or key area of the same record. For example, a Read Data command chained from a Read Count command or a Read Data command chained from a search ID or search key command.

The validity of each of the count, key, and data areas is verified by the correction code bytes following the data area. If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel.

If the data error is correctable, the correctable sense bit is set along with the pattern and displacement bytes of the error so that the system error recovery procedures can correct the error.

Paging Mode

When the paging storage director receives the Read Data command, it first checks for the specified block in cache. If the search is successful, the 4,096-byte data block is transferred to channel from cache.

If the search is not successful, the paging storage director then must go to DASD for the data block. The paging storage director disconnects from the channel and transfers the block from DASD to cache. If the preceding Set Paging Parameters command had specified sequential read, additional contiguous records are also transferred. If the Set Paging Parameters command did not specify sequential read for this Read Data command, a single record is transferred.

A format check is made on each record transferred. If the key length (KL) is not 0, the data length other than 4096 bytes, or the record is a segment of an overflow record, the command is terminated. Unit check (invalid track format) and device end are then presented to channel.

When all the data blocks have been transferred into cache, the paging storage director presents device end to channel. The channel reissues the Read Data command and only the data area of the record specified by the preceding Search ID Equal command is transferred to channel.

When the data transfer to channel is completed, the paging storage director checks for the read once attribute of the Set Paging Parameters command. If the attribute is on and the data block just transferred was not modified, the data in cache is marked for discard. Otherwise, the data is kept in cache after the channel program is completed.

After the processing of the Read Data command is completed and if no errors have occurred, channel end and device end are presented to channel.

Read Home Address

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 1010 '1A' Multi-track: 1001 1010 '9A'	Specifies the main storage location where the home address is stored.	Used at the discretion of programmer	00		5

Function

The Read Home Address command transfers the home address area of a track to main storage

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after reading the home address correction bytes.

Description

Direct Mode

The Read Home Address command transfers the flag, cylinder, and head bytes of the home address area to the channel. The validity of the data is verified by the correction code bytes following the home address area.

If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Initial Program Load

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 0010 '02'	Specifies the main storage location where the first byte of data is to be transferred.	Used at the discretion of programmer	00		Specifies the number of data bytes to be read

Function

The Read Initial Program Load (IPL) command causes the addressed device to seek to cylinder zero, head zero, and read the data area of record 1.

Chaining Requirements

The Read IPL command cannot be preceded by a Space Count or Set File Mask command in the same chain.

Status

Initial status is normally zero. Channel end and device end are presented after reading the data area correction code bytes.

Description

Direct Mode

The Read IPL command is normally initiated by setting the device address into the Load Unit switches and pressing the IPL pushbutton on the system console. The command causes the addressed device to seek cylinder zero, head zero, and search for index. When index is detected, the storage director clocks over record zero and reads the data area of record 1.

The validity of the data is verified by the correction code bytes following the data area. If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel at the end of the area in which the error occurred.

If the data error is correctable, the correctable sense bit is set along with the pattern and displacement bytes of the error so that the system error recovery procedures can correct the error.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Key and Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 1110 '0E' Multi-track: 1000 1110 '8E'	Specifies the main storage location where the first byte of key data is to be transferred.	Used at the discretion of programmer	00		Specifies the number of key and data bytes to be read

Function

The Read Key and Data command transfers the key and data areas of a record from the drive to the channel.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after reading the data area correction code bytes.

Description

Direct Mode

The key and data areas read by this command are either:

- The key and data areas of the record following the next count area (excluding R0) encountered on the track.
- The key and data areas of the record specified by a CCW that has been command chained from the count area of the same record. For example, a Read Key and Data command chained from a Read Count command or a Read Key Data command chained from a search ID or search key command.

The validity of each of the count, key, and data areas is verified by the correction code bytes following the data area. If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel.

If the data error is correctable, the correctable sense bit is set along with the pattern and displacement bytes of the error so that the system error recovery procedures can correct the error.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Multiple Count, Key, and Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0101 1110 '5E'	Specifies the main storage location where the first byte of data is to be transferred	Used at the discretion of programmer	00		Larger than maximum R1 capacity 3330/3333 - 13,030 3350 native - 19,069

Function

The Read Multiple Count, Key, and Data (CKD) command transfers the next record encountered (excluding R0) and all remaining records from the storage director to the channel.

Chaining Requirements

The Read Multiple CKD command should be preceded by a Set File Mask command inhibiting head switching to avoid processing overflow records that may continue on the next track.

Status

Initial status is normally zero. Channel end and device end are presented after the last record on the track has been read.

Description

Direct Mode

This command provides a means of reading all the records on a track in a single disk revolution. It is similar to executing a chain of Read CKD commands which reads records into contiguous main storage locations.

Reading starts at the next count field encountered (excluding R0) and continues until the last record on the track has been read. If a Read Multiple CKD command is issued after the count field of the last record on the track has been passed, channel and device end status are presented and no data is transferred.

Since the actual number of bytes to be read is probably not known, the byte count should be greater than track capacity of the device. The CSW residual count, in conjunction with the CCW count, can be used to determine how many bytes were actually read.

The Read Multiple CKD command does not have to start at the beginning of track. For example if a track has 50 records and the key field of record 26 cannot be read, the following chain will read the first 25 records and detect the error in the key area of record 26:

Read Home Address

Read R0

Read Multiple CKD

Analysis of the sense information, CSW residual count, CCW count, and the records already transferred to main storage, allows construction of the following chain:

Search ID (record 26)

TIC*-8

Read Data

Read Multiple CKD

This chain would recover the data of record 26 and all subsequent records on the track. The only unrecovered data would be the key area of record 26.

Note: Because command retry works only on single records, certain errors cannot be retried in the multi-record mode after the first record has been processed. Use of this command should be limited to those applications where its convenience outweighs the exposure to reduced error recovery capability.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Record Zero

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0110 '16' Multi-track: 1001 0110 '96'	Specifies the main storage location where the first byte of record zero count data is to be transferred.	Used at the discretion of programmer	00		Specifies the number of count, key, and data bytes to be read

Function

The Read Record Zero (R0) command transfers the count, key, and data bytes of record zero from the drive to the channel.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after reading the data area correction code bytes.

Description

Direct Mode

Record 0, the track descriptor record, has the normal count, key, and data format and may used as a normal data record. However, it is usually reserved by the operating system for nonuser functions.

During the execution of this command, the storage director searches for index, clocks through gap G1, home address, and gap G2, and transfers the count key, data areas of R0 to the channel.

> **Note:** A Read R0 chained from a Read Home Address or Search Home Address command is executed immediately and does not cause a search for index.

The validity of each of the count, key, and data areas is verified by the correction code bytes following each of the areas.

If a data overrun or data check is detected on a 3330 or 3350 during the execution of this command, the storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented to the channel.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read Sector

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0010 0010 '22'	Specifies the main storage location where the sector number is to be stored.	Used at the discretion of programmer	00		1

Function

The Read Sector command transfers one byte of data (sector number) from storage director to the channel.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after the sector number has been transferred.

Description

Direct Mode

The byte transferred to the channel contains the angular position number required to access the last record processed on the drive. If no record has been processed since the last Set Sector command, the value is that set in the Set Sector command minus for 3330 or 3350.

If the last record processed was an overflow record, the angular position returned is that of the last segment.

A system reset or power on reset sequence causes the sector value to be reset. Also, the execution of this command resets orientation information in the storage director.

If this command is issued to a device that does not have RPS, the byte returned to the channel will be '20'.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Sense Commands

Sense commands transfer information that identify error conditions as well the status of the unit and attached devices. The 3880 uses 24 bytes to provide information concerning unusual conditions detected in the last operation and the current status of the storage director and device. Sense commands are used to transfer the information from storage director to the channel. Other sense functions are reserving a device or defining the DASD configuration, in addition to transferring the sense information.

Two commands, Sense Subsystem Counts and Sense Subsystem Status, are executed in direct mode but are accepted only by the paging storage director. The Sense and Sense ID commands are the only sense-type commands that are accepted in both paging and direct modes.

The following chart lists the sense commands.

COMMANDS	COMMAND CODES
Device Release	94
Device Reserve	B4
Read and Reset Buffered Log	A4
Sense*	04
Sense ID*	E4
Sense Subsystem Counts**	54
Sense Subsystem Status**	74
Unconditional Reserve	14

*Accepted in paging mode.

**Accepted only by the paging storage director in direct mode.

Device Release

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1001 0100 '94'	Specifies the main storage location where the first byte of sense data is to be transferred.	Used at the discretion of programmer	00		24

Function

The Device Release command terminates the reservation of the addressed device from the channel.

Chaining Requirements

The Device Release command cannot be preceded by a Set File Mask or Space Count command in the same chain.

Status

Initial status is normally zero. Channel end and device are presented after the 24 sense bytes have been transferred.

Description

Direct Mode

In addition to terminating the reservation of the addressed device, the Device Release command transfers 24 sense bytes to the channel. A Device Release command will be executed regardless of any abnormal device status conditions.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Device Reserve

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1011 0100 'B4'	Specifies the main storage location where the first byte of sense data is to be transferred	Used at the discretion of programmer	00		24

Function

The Device Reserve command reserves the addressed device to the channel issuing the command.

Chaining Requirements

The Device Reserve command cannot be preceded by a Set File Mask or Space Count command in the same chain.

Status

Initial status is normally zero. Channel end and device end are presented after the 24 sense bytes have been transferred.

Description

Direct Mode

In addition to reserving the addressed device, the Device Reserve command transfers the 24 sense bytes to channel. Reservation is maintained until the channel successfully completes a Device Release command to the device.

A system reset will remove reservation of the device to the resetting channel only.

Execution of a Device Reserve command resets track orientation information in the storage director.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Read and Reset Buffered Log

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1010 0100 'A4'	Specifies the main storage location where the first byte of usage/error information is to be transferred	Used at the discretion of programmer	00		24

Function

The Read and Reset Buffered Log command transfers 24 bytes of usage/error information from the storage director to the channel.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after the usage/error information is transferred.

Description

Direct Mode

The format of the usage/error information transferred to the channel is the same as the 24 bytes of sense information generated after the usage or error counters overflow.

The usage/error pertain to the logical device addressed by the Start I/O instruction. The statistics are reset to zero after the data transfer is complete.

Execution of a Read and Reset Buffered Log command resets track orientation information in the storage director.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Sense

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
000 0100 '04'	Specifies the main storage location where the first byte of sense information is to be transferred.	Used at the discretion of programmer	00		24

Function

The Sense command transfers 24 bytes of sense information from the storage director to the channel.

Chaining Requirements

None in direct mode. In paging mode, this command must be chained from a Read Data, Write Data, or Discard Block command, or be the first command in the chain. No commands may be chained from the Sense command.

Status

Initial status is normally zero. Channel end and device end are presented after the sense bytes are transferred. In paging mode, the command is rejected with unit check, channel end, and device end being presented to channel if the chaining requirements are not met.

Description

Direct and Paging Mode

The sense information transferred by this command describes the reasons for unit check status, the current status of the device that performed the operation, and system error recovery information.

A unit check should always be followed by a Sense command whether the information is used or not. Otherwise, expected future interrupts may not occur and some I/O access paths may not be available.

A contingent connection state is established in the storage director after the channel accepts a status byte containing unit check. This state lasts until a command (other than Test I/O or No-Op) receives an initial status byte of zero for the storage director and device address which generated the unit check. During the contingent connection state, the storage director is busy to all addresses other than the address for which the contingent connection was established. If no contingent connection exists, device type and feature information is generated and the rest of the sense bytes are set to zero.

Sense information is reset to zero after data transfer is complete or when an initial status byte of zero is given to any command except Test I/O or No-Op.

A Sense command issued during a contingent connection should be a standalone command. This is because much of the device status testing performed during initial selection is bypassed so that an initial status of zero can be presented and error information related to the last unit check can be reported. If other commands are chained from the Sense command, the devices may not prepared to execute them, which could result in unpredictable results.

Execution of a Sense command resets track orientation information in the storage director.

Sense ID

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1110 0100 'E4'	Specifies the main storage location where the first byte of sense data is to be transferred	Used at the discretion of programmer	00		7

Function

The Sense ID command transfers seven bytes of sense information from the storage director to the channel.

Chaining Requirements

None in direct mode. In paging mode, Sense ID must be the first command in the chain and no command may be chained from it.

Status

Initial status is normally zero. Channel end and device end are presented after the sense bytes are transferred.

Description

Direct Mode

The sense information transferred by this command describes the type and model of the storage director and device being addressed by this command. The format of the sense bytes is as follows:

Byte 0 contains all ones (XX'FF')
Bytes 1 and 2 contain storage control machine type number (XX'3880')
Byte 3 contains storage control model identifier (XX'08')
Bytes 4 and 5 contain device machine-type number (XX'3350')
Byte 6 contains device model number (XX'00')

If the device is available and not busy, the Sense ID command is executed even if the device is in the not ready state.

Sense and track orientation information is reset after the execution of this command.

Paging Mode

In paging mode, this command is executed as in direct mode. However, the command is rejected with unit check if it is not the first command in the chain.

Sense Subsystem Counts

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0111 0100 '74'	Specifies the main storage location where the first byte of subsystem performance data is to be transferred.	Used at the discretion of programmer	00		80

Function

In direct mode, the Sense Subsystem Counts command transfers the subsystem performance data from the paging storage director to the channel.

Note: This command is executed in direct mode and accepted only by the paging storage director.

Chaining Requirements

None.

Status

Initial status is normally zero. Channel end and device are presented after the data transfer is completed.

Description

Direct Mode

Upon receipt of the Sense Subsystem Counts command, the paging storage director transfers 80 bytes of performance data to the channel. After the 80 bytes are transferred, channel end and device end are presented to channel. The contents of the subsystem performance counters associated with the addressed device are not changed.

The performance data bytes have the following format:

- Byte 0 - Storage director identification

  This byte contains the storage director identification.

- Byte 1 - Device address

  This byte contains the base address specified by the channel program.

- Bytes 2 to 3 - Must be zero

- Bytes 4 to 7 - Paging mode data transfer command chains

  This is the number of paging data command chains that were executed successfully. A paging data command chain is any chain executed in paging mode which contains at least one Write Data or Read Data command.

- Bytes 8 to 11 - Paging mode data transfer commands chains that required no DASD access

  This is the number of paging data command chains that were completed successfully and which did not require a transfer of data from DASD in order to execute the Read Data command.

- Bytes 12 to 15 - Nonsequential paging operations

  This is the number of Set Paging Parameters commands executed successfully and which met the following requirements:

  - The Set Paging Parameters command had at least one Read Data or Write Data command in the chain prior to another Set Paging Parameters command.
  - Sequential read was not specified.
  - Read once was not specified or there were no Read Data commands in the chain.

- Bytes 16 to 19 - Nonsequential paging read operations

  This is the number of Read Data commands executed successfully in paging mode to which the sequential read attribute did not apply.

- Bytes 20 to 23 - Nonsequential paging read hits

  This is the number of Read Data commands executed successfully in paging mode to which the sequential read attribute did not apply and that did not require a data transfer from DASD to complete.

- Bytes 24 to 27 - Sequential paging read operations

  This the number of Set Paging Parameters commands that executed successfully and which met the following requirements:

  - The Set Paging Parameters command had at least one Read Data command in the chain which was prior to another Set Paging Parameters.
  - The Set Paging Parameters command had the sequential read attribute specified and not the read once attribute specified.

- Bytes 28 to 31 - Sequential paging read commands

  This is the number of Read Data commands successfully executed in paging mode and which met the following requirements:

  - The sequential read attribute applied to the Read Data commands.
  - The read once attribute did not apply to the Read Data commands.

- Bytes 32 to 35 - Sequential paging read hits

  This the number of Read Data commands successfully executed in paging mode that did not require a data transfer from DASD and which met the following requirements:

  - The sequential read attribute applied to the Read Data commands.
  - The read once attribute did not apply to the Read Data commands.

- Bytes 36 to 39 - Block writes

  This the number of Write Data commands executed successfully in paging mode.

- Bytes 40 to 43 - Swap in operations

  This is the number of Set Paging Parameters commands that executed successfully and which met the following requirements:

  - The Set Paging Parameters command had at least one Read Data command in the chain which was prior to another Set Paging Parameters.
  - The Set Paging Parameters command had the sequential read attribute and the read once attribute specified.

- Bytes 44 to 47 - Swap in read commands

  This is the number of Read Data commands successfully executed in paging mode to which both the sequential read and the read once attribute applied.

- Bytes 48 to 51 - Swap in read hits

  This is the number of Read Data commands successfully executed in paging mode that did not require a data transfer from DASD and to which both the sequential read and read once attributes apply.

- Bytes 52 to 55 - Block discards

  This is the number of blocks discarded from the cache as the result of Discard Block commands that did not have discard all specified.

- Bytes 56 to 59 - DASD update operations

  This is the number of internal command chains performing cache to DASD operations that successfully transferred at least one block of data.

- Bytes 60 to 63 - DASD block updates

  This is the number of data blocks written successfully on DASD from cache. This count includes DASD updates from swapping as well as from paging.

- Bytes 64 to 79 - Must be zero

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Sense Subsystem Status

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0101 0100 '54'	Specifies the main storage location where the first byte of status is to be transferred.	Used at the discretion of programmer	00		40

Function

The Sense Subsystem Status command transfers the status of the subsystem to channel.

Note: This command is executed in direct mode and accepted only by the paging storage director.

Chaining Requirements

None.

Status

Initial status is normally zero. Channel end and device end are presented after the data transfer is completed.

Description

Direct Mode

Upon receipt of the Sense Subsystem Status command, the paging storage director transfers 40 bytes of status information to the channel. Channel end and device end are presented after the data transfer is completed.

If the CCW count is greater than 40, only 40 bytes are sent. If the CCW count is less that 40, only the specified number of bytes are sent.

If the CCW count is not equal to 40, the SLI bit must be set to prevent incorrect length indication.

The status bytes have the following format:

- Byte 0 - Storage director identification

  This byte contains the storage identification.

- Byte 1 - Device address

  This byte contains the device address specified by the channel program.

- Bytes 2 to 3 - Must be zero.

- Bytes 4 to 7 - Configured subsystem storage capacity

  These bytes contain the configured subsystem storage capacity in bytes.

- Bytes 8 to 11 - Available subsystem storage capacity

  These bytes contain the quantity, in bytes, of subsystem storage that is available to the paging storage director for allocation.

- Bytes 12 to 15 - Offline subsystem storage capacity

  These bytes contain the quantity, in bytes, of subsystem storage that is not available to the paging storage director for allocation. The storage space is not available because of storage failures that occurred during attempts to transfer data from subsystem storage.

- Bytes 16 to 19 - Unavailable subsystem storage capacity

  These bytes contain the quantity, in bytes, of subsystem storage space that is not available to the paging storage director because of DASD exception conditions which prevent successful completion of a cache to DASD transfer.

- Bytes 20 to 39 - Must be zero.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Unconditional Reserve

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0100 '14'	Specifies the main storage location where the first byte of sense data is to be transferred	Used at the discretion of programmer	00		24

Function

The Unconditional Reserve command breaks device allocation to the primary (failing) path and establishes allocation to the alternate path in the same system.

Chaining Requirements

The Unconditional Reserve command must be the first command in a chain or the command is rejected with channel end, device end, and unit check status.

Status

Initial status is normally zero. Channel end and device are presented after the 24 sense bytes are transferred.

Description

Direct Mode

The Unconditional Reserve command is used to recover from hardware malfunctions. It performs all of the functions of the Device Reserve command and, in addition, reserves the device to the executing path even when the device is reserved or in use through the another path. Reservation or information in use for the other path is reset in the device and the storage director through which the command was issued. It does not reset information in the other storage director.

Control of the device must be established by the system before the Unconditional Reserve command can be issued. Device control is established if the channel has the device reserved, or the channel has a CCW chain in progress (between the Start I/O instruction with a condition code of 0, and the ending interrupt). If the system issues an Unconditional Reserve command to a device not assigned to it, one of the following conditions may occur on the other system.

- If the device was reserved, the reservation is reset and the device becomes reserved to the channel that issued the Unconditional Reserve command.
- If the device is disconnected between chained commands, an interrupt will be lost.

- If the device is active when the command is executed, a recoverable equipment check will be presented.
- If the device is idle and not reserved, there is no effect.

If the system does not want the device reserved to the issuing path, it must issue a Device Release command. (The Device Release command may chained to the Unconditional Reserve command.)

The Unconditional Reserve command will be executed regardless of any abnormal device status, such as offline, unless the device does not respond to the selection (condition code 3) or there is a preselection check as indicated by unit check status and equipment check in sense byte 0.

Execution of an Unconditional Reserve command resets track orientation information in the storage director.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Write Commands

In direct mode, write commands transfer data from main storage to DASD. Data is fetched from main storage in an ascending order of addresses, starting with the address specified in the data address field of the channel command word.

In paging mode, Write Data is the only command that is accepted. Data is transferred from main storage to cache instead of DASD. The device is not accessed by the Write Data command.

COMMANDS	COMMAND CODE
Erase	11
Write Count, Key, and Data (CKD)	1D
Write Data*	05
Write Home Address	19
Write Key and Data	0D
Write Record Zero (R0)	15
Write Special Count, Key, and Data	01

*Accepted in paging mode.

Erase

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0001 '11'	Specifies the main storage location of the count, key, and data bytes	Used at the discretion of programmer	00		Specifies the number of count, key, and data bytes

Function

The Erase command writes zeros in the count, key, and data areas of the specified record, then pads the remainder of the track with zeros.

Chaining Requirements

Must be chained from a Write R0, Write CKD, or Search ID Equal command. The search commands must have compared equal on all bytes.

Status

Initial status is normally zero. Channel end and device end are presented after the correction code bytes have been written at the end of data area.

Description

Direct Mode

In direct mode, initial status is normally zero. Channel end and device end are presented after the correction code bytes have written at the end of the data area. This command is executed like a Write Count, Key, and Data command, except that zeros are written in each area. Although data is transferred from the channel, the erased record and all subsequent data on the track are not recoverable.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Write Count, Key, and Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 1101 '1D'	Specifies the main storage location of the count, key, and data bytes	Used at the discretion of programmer	00		Specifies the number of bytes in count, key and data areas

Function

The Write Count, Key, and Data (CKD) command causes and entire record to be transferred from main storage and written on the device.

Chaining Requirements

The Write CKD command must be chained from a Write R0, Write CKD, or a Search ID Equal command. The search commands must have compared equal on all bytes of the searched field.

> **Note:** A Read Data or Read Key and Data CCW may be inserted between a Search ID Equal and the Write CKD command. A Read Data command may be inserted between a Search Key Equal and the Write CKD command.

Status

Initial status is normally zero. Channel end and device end are presented after the correction code bytes have been written at the end of the data area.

Description

Direct Mode

In direct mode, the count, key, and data areas of a record are transferred from processor storage and written on the addressed device. The first eight bytes of data transferred are the count area: cylinder number (2 bytes), head number (2 bytes), record number (1 byte), key length (1 byte), and data length (2 bytes). The remaining data sent from main storage is written in the key and data areas as specified by the values set in the key length (KL) and data length (DL) bytes.

The count field of the CCW specifies the total number of bytes to be transferred (8+KL+DL). If the count is less than specified, zeros are written in the remainder of the record. Correction code bytes are written at the end of the count, key, and the data areas.

If the Write CKD command is the last format write command in a chain, the remaining portion of the track is erased. If a command other than another format write is chained from Write CKD, it is executed after the track is erased.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Write Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 0101 '05'	Specifies the main storage location of the data used to update a record	Used at the discretion of programmer	00		Specifies the number of bytes to be written

Function

The Write Data command causes the specified data in main storage to be written in the data area of the selected record.

Chaining Requirements

In direct mode, the Write Data command must be chained from a Search ID Equal or Search Key Equal command that compared equally on all bytes of the searched field.

In paging mode, the Write Data command must chained from a Search ID Equal command.

Status

Initial status is normally zero. Channel end and device end are presented after the correction code bytes have been written. In paging mode, the command is rejected with unit check, channel end, and device end if the chaining requirements are not met.

Description

Direct Mode

In direct mode, the Write Data command is used to perform normal record updating after track formatting. The number of bytes to be written is specified in the count field of the Write Data CCW.

If the number of bytes specified in the CCW count is less than that specified in the count area data length (DL) bytes, the storage director writes zeros in the remaining data area and then writes the correction code bytes. If the CCW count is greater than the number of bytes specified in the count area DL bytes, only the number of bytes specified in the count area DL bytes are written. The storage director then writes the correction code bytes after the data area.

Paging Mode

When the Write Data command is received in paging mode, the paging storage director checks that the block to be updated is currently in cache. The directory is

searched using the previous Search ID Equal command, the most recent Set Paging Parameters, Seek, or Seek Cylinder command, and the device address. If the search is successful, the specified 4096-byte block slot in cache is marked for updating.

If the search is not successful and there are no block slots available for allocation, channel command retry status is presented. The paging storage director disconnects from channel and then attempts to make storage space available for the data block.

If no block slot can be made available, device end is presented to channel. When the Write Data command is reissued, the paging storage director presents unit check (intervention required), channel end, and device end.

If a block slot is made available, device end is presented to channel. When the Write Data command is reissued, the paging storage director executes the command as though this were the first time the command had been received.

If the search for the specified block slot is not successful but there is space available for allocation, an entry is created in the directory. A 4096-byte data block is then transferred from channel to the cache. If fewer than 4096 bytes are transferred, the paging storage director pads the remaining data area with zeros. If more than 4096 bytes are sent, the paging storage director accepts only 4096 bytes.

If the write operation completes successfully, channel end and device end are presented in the ending status.

Write Home Address

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 1001 '19'	Specifies the main storage location of the home address byte	Used at the discretion of programmer	00		5 for 3330 and 11 for 3350

Function

The Write Home Address command causes the home address area of a track to be transferred from main storage and written on the drive.

Chaining Requirements

The Write Home Address command must be chained from a successful Search Home Address command with a CCW count of four or more unless the command is used by a 3350 to flag the track as defective. It must be preceded by a Set File Mask command that allows writing of the home address.

Status

Initial status is normally zero. Channel end and device end are presented after the correction code bytes have been written at the end of the home address.

Description

Direct Mode

One home address is written on each track to establish track identity. This is a requirement to perform data operations on that track. The home address is normally written on the tracks by the disk manufacturer. The use of this command should be limited to identifying defective tracks and assigning alternate tracks. Utility programs are available to perform these functions.

During the execution of this command, the storage director orients on index and then writes gap G1, home address, and the correction code bytes. Bits 0 through 5 of the flag byte are generated by the storage director before the flag byte is transferred to the drive.

The cylinder and head numbers from main storage must match the value stored by the storage director on the most recent seek, or the command is not executed.

If a Write Home Address command is the last format write command in a chain, the remaining portion of the track is erased. If a command other than Write R0 is chained from this command it is executed after the track is erased. Since reconnection may not occur until some time after index, the next command will not be oriented.

3330 Home Address Area: The home address area consists of a flag (1 byte), cylinder number (2 bytes), and a head number (2 bytes). If the CCW count is less than five, the storage director writes zeros in the remaining bytes. If the CCW count is greater than five, only five bytes are written.

3350 Home Address Area: The home address area consists of the skip displacement (6 bytes), flag (1 byte), cylinder number (2 bytes), and head number (2 bytes). If the CCW count is less than seven, the command is rejected. If the CCW count is less than 11, the storage director writes zeros in the remaining bytes. If the CCW count is greater than 11, only 11 bytes are written.

> **Note:** Use of the Write Home Address command can cause loss of defect skipping information recorded at the time of manufacture.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Write Key and Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 1101 'OD'	Specifies the main storage location of the data used to update a record	Used at the discretion of programmer	00		Specifies the number of bytes to be written

Function

The Write Key and Data command causes the specified data in main storage to be written in the key and data areas of the selected record.

Chaining Requirements

The Write Key and Data command must be chained from a Search ID Equal command that compared equally on all bytes of the searched field.

Status

Initial status is normally zero. Channel end and device end are presented after the correction code bytes have been written.

Description

Direct Mode

The Write Key and Data command is used to perform the normal updating of the key and data areas after track formatting. The number of bytes to be written is specified in the count field of the Write Key and Data CCW. If the number of bytes specified in the CCW count is less than that specified in the count area key length (KL) and data length (DL) bytes, the storage director writes zeros in the remaining area If the CCW count is greater than the number of bytes specified in the KL and DL bytes, only the number of bytes specified in the KL and DL bytes are written. The storage director then writes the correction code bytes after the key and data areas.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Write Record Zero

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0001 0101 '15'	Specifies the main storage location of the R0 count, key, and data bytes	Used at the discretion of programmer	00		Specifies the number of bytes in R0 count, key, and data areas

Function

The Write Record Zero (R0) command causes the count, key, and data areas of record zero to be transferred from main storage and written on the drive.

Chaining Requirements

The Write R0 command must be chained from a Write Home Address command or a Search Home Address Equal command whose argument was equal to four bytes (cylinder and head numbers) of the home address area.

Status

Initial status is normally zero. Channel end and device end are presented after writing the data area correction bytes.

Description

Direct Mode

Record 0, the track descriptor record, is always the first record on the track following the home address area. Although R0 may be used as a normal data record, it is usually reserved by the operating system to store pertinent track information.

The first eight bytes of data transferred are the count area: cylinder number (2 bytes), head number (2 bytes), record number (1 byte), key length (1 byte), and data length (2 bytes). The remaining data sent from main storage is written in the key and data areas as specified by the values set in the key length (KL) and data length (DL) bytes.

The count field of the CCW specifies the total number of bytes to be transferred (8+KL+DL). If the count is less than specified, zeros are written in the remainder of the record. Correction code bytes are written at the end of the count area, end of the key area, and end of the data area.

If the Write R0 command is the last format write command in a chain, the remaining portion of the track is erased. If a command other than another format write is chained from Write R0, it is executed after the track is erased. Since reconnection may not occur some time until after index, the next command will not be oriented.

> **Note:** Record zero is normally written on the tracks by the disk manufacturer. The use of this command should be limited to identifying defective tracks and assigning alternate tracks. Utility programs are available to perform these functions. Proper operation with IBM operating systems requires a 0 key length and an 8-byte data field.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Write Special Count, Key, and Data

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 0001 '01'	Specifies the main storage location of the count, key, and data bytes	Used at the discretion of programmer	00		Specifies the number of bytes in count, key, and data bytes in the record segment

Function

The Write Special Count, Key, and Data (CKD) command is used to format overflow records. (See the Record Overflow section of this manual.)

The Write Special CKD command must be chained from a Write R0, Write CKD, Search Key Equal, or a Search ID Equal command. The search commands must have compared equal on all bytes of the searched field.

> **Note:** A Read Data or Read Key and Data CCW may be inserted between a Search ID Equal and the Write Special CKD command. A Read Data command may be inserted between a Search Key Equal and the Write Special CKD command.

Status

Initial status is normally zero. Channel end and device end are presented after the correction code bytes have been written at the end of the data area.

Description

Direct Mode

This command is executed exactly the same as a normal Write CKD command except that the storage director writes a 1 in bit position 4 of the flag byte to indicate that it is a segment of an overflow record.

All segments of an overflow record are formatted with the Write Special CKD command except the last segment. The last segment is formatted with a normal Write CKD command.

During the execution of this command, the count, key, and data areas are transferred from main storage and written on the addressed device. The first eight bytes of data transferred are the count area: cylinder number (2 bytes), head number (2 bytes), record number (1 byte), key length (1 byte), and data length (2 bytes). The remaining data sent from main storage is written in the key and data areas as specified by the values set in the key length (KL) and data length (DL) bytes.

The count field of the CCW specifies the total number of bytes to be transferred (8+KL+DL). If the count is less than specified, zeros are written in the remainder of the record. Correction code bytes are written at the end of the count area, end of the key area, and end of the data area.

If the Write Special CKD command is the last format write command in a chain, the remaining portion of the track is erased. If a command other than another format write is chained from Write Special CKD, it is executed after the track is erased.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Diagnostic Commands

Diagnostic commands are used to transfer diagnostic information between the channel and storage director. None of these commands are accepted in paging mode.

These commands are used for maintenance purposes only. Any use other than that provided by IBM diagnostic programs may yield unpredictable results.

The following chart lists the diagnostic commands.

COMMANDS	COMMAND CODE
Diagnostic Load	53
Diagnostic Sense	44
Diagnostic Sense/Read	C4
Diagnostic Write	73

Diagnostic Load

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0101 0011 '53'	Specifies the main storage location of the control byte for diagnostic test	Used at the discretion of programmer	00		1

Function

The Diagnostic Load command transfers one byte of control information (diagnostic program ID number) from processor storage to the storage director.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after the diagnostic program has been transferred from the diagnostic diskette to a buffer in the storage director.

Description

Direct Mode

The control byte transferred by the Diagnostic Load command specifies the program ID number of the diagnostic test that is to be transferred from the diskette to the buffer.

When addressing the storage director, the address of any device attached to the storage director may used with the Diagnostic Load command.

> **Note:** This command is intended for maintenance purposes only. Any use other than that provided by IBM diagnostic programs may yield unpredictable results.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Diagnostic Sense

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0100 0100 '44'	Specifies the main storage location where the first byte of the error code message accumulated during a previous Diagnostic Write Command is to be tranferred	Used at the discretion of programmer	00		16

Function

The Diagnostic Sense command transfers the error code message accumulated during a previous Diagnostic Write command from the storage director to main storage.

Chaining Requirements

The Diagnostic Sense command should be chained from a Diagnostic Write command.

Status

Initial status is normally zero. Channel end and device end are presented after the data transfer.

Description

Direct Mode

The execution of a Diagnostic Sense command that is chained to a Diagnostic Write command causes 16 bytes of error code information to be transferred to main storage. The error code information was accumulated during execution of the previous Diagnostic Write command. When chained to a Diagnostic Write command, the CCW count field should be set to 16.

> **Note:** This command is intended for maintenance purposes only. Any use other than that provided by IBM diagnostic programs may yield unpredictable results.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Diagnostic Sense/Read

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1100 0100 'C4'	Specifies the main storage location where the first byte of diagnostic information is to be transferred	Used at the discretion of programmer	00		4,092 or 8,192 (maximum)

Function

The Diagnostic Sense/Read command transfers the contents of the trace/dump buffer from the storage director to the channel.

Note: The count of 8,192 is used only by the paging storage director.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after the contents of the trace/dump buffer have been transferred to channel.

Description

Direct Mode

The trace/dump buffer contains information about channel interface sequences, microcode sequences, and status information that is used by the customer engineer to isolate hardware failures.

Note: This command is intended for maintenance purposes only. Any use other than that provided by IBM diagnostic programs may yield unpredictable results.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Diagnostic Write

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0111 0011 '73'	Specifies the main storage location of the diagnostic test	Used at the discretion of programmer	00		8

Function

The Diagnostic Write command transfers 8 bytes of data from main storage to the storage director and initiates execution of the diagnostic test previously loaded by a Diagnostic Load command.

Chaining Requirements

The Diagnostic Write command must be preceded by a Set File Mask command which allows the execution of Diagnostic Write commands. See Set File Mask in this section of the manual.

Status

Initial status is normally zero. Channel end and device end are presented after the test has been transferred, run, and the results stored in a buffer of the storage director.

Description

Direct Mode

The diagnostic test to be run had been previously transferred by a Diagnostic Load command. After data transfer is complete, the test is run and a 16-byte error code stored in a buffer of the storage director.

A subsequent Diagnostic Sense command transfers the error code to main storage.

> **Note:** This command is intended for maintenance purposes only. Any use other than that provided by IBM diagnostic programs may yield unpredictable results.

Paging Mode

In paging mode, this command is rejected with unit check, channel end, and device end in the status.

Error Recovery Procedures

The error recovery procedures include an error condition table and recovery actions for the 3330s and 3350s that attach to the 3880 Model 11. The error condition table identifies all unique configurations of the sense bits in sense bytes 0, 1, and 2. Each configuration has a specific recovery action to take for each error condition. The recovery action procedure provides the steps to take in order to recover from an error condition. The error condition and recovery action procedures are provided later in this section.

Note: In this section, the term storage director refers to either the paging storage director or the nonpaging storage director.

Console Error Message

The console error message should be printed for all permanent errors and should contain the:

- Message code
- Error type (read, write, or control)
- Module designation (drive address), cylinder number, and head number (seek address)
- Channel designation
- Status and sense bytes sent to the processor

Error Correction Function

The recovery action procedures uses an error correction function as a step in recovering from data errors. The error correction function is used when the storage director posts the data check and correctable sense bits in the sense information. These bits are posted if a correctable data error is detected in any data area.

Correctable data errors in home address, count, and key areas on 3330s and 3333s are corrected internally by the storage director using command retry. Data check and correctable sense bits are not posted for these errors and do not cause a system interrupt.

When the correctable and data check sense bits are included in the sense information, sense bytes 18 through 22 in format 5 provide the error pattern and displacement. Error correction is accomplished by aligning the error pattern provided in sense bytes 20 though 22 with the erroneous data in main storage and exclusively ORing the error pattern and main storage bytes.

The location of the erroneous data in main storage is determined by using displacement information provided in the sense bytes and the counts provided in the interrupted CCW chain. The storage director specifies the location of the error bytes, relative to the first byte transferred in the operation that incurred the error. The displacement between the first byte transferred and the first byte in error is calculated by subtracting the error displacement provided in sense bytes 18 and 19 from the restart displacement in sense bytes 15 through 17. The result constitutes the forward error displacement and is used in conjunction with the count specified in the interrupt CCW, to locate the erroneous main storage data.

If data chaining was indicated in the operation that posted the correctable error, the forward displacement may reference data from the second (or subsequent) CCW in the data chain.

If the indirect address bit is on during the operation that posted the correctable error, the first data address is obtained from the first indirect address word (IDAW). The CCW data address points to the IDAW, and correction proceeds as described for data chaining.

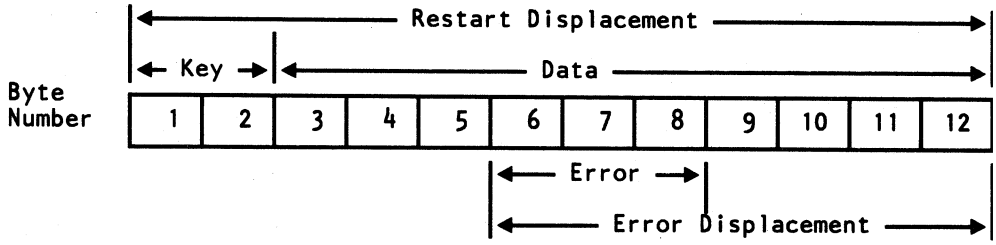
Before applying the error correction function, determine whether any error bytes were not transferred because the skip bit was on, there was a short count in the CCW, or if the error bytes are not in adjacent main storage locations because of data chaining between CCWs.

- If any of the error bytes are in data specified by a CCW with the skip bit on, the error correction function cannot be used for the bytes that were not transferred to main storage.
- If any of the error bytes are in data not transferred to processor storage because of a short CCW count, the error correction function cannot be used for bytes that were not transferred to main storage.
- If no short CCW count is found and bit 7 of sense byte 23 indicates that a channel truncation occurred (3330 only), the error correction function cannot be applied correctly.
- If the error pattern covers non-adjacent main storage boundaries because of data chaining, the error correction function must be selectively applied to the separate storage locations.
- If the error displacement in sense bytes 18 and 19 is less than 3, the error is partially or totally contained in the correction code bytes. The error pattern in sense bytes 20 through 22 is then constructed as follows:

  1. If the error displacement is zero, or if the error is totally contained in the gap that immediately precedes the data area, the error pattern must be set to zero by the error recovery procedures.
  2. If the error displacement is one, the two low-order error pattern bytes (bytes 21 and 22) must be set to zero by the error recovery procedures. The high-order bytes contain the correction syndrome.
  3. If the error displacement is two, the low-order pattern byte must be set to zero by the error recovery procedures. The high-order bytes contain the correction syndrome.

For example, assume the key length is 2 and the data length is 10. CSW-8 points to CCW 1 in the following chain:

CCW	Command	Address	Count	Flags
1	Read Key and Data	A	2	Data chaining
2	TIC	CCW 3	—	—
3	—	B	4	Data chaining, skip
4	—	C	1	Suppress incorrect length



The error affects bytes 6, 7, and 8 as follows:

Byte 6 - - - - - - X X

Byte 7 X X X - - - - -

Byte 8 X - - - - - - -

Where (-) corresponds to correct bit and X corresponds to an incorrect bit.

In the example, the error condition generates a restart displacement of 12 and an error displacement of 7. The following error pattern is produced.

Pattern byte 1 (sense byte 20) 0 0 0 0 0 0 1 1

Pattern byte 2 (sense byte 21) 1 1 1 0 0 0 0 0

Pattern byte 3 (sense byte 22) 1 0 0 0 0 0 0 0

Application of the error correction function, as outlined in the preceding sections, results in the following system recovery action.

1. Pattern 1 does not apply to data byte 6, since this byte is not transferred to main storage due to the skip flag in CCW 3.
2. Pattern byte 2 is exclusively ORed to main storage location B, where data byte 7 resides.
3. Pattern byte 3 does not apply to data byte 8, since this byte is not transferred to main storage due to a short count in CCW 4.

Restart CCWs

If operation incomplete (byte 1, bit 7) is set in the sense information, it indicates that an error or unusual condition occurred during a logical operation after data transfer had been initiated.

By constructing restart CCWs, the error recovery procedures are able to correct the unusual condition and continue the current operation from the point of interruption to the normal ending point.

The recovery action table specifies the restart CCW required, either 1 or 2.

Restart CCW 1

Construct restart CCW 1 as follows:

1. Use the command code provided in sense byte 3.
2. Use the data address of the interrupt CCW, plus the count of that CCW, minus the residual count in the channel status word.
3. Use the flags (except PCI) of the interrupted CCW.
4. Use the residual count in the CSW for the count. If the residual count is zero, a count of one must be used.

If a write command was in progress, the data address must specify a byte containing XX'00'. If a read command was in progress, the skip bit must be on.

Restart CCW 2

Construct restart CCW 2 as follows:

1. Use the command code provided in sense byte 3.
2. Construct the count as follows:
   a. Get the count of the CCW designated by CSW-8, and set a pointer to this CCW.
   b. Subtract the restart displacement from the count obtained in step a. If this result is positive, go to step f; otherwise, go to step c.
   c. Check the chain data flag of the CCW designated by the pointer. If the flag is not set (truncation occurred), go to step e; otherwise, go to step d.
   d. Advance the pointer to the next non-TIC CCW in the data chain and add the count of this CCW to the counts of all preceding non-TIC CCWs in the data chain. Return to step b.
   e. Set Restart CCW 2 count to 1. Go to step 3 and include the skip bit in the restart CCW flags.
   f. Set the restart CCW 2 count equal to the result of the subtraction in step b. Go step 3.

Error Condition Tables for 3330 and 3350

BYTE	BIT	NAME	GENERAL DESCRIPTION	ACTION	LOGGED
0	0	Command reject	Programming error	2	No
0 1	0 6	Command reject Write inhibited	A write command received with the Write Inhibit switch in the Read-Only position	1	No
0	1	Intervention required	Device offline or not installed. In paging mode, device busy was detected while attempting a data transfer between cache and DASD.	3	Yes* - 3350 No - 3330
0 2	1 3	Intervention required Environmental data present	Device offline or not installed. In paging mode, device busy was detected while attempting a data transfer between cache and DASD. (Not related to current operation.)	1	Yes*
0	2	Bus out parity	Bus out parity error	3	Yes
0	3	Equipment check	Equipment malfunction	4	Yes**
0 1	3 0	Equipment check Permanent error	Equipment malfunction--Storage director retry exhausted or undesirable	1	Yes
0 1 2	3 0 3	Equipment check Permanent error Environmental data present	Equipment malfunction. Storage director retry exhausted or undesirable (not related to current operation).	4A	Yes
0 1	3 3	Equipment check Message to operator	Permanent equipment malfunction of the alternate storage director, a state save operation in reporting storage director, or the subsystem storage is unusable because of previous failures.	4	Yes
0	4	Data check	Data check not correctable with a Read Multiple CKD command	4	Yes - 3350 No - 3330
0 1	4 0	Data check Permanent error	Uncorrectable data check, storage control retry exhausted	1	Yes
0 1 2	4 0 3	Data check Permanent error Environmental data present	Uncorrectable data check. The retry count is exhausted. (Not related to current operation.)	4A	Yes

*If bits 4 and 5 of sense byte 10 are zero, no logging is performed.

**If sense byte 7 contains X'29', no logging is performed.

BYTE	BIT	NAME	GENERAL DESCRIPTION	ACTION	LOGGED
0 1	4 7	Data check Operation incomplete	Data check in the second or subsequent overflow segment but not a data field correctable error	6A	Yes - 3350 No - 3330
0 1 2	4 7 1	Data check Operation incomplete Correctable	Correctable data check in the data area of an overflow segment that is not the last segment	6	Yes - 3350 No - 3330
0 2	4 1	Data check Correctable	Correctable data check in the data area in the data area, in the data area of the last overflow segment, or the Read Multiple CKD command	5	Yes - 3350 No - 3330
0	5	Overrun	Command retry exhausted on service overrun; or sevice overrun on second or subsequent overflow segment, or during a format write	4	Yes
1 1	0 3	Permanent error Message to operator	Discard of all blocks is required	1	Yes
1	1	Invalid track format	Track capacity exceeded	2	No
1 1 2	1 3 3	Invalid track format Message to operator Environmental data present	Format not supported in paging mode	4A	Yes
1	2	End of cylinder	Cylinder boundary detected during a multitrack operation	8	No
1 1	2 7	End of cylinder Operation incomplete	Cylinder boundary detected during a overflow operation	9	No
1 2	3 3	Message to operator Environmental data present	Subsystem storage availability threshold crossed	4A	Yes
1 1 2	3 4 3	Message to operator No record found Environmental data present	Record not found during cache to DASD data transfer	4A	Yes
1	4	No record found	Record not found in the basic command sequence	2	No
1	5	File protected	The Seek command or Read/Search multitrack operation has violated the file mask	10	No
1 1	5 7	File protected Operation incomplete	A read or write overflow operation has violated the file mask	11	No

3. Use the flags (except PCI) of the CCW designated by the pointer in step 2. Set the skip bit if step 2e was executed.

4. Use the data address of the CCW designated by the pointer in step 2, plus the count of that CCW, minus the restart CCW count generated in step 2. If step 2e was executed and the interrupted operation was a write, the data address must specify a byte containing zeros.

If another operation incomplete or an error in a Read Multiple CKD command occurs while executing the restart CCW, a new restart CCW may be generated from the old restart CCW. Return to step 2d, but do not destroy the old restart CCW before generating the new one.

Command Retry

Command retry is a combined channel and storage director procedure that causes an improperly executed command in a channel program to be automatically retried. Command retry is requested when the storage director sends unit check with channel end and/or device end and status modifier to the channel. The retry procedures are device dependent and are not implemented in the same manner for all devices. In some applications command retry is not performed but the retry status is used to orient the CCW address to the proper processor storage location for system error recovery procedures.

For 3330 and 3350 devices, command retry is used to recover from the following error conditions.

- When a correctable data error occurs during a read or search operation on a home address, count or key area on 3330 devices.
- When a correctable data error occurs in the data area of a record on a 3330 or a 3350, command retry is used to orient the system error recovery procedures to the initial CCW of the chain in which the error occurred. The data error is corrected by use of the sense information and the chain is restarted under control of the error recovery procedures.
- When an uncorrectable data error is detected in any field during a read or search operation, the command is retried until the error is corrected or until it is determined that the error cannot be corrected.
- When a defective or alternate track is detected before data transfer has started, the storage director initiates a seek to the appropriate track, orients on index, and reissues the command.
- When a seek error is detected or seek incomplete is signaled by the device, the storage director retries the seek until the access mechanism is positioned correctly, or until it is determined that the error is permanent. If the error is permanent, the sense information indicates equipment check, permanent error, and seek check.
- When a command overrun occurs, the storage director initiates a retry of the last command.
- When a data overrun occurs, the command is retried (unless the data overrun occurred during the second or subsequent segment of an overflow record, during a format write operation, or during a Read Multiple CKD command).

- When command retry is used to allow the channel to disconnect during some padding operations, and to reconnect upon completion of padding.
- When command retry is used to initiate a seek operation previously received from the channel but not initiated by the device. If a Space Count, Write Home Address, read or search command is received, the storage director disconnects from the channel, seeks to the specified track, and reissues the command.

Execution of command retry may cause the following conditions to be detected by the initiating program:

- A CCW containing a PCI may, if retried because of command retry, cause multiple PCI interruptions to occur.
- A channel program consisting of a single, unchained CCW specfying an immediate command may cause a condition code of 0 rather than 1 to be set. This condition code is set if the storage director signals command retry at the time initial status is presented to the channel. The channel program then causes a later interruption upon completion of the operation.
- If a channel program stops prematurely during a command retry, the residual count and command address field in the CSW may not necessarily indicate the extent of main storage used.
- If a CCW used in an operation is changed before that operation has been successfully completed, the results are unpredictable.

BYTE	BIT	NAME	GENERAL DESCRIPTION	ACTION	LOGGED
1 2	6 3	Write Inhibited Environmental data present	A cache to DASD data transfer failure because the Write Inhibit switch was in the Read Only position	4B	No
1	7	Operation incomplete	One of the following is detected after beginning data transfer of an overflow operation: switching from an alternate track, or seek error in the second or subsequent segment	7	No - 3350
2	3	Environmental data present	Statistical usage/error log information present	4A	Yes

Error Recovery Actions - 3330 and 3350

Action	Explanation
1	a. If sense format F, print the console message defined by sense byte 7. b. Print basic console error message
2	Exit with programming error or unusual condition indication.
3	Repeat the operation once. If the error condition persists, perform action 1.
4	a. If message to operator (byte 1, bit 3) is set, print console message defined by sense byte 7. b. Repeat the operation. c. If error condition persists after 10 retries, perform action 1.
4A	a. If message to operator is on (byte 1, bit 3), print the console message defined by sense byte 7. b. Repeat the operation. c. If the error condition persists after 256 retries, perform action 1.
4B	a. Print message asking operator to set the R/W Read switch to the R/W position. b. Suspend operations until reply is received. c. Repeat the operation when reply is received.

5	a. Perform the error correction function.
	b. Examine bit 7 of the file mask. If zero, go to step c. If on, indicate that the data has been corrected. The user is operating in PCI fetch mode and must supply the restart recovery action.
	c. Examine the interrupted CCW (CSW-8). If it is a Read Multiple CKD (5E), perform action 5B: otherwise continue. If the user's chain is not complete, examine the next non-TIC command in the chain. If the CCW is a Write Special CKD, Read Sector, or if bits 3, 6 and 7 are equal to 000 or 011, go to step d. Otherwise, perform action 5A.
	d. Continue the user's chain by executing:
	`Seek (see note below)`
	`Set File Mask (same as original)`
	`Read Home Address (skip bit on)`
	`Search ID Equal (CCHHR from sense bytes 8 to 12)`
	`TIC*-8`
	`TIC (channel status word)`
	Note: The cylinder bytes and high-order head byte are obtained from user data, not from sense data. The low-order head byte is obtained from bits 3 to 7 of sense byte 6.

5A

a. Continue the user's chain by executing:

```
Seek                (see note below)
Set File Mask       (same as original)
Read Home Address   (skip bit on)
Search ID Equal     (CC HH R from sense bytes 8 to 12)
TIC*-8
Read Count          (skip bit on)
TIC                 (channel status word)
```

Note: The cylinder bytes and high-order head byte are obtained from user data, not from sense data. The low-order head byte is obtained from bits 3 to 7 of sense byte 6.

5B

This action is used to restart a Read Multiple CKD data recovery process after a correctable data check has been processed. Reconstruct the Read Multiple CKD as follows:

a. Construct restart CCW 2.

b. Set command code to '5E'.

Restart the operation by executing:

```
Seek                (see note below)
Set File Mask       (same as original)
Read Home Address   (skip bit on)
Search ID Equal     (CC HH R from sense bytes 8 to 12)
TIC*-8
Read Multiple CKD   (from step a)
TIC (CSW)
```

Note: The cylinder bytes and high-order head byte are obtained from user data, not from sense data. The low-order head byte is obtained from bits 3 to 7 of sense byte 6.

6

a. Perform the error correction function.

b. Examine bit 7 of the file mask (PCI). If off, go to step c. If on, return to the user with an indication that the data has been corrected. The user is operating in PCI fetch mode and must supply the restart recovery action.

c. Increment the seek argument by 1. If the modified seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek. If that is impossible, then IOS must perform action 2.

d. Construct restart CCW 2.

e. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following:

```
Seek                (increment seek argument
                     by 1, see note below)
Set File Mask       (same as original)
Set Sector          (argument 0)
Search ID Equal     (record 1)
TIC*-8
Restart CCW 2
TIC (CSW)           (pointer established while
                    constructing restart CCW 2+8)
```

Note: The cylinder bytes and high-order head byte are obtained from user data, not from sense data. The low-order head byte is obtained from bits 3 to 7 of sense byte 6.

6A

a. Examine bit 7 of the file mask (PCI). If off, go to step b. If on, indicate that data has been corrected. The user is operating in PCI fetch mode and must supply the restart recovery action.

b. Construct restart CCW 2.

c. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following:

```
Seek                (see note below)
Set File Mask       (same as original)
Set Sector          (argument 0)
Search ID Equal     (record 1)
TIC*-8
Restart CCW 2
TIC (CSW)           (pointer established while
                     constructing restart CCW 2+8)
```

Note: The cylinder bytes and high-order head byte are obtained from user data, not from sense data. The low-order head byte is obtained from bits 3 to 7 of sense byte 6.

7

a. Construct restart CCW 1.

b. Continue the user's chain by executing the following:

```
Seek                (see note below)
Set File Mask       (same as original)
Set Sector          (argument 0)
Search ID Equal     (record 1)
TIC*-8
Restart CCW 1
TIC                 (channel status word)
```

Note: The cylinder bytes and high-order head byte are obtained from user data, not from sense data. The low-order head byte is obtained from bits 3 to 7 of sense byte 6.

8

a. Increment the cylinder address of the user's seek argument by 1. Reset the head address. If the modified seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek. If that is impossible, IOS must perform action 2.

b. Continue the operation by executing the following:

```
Seek                (argument from step a)
Set File Mask       (same as original)
Set Sector          (argument 0)
Read Home Address   (skip bit is on)
TIC                 (channel status word-8)
```

9

a. Increment the cylinder address of the user's seek argument by 1. Reset the head address. If the modified seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek. If that is impossible, IOS must perform action 2.

b. Construct restart CCW 1.

c. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following:

```
Seek                (argument from step a)
Set File Mask       (same as original)
Set Sector          (argument 0)
Search ID Equal     (record 1)
TIC*-8
Restart CCW 1
TIC                 (channel status word)
```

10

Determine if the interrupted command is a seek. If it is, go to step b. If not, perform action 10A.

If the seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek. If that is impossible, IOS must perform action 2.

b. Continue the operation by executing the following:

```
Seek                (user's argument)
Set File Mask       (same as original)
Set Sector          (argument 0)
Read Home Address   (skip bit is on)
TIC                 (channel status word)
```

10A

a. This is a multitrack operation. Increment the user's seek argument by one. If the modified seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek. If that is impossible, IOS must perform action 2.

b. Continue the operation by executing the following:

```
Seek                (argument from step a)
Set File Mask       (same as original)
Set Sector          (argument 0)
Read Home Address   (skip bit is on)
TIC                 (channel status word-8)
```

11

a. Increment the user's seek argument by 1. If the modified seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek. If that is impossible, IOS must perform action 2.

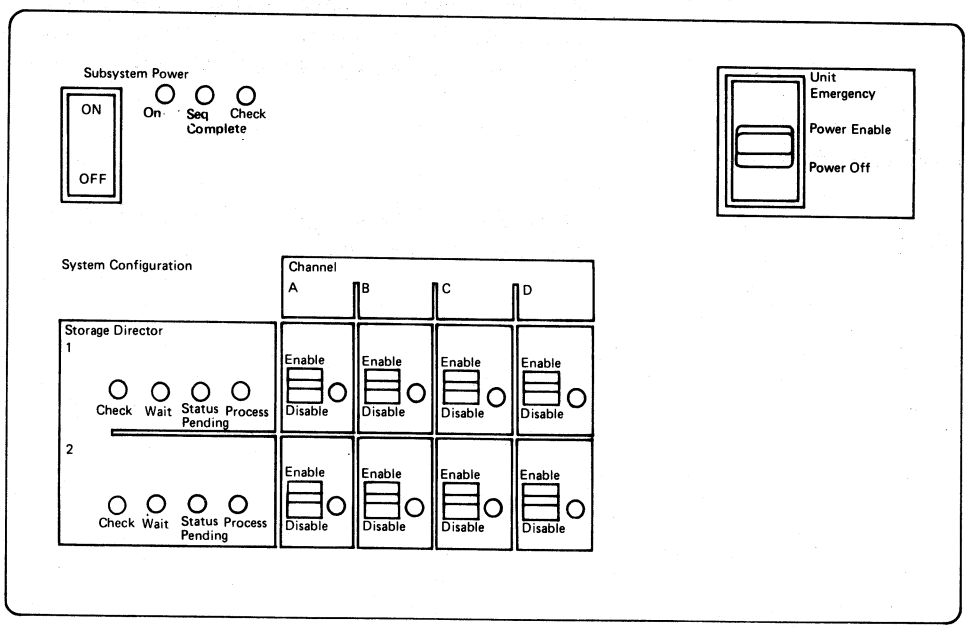
b. Construct restart CCW 1.

c. Complete the interrupted operation and continue the user's chain (if appropriate) by executing the following:

```
Seek                (argument from step a)
Set File Mask       (same as original)
Set Sector          (argument 0)
Search ID Equal     (record 1)
TIC*-8
Restart CCW 1
TIC                 (channel status word)
```

Operator Panel

The operator panel consists of switches and indicators that are used to monitor and control functions of the 3880 and its attached disk storage.



Subsystem Power

On/Off: switch provides manual control of subsystem power.

On: indicates that power is applied to the subsystem.

Seq Complete: indicates that a signal has been sent to the processor verifying that power sequencing for the subsystem is completed.

Check: indicates that there is a problem in the power circuitry.

System Configuration

Check: indicates that there is a malfunction in the associated cache storage director.

Wait: indicates that this cache storage director is in the wait state and is not processing any information.

Process: indicates that the associated cache storage director is processing information.

Status Pending: indicates that the associated cache storage director has status pending, is in contingent connection status or is waiting for a device response during a cache storage director and/or device retry.

Enable/Disable: switches must be in the Enable position before the associated cache storage director is available to the channel. (The switch configuration shown is for a 3880 with the Two Channel Switch–Pair, Additional feature installed.)

Unit Emergency

Power Enable/Power Off: switch is provided for operator control of subsystem power in case of an emergency.

Sense Bytes–3330

Sense information for the 3330 (24 bytes) identifies the conditions that caused the unit check status to be generated. The sense information also provides secondary information for system error recovery and for diagnosing and isolating storage director and device malfunctions.

Sense Byte 0

Bit 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
- Issuing a write command with the Write Inhibit switch in the Read-Only position
- Attempting a format write command (other than Write Home Address or Write R0) on a defective track.
- Issuing a write command that violates the file mask
- A record zero count field of a defective track that points to itself instead of the alternate track

Bit 1 - Intervention Required

Bit 1 is set by:

- Addressing a drive that is not attached to the system
- Addressing a drive that is not ready
- Issuing a Diagnostic Write or Diagnostic Load command while an in line diagnostic is resident in control storage

Bit 2 - Bus Out Parity

Bit 2 is set when a parity error is detected during transfer of a command from the channel to the 3880.

Bit 3 - Equipment Check

Bit 3 is set when an unusual hardware condition occurs in the channel, storage director, or drive. The condition is further defined in sense bytes 7 through 23.

Bit 4 - Data Check

Bit 4 is set when the storage director detects a data error in the information received from the drive. 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 5 - Overrun

Bit 5 is set when the storage director 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 a replicated data byte.

All data overrun conditions are retried by the storage director except those that occur in the second or subsequent segments of an overflow record, those that occur during a format write operation, or those that occur during a Read Multiple Count, Key, and Data command.

The storage director posts an overrun only if the condition occurs more than ten times during a CCW chain, or if the overrun occurs during one of the above operations not retried by the storage director.

Command overruns are also retried by the storage director and do not cause an overrun to be posted.

Bits 6 and 7

These bits are not used and are set to zero.

Sense Byte 1

Bit 0 - Permanent Error

Bit 0 is set when internal error recovery has been exhausted (through the use of command retry) and was unsuccessful, or when internal error recovery was not possible or desirable.

The bit overrides any other bit settings and indicates that system error procedures may not be required.

Bit 1 - Invalid Track Format

Bit 1 is set when:

- An attempt is made to write data that exceeds 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 while attempting to execute a read, search, or write command. As long as this

record remains on the track, invalid track format may be posted while attempting to locate a record successfully written on the track. However, a search ID-type command will be able to execute on any count field successfully written on the track without posting invalid track format.

Bit 2 - End of Cylinder

Bit 2 is set when:

- A multitrack read or search operation continues past the end of cylinder boundary.
- An overflow operation continues past the end of the cylinder boundary. Byte 1, bit 7 (operation incomplete) is also set.

Bit 3 - Message to Operator

Bit 3 is set when there is a permanent failure in the alternate storage director or a state save operation in the reporting storage director. Byte 0, bit 3 (equipment check) is also set. A message is also sent to the operator console. This bit is used for format 3 only.

Bit 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 the data area, or without an intervening write, sense, or control command.

Bit 5 - File Protected

Bit 5 is set when:

- A seek command violates the file mask.
- A multitrack read or search operation violates the file mask.
- An overflow operation violates the seek portion of the file mask. Byte 1, bit 7 (operation incomplete) is also set.

Bit 6 - Write Inhibited

Bit 6 is set when a write command is received for a drive that has its Write Inhibit switch in the Read-Only position. Byte 0, bit 0 (command reject) is also set.

Bit 7 - Operation Incomplete

Bit 7 is set when one of following conditions occurs during the processing of an overflow record.

- An overflow to a file protected boundary. Byte 1 bit 5 (file protected) is also set.
- An overflow past the cylinder boundary. Byte 1 bit 2 (end of cylinder) is also set.
- A correctable data check is detected in a data field other than the last segment. Byte 0 bit 4 (data check) and byte 2, bit 1 (correctable) are also set.

- An uncorrectable data check is detected in any field in other than the first segment.
- A defective or alternate track condition is detected after the the start of data transfer.
- A seek error is detected in the second or subsequent segment.

Sense byte 3 provides the restart command, and sense bytes 8 through 13 provide the restart information.

Sense Byte 2

Bit 0

Bit 0 is not used and is set to zero.

Bit 1 – Correctable

Bit 1 is set when the data check condition indicated by byte 0, bit 4 (data check) is correctable.

Bit 2

Bit 2 is not used and is set to zero.

Bit 3 – Environmental Data Present

Bit 3 is set to indicate that bytes 8 through 23 contain usage or error statistics, or error log information. Byte 7 indicates the format for bytes 8 through 23.

Bits 4 through 7

Bits 4 through 7 are not used and are set to zero.

Sense Byte 3

Bits 0 Through 7 – Restart Command

Bits 0 through 7 are set when byte 1, bit 7 (operation incomplete) is set. These bits identify the type of operation in progress when the interrupt occurred. If the bits are set to 0000 0110, a read operation was in progress; if they are set 1000 0101, a write operation was in progress.

Sense Byte 4

Bits 0 and 1 – Controller Identification

Bits 0 and 1 identify the physical controller selected.

Bits 2 Through 7 – Drive Identification

Bits 2 through 7 identify the physical address of each drive.

111000 = A	011100 = E
110001 = B	010101 = F
101010 = C	001110 = G
100011 = D	000111 = H

Sense Byte 5

Bits 0 Through 7 – Cylinder-Low Address

Bits 0 through 7 identify the low-order cylinder address of the most recent seek argument from the data channel.

In conjunction with sense format 3 (microcode detected), byte 5 indicates the high-order byte of the instruction address register.

In conjunction with sense format 6, byte 5 indicates the number of diskette checks after an initial microcode load (IML) or storage director-to-storage director communication failure.

Bit 0 – Communication failure during an IML
Bit 1 – Not used
Bits 2-4 – Diskette check (seek errors)
Bits 5-7 – Diskette check (read errors)

Sense Byte 6

If an alternate track condition is detected and byte 1, bit 7 (operation incomplete) is posted during an overflow operation, byte 6 is set to the head address of the defective track plus 1. The ERPs use this byte to construct the seek argument to continue the operation. The remainder of the seek argument is obtained from the user, not the sense bytes.

In conjunction with sense format 3 (microcode detected), byte 6 indicates the low-order byte of the instruction address register.

In conjunction with sense format 6, byte 6 identifies the storage director.

In all other cases, sense byte 6 contains the following information.

Bit 0

Bit 0 is not used and is set to zero.

Bit 1 – Cylinder-High Address

On 3330-1, bit 1 identifies the high-order bit (256) of the cylinder address in sense byte 5.

On 3330-11, bit 1 identifies the high-order bit (512) of the cylinder address in sense byte 5.

Bit 2 – Difference

On 3330-1, bit 2 is not used and is set to zero.

On 3330-11 bit 2 identifies the high-order bit (256) of the cylinder address in sense byte 5.

Bits 3 Through 7 – Head Address

Bits 3 through 7 identify the head address of the last seek (excluding retry seeks). The head address is updated during multitrack and overflow operations.

Sense Byte 7

Bits 0 Through 3 – Format

Bits 0 through 3 specify the format of sense bytes 8 through 23 as follows:

Code	Meaning
0000	Format 0 - Program or system checks
0001	Format 1 - Device equipment checks (CE information)
0010	Format 2 - Storage director equipment checks (CE information)
0011	Format 3 - Storage director control checks (CE information)
0100	Format 4 - Data checks without displacement
0101	Format 5 - Data checks with displacement information
0110	Format 6 - Usage statistics/overrun errors

Note: Format 5 may also be presented on errors which are not ECC correctable but which require restart displacement information.

Bits 4 Through 7 – Message

Bits 4 through 7 describe the specific nature of the error conditions for each of the above formats. The message table that accompanies the format descriptions specifies the function of the message bits for the format.

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. Bytes 8 to 23 contain the following information for Format 0.

- **Bytes 8 Through 20** are not used and are set to zero.
- **Byte 21** contains the storage director identification.
- **Bytes 22 and 23** contain the symptom code.

Message Table – Format 0

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000	0	No message. No additional information is required.
0001	1	An invalid command was issued to the 3880.
0010	2	An invalid command sequence was issued to the to the 3880.
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 Write 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	A Diagnostic Load Command was issued but the IML device was not ready.
1001	9	A Diagnostic Load command was issued but the IML device had a permanent seek check.
1010	A	A Diagnostic Load Command was issued but the IML device had a permanent read check.
1011	B	The alternate track pointer of a defective track pointed to the defective track.
1100	C	Not used.
1101	D	The index point was detected in the gap of a record.
1110 and 1111	E, F	Not used.

Format 1 – Device Equipment Check

Format 1 is generated when:

- A device, device interface, or a controller equipment check is detected. Byte 0, bit 3 (equipment check) is also set.
- 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 bits in sense byte 7 indicated a seek error.
- Error log information is off-loaded after a successful retried seek that occurred during error logging. Byte 3, bit 2 (environmental data present) is also set. The message bits in sense byte 7 indicate a seek error.
- Byte 8, bit 4 (on line) is off. Byte 0, bit 1 (intervention required) is also set.

Bytes 8 to 23 have the following format:

Byte 8 – Module Status

```
Bit 0=Index error              Bit 4=On line
Bit 1=Offset active            Bit 5=Attention
Bit 2=Seek incomplete          Bit 6=Busy
Bit 3=Seek complete            Bit 7=Record ready
```

Byte 9 – Monitor Mode

```
Bit 0=Not used                  Bits 5-7 identify the
Bit 1=Diagnostic state 4        the monitor modes as follows:
Bit 2=Diagnostic state 2
Bit 3=Diagnostic state 1                001=Mode 1-rezero
Bit 4=Not used                          010=Mode 2-seek accelerate
                                        100=Mode 4-head load
                                        101=Mode 5-seek decelerate
                                        110=Mode 6-read
                                        111=Mode 7-write
```

Byte 10 – Monitor State

These bits identify a monitor state that exists for each of the monitor modes described in byte 9.

```
Bit 0=State 8                  Bit 4=State 4
Bit 1=State 7                  Bit 5=State 3
Bit 2=State 6                  Bit 6=State 2
Bit 3=State 5                  Bit 7=State 1
```

Byte 11 – Check Status

```
Bit 0=CE program stop          Bit 4=CTL-I bus out parity
Bit 1=Not used                 Bit 5=Monitor check
Bit 2=Not used                 Bit 6=Not used
Bit 3=Not used                 Bit 7=Drive command reject
```

```
Byte 12  Safety
Bit 0=Data safety              Bit 4=Power on reset latched
Bit 1=Servo safety             Bit 5=Drive power on reset
Bit 2=Not used                 Bit 6=Not heads loaded
Bit 3=Pad safety (Model 11)    Bit 7=Even latch
```

Byte 13 – Device Bus Out

Byte 13 contains the actual device bus out (DBO) value for message code C. It is also set to the DBO value if the message code is 2 and byte 18, bits 4 through 7 are 1, 3, 5, 6, 9 or E. Byte 13 contains the expected device bus in (DBI) value for message codes 1, 3, 6, 7, 8, and 9. Otherwise, it is set to zero.

Byte 14 – Device Bus In

Byte 14 contains the actual DBI value for message codes 1, 3, 6, 7, 8, 9, and C and for message code 2 if byte 18 equals '01', '03', '05', '06', '09', or '0E'. Otherwise, it is set to zero.

Byte 15 – Device Tag Gate

Byte 15 contains the actual device tag gate (DTG) register value for message codes 1, 3, 6, 7, 8, 9, and C and for message code 2 if byte 18 equals '01', '03', '05', '06', '09', or '0E'. Otherwise, it is set to zero.

Byte 16 – Controller Check 1

Bit 0=PLO error
Bit 1=Write parity error
Bit 2=Read parity error
Bit 3=Bit ring error
Bit 4=Write compensation check
Bit 5=Data transfer control check
Bit 6=Missing PLO pulses
Bit 7=VFO phase error

Byte 17 – Controller Check 2

Bit 0=ECC no input data
Bit 1=ECC P0 or write
Bit 2=ECC P2 or P3
Bit 3=ECC P1
Bit 4=Sync out check
Bit 5=PLO control check
Bit 6=Gap counter check
Bit 7=Gap control check

Byte 18 – Controller Check 3

Bit 0=Error alert
Bit 1=Select active check
Bit 2=Controller interface bus in check
Bit 3=Not used

Bits 4 through 7 indicate the following microcode detected errors:

0000=No message
0001=Device interface Tag Valid missing (read or write)
0010=Device interface Normal End and Check End missing
0011=Device interface Normal End missing (control operation)
0100=Either no index for 40 milliseconds or index on at all times.
0101=Unexpected status with Check End
0110=3330 selection check
0111=Preselection check
1000=Zero pattern alignment check
1001=Repetitive command overruns
1010=Drive interrupt during busy
1011=Drive status not as expected after a Seek or Set Sector command
1100-1110=Not used
1111=Always active bus in bit

Byte 19 – Controller Check 4

Bit 0=Drive selection error
Bit 1=CTL-I tag bus check
Bit 2=Device check
Bit 3=CTL-I bus out check
Bit 4=Write sense check
Bit 5=Read/Write valid check
Bit 6=DBO register check
Bit 7=Controller bus in assembler

Bytes 20 and 21 are not used.

Bytes 22 and 23 contain the symptom code.

Message Table–Format 1

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000	0	No message. No additional information is required
0001	1	Set target error
0010	2	Microcode detected error
0011	3	Not used
0100	4	Not used
0101	5	String switch primed interrupt error
0110	6	Transmit cylinder error
0111	7	Transmit head error
1000	8	Transmit difference error
1001	9	Drive status not as expected during execution of a Read IPL or during a retry that required the reset of the offset active or set sector bits
1010	A	Seek error
1011	B	Seek incomplete on retry
1100	C	No interrupt from device
1101	D	ECC P2 or P3 compare failure
1110	E	ECC P1 compare failure
1111	F	Retry PLO counter or sector value incorrect

Format 2–Storage Director Equipment Check

Format 2 is generated to provide sense information when the microcode detects a storage error condition. Bytes 8 to 23 have the following format.

Byte 8 contains the contents of the transfer complete status (XCS) register

Byte 9 contains the contents of the transfer error status (XES) register

Byte 10 contains the contents of the check (CHK) register

Byte 11 contains the contents of the channel transfer complete (CXC) register

Byte 12 contains the contents of the channel control 2 (CC2) register

Byte 13 contains the contents of the device bus out (DBO) register

Byte 14 contains the contents of the device bus in (DBI) register

Byte 15 contains the contents of the device tag out (DTO) register

Byte 16 contains the contents of the device tag gate (DTG) register

Byte 17 contains the contents of the device tag in (DTI) register

Byte 18 contains the contents of the channel status 2 (CS2) register

Byte 19 is not used

Byte 20 indicates microcode detected check 2 conditions.

Bits 0 through 3 are not used. If bits 4 through 7 equal 0001, the device attempted to end data transfer prematurely.

Byte 21 contains the physical storage director identification

Bytes 22 and 23 contain the symptom code

Message Table – Format 2

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0111	0-7	Reserved for other types of storage control units.
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 Line.
1011-1110	B-E	Reserved
1111	F	Microcode detected check. The message appears in bytes 20, bits 4 through 7.

Format 3 – Storage Director Control Check (Clock Stopped)

Format 3 is generated to provide sense information for a failing storage director that requires a reset procedure for recovery.

If sense byte 7 indicates format 3 message code 8, bytes 8 to 23 are formatted as follows:

Byte 8 contains the contents of field replaceable unit (FRU) register 2 (bit 4=0)

Byte 9 contains the contents of the check register 1

Byte 10 contains the contents of the check register 2

Byte 11 contains the contents of the check register 3

Bytes 12 and 13 are not used

Byte 14 contains the contents of FRU register 1

Byte 15 contains the contents of FRU register 3

Byte 16 contains the contents of FRU register 4

Bytes 17 Through 20 are not used

Byte 21 contains the physical storage director identification

Bytes 22 and 23 contain the symptom code

If sense byte 7 does not indicate format 3 message code 8, bytes 8 to 23 are formatted as follows:

Byte 8 is not used

Byte 9 contains the contents of the transfer error status (XES) register

Byte 10 contains the contents of the check register

Byte 11 contains the contents of the condition register 0 (CR0)

Byte 12 contains the contents of the channel status 2 (CS2) register

Byte 13 contains the contents of the channel control 1 (CC1) register

Byte 14 contains the contents of the channel control 2 (CC2) register

Byte 15 contains the contents of the channel status 1 (CS1) register

Byte 16 contains the contents of the channel status 3 (CS3) register

Byte 17 contains the contents of the channel transfer control (CXC) register

Byte 18 contains the contents of the channel bus out (CBO) register

Byte 19 contains the contents of the channel bus in (CBI) register

Byte 20 contains the interrupt level and block identification

Byte 21 contains the physical storage director identification

Bytes 22 and 23 contain the symptom code

Message Table – Format 3

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0111	0-7	Reserved for other types of storage control units.
1000	8	No message for clock stopped (check 1 error).
1001	9	Channel check 1 or storage director timeout.
1010	A	Trace table saved in this storage director.
1011-1111	B-F	Reserved

Format 4 – Data Check Without Displacement Information

Format 4 is generated when:

- Errors that were 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 offloaded 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.

Bytes 8 to 23 are formatted as follows:

Bytes 8 Through 12 - Count ID

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, or 9. Byte 12 is zero if the message code is 0 or 4.

Byte 13 – Sector Number Byte 13 contains the sector number of the record in error.

Byte 14 – Access Offset

For permanent errors, this byte contains the head offset last used for retrying a data check. If the error was not permanent, this byte provides the offset required to recover from the error.

Byte 15 – Retry Count

Byte 15 contains the number of retries required to process the error condition.

Byte 16 – Source Drive ID

Byte 16 identifies the physical controller and drive that recorded the data in which the error occurred. (See Sense Byte 4.)

Bytes 17 Through 21 are not used.

Bytes 22 and 23 contain the symptom code.

Message Table – Format 4

SENSE BYTE 7, 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 occured in the key area and could not be corrected by the ECC.
0011	3	An error occured in the data area and could not be corrected by the ECC.
0100	4	Data synchronization on the home address 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	Not used
1001	9	Address mark reorientation was unsuccessful on retry
1010-1111	A-F	Not used

Format 5 – Data Check With Displacement Information

Format 5 is generated when:

- 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 offloaded after an ECC correctable error occurred during error logging.
- Data checks are detected while processing a second or subsequent segment of an overflow record.

Bytes 8 to 23 are formatted as follows:

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, or 5. Byte 12 is unreliable after a Space Count command.

Byte 13 – Sector Number This byte contains the sector number of the record in error.

Byte 14 – Access Offset For permanent errors, this byte contains the head offset last used for retrying a data check. If the error was not permanent, this byte provides the offset required to recover from the error.

Bytes 15 Through 17 contain the restart displacement.

Bytes 18 and 19 contain the error displacement.

Bytes 20 Through 22 contain the error pattern.

Byte 23

Bits 0 through 6 are not used. Bit 7 indicates that the channel truncated the data transfer.

Message Table – Format 5

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000	0	Home address data check
0001	1	Count area data check
0010	2	Key area data check
0011	3	Data area data check
0100-1111	4-F	Not used

Format 6 – Usage Statistics/Overrun Errors

Format 6 is generated when:

- A Read and Reset Buffered Log command is executed.
- Usage/error statistics require offloading due to counter overflow.

Bytes 8 to 23 are formatted as follows:

Bytes 8 Through 11 – Bytes Read or Searched

Bytes 8 through 11 contain an accumulated count of the number of bytes processed by the storage director during read and search operations. (Only key and data area bytes are counted.) Bytes processed during retry operations are not counted.

Byte 12 and 13 – Correctable Data Checks Bytes 12 and 13 contain the accumulated count of the number of ECC correctable data checks which were detected by the storage director.

Bytes 14 and 15 – Uncorrectable Data Checks Retried

Bytes 14 and 15 contain the number of ECC uncorrectable data checks retried by the storage director.

Bytes 16 and 17 – Number of Seeks

Bytes 16 and 17 contain the number of access moves processed by the storage director.

Byte 18 – Channel Select

Byte 18 specifies which channels the information in bytes 20 through 23 pertain to.

If bits 0 and 1 are:

00=Channels A and B	01=Channels E and F
10=Channels C and D	11=Channels G and H

Bits 2 through 7 are not used.

Byte 19 – Seek Errors

Byte 19 contains the number of seek errors retried by the storage director.

Byte 20 – Command Overruns Channel A, C, E, or G

Channel A if Byte 18, bits 0 and 1 = 00
Channel C if Byte 18, bits 0 and 1 = 10
Channel E if Byte 18, bits 0 and 1 = 01
Channel G if Byte 18, bits 0 and 1 = 11

Byte 21 – Data Overruns Channel A, C, E, or G

Channel A if Byte 18, bits 0 and 1 = 00
Channel C if Byte 18, bits 0 and 1 = 10
Channel E if Byte 18, bits 0 and 1 = 01
Channel G if Byte 18, bits 0 and 1 = 11

Byte 22 – Command Overruns Channel B, D, F, or H

Channel B if Byte 18, bits 0 and 1 = 00
Channel D if Byte 18, bits 0 and 1 = 10
Channel F if Byte 18, bits 0 and 1 = 01
Channel H if Byte 18, bits 0 and 1 = 11

Byte 23 – Data Overruns Channel B, D, F, or H

Channel B if Byte 18, bits 0 and 1 = 00
Channel D if Byte 18, bits 0 and 1 = 10
Channel F if Byte 18, bits 0 and 1 = 01
Channel H if Byte 18, bits 0 and 1 = 11

Message Table – Format 6

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0111	0-7	Not used
1000	8	3880 offload
1001-1111	9-F	Not used

Sense Bytes–3350

Sense information for the 3350 (24 bytes) identifies the conditions that caused the unit check status to be generated. The sense information also provides secondary information for system error recovery and for diagnosing and isolating storage director and device malfunctions.

Sense Byte 0

Bit 0 – Command Reject

Bit 0 is set by:

- An invalid command code
- A command which is invalid in paging mode is received on an paging address
- A command which is invalid in direct mode is received on a base address
- An invalid command sequence
- An invalid or incomplete argument transferred by a control command
- A track formatted without a home address
- Issuing a write command with the Write Inhibit switch in the Read-Only position
- Attempting a format write command (other than Write Home Address or Write R0) on a defective track.
- Issuing a write command that violates the file mask
- A record zero count field of a defective track that points to itself instead of the alternate track
- Less than eight bytes received with the Diagnostic Write command
- A diagnostic command was received which violated the file mask

Bit 1 – Intervention Required

Bit 1 is set by:

- Addressing a device that is not attached to the Model 11.
- Addressing a device that is not ready.
- Not completing a cache to DASD transfer because the device is not ready or not installed.
- Attempting to select the 3350 when transferring data between cache and DASD and determining that the 3350 or the controller is busy
- Issuing a Diagnostic Write or Diagnostic Load command while an inline diagnostic is resident in control storage.
- Addressing a drive that is CE mode and not available.

Bit 2 – Bus Out Parity

Bit 2 is set when a parity error is detected during transfer of a command from the channel to the 3880.

Bit 3 – Equipment Check

Bit 3 is set when an unusual hardware condition occurs in the channel, the paging storage director, subsystem storage, the other storage director, or the device. The condition is further defined in sense bytes 7 through 23.

Bit 4 – Data Check

Bit 4 is set when the storage director detects a data error in the information received from the drive. If byte 2, bit 1 (correctable) is also set, the data error is correctable and bytes 15 through 23 provide correction information. If the data error is uncorrectable, sense byte 7 defines the specific nature of the condition.

Bit 5 – Overrun

Bit 5 is set when the storage director 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 director except those that occur in the second or subsequent segments of an overflow record, those that occur during a format write operation, or those that occur during a Read Multiple Count, Key, and Data command.

The storage director posts an overrun only if the condition occurs more than ten times for a single command, or if the overrun occurs during one of the above operations not retried by the storage director.

Command overruns are also retried by the storage director and do not cause an overrun to be posted.

Bits 6 and 7

These bits are not used and are set to zero.

Sense Byte 1

Bit 0 – Permanent Error

Bit 0 is set when internal error recovery has been exhausted (through the use of command retry) and was unsuccessful, or when internal error recovery failed, or was not possible or desirable.

The bit overrides any other bit settings and indicates that system error procedures may not be required. If environmental data present (byte 2, bit 3) is also set, the error is not related to the current operation and retry is required.

This bit is also set along with bit 3 of byte 1 (message to operator) when the discard of all blocks in the cache is required.

Bit 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 while attempting to execute a read, search, or write command. As long as this record remains on the track, invalid track format may be posted while attempting to locate a record successfully written on the track. However, search ID-type commands will be able to execute on any count field successfully written on the track without posting invalid track format.

The paging storage director sets this bit in paging mode when data is transferred between cache and DASD and the data format is not supported in paging mode. The following formats are invalid: a segment of an overflow record, a key length other than 0, a data length other than 4096, or the Record 0 count field of a defective points to itself instead the alternate track.

Bit 2 – End of Cylinder

Bit 2 is set when:

- A multitrack read or search operation continues past the end of cylinder boundary.
- An overflow operation continues past the end of the cylinder boundary. Byte 1, bit 7 (operation incomplete) is also set.

Bit 3 – Message to Operator

Bit 3 is set whenever one of the following messages is contained in sense byte 7.

Where:

cccc is fault symptom code from sense bytes 22 and 23
cuu is the address of reporting path
ddd is the physical device address

Byte 7	Operator Console Message
3x	ddd REPORTS DISABLED INTERFACE (nn) - FAULT CODE = cccc
F1	MICROCODE LOGICAL ERROR - FAULT CODE = cccc - cuu
F2	SUBSYSTEM STORAGE EQUIPMENT CHECK - FAULT CODE = cccc - cuu

F3 SUBSYSTEM STORAGE AVAILABILILTY THRESHOLD CROSSED - cuu

F4 SUBSYSTEM STORAGE UNUSABLE - FAULT CODE = cccc - cuu

F5 SUBSYSTEM STORAGE MUST BE INITIALIZED - FAULT CODE = cccc -cuu

F7 TRACK FORMAT NOT SUPPORTED FOR PAGING - DEVICE ddd - cuu

Bit 4 – No Record Found

Bit 4 is set:

- In direct mode when two index points have been detected in the same CCW chain without an intervening read operation in the home address area or the data area, or without an intervening write, sense, or control command.
- In paging mode while processing a Read Data command when the paging storage director is unable to locate a record whose logical block identifier was transferred by the preceding Search ID Equal command.
- While executing a Read Data or Write command, the paging storage director finds a cache directory entry which matches the physical block identifier of the requested block but which contains a logical cylinder address which does not match the CC of the logical block identifier.
- While trying to transfer data from the cache to the drive, is unable to locate a record whose logical block identifier is taken from the cache directory. Environmental data present (byte 2, bit 3) and message to the operator (byte 1, bit 3) are also set.

Bit 5 – File Protected

Bit 5 is set when:

- A multitrack read or search operation or Seek command violates the file mask.
- A read or write operation that accesses an overflow record violates the file mask Operation incomplete (byte 1, bit 7) is also set.

Bit 6 – Write Inhibited

Bit 6 is set when a write command is received for a drive that has its Write Inhibit switch in the Read-Only position. Byte 0, bit 0 (command reject) is also set.

In the paging storage director, bit 6 is set, along with environmental data present (byte 2, bit 3) when a data transfer from cache to drive fails because the Write Inhibit switch is in the read-only position.

Bit 7 – Operation Incomplete

Bit 7 is set when one of following conditions occurs during the processing of an overflow record.

- An overflow to a file protected boundary occurs. File protected (byte 1, bit 5) is also set.
- An overflow past the cylinder boundary occurs. End of cylinder (byte 1, bit 2) is also set.
- A correctable data check is detected in a data field other than the last segment. Data check (byte 0, bit 4 and correctable (byte 2, bit 1) are also set.
- An uncorrectable data check is detected in any field in other than the first segment.
- A defective or alternate track condition is detected after the the start of data transfer.
- A seek error is detected in the second or subsequent segment.

Sense byte 3 provides the restart command, and sense bytes 8 through 13 provide the restart information.

Sense Byte 2

Bit 0

Bit 0 is not used and is set to zero.

Bit 1 – Correctable

Bit 1 is set when the data check condition indicated by byte 0, bit 4 (data check) is correctable. Bytes 18 to 23 of format 5 provide the error pattern and displacement information to allow correction.

Bit 2 – Alternate Controller Selected

Bit 2 is set when the controller in the C2 model is selected.

Bit 3 – Environmental Data Present

Bit 3 is set to indicate that bytes 8 through 23 contain usage or error statistics, or error log information. Byte 7 indicates the format for bytes 8 through 23.

If one of the following sense bits is also set, the error reported by this sense record is not related to the current operation.

- Intervention Required (byte 0, bit 1)
- Equipment check (byte 0, bit 3)
- Data check (byte 0, bit 4)
- Invalid track format (byte 1, bit 1)

- No record found (byte 1, bit 4)
- Write inhibited (byte 1, bit 6)
- Message to operator (byte 1, bit 3)

Bits 4 through 7

Bits 4 through 7 are not used and are set to zero.

Sense Byte 3

Bits 0 Through 7 – Restart Command

Bits 0 through 7 are set when operation incomplete (byte 1, bit 7) is set. These bits identify the type of operation in progress when the unit check occurred. If the bits are set to 0000 0110, a read operation was in progress; if they are set 0000 0101, a write operation was in progress.

Sense Byte 4

Bits 0 Through 7 – Drive Identification

Bits 0 through 7 identify the drive associated with the sense information. When the sense data is presented on a direct address or when sense formats 1, 2, 4, 5, or message code 7 of format F are presented on a paging address, the byte description is as follows:

Bit 0=Drive 0	Bit 4=Drive 4
Bit 1=Drive 1	Bit 5=Drive 5
Bit 2=Drive 2	Bit 6=Drive 6
Bit 3=Drive 3	Bit 7=Drive 7

When sense formats 0, 3, and message codes 1 through 5 of format F are presented on a paging address, this byte contains all zeros.

Sense Byte 5

This byte contains different types of information depending upon the format being reported in sense byte 7.

- High-order instruction address register

  If sense format 3 and not message code 8 is indicated, this byte contains the high-order byte of the instruction address register at the time of the error.

- Diskette checks

If sense format 6 is indicated, this byte indicates the number of recoverable diskette checks after an initial microcode load (IML), or whether or not a storage director-to-storage director communication failure occurred during IML.

Bit 0 – Communication failure during an IML
Bit 1 – Not used
Bits 2-4 – Diskette check (seek errors)
Bits 5-7 – Diskette check (read errors)

- Cylinder-Low Address

  This byte in conjunction with formats 0, 1, 2, 4, 5, F, and format 3 message code 8 identify the low-order cylinder address of the most recent seek argument from the data channel as follows:

  Bit 0=Cylinder 128 Bit 4=Cylinder 8
  Bit 1=Cylinder 64 Bit 5=Cylinder 4
  Bit 2=Cylinder 32 Bit 6=Cylinder 2
  Bit 3=Cylinder 16 Bit 7=Cylinder 1

Sense Byte 6

This byte contains different types of information depending upon the format being reported in sense byte 7.

- Low-order byte of instruction counter register

  In conjunction with sense format 3 and not message code 8, this byte indicates the low-order byte of the instruction address register at the time the error occurred.

- Storage director identification

  In conjunction with sense format 6, this byte identifies the storage director.

- Head address and high-order cylinder address

  If formats 0, 1, 2, 4, 5, F, and format 3 and not message code 8 are indicated, this byte provides the high-order cylinder address of the most recent seek argument from the data channel and the head address resulting from the most recent head switch.

  In direct mode, the head address and high-order cylinder address values of rejected seek commands are not provided in this byte. In paging mode, they are provided.

  The format of byte 6 is as follows:

  Bit 0= CE cylinder
  Bit 1= Cylinder 512
  Bit 2= Cylinder 256
  Bits 3 to 7= Head address

Operations involving head switching update the head address bits (3 through 7) of this byte.

If an alternate track condition is detected and operation incomplete (byte 1, bit 7) is posted during an overflow operation, byte 6 is contains the head address of the defective track plus 1. The ERPs use this byte to construct the seek argument to continue the operation.

Sense Byte 7

This byte identifies the sense format and messages for bytes 8 to 23.

- Format

Bits 0 through 3 specify the format of sense bytes 8 through 23 as follows:

CODE	MEANING
0000	Format 0 - Program or system checks
0001	Format 1 - Device equipment checks
0010	Format 2 - Storage Director equipment checks
0011	Format 3 - Storage director control checks
0100	Format 4 - Uncorrectable data checks
0101	Format 5 - Correctable data checks
0110	Format 6 - Usage statistics/overrun errors
1111	Format F - Subsytem storage errors

Note: Format 5 may also be presented on errors which are not ECC correctable but which require restart displacement information.

- Message

  Bits 4 through 7 describe the specific nature of the error conditions for formats 0 to F. The message table that accompanies the format descriptions specifies the function of the message bits for the format.

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.

Bytes 8 to 23 contain the following data:

Bytes 8 Through 17 are not used and are set to zero.

Byte 18 Through 23 – Skip Displacement

If a Sense command is chained from a successful Read Home Address command and no contingent connection exists, bytes 18 through 23 contain the skip displacement bytes on the track.

If a Sense command is not chained from a Read Home Address and a contingent connection exists, bytes 8 to 20 contain zeros, byte 21 contains the storage director identification, and bytes 22 and 23 contain the symptom code.

Otherwise, bytes 18 through 23 are set to zero.

Message Table – Format 0

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000	0	No message. No additional information required.
0001	1	An invalid command was issued to the 3880.
0010	2	An invalid command sequence was issued to the 3880.
0011	3	The CCW count was less than required for the command.
0100	4	An invalid data argument was used for the command command.
0101	5	A Diagnostic Write 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	A Diagnostic Load command was issued but the IML device was not ready.
1001	9	A Diagnostic Load command was issued but the IML device had a permanent seek check.
1010	A	A Diagnostic Load command was issued but the IML device had a permanent read check.
1011	B	The alternate track pointer of a defective track pointed to the defective track.
1100-1111	C-F	Not used

Format 1 – Device Equipment Check

Format 1 is generated when:

- A device, device interface, or a controller equipment check is detected. Equipment check (byte 0, bit 3) is also set.
- A permanent device seek check is detected. Equipment check (byte 0, bit 3) and permanent error (byte 1, bit 0) are also set. The message bits in sense byte 7 indicate a seek error.

  If the error is associated with a cache to DASD transfer, environmental data present (byte 2, bit 3) is also set.
- A permanent device equipment check, permanent device interface check or permanent controller check is detected during a cache to DASD transfer. Equipment check (byte 0, bit 3), permanent error (byte 1, bit 0), and environmental data present (byte 2, bit 3) are set.
- The microcode detected an error that is normally reported in this format. The sense bits set are intervention required (byte 0, bit 1) alone, or equipment check (byte 0, bit 3) with or without permanent error (byte 1, bit 0).

  If the error is associated with a cache to DASD transfer, environmental data present (byte 2, bit 3) is also set.
- The paging storage director determines that a device did not respond with completion status to some activity associated with moving data between cache and DASD. Equipment check (byte 0, bit 3) and permanent error (byte 1, bit 0) are also set. If the error is associated with a cache to DASD transfer, environmental data present (byte 2, bit 3) is also set.
- Error log information is off-loaded after a successful retried seek check that occurred during error logging. Environmental data present (byte 2, bit 3) is set and the message code in sense byte 7 indicates a seek error.
- Online (byte 8, bit 4) is off and intervention required (byte 0, bit 1) is set. If the error is associated with a cache to DASD transfer, environmental data present (byte 2, bit 3) is also set.
- The microcode attempted to select a device in order to perform data transfer between the cache and the device. The selected device or the controller was found busy. Intervention required (byte 0, bit 1) and environmental data present (byte 2, bit 3) are also set.

Bytes 8 to 23 contain the following data:

Byte 8 – Drive Status

When byte 19, bit 0 (Set R/W) is off:

```
Bit 0=Controller Check
Bit 1=Device interface check
Bit 2=Drive check
Bit 3=R/W check
Bit 4=On line
Bit 5=HDA attention
Bit 6=Busy
Bit 7=Seek complete, search
      sector, or pad complete.
      If bit 6 is on, search
      sector is in progress
```

When byte 19, bit 0 is on:

```
Bit 0=Controller Check              Bit 4=On line
Bit 1=Initialize write sense        Bit 5=Pad in progress
Bit 2=Drive check                   Bit 6=Index mark
Bit 3=R/W check                     Bit 7=3330 modes
```

Byte 9 – Drive Checks

```
Bit 0=Pad in progress                        Bit 4=Write Enable
Bit 1=Sector compare check                   Bit 5=Fixed head installed
Bit 2=Motor-at-speed switch latched          Bit 6=Spindle mode 2
Bit 3=Air switch latched                     Bit 7=Spindle mode 1
```

Byte 10 – DM Sequence Control

```
Bit 0=Mode size check               Bit 4=Timer latch
Bit 1=HDA sequence latch 4          Bit 5=HDA Sequence check latched
Bit 2=HDA sequence latch 2          Bit 6=Not used
Bit 3=HDA sequence latch 1          Bit 7=Odd physical track
```

Byte 11 – Load Switch Status

```
Bit 0=Drive start switch            Bit 4=Not used
Bit 1=Guardband pattern             Bit 5=Air switch
Bit 2=Target velocity               Bit 6=Not used
Bit 3=Track crossing                Bit 7=Motor-at-speed switch
```

Byte 12 – R/W Safety

```
Bit 0=Multiple head select check    Bit 4=Delta current check
Bit 1=Capable/enable check          Bit 5=Control check
Bit 2=Write overrun                 Bit 6=Write transition check
Bit 3=Index check                   Bit 7=Write current during
                                         read check
```

Byte 13 – Control Interface Check

Byte 13 contains the actual device bus out (DBO) value for message code C and for message code 2, if byte 18 equals '01', '03', '05', '06', '09', or '0E'. Byte 13 contains the expected device bus in (DBI) value for message codes 1, 3, 5, 6, 7, 8, and 9.

If bits 4 through 7 equal 1010, or if they equal 1011 and bit 1 of byte 9 equals 0, byte 13 contains the low physical cylinder address of the previous seek.

```
Bit 0=128     Bit 4=8
Bit 1=64      Bit 5=4
Bit 2=32      Bit 6=2
Bit 3=16      Bit 7=1
```

Otherwise, byte 13 is set to zero.

Byte 14 – Control Interface Bus In

Byte 14 contains the actual DBI value for message codes 1, 3, 5, 6, 7, 8, 9, and C and for message code 2 if byte 18 equals '01', '03', '05', '06', '09', or '0E'.

If bits 4 through 7 equal 1010, or if they equal 1011 and bit 1 of byte 9 equals 0, byte 14 contains the high physical cylinder address and physical head address of the previous seek.

Bit 0=512	Bit 4=8
Bit 1=256	Bit 5=4
Bit 2=32	Bit 6=2
Bit 3=16	Bit 7=1

Otherwise, byte 14 set to zero.

Byte 15 – Control Interface Tag Gate

Byte 15 contains the actual DTO register value for message codes 1, 3, 5, 6, 7, 8, 9, and C and for message code 2 if byte 18 equals '01', '03', '05', '06', '09', or '0E'. Otherwise, byte 15 is set to zero.

Byte 16 – Access Status

Bit 0=Access timeout check	Bit 4=Servo latch
Bit 1=Overshoot check	Bit 5=Linear mode latch
Bit 2=Servo off-track check	Bit 6=Control latch
Bit 3=Rezero mode latch	Bit 7=Wait latch

Byte 17

Bit 0=VFO detected error, 2 bit	Bit 4=Write data check
Bit 1=VFO detected error, 1 bit	Bit 5=Monitor check
Bit 2=SERDES check	Bit 6=ECC check
Bit 3=Gap counter check	Bit 7=ECC zero detected

Byte 18 – Microcode Detected Errors

Bits 0 through 3 are not used. Bits 4 through 7 indicate the following error conditions:

0000	Not used
0001	Tag Valid indication missing on a read or write operation
0010	Normal End or Check End indication missing on a read, write, or ECC operation
0011	No response from the controller on a control operation
0100	A timeout occurred while waiting for index
0101	ECC hardware check
0110	Either more than one controller was selected or no controller was selected
0111	Preselection check
1000	Repetitive command overruns on gap 1 operations
1001	Repetitive command overruns on gap 2 or gap 3 operations

1010	Incorrect drive selected
1011	Busy missing after seek start was issued
1100-1101	Not used
1110	Bus in bit always active
1111	Interrupt cannot be reset

Byte 19 – Status

```
Bit 0=Set R/W on          Bit 4=Head short check
Bit 1=Reserved            Bit 5=Pad gate check
Bit 2=Reserved            Bit 6=1.2 megabyte controller
Bit 3=Reserved            Bit 7=Always on
```

Byte 20 – Interface Checks

When bits 4 through 7 of sense byte 7 are not equal to 1010, or when they equal 1010 and bit 2 of byte 8 is on, the bits in byte 20 have the following meaning:

```
Bit 0=Control interface tag       Bit 4=Control interface bus
     bus parity check                  in parity check
Bit 1=Control interface bus       Bit 5=Initialize write failur
     out parity check
Bit 2=Drive selection check       Bit 6=Not used
Bit 3=Device bus in parity check  Bit 7=Reorient counter check
```

When bits 4 to 7 of sense byte 7 equal 1010 and bit 2 of byte is off, byte 20 contains the physical cylinder address of the present seek.

```
Bit 0=Cylinder 128        Bit 4=Cylinder 8
Bit 1=Cylinder 64         Bit 5=Cylinder 4
Bit 2=Cylinder 32         Bit 6=Cylinder 2
Bit 3=Cylinder 16         Bit 7=Cylinder 1
```

Byte 21 – Device Interface Check

When bits 4 through 7 of sense byte 7 are not equal to 1010, or when they equal 1010 and bit 2 of byte 8 is on, byte 21 contains device interface check information.

```
Bits 0 to 5=Not used
Bit 6=Device bus out parity check
Bit 7=Device tag parity check
```

When bits 4 to 7 of sense byte 7 equal 1010 and bit 2 of byte 8 is off, byte 21 contains the high physical cylinder and physical head address of the present seek.

Bit 0=Cylinder 512	Bit 4=Cylinder 8
Bit 1=Cylinder 256	Bit 5=Cylinder 4
Bit 2=Cylinder 32	Bit 6=Cylinder 2
Bit 3=Cylinder 16	Bit 7=Cylinder 1

Bytes 22 and 23 contain the symptom code.

Message Table – Format 1

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000	0	No message. No additional information is required
0001	1	Transmit target error
0010	2	Microcode detected error
0011	3	Transmit difference-high error
0100	4	Sync-out timing error
0101	5	Unexpected drive status at initial selection
0110	6	Transmit cylinder address error
0111	7	Transmit head error
1000	8	Transmit difference error
1001	9	Unexpected drive status
1010	A	Seek error
1011	B	Seek incomplete on retry or sector non-compare
1100	C	No interrupt from drive. In paging mode, this message is set when the device does not respond with completion status for an internal operation
1101	D	Defect skipping - reorientation check
1110	E	Unable to determine device type during initial selection
1111	F	Retry orientation check

Format 2 – Storage Director Equipment Check

Format 2 is generated to provide sense information when the microcode detects a storage director error condition. Bytes 8 to 23 contain the following data:

Byte 8 has the contents of the transfer complete status (XCS) register

Byte 9 has the contents of the transfer error status (XES) register

Byte 10 has the contents of the check (CHK) register

Byte 11 has the contents of the channel transfer complete (CXC) register

Byte 12 has the contents of the channel control 2 (CC2) register

Byte 13 has the contents of the device bus out (DBO) register

Byte 14 has the contents of the device bus in (DBI) register

Byte 15 has the contents of the device tag out (DTO) register

Byte 16 has the contents of the device tag gate (DTG) register

Byte 17 has the contents of the device tag in (DTI) register

Byte 18 has the contents of the channel status 2 (CS2) register

Byte 19 is not used.

Byte 20 indicates microcode detected error codes for message F. Bits 0 through 3 are not used. If bits 4 through 7 equal 0001, the device attempted to end data transfer prematurely. If bits 4 through 7 equal 0010, selection was lost at the time a device error was detected.

Byte 21 contains the storage director identification.

Bytes 22 and 23 contain the symptom code.

Message Table – Format 2

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0111	0-7	Reserved for other types of storage control units.
1000	8	No message. No additional information is required.
1001	9	Selective reset occured while the drive was selected.
1010	A	Failed to latch the First Sync In Line
1011-1110	B-E	Reserved
1111	F	Microcode detected check. The message appears in byte 20, bits 4 through 7.

Format 3 – Storage Director Control Check (Clock Stopped)

Format 3 is generated to provide sense information for a failing storage director that requires a reset procedure for recovery.

If sense byte 7 indicates format 3 message code 8, bytes 8 to 23 contain the following data:

Byte 8 has the contents of field replaceable unit (FRU) register 2

Byte 9 has the contents of the check register 1

Byte 10 has the contents of the check register 2

Byte 11 has the contents of the check register 3

Bytes 12 and 13 are not used

Byte 14 has the contents of FRU register 1

Byte 15 has the contents of FRU register 3

Byte 16 has the contents of FRU register 4

Byte 17 Through 20

Byte 21

Storage director ID

Bytes 22 and 23 has the symptom code

If sense byte 7 does not indicate format 3 message code 8, bytes 8 to 23 contain the following data:

Byte 8 is not used

Byte 9 has the contents of the transfer error status (XES) register

Byte 10 has the contents of the check register

Byte 11 has the contents of the condition register 0 (CR0)

Byte 12 has the contents of the channel status 2 (CS2) register

Byte 13 has the contents of the channel control 1 (CC1) register

Byte 14 has the contents of the channel control 2 (CC2) register

Byte 15 has the contents of the channel status 1 (CS1) register

Byte 16 has the contents of the channel status 3 (CS3) register

Byte 17 has the contents of the channel transfer control (CXC) register

Byte 18 has the contents of the channel bus out (CBO) register

Byte 19 has the contents of the channel bus in (CBI) register

Byte 20 has the interrupt level and block identification

Byte 21 has the storage director identification

Bytes 22 and 23 have the symptom code

Message Table – Format 3

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0111	0-7	Reserved for other types of storage control units.
1000	8	No message for clock stopped. (Check 1)
1001	9	Channel check 1 or storage director timeout.
1010	A	Trace table saved in this storage director.
1011-1111	B-F	Reserved

Format 4 – Uncorrectable Data Check

Format 4 is generated when:

- Errors that were not correctable by the ECC are detected after retry has been unsuccessful. Byte 1, bit 0 (permanent error) and byte 0, bit 4 (data check) are set.
- Error log information is offloaded after an ECC uncorrectable error occurred during error logging. The information was recovered through use of command retry. Environmental data present (byte 2, bit 3) is set.
- An uncorrectable data error in information received from the device has prevented the completion of a cache to DASD update. Data check (byte 0, bit 4), permanent error (byte 1, bit 0) and environment data present (byte 2, bit 3) are also set.
- Data synchronization errors are detected after retry has been unsuccessful. Permanent error (byte 1, bit 0) and data check (byte 0, bit 4) are set.
- Uncorrectable data checks are detected while processing a Read Multiple CKD command. Data check (byte 0, bit 4) is set.

Bytes 8 to 23 contain the following data:

Bytes 8 Through 12 – Count ID

Bytes 8 through 12 contain the record ID (CCHHR) obtained from the count field of the record in which the error occurred. The record number (R) is zero, the error occurred in the home address. These bytes are unreliable if the message code in byte 7 is 0, 1, 4, 5, or 9, and after a Space Count command.

Byte 12 is zero if the message code is 0 or 4.

Byte 13 – Sector Number Byte 13 contains the sector number of the record in error.

Bytes 14 Through 21 are not used.

Bytes 22 and 23 contain the symptom code.

Message Table – Format 4

SENSE BYTE 7, 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 sychronization on the data area was unsuccessful
1000	8	Not used
1001	9	No address mark was detected upon retry
1010-1111	A-F	Not used

Format 5 – Correctable Data Check

Format 5 is generated when:

- Data checks that are correctable by the ECC are detected in the data areas of a record. Data check (byte 0, bit 4) and correctable (byte 2, bit 1) are set.
- Data checks in data areas that are not correctable by the ECC were successfully retried but the file mask specified PCI fetch mode. The error displacement and correction patterns are set to zero. Data check (byte 0, bit 4) and correctable (byte 2, bit 1) are set.
- Error log information is offloaded after an ECC correctable error occurred during error logging.
- Data checks are detected while processing a second or subsequent segment of an overflow record. Data check (byte 0, bit 4) and operation incomplete (byte 1, bit 7) are set.
- ECC correctable data checks in the home address area when channel retry is inhibited by the file mask.
- A correctable data check occurred during a DASD to cache transfer. Environmental data present (byte 2, bit 3) is set.

Bytes 8 to 23 contain the following data:

Bytes 8 Through 12 contain the record identification obtained from the count field of the record in which the error occurred.

Byte 13 contains the sector number of the record in error.

Byte 14 is not used.

Bytes 15 Through 17 contain the restart displacement.

Bytes 18 and 19 contain the error displacement.

Bytes 20 Through 22 contain the error pattern.

Byte 23 is not used.

Message Table – Format 5

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0010	0-2	Not used
0011	3	Error occured in data area
0100-1111	4-F	Not used

Format 6 – Usage Statistics/Overrun Errors

Format 6 is generated when:

- A Read and Reset Buffered Log command is executed.
- Usage/error statistics require offloading due to counter overflow.

Bytes 8 to 23 contain the following data:

Bytes 8 Through 11 – Bytes Read or Searched

Bytes 8 through 11 contain an accumulated count of the number of bytes processed by the storage director during read and search operations. (Only key and data area bytes are counted.) Bytes processed during retry operations are not counted.

Bytes 12 and 13 are not used.

Bytes 14 and 15 contain the number of ECC uncorrectable data checks retried by the storage director.

Bytes 16 and 17 contain the number of seek commands processed by the storage director.

Byte 18 – Channel Select

Byte 18 specifies which channels the information in bytes 20 through 23 pertain to. Only bits 0 and 1 are used.

If bits 0 and 1 are:

00=Channels A and B 01=Channels E and F
10=Channels C and D 11=Channels G and H

Byte 19 contains the number of seek errors retried by the storage director.

Byte 20 contains the command overruns for:

Channel A if Byte 18, bits 0 and 1 = 00
Channel C if Byte 18, bits 0 and 1 = 10
Channel E if Byte 18, bits 0 and 1 = 01
Channel G if Byte 18, bits 0 and 1 = 11

Byte 21 contains the data overruns for:

Channel A if Byte 18, bits 0 and 1 = 00
Channel C if Byte 18, bits 0 and 1 = 10
Channel E if Byte 18, bits 0 and 1 = 01
Channel G if Byte 18, bits 0 and 1 = 11

Byte 22 contains the commands overruns for:

Channel B if Byte 18, bits 0 and 1 = 00
Channel D if Byte 18, bits 0 and 1 = 10
Channel F if Byte 18, bits 0 and 1 = 01
Channel H if Byte 18, bits 0 and 1 = 11

Byte 23 contains the data overruns for:

Channel B if Byte 18, bits 0 and 1 = 00
Channel D if Byte 18, bits 0 and 1 = 10
Channel F if Byte 18, bits 0 and 1 = 01
Channel H if Byte 18, bits 0 and 1 = 11

Message Table – Format 6

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000-0111	0-7	Not used
1000	8	3880 offload
1001-1111	9-F	Not used

Format F – Subsystem Data

Format F is generated when:

- A microcode logic error is detected by the paging storage director microcode.
- An equipment check or microcode detected equipment failure is detected in the subsystem storage.
- The amount of subsystem storage space is decreased across a reporting boundary.
- The subsystem storage becomes unusable because of insufficient space or because of a suspected but indeterminate data loss.
- A no record found or invalid track format was detected on an asynchronous operation.

The format of sense bytes 8 through 23 depends on the message code in sense byte 7.

Bytes 8 Through 23 – Message Code 1

Bytes 8 through 23 contain the following data for message code 1.

Bytes 8 and 9 contain the microcode module identification.

Bytes 10 Through 17 contain the contents of primary registers 0 to 7.

Byte 18 contains the internal register group address.

Bytes 19 and 20 are not used.

Byte 21 contains the storage director identification.

Bytes 22 and 23 contain the symptom code.

Bytes 8 Through 23 – Message Code 2

Bytes 8 through 23 contain the following data for message code 2.

Byte 8 contains the contents of the external port check register.

```
Bit 0=Always zero                    Bit 4=EPC data in check
Bit 1=Invalid operation code         Bit 5=EPC data out check
Bit 2=Port check                     Bit 6=EPC control check
Bit 3=Data transfer check            Bit 7=Run sequence check
```

Byte 9 contains the contents of the external port status register.

```
Bit 0=Port data ready                Bit 4=Degate data channel
Bit 1=Operation complete                   active
Bit 2=Summary check                  Bit 5=Degate device active
Bit 3=Run active                     Bit 6=Data transfer complete
                                     Bit 7=Timer overflow
```

Byte 10 contains the contents of the address operations register.

```
Bits 0 to 2=SSAR address

Bit 3=Address extension

Bits 4 to 7=Operation code
```

Bytes 11 Through 13 contain the failing address of subsystem storage.

Byte 14 contains subsystem storage sense byte 2.

```
Bit 0=CRC parity check
Bit 1=General check
Bit 2=Port data in check
Bit 3=Port data out check
Bit 4=CRC storage check
Bit 5=EPC address bus parity
      check
Bit 6=Byte counter parity
      check
Bit 7=AOR parity check
```

Byte 15 contains subsystem storage sense byte 3.

```
Bit 0=Double bit ECC check
Bit 1=Storage address parity check
Bit 2=Port bus parity check (high)
Bit 3=Single bit ECC check
Bit 4=Refresh counter parity
      check
Bit 5=Port bus parity check
      (low)
Bit 6=SSAR write/load/data
      check
Bit 7=SSAR address check
```

Byte 16 contains subsystem storage sense byte 4.

```
Bit 0=Storage bus odd bytes
      parity check
Bit 1=Storage bus even bytes
      parity check
Bit 2=ECC odd bytes parity
      check
Bit 3=ECC even bytes parity
      check
Bit 4=Invalid address check
Bit 5=Refresh address parity
      check
Bit 6 to 7=Always zero
```

Byte 17 contains subsystem storage sense byte 5.

```
Bit 0=Always zero
Bit 1=ECC control odd (active)
Bit 2=ECC control even (active)
Bit 3=Data channel speed
Bit 4=CRC inhibit/accumulate
      active
Bit 5=Force SSAR check active
Bit 6 to 7=Always zero
```

Bytes 18 Through 20 are not used.

Byte 21 contains the storage director identification.

Bytes 22 and 23 contain the symptom code.

Bytes 8 Through 23 – Messages Codes 3 and 4

Bytes 8 through 23 are contain the following data for messages 3 and 4.

Bytes 8 Through 11 contain the amount of subsystem storage capacity available.

Bytes 12 Through 15 contain the amount of subsystem storage capacity offline.

Bytes 16 Through 19 contain the amount of subsystem storage capacity that is unavailable.

Byte 20 contains the amount of subsystem storage, in megabytes, that is configured.

Byte 21 contains the storage director identification.

Bytes 22 and 23 contain the symptom code.

Bytes 8 Through 23 – Messages Codes 5 and 7

Bytes 8 through 23 contain the following data for messages 5 and 7.

Bytes 8 Through 20 are not used.

Byte 21 contains the storage director identification.

Bytes 22 and 23 contain the symptom code.

Message Table – Format F

SENSE BYTE 7, 4-7 =	MESSAGE CODE	MESSAGE
0000	0	Not used
0001	1	Microcode logic error
0010	2	Subsystem storage equipment failure
0011	3	Subsystem storage availability threshold crossed
0100	4	Subsystem storage is unusable
0101	5	Subsystem storage must be initialized
0110	6	Not used
0101	7	Invalid track format for paging

Appendix—Device Addressing

The following table lists all the valid device addresses that can be used on Model 11.

Storage Director 1

CONFIGURATION	VALID ADDRESSES (HEXADECIMAL)			
1 String	00-1F 20-3F	40-5F 60-7F	80-9F A0-BF	C0-DF E0-FF

Storage Director 2

CONFIGURATION	VALID ADDRESSES (HEXADECIMAL)			
1 String	00-07 08-0F 10-17 18-1F 20-27 28-2F 30-37 38-3F	40-47 48-4F 50-57 58-5F 60-67 68-6F 70-77 78-7F	80-87 88-8F 90-97 98-9F A0-A7 A8-AF B0-B7 B8-BF	C0-C7 C8-CF D0-D7 D8-DF E0-E7 E8-EF F0-F7 F8-FF
2 Strings	00-0F 10-1F 20-2F 30-3F	40-4F 50-5F 60-6F 70-7F	80-8F 90-9F A0-AF B0-BF	C0-CF D0-DF E0-EF F0-FF
3 or 4 Strings	00-1F 20-3F	40-5F 60-7F	80-9F A0-BF	C0-DF E0-FF

Index

S

T

U

W

3

IBM 3880 Storage Control
Model 11 Description
Order No. GA32-0061-0

READER'S COMMENT FORM

This manual is part of a library that serves as a reference source for systems analysts, programmers, and operators of IBM systems. This form may be used to communicate your views about this publication. They will be sent to the author's department for whatever review and action, if any, is deemed appropriate. Comments may be written in your own language; use of English is not required.

You may use this form to communicate your comments about this publication, its organization, or subject matter with the understanding that IBM may use or distribute whatever information you supply in any way it believes appropriate without incurring any obligation to you.

Note: Copies of IBM publications are not stocked at the location to which this form is addressed. Please direct any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative or the IBM branch office serving your locality.

	Yes	No
• Does the publication meet your needs?	☐	☐
• Did you find the information:		
Accurate?	☐	☐
Easy to read and understand?	☐	☐
Easy to retrieve?	☐	☐
Organized for convenient use?	☐	☐
Legible?	☐	☐
Complete?	☐	☐
Well illustrated?	☐	☐
Written for your technical level?	☐	☐

• How do you use this publication:

- ☐ As an introduction to the subject?
- ☐ For advanced knowledge of the subject?
- ☐ To learn about operating procedures?
- ☐ As an instructor in class?
- ☐ As a student in class?
- ☐ As a reference manual?

• What is your occupation?

Comments:

If you would like a reply, please give your name and address.

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments or you may mail them directly to the address on the back of the title page.)

Reader's Comment Form

Fold and tape | Please Do Not Staple | Fold and tape

Attention: Information Development
Department 61C

NO POSTAGE
NECESSARY IF
MAILED IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 40 ARMONK, NEW YORK

POSTAGE WILL BE PAID BY ADDRESSEE

International Business Machines Corporation
General Products Division
P. O. Box 27155
Tucson, Arizona 85726

Fold and tape | Please Do Not Staple | Fold and tape

IBM 3880 Storage Control Model 11 Description Printed in U.S.A. GA32-0061-0

IBM

IBM 3880 Storage Control
Model 11 Description
Order No. GA32-0061-0

READER'S COMMENT FORM

This manual is part of a library that serves as a reference source for systems analysts, programmers, and operators of IBM systems. This form may be used to communicate your views about this publication. They will be sent to the author's department for whatever review and action, if any, is deemed appropriate. Comments may be written in your own language; use of English is not required.

You may use this form to communicate your comments about this publication, its organization, or subject matter with the understanding that IBM may use or distribute whatever information you supply in any way it believes appropriate without incurring any obligation to you.

Note: Copies of IBM publications are not stocked at the location to which this form is addressed. Please direct any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative or the IBM branch office serving your locality.

	Yes	No
• Does the publication meet your needs?	☐	☐
• Did you find the information:		
Accurate?	☐	☐
Easy to read and understand?	☐	☐
Easy to retrieve?	☐	☐
Organized for convenient use?	☐	☐
Legible?	☐	☐
Complete?	☐	☐
Well illustrated?	☐	☐
Written for your technical level?	☐	☐

• How do you use this publication:

- As an introduction to the subject? ☐
- For advanced knowledge of the subject? ☐
- To learn about operating procedures? ☐
- As an instructor in class? ☐
- As a student in class? ☐
- As a reference manual? ☐

• What is your occupation?

Comments:

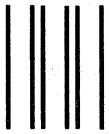
If you would like a reply, please give your name and address.

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments or you may mail them directly to the address on the back of the title page.)

Reader's Comment Form

Fold and tape | Please Do Not Staple | Fold and tape

Attention: Information Development
Department 61C



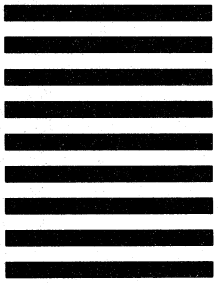
NO POSTAGE
NECESSARY IF
MAILED IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 40 ARMONK, NEW YORK

POSTAGE WILL BE PAID BY ADDRESSEE

International Business Machines Corporation
General Products Division
P. O. Box 27155
Tucson, Arizona 85726



Fold and tape | Please Do Not Staple | Fold and tape

IBM

IBM 3880 Storage Control Model 11 Description Printed in U.S.A. GA32-0061-0

GA32-0061-0

IBM 3880 Storage Control Model 11 Description Printed in U.S.A. GA32-0061-0

IBM®