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File No. 4300-07/S370-07

Systems

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IBM

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Preface

This publication describes the IBM 3880 Storage Control Model 13. It is intended for use by programmers and is intended to provide accessible 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 functions, and the input/operations between the processor, channel, and the storage control.
- Command Set—describes each command of the count, key, data command set.
- Error Recovery Procedures—describes the recovery procedures needed for the 3880 Model 13 and 3380.
- Operator Panel—describes the switches and indicators associated with the operation of the 3880.
- Sense Bytes—describes all the sense data collected by the 3880.
- Appendix—Device Addressing—lists all the addresses that can be used on both cache storage directors.

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, 2, and 3 and about the IBM 3380 can be found in:

- *IBM 3880 Storage Control Description*, GA26-1661
- *IBM 3380 Direct Access Storage Description and User's Guide*, GA26-1664

Contents

Introduction

The IBM 3880 Storage Control Model 13 is a high-performance cache DASD subsystem designed for use with the MVS/SP Release 1.3 operating system and with the Data Facility/Device Support program product release 1.1.5. The 3880 Model 13 has two storage directors; called cache storage directors, and a 4- or 8-megabyte high-speed, electronic storage unit, called subsystem storage. A larger portion of subsystem storage is the cache which is used to store active data for quick access; a smaller portion of the storage is the directory which is used to locate the data stored in the cache. Both cache storage directors can access subsystem storage.

Cache Storage Directors

Each cache storage director attaches to 3.0 megabyte-per-second data streaming channels and attaches strings of 3380 devices.

The cache storage director manages data by:

- Copying data records from DASD to the cache and from the cache to DASD
- Copying data records from the cache to the processor
- Copying data records from DASD to the processor
- Determining which data to delete from the cache
- Searching the directory for requested data records when it is addressed by the processor
- Performing error recovery procedures (ERPs) within the subsystem storage

Subsystem Storage

Subsystem storage is offered in two capacities, 4 megabytes and 8 megabytes, and is divided into two parts. The larger area, called the cache, is divided into track slots that store data from the 3380's tracks. The smaller area is a directory; it contains entries that allow data to be located in the cache.

Processor Attachment

The 3880 Storage Control Model 13 attaches to the following processors through a block multiplexer channel with the data streaming feature:

- IBM 3081, 3033, and 3042 Model 2
- IBM 3032, 3031, and 4341 Model Groups 1 and 2

Channel Attachment

The Model 13 must attach to a 3.0 megabyte-per-second block multiplexer channel to attach to any of the processors. The IBM 3031, 3032, 3033, and the 3042 Model 2 processors require the data streaming feature in order to support the 3 megabyte-per-second data transfer required for 3380 DASD. No special features are required for the IBM 3081 processor.

The IBM 4341 Model Group 2 processor can attach the 3880 Model 13 without modification if the processor was manufactured after March 1981. If the processor

was manufactured before March 1981, it requires an engineering change to have the data streaming feature added.

DASD Attachment

The cache storage director attaches only 3380 strings of AA4 models, and up to three B4 models. The minimum 3380 configuration is a single AA4 model. The maximum 3380 configuration is two AA4 models with three B4 models attached to each AA4. The 3380 Model AA4 has dynamic path selection, which is required for attaching the 3380s to the Model 13. If there are two strings of 3380s, both strings must attach to the same 3880 Model 13. The Model 13 can have up to 32 device addresses.

Channel Switching

There are two channel switching features available with the 3880 Model 13.

- Two Channel Switch—Pair which allows each cache storage director and its attached devices to be shared by two channels
- Two Channel Switch—Pair, Additional which allows each cache 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 program. Three commands are associated with the channel-switching feature: Device Reserve, Device Release, and Unconditional Reserve.

Four Enable/Disable switches are added to the operator panel for the Two Channel Switch—Pair feature; four additional switches are added for the Two Channel Switch—Pair, Additional feature.

Remote Attachment

The following remote switch features are available on the Model 13.

- Remote Attachment which is used in conjunction with the Two Channel Switch—Pair feature
- Remote Attachment, Additional which 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 an operator to reconfigure the system from a central point. Some systems, such 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 cache storage director and device is assigned an I/O address at the time of installation. The address (eight bits) is used by the program to select a particular

device. The address is specified in bits 24 through 31 of the I/O instruction and has the following format:

Bit	Function
0-2	Cache storage director address
3	3380 controller address
4-7	Actuator address

This addressing configuration allows the attachment of two 3380 Model AA4 controllers, each with up to four actuators. Both controllers must attach to the same 3880.

The controller address depends on the number of strings attached to the 3880 Model 13. If there is one string of 3380 Model AA4s attached, both controllers must have the same bit address, either 0's or 1's. Both controllers can not attach to the same cache storage director. If there are two strings attached, the controller addresses in one string must be 0's, and in the other string the addresses must be 1's. See the address table in the Appendix for the address ranges used on Model 13.

The actuator address range is 0 to 15. For each controller, the actuator addresses start with 0 and are sequential. The addresses are set at the time of installation with switches on the 3880 interface card.

Subsystem Operation

Both cache storage directors have access to subsystem storage. Subsystem storage is divided into two parts: cache and directory. Cache is further divided into units called track slots; each track slot can contain all the data of one 3380 track. The directory contains information about the contents of each track slot as well as when the data was last used by the processor.

Data Transfer To Channel

During a read operation, data is requested by the channel program. If the data is in cache, it is called a "read hit" and the data is transferred to channel immediately.

If the requested data is not in cache, it is called a "read miss." The cache storage director then accesses DASD for the data and transfers it to channel to satisfy the request. In most cases, after the data has been transferred to the channel, the cache storage director allocates space for the track containing the requested data and then transfers the entire track of data from DASD into cache. This permits subsequent requests for data that is on that track to be satisfied immediately.

Data Transfer From Channel

When the channel transfers data to the cache storage director, if the record is already in cache, it is called a "write hit" and the cache data is updated. To make sure that the DASD and cache copy are the same, the data is transferred from cache to DASD before completion of the command.

If the data from the channel is not in cache, it is called a "write miss" and the data is written directly onto DASD.

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, cache 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 they are 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 cache storage director is disconnected from the channel.
- Halt Device - This instruction terminates the operation in progress at the cache 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, cache 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 that was 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 cache storage director and the drive that is 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 normal conditions the 3880 Model 13 may add up to 180 microseconds to initial-selection time and may wait up to 124 microseconds before propagating the requested channel selection tag because of a withdrawal of the request.

All read, write, or search data transfer operations occur at a maximum instantaneous data rate of 3.03 megabytes per second.

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 (CAW) from processor storage location 72. Bits 0 through 3 of the channel address word 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 zeros to specify the channel command word on doubleword boundaries.

A detailed description of the channel address 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 command 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 cache storage director, which responds by sending 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 command execution 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 long; it 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, the 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 on 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 program 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 contains zeros for Test I/O instructions and for all nonimmediate 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 cache storage director is disconnected during command chaining when a storage control error recovery procedure is in progress.
  - The cache storage director is performing a format defective block, check data, or format ID operation.
  - The cache storage director is executing a Diagnostic Load command or a diagnostic test.

- The device is busy.
- The cache storage director is performing a housekeeping operation following the completion of a command chain.
- The cache storage director is initializing cache following an IML operation.
- A status condition is pending in the cache storage director for other than the addressed device.
- A system reset is in progress.
- The cache storage director is maintaining a contingent connection to some device other than the addressed device.
- A connection initiated by the cache storage director 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 cache storage director.
- The cache storage director is in a long connection with another channel.
- The cache storage director is initiating a seek operation after having disconnected from the channel.
- The cache storage director is accumulating sense data for a previously presented unit check, and a Start I/O or Test I/O instruction is received for the device in the contingent connection.

- A status condition is pending in the cache 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.
- A unit check condition exists at the cache storage director or device. In this case, unit check is presented as initial status unless the command was one of the sense commands. An initial status byte of all zeros 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 cache 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 were 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.

  Note: If device end status for a not ready-to-ready interrupt is stacked in a multichannel environment, the status is pending in the cache storage director, but it does not appear busy for all devices.

Status pending for the cache storage director (except for control unit end) causes it to appear busy for all devices except the device for which the status condition exists. Unless it is busy, the cache 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 was 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 was stacked.

Status pending for a device causes the cache storage director to request service when both the cache 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 by 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 cache 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 by polling, the address associated with control unit end status is always the lowest nonbusy device within the range of addresses recognized by that cache storage director, whether or not the device exists.

Note: Generally, when all of the device addresses within a specified address range on cache storage director do not exist, the system control program (SCP) I/O generation does not include nonexistent device addresses. When the SCP receives an interrupt, like control unit end, from a nonexistent device, the interrupt is ignored. For the 3880, the lowest nonexistent 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 cache 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 zeros for the cache storage director and device that generated the unit check, or a selective or system reset occurs.

During the contingent connection state, the cache 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 IBM 3880 Model 13 supports the count, key, and data format used for 3380 disk storage operations. The commands are the same as those used for 3330 and 3350 disk operations, with the following differences:

- There is no Write Special Count, Key, and Data command because there is no record overflow function on the 3380.
- Five new commands have been added: Set Path Group ID and Sense Path Group ID, which can be used in conjunction with Device Reserve and Device Release commands, and Define Extent, Set High-Performance Storage Limits, and Set Subsystem Mode commands which are used in controlling cache.
- There are two new diagnostic commands for the 3380s: Diagnostic Write Home Address and Diagnostic Read Home Address.

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

Control Commands

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

The data address field of the channel command word defines the location that contains the required additional information.

The following table lists the control commands.

Command	Command Code
Define Extent	63
No Operation (No-Op)	03
Recalibrate	13
Restore	17
Seek	07
Seek Cylinder	0B
Seek Head	1B
Set File Mask	1F
Set High-Performance Storage Limits	8B
Set Path Group Identifier	AF

Command	Command Code
Set Sector	23
Set Subsystem Mode	87
Space Count	0F
Transfer-In-Channel (TIC)	X8*

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

Define Extent

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0110 0011 '63'	Specifies the main storage location of the first extent parameter byte	Used at the discretion of programmer	00		16

Function

The Define Extent command causes parameter bytes to be transferred to the cache storage director. These parameter bytes define limits on subsequent operations of the channel program and indicate global access intent information.

Chaining Requirements

The Define Extent command can not follow a Set File Mask, Space Count, or another Define Extent command in the same chain. If the chaining requirements are not met, the command is rejected with unit check in the ending status.

Status

Initial status is normally zero. Channel end and device end are presented after the parameters are validated.

Description

After the transfer of the 16 parameter bytes, the cache storage director stores the parameters for later use and returns channel end and device end in the ending status.

The Define Extent command requires that 16 parameter bytes be transferred. If the channel transfers more than 16, only 16 bytes are accepted. If fewer than 16 bytes are transferred, the command is rejected with unit check, channel end, and device end in the ending status.

The format of the parameter bytes are:

- Byte 0 - File mask
- Byte 1 - Global attributes
- Bytes 2 to 3 - Block size
- Bytes 4 to 7 - Must be zeros
- Bytes 8 to 11 - Beginning extent address
- Bytes 12 to 15 - Ending extent address

Byte 0—File Mask: Byte 0 is used to inhibit or control certain operations of commands that follow in the chain. The format and function are identical to the file mask transferred by a Set File Mask command. Bits 2 and 6 must be zeros. If either

is not, the command is rejected with unit check, channel end, and device end in the ending status.

Bits 0-1	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
	This bit must be zero or unit check, channel end, and device end are presented in the ending status.

Bits 3-4	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.
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 the ending status.

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

Byte 1—Global Attributes: Byte 1 contains the attributes that control the cache management algorithm during the entire CCW chain. If the bits are not used as specified, the command is rejected with unit check, channel end, and device end in the ending status.

Bits 0-1	Function
11	Both bits must a 1 for Model 13. If either is not, the command is rejected with unit check in the ending status.

Bit 2	Function
0	Not used

Bits 3-5	Function
000	Normal cache replacement The cache is managed as if no Define Extent command had been received.
001	Bypass cache All subsequent commands within the CCW chain access DASD directly even though the requested data is also in the cache.
010	Inhibit cache loading Prevents any allocation of space in cache for new data
011	Sequential access One or more of the tracks following the track accessed by the CCW chain will be transferred to cache.

Bits 6-7	Function
00	Not used

Bytes 2 and 3—Block Size: Bytes 2 and 3 are not used by the Model 13

Bytes 4 through 7: Bytes 4 through 7 must contain zeros.

Bytes 8 through 11—Beginning Extent Address: Bytes 8 through 11 contain the track address, in CCHH format, that is at the beginning of the extent in which subsequent commands are permitted to operate.

The track address used must be valid and be less than or equal to the address used in bytes 12 through 15. If not, the command is rejected with unit check, channel end, and device end in the ending status.

Bytes 12 through 15—Ending Extent Address: Bytes 12 through 15 contain the track address, in CCHH format, that is at the end of the extent in which subsequent commands are permitted to operate.

The track address must valid and be more than or equal to the address used in bytes 8 through 11. If not, the command is rejected with unit check, channel end, and device end in the ending status.

If the CCW count is greater than 16, the SLI flag (bit 34) must be on to prevent incorrect length indication.

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

Status

Channel end and device end are presented in the initial status.

Description

The No-Op command is processed as an immediate command. (Channel end is 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 cache 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 command 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.

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 a program check

Function

The Recalibrate command causes the addressed drive to seek to cylinder 0, head 0.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end is presented after initial status and device end is presented after the access mechanism is positioned at cylinder 0, head 0.

Description

The Recalibrate command is processed similarly to a seek command and the file mask must be set to allow seeks. If is not, the command is rejected with unit check in the ending status. Because 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.

The access mechanism is positioned immediately at cylinder 0, head 0. Device end is presented after the operation is completed.

The Recalibrate command is accepted whether or not the extent limits set by the Define Extent command in this chain had a beginning extent address equal to zero. When a following command requires track orientation, unit check (file protected) is presented in the ending status if the beginning extent limit address was other than zero.

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) must be on	00		Must be nonzero to avoid program check

Function

The Restore command causes no activity in the cache or at the addressed device.

Chaining Requirements

None

Status

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

Description

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.

Because 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 cache storage director.

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 cache storage director.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after the seek address has been transferred. See the following description for other status conditions.

Description

The Seek command transfers the six-byte seek address from the channel to the cache storage director. The cache storage director saves the address to do a cache directory search or to position the access mechanism at a later time.

The cache storage director checks the seek address for validity. If the seek address is not valid, the command is rejected with channel end, device end, and unit check 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.

User cylinders are 0 through 884 (X'0000' through X'0375')

Alternate cylinder is 885 (X'0376')

Bytes 4 and 5 contain the head address, 0 through 14 (X'00' through X'0E')

If access motion is required, it is not initiated until a read, search, or Space Count command is received in the same chain.

If the seek address is not within the extent limits set by the Define Extent command, unit check (file protected), channel end, and device end are presented in the ending status.

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. If the mask does not, the command is rejected with unit check in the ending status. See the Set File Mask command description.

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

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 the channel to the cache storage director. This command performs the same functions as the Seek command.

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device end are presented after the seek address has been transferred. See the following description for other status conditions.

Description

The Seek Cylinder command transfers the six-byte seek address from the channel to the cache storage director. The cache storage director saves the address to do a cache directory search or to position the access mechanism at a later time.

The cache storage director checks the seek address for validity. If the seek address is not valid, the command is rejected with channel end, device end, and unit check in the ending status if the Seek Cylinder command was the first one in a CCW chain. Otherwise, unit check is presented alone.

The format for the seek address is:

Bytes 0 and 1 contain zeros.

Bytes 2 and 3 contain the cylinder address.

User cylinders are 0 through 884 (X'0000' through X'0375').

Alternate cylinder is 885 (X'0376').

Bytes 4 and 5 contain the head address, 0 through 14 (X'00' through X'0E')

If access motion is required, it is not initiated until a read, search, or Space Count command is received in the same chain.

If the seek address is not within the extent limits set by the Define Extent command, unit check (file protected), channel end and device end are presented in the ending status.

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

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

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 the channel to the cache storage director.

Chaining Requirements

The Seek Head command must be preceded by a Seek, Seek Cylinder, Read Initial Program Load (IPL), or Recalibrate command.

Status

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

If the chaining requirements are not met, the command is rejected with unit check in the ending status.

Description

The Seek Head command transfers the six-byte seek address from the channel to the cache storage director. The cache storage director saves the head portion of the address for a cache directory search or to select the head at a later time. 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.

However, if a Set File Mask or a Define Extent command has been issued, the file mask must be set to allow Seek Head commands. See the Set File Mask command description.

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

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 cache 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 or Define Extent 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 cache storage director.

If the chaining requirements are not met, the command is rejected with unit check in the ending status.

Description

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 mask.

Bits 0-1	**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**
	This bit must be zero; if it is not, unit check, channel end, and device end are presented in initial status.

Bits 3-4	**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.
1	Permits Diagnostic Write and Diagnostic Read Home Address commands, and seeks to CE tracks only. On 3380s, it also inhibits retry when data checks occur in the count, key, and data areas of any record other than home address.

Note: Bit 5 is used for diagnostic purposes only. Use of this bit for any other purpose will yield unpredictable results.

Bit 6	Function
	This bit must be zero; if it is not, unit check, channel end, and device end are presented in the initial status.

Bit 7	Function
0	Not PCI fetch mode
1	PCI fetch mode. The cache 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 cache storage director.

Set High-Performance Storage Limits

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0011 1011 '3B'	Specifies the main storage location of the first parameter byte	Used at the discretion of programmer	00		10

Function

The Set High-Performance Storage Limits command establishes a high-performance storage area for the addressed device or terminates the one or more high-performance storage areas with the subsystem.

Chaining Requirements

This command must be the only command in the chain. If it is not, it is rejected with unit check in the ending status. If any command is chained from the Set High-Performance Storage Limits command, that command is rejected in the initial status. The rejection of the command has no effect on the execution of the Set High-Performance Storage Limits command.

Status

Initial status is normally zero. Channel end is presented after the parameter bytes are transferred. Device end is presented at the end of the operation. If the chaining requirements are not met, the command is rejected with unit check, channel end, and device end in the ending status.

Description

After the presentation of initial status, the 10 parameter bytes are transferred to the cache storage director. The cache storage director then presents channel end and disconnects from channel to finish the operation. If more than 10 bytes are transferred, only 10 are accepted. If fewer than 10 bytes are transferred, the command is rejected with unit check, channel end, and device end in the ending status.

The parameter bytes have the following format:

Bytes 0 and 1 - function

Bytes 2 through 5 - lower storage limit

Bytes 6 through 9 - upper storage limit

Bytes 0 and 1—Function: These bytes specify the function to be performed. Only bits 0 and 1 of byte 0 are used. The remaining bits in both bytes must be zeros. If they are not, the command is rejected with unit check, channel end, and device end in the ending status.

Bits 0-1	Operation
00	Establishes the specified high-performance area
01	Terminates the specified high-performance area
10	Terminates all high-performance areas for the addressed device
11	Terminates all high-performance areas for all devices in the subsystem. Any address of any DASD attached to the cache storage director can be used.

Bytes 2 through 5—Lower Storage Limit: Bytes 2 through 5 contain the track address, in CCHH format, that is to be the lower limit of the high-performance area. The track address must be valid and be less than or equal to the track address contained in Bytes 6 through 9. If it is not, the command is rejected with unit check, channel end, and device end in the ending status.

Bytes 6 through 9—Upper Storage Limit: Bytes 6 through 9 contain the track address, in CCHH format, that is to be the upper limit of the high-performance area. The track address must be valid and be more than or equal to the track address contained in bytes 2 through 5. If it is not, the command is rejected with unit check, channel end, and device end in the ending status.

When a high-performance area is established, all tracks, except defective and alternate tracks, within the specified range for the device are transferred to cache. These tracks become bound to cache and are not removed until the high-performance area is terminated by one of the following:

- A Set High-Performance Storage Limits command
- Initial microcode load of the cache storage director
- Use of the Set Subsystem Mode command
- Termination of cache operations

Individual tracks within a high-performance area become unbound if failures occur while updating either cache or DASD. The cache storage director does not indicate to the processor when a high-performance area is implicitly terminated or implicitly unbound.

If a high-performance area is being terminated, any tracks within that area for the addressed device are unbound. The range of tracks being terminated need not coincide with a previously established high-performance area. A portion of an area may be terminated or the specified range may overlap other established areas.

If all of the high-performance areas for an addressed device, or for the subsystem, are terminated, all bound tracks are then unbound.

Device end is presented to the channel when all the tracks have been bound or unbound as specified.

Programming Notes:

1. When a high-performance area is established, the cache must have sufficient space to accommodate the request. The space must be unbound and available for storing data. If there is not sufficient space, the command is rejected with unit check, channel end, and device end in the ending status.

2. When a high-performance area is established and a correctable or uncorrectable data check occurs in DASD data, the track on which the error occurs is not transferred into cache. The operation continues with the next track and no error is indicated in the ending status when the operation is completed.

3. If a high-performance area is being established when a DASD error (not a correctable or uncorrectable data check) or a subsystem storage failure occurs while accessing a track in cache, the high-performance area is not established. No tracks become bound because of the command, but any tracks within the specified area that are already bound remain bound. Ending status includes unit check.

Set Path Group ID

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1010 1111 'AF'	Specifies the main storage location of the first byte of the path group identification	Used at the discretion of programmer	00		12

Function

The Set Path Group ID command transfers 12 bytes of path group identification information from main storage to the cache storage director. This command is valid only on 3380s that have the dynamic path selection function.

Chaining Requirements

The Set Path Group ID command must be the only command in the chain. If it is not, the command is rejected with unit check in the ending status. Any command that is chained from Set Path Group ID is rejected with unit check in the initial status. The rejection of the command has no effect on the execution of the Set Path Group ID command.

Status

The initial status is normally zero. Channel end and device end are presented after the 12 bytes have been transferred and checked for validity.

Description

The path group identification is used to identify the system control program (SCP) governing a group of channels. Subsequent Device Reserve commands can be used to reserve devices to the group of channels with this identification.

Each SCP must have a unique identification. If the same identification is assigned to more than one SCP, a reserved device will be available to each SCP with the common identification.

When a Set Path Group ID command is received, the cache storage director checks to see if a path group identification has been set for the interface since the last system reset. If not, the path group identification is accepted. If a previous path group identification had been accepted by the cache storage director, the new identification is compared against it. If they do not compare, the command is rejected.

The path group identification is common for all the devices attached to the cache storage director.

> **Note:** Devices are grouped on an individual basis and all devices do not have to be grouped alike. To group all devices alike, the same command must be executed on each device, over each path.

The 12 bytes transferred by this command have the following format:

Byte	Description
0	Function control byte
1-11	SCP identification

Byte 0—Function Control Byte: This byte has the following format:

Bit	Description
0	Must be zero
1-2	00=Establish group 01=Disband group 10=Resign from group 11=Invalid
3-7	Must be zeros

Establish Group: This function causes the cache storage director to compare the identification in bytes 1 through 11 with all other identifications received for the same device over other interfaces. If any comparison is made, an interface group is formed for the addressed device consisting of all interfaces with the same identification.

Disband Group: This function causes each member of an interface group to become a stand-alone interface to the addressed device. Interface groups for the addressed device that do not include the interface issuing the command are not affected.

Resign from Group: This function causes the issuing interface to be removed from an interface group for the addressed device. The issuing interface becomes a stand-alone interface.

Bytes 1 through 11—System Control Program: These bytes cannot be all zeros. If they are, the parameters are invalid and the command is rejected. If the addressed device is reserved and an interface group is expanded, the device is reserved to the expanded group.

If the device is reserved to a group with multiple interfaces and the group is made smaller by the resign-from-group function, the device remains reserved to the remaining interfaces.

If a device is reserved to an interface group that is disbanded, the device remains reserved to the interface that executed the disband-group function.

A system reset causes the path group identification for the interface to be reset. A device that is reserved to the resetting interface is released if the resetting interface is the only member of an interface group. A device that is reserved to more than one interface remains reserved to the interfaces that did not execute the reset.

A system control program should not attempt to expand or contract a path group while it has CCW chains in progress. Such attempts may cause interrupts to be lost or misdirected, or may give other unpredictable results.

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 cache storage director.

Chaining Requirements

None

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.

Description

If the Set Sector command follows a command that accessed data on the device, rather than in cache, channel end is presented after acceptance of the sector number and the cache storage director disconnects from the channel. When the device reaches the angular position, the cache storage director reconnects and device end is presented.

If the Set Sector command follows a command that has accessed data in the cache, or if a seek address is saved, the sector number is also saved and channel end and device end are presented. No further action is taken until a command requiring track orientation is received. At that time all cache directory searches and/or access motions will be performed prior to attempting orientation.

When orientation is necessary, the location of the track determines what happens next. If the track is not in the cache, the saved seek address and sector number are transferred to the device. If the track is in the cache, the cache storage director performs an internal orientation to the first count area following the specified sector number.

The cache storage director checks the byte transferred by the Set Sector command for validity. For 3380s, the byte count must contain a value 0 through 221 or be set to 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 cache storage director presents channel end and device end 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 cache storage director attempts reconnection just before index.

All valid Set Sector arguments, except 255, are adjusted by the cache 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 a search multitrack command sequence will avoid this problem.

Set Subsystem Mode

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	 39	NOT USED 40 47	COUNT (DECIMAL) 48 63
1000 0111 '87'	Specifies the main storage location of the first parameter byte	Used at the discretion of programmer	00		2

Function

The Set Subsystem Mode command activates or deactivates the cache operations for the addressed device or makes the subsystem storage available or unavailable to the subsystem.

Chaining Requirements

Set Subsystem Mode must be the only command in the chain.

Status

Initial status is normally zero. Channel end is presented after the parameter bytes are transferred. Device end is presented at the end of the operation.

If Set Subsystem Mode is not the only command in the chain, it is rejected with unit check in the ending status. When any command is chained from the Set Subsystem Mode command, that command is rejected with unit check in the initial status. The rejection of the command has no effect on the execution of the Set Subsystem Mode command.

Description

After the the two parameter bytes are transferred, the cache storage director disconnects from the channel. If the channel sends more than two bytes, only two are accepted. If fewer than two are sent, the command is rejected with unit check and device end in the ending status. The two bytes indicate the function to be performed. Only bits 0 through 2 of the first byte are used. The remaining bits must be zeros. If they are not, the command is rejected with unit check and device end in the ending status. Bits 0 through 2 have the following format:

Bits 0-2	Operation
000	No operation is performed.
001	Activate cache
010	Deactivate cache
011	Subsystem storage available
100	Subsystem storage unavailable

Activate cache: Sets control flags in the 3380 controllers to show that cache operations are permitted on the addressed device.

Deactivate cache: Sets control flags in 3380 controllers to show that cache operations have been terminated with the addressed device.

The cache storage director receiving the command invalidates all cache entries for the DASD and terminates any high-performance areas that were assigned to the addressed DASD. All channel programs that address that DASD will bypass cache and access data directly on DASD.

Subsystem storage available: Makes cache available to the the subsystem. The cache storage director alerts the other cache storage director that subsystem storage is available. The cache storage director receiving the command generates the control information that is maintained in subsystem storage. All cache entries are marked as available and no high-performance areas are restored.

If, while attempting to make subsystem storage available, the cache storage director is unable to alert the other cache storage director, the receiving cache storage director will, instead, make subsystem storage unavailable to the subsystem. The control flags are set to indicate that the subsystem storage is unavailable and the Set Subsystem Mode command is terminated with unit check (equipment check). The sense data also indicates that the status of the other cache storage director is unknown.

If this command is received while the subsystem storage is available, it reinitializes the cache.

Subsystem storage unavailable: Makes cache unavailable to the subsystem. The other cache storage director is alerted that cache operations are to stop. Any channel command received after the completion of this command bypasses the cache regardless of the status of the cache (activated or inactivated).

If the cache storage director is unable to alert the other director that cache operations are to stop, the receiving cache storage director completes the operation and discontinues use of subsystem storage. It also sets control flags to indicate that all cache operations are terminated. The ending status contains unit check (equipment check) and device end, and the sense data indicates that the status of the other cache storage director is unknown. To terminate all cache operations, another Set Subsystem Mode command should be issued to make the subsystem storage unavailable.

If subsystem storage fails while processing this command, the operation is terminated with unit check (equipment check) and device end in the ending status.

> **Note:** The subsystem storage available or unavailable attributes may prevent completion of a channel program. If this occurs, the command is terminated with unit check and sense format F, message 0. The system ERPs will reissue the command chain.

Space Count

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

Function

The Space Count command provides a means of bypassing a defective count area (including R0) of a track in the cache or on the addressed device. This allows recovery of the key and/or data areas following a defective count area.

Chaining Requirements

The Space Count command can not be chained from a Set High Storage Limits, Set File Mask, Read IPL, Device Reserve, Device Release, or any write command in the same chain.

Status

Initial status is normally zero. If the chaining requirements are not met, the command is rejected with unit check in the initial status. See the following description for ending status presentation.

Description

The Space Count command is used for data recovery. It causes the count area of a track in the cache or on the addressed device to be bypassed.

When the Space Count command is chained from a read, search, write or Space Count command, the track has already been located in the cache or is only on DASD. (The previous command required track orientation.) The cache storage director then:

1. Orients at the start of the next count area (including R0).
2. Spaces over the count area while accepting the three bytes of data from the channel.
3. Sets an end of count area internal orientation indicator.
4. Presents channel end and device end to the channel.

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

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 Equal                    Search ID Equal
     (record N-1)                       (record N-1)
     TIC*-8                             TIC*-8
     Space Count**                      Space Count**
     Read KD                            Read CKD
```

* Transfers to the TIC command's address, minus 8.
** Must specify correct key and data lengths or a data check will occur.

If the command is not chained from a read, write, search, or Space Count command, the command:

1. Determines whether a Seek or Set Sector command has been received and not yet executed. If so, the cache storage director determines if the track is stored in the cache. If so, the track is made ready for processing. If it is not in the cache, the cache storage director disconnects from channel and seeks to the specified address or orients to the specified sector number. When the operation is complete, device end is presented to the channel. The Space Count command is reissued and command execution proceeds with access motion no longer required.
2. Searches for index
3. Clocks through gap 1, home address and gap 2
4. Spaces over the R0 count area
5. Receives key and data length from the channel
6. Sets end-of-count area internal orientation state indicator
7. Presents channel end and device end to the channel

Using chain (a): Space Count followed by a Read Key and Data command recovers or bypasses a bad R0 count area; using chain (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 3, only three bytes are transferred. If the CCW count is less than 3, the number of bytes specified is transferred and a value of zero is assumed for bytes not transferred.

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 cache 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 bits 0 through 3, and 32 through 63, are ignored.

Search Commands

Search commands cause the cache storage director to compare data from the device or cache with data from main storage. During the execution of the search commands, the channel operates in write mode and the device or cache operates in read mode. The cache storage director compares the data from main storage with the data coming from the device or cache. When the search requirement has been satisfied, the cache 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 that is 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 chain:

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. All the search commands can operate in either single track or multitrack mode. The following chart lists the search commands.

	Command Code	
Command	**Multitrack Off**	**Multitrack On**
Search Home Address Equal	39	B9
Search ID Equal	31	B1
Search ID Equal or High	71	F1
Search ID High	51	D1
Search Key Equal	29	A9
Search Key Equal or High	69	E9
Search Key High	49	C9

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 head number (HH)	Used at the discretion of programmer	00		4

Function

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

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

Initial status is 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

The execution of a Search Home Address Equal command causes the cache storage director to search for index. When index is detected, the cache storage director compares the cylinder and head numbers from main 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 advances when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied, the head number advances beyond the end of the cylinder (head 14 for 3380), or the head number is advanced beyond the extent specified. Channel end, device end, and unit check are presented when the end of the cylinder is reached.

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. The status modifier bit is also presented if the comparison was equal.

Search ID Equal

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0011 0001 '31' MULTI-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 ID Equal command causes the cache storage director to compare the five bytes (CC HH R) from main storage with the five bytes from the device or cache.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

Initial status is 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

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) or in the cache.

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 advances when the index is detected. The search continues (as long as the channel repeats the command) until the search condition is satisfied, the head number advances beyond the end of the cylinder (head 14 for 3380), or until the head number is advanced beyond the extent specified. Channel end, device end, and unit check are presented when the end of the cylinder is reached.

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. The status modifier bit 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.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device are presented to the channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director disconnects from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation. The status modifier bit is included if the comparison is successful.

Search ID 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 ID Equal or High command causes the cache storage director to compare the five bytes (CC HH R) from main storage with the five bytes from the device or cache.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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, the head number advances beyond the end of the cylinder (head 14 for 3380), or until the head number advances beyond the extent specified. 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.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director disconnects from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation. Status modifier is included if the comparison is successful.

Search ID 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 programmer	00		5

Function

The Search ID High command causes the cache storage director to compare the five bytes (CCHHR) from main storage with five byte count area ID from the device or cache.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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, the head number advances beyond the end of the cylinder (head 14 for 3380), or until the head number advances beyond the extent specified. 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 device or cache ID was higher than the record 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 device or cache ID is higher than the record ID from main storage.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director disconnects from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation. Status modifier is included if the comparison is successful.

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 cache storage director to compare the key data from main storage with the key area read from the device or cache.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

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 device or cache. Channel end and device end are presented if the comparison is not equal.

Description

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

> **Note:** When this command is chained from a Space Count, Read Count, or search ID-type 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, the head number advances beyond the end of the cylinder (head 14 for 3380), or until the head number advances beyond the extent specified. Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is not equal to the key length, the search operation is completed when the comparison is made on the shorter length. Channel end and device end status are presented to terminate the command. Status modifier is also presented if the if the comparison was equal. If the key length is zero, the comparison is unsuccessful.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director disconnects from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation. Status modifier is included if the comparison is successful.

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 cache storage director to compare the key data from main storage with the key area read from the device or cache.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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-type 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, the head number advances beyond the end of the cylinder (head 14 for 3380), or until the head number is advanced beyond the extent specified. Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is not equal to the key length, the search operation is completed when the comparison is made on the shorter length. 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 key length is zero, the comparison is unsuccessful.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director disconnects from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation. Status modifier is included if the comparison is successful.

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 programmer	00		Equal to the length of the argument

Function

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

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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 device (excluding R0) or cache.

> **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, the head number advances beyond the end of the cylinder (head 14 for 3380), or until the head number is advanced beyond the extent specified. Channel end, device end, and unit check are presented at the end of the cylinder.

If the CCW count is not equal to the key length, the search operation is completed when the comparison is made on the shorter length. 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 key length is zero, the search is unsuccessful.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director disconnects from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation. Status modifier is included if the comparison is successful.

Read Commands

Read commands transfer data from disk storage or cache 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 following chart lists the read commands.

	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	

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 device or cache to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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 (two bytes), head number (two bytes), record number (one byte), key length (one byte), and the data length (two bytes).

If a data overrun or data check is detected on the 3380 during the execution of this command, the cache 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.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device end are presented to the channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

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 device or cache to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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 each area. If a data overrun or data check is detected on the 3380 during the execution of this command, the cache 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.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device end are presented to channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

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

The Read Data command transfers the data area of a record from the device or cache to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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 that has been command chained from the count or key area of the same record. For example, if a Read Data is command chained from a Space Count, Read Count, a search ID- or search key-type command, the data area is from the record accessed by the previous command.

The validity of each of the count, key, and data areas is verified by the correction-code bytes following each area. If a data overrun or data check is detected on a 3380 during the execution of this command, the cache 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.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device end are presented to the channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses channel command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

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 from the device or the cache storage director to main storage.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

After presenting initial status, the five bytes of home address (F CC HH) are transferred from the device, or from the cache storage director if record 0 of the specified track is in the cache.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from channel. Channel end and device end are presented to channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

If a data overrun or data check is detected on the 3380 during the execution of this command, the cache 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.

Read IPL

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 IPL command causes the addressed device to seek to cylinder 0, head 0, and read the data area of record 1.

Chaining Requirements

The Read IPL command cannot be preceded by a Define Extent, Space Count, or Set File Mask command in the same chain. However, a Read IPL can precede them in the same chain.

Status

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

If the chaining requirements are not met, the command is rejected with unit check in the ending status.

Description

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 0, head 0, and search for index. When index is detected, the cache storage director clocks over record 0 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 the 3380 during the execution of this command, the cache 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.

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 device or cache to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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, if a Read Key and Data command is chained from a Read Count, Space Count, or search ID-type command, the key and data areas are from the record accessed by the previous 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 the 3380 during the execution of this command, the cache storage director attempts recovery by using 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.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device are presented to the channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses channel command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

Read Multiple Count, Key, and Data (CKD)

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 (Maximum is 47,476)

Function

The Read Multiple Count, Key, and Data (CKD) command transfers the next record encountered (excluding R0) and all remaining records on the track from the device or cache to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

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

This command provides a means of reading all the records on a track during a single disk revolution. It is similar to executing a chain of Read CKD commands that read 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.

Because the actual number of bytes to be read is probably not known, the byte count should be greater than the 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.

Notes:

1. Because command retry works only on single records, certain errors cannot be retried in the multiple-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.

2. If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device end are presented to channel at the completion of the operation.

   If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses channel command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

Read Record Zero (R0)

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 0 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 0 from the device or cache to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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

> **Note:** A Read R0 command 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 that follow each of the areas.

If a data overrun or data check is detected on the 3380 during the execution of this command, the cache storage director attempts recovery through the use of command retry. If command retry is unsuccessful, channel end, device end, and unit check are presented to the channel.

If the command chain is operating with the device or the track is in the cache, the cache storage director completes the operation without disconnecting from the channel. Channel end and device end are presented to channel at the completion of the operation.

If the command causes the cache storage director to begin operating with the device or to get the track from the device, the cache storage director uses channel command retry to disconnect from the channel until appropriate device activity is completed. The cache storage director then presents device end so that the channel will reissue the command. Channel end and device end are presented at the completion of the operation.

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 the cache storage director to the channel.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command.

Status

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

Description

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 was executed, the value is the current value in the Set Sector command, minus 4 for 3380.

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

Sense Commands

There are nine sense commands. All but the Sense ID command transfers 24 bytes to the channel; the Sense ID command transfers seven bytes. The 24 sense bytes provide information concerning unusual conditions detected in the last operation and the current status of the storage control and device.

Other sense-type commands perform other functions (such as reserving a device) in addition to transferring the sense information.

The following chart lists the sense commands.

Commands	Command Code
Device Release	94
Device Reserve	B4
Read and Reset Buffered Log	A4
Sense	04
Sense ID	E4
Sense Path Group ID	34
Sense Subsystem Counts	74
Sense Subsystem Status	54
Unconditional Reserve	14

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 issuing the command or from all channels in the interface path group.

Chaining Requirements

The Device Release command cannot be preceded by a Set File Mask, Define Extent, 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.

If the chaining requirements are not met, the command is rejected with unit check in the ending status.

Description

In addition to terminating the reservation of the addressed device, the Device Release command transfers 24 sense bytes to the channel. The Device Release command is executed regardless of any abnormal device status conditions, such as offline.

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

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 or to all channels in the same interface path group.

Chaining Requirements

The Device Reserve command cannot be preceded by a Set File Mask, Define Extent, or Space Count command in the same chain. If any of those commands are in the same chain, the command is rejected with unit check in the ending status.

Status

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

Description

This command reserves the addressed device to all channels in the interface path group. Reservation is maintained until the channel, or any channel in the same group, successfully completes a Device Release command to the device.

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

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

> **Note:** See the description of the Set Path Group ID command for further information regarding device reservation with the dynamic path selection function.

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 cache 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

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.

With 3380s, the counts are only updated at the end of the chain. If a Read and Reset Buffered Log command is executed in a CCW chain, it will not report any counts accumulated during that chain.

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

Sense

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 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 cache storage director to the channel.

Chaining Requirements

None

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

Description

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 is established in the cache 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 zeros for the cache storage director and device address that generated the unit check. During the contingent connection state, the cache 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 zeros.

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

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

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

Sense information for the 3880 and the attached 3380s is described later in this manual.

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 cache storage director to the channel.

Chaining Requirements

None

Status

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

Description

The sense information transferred by this command describes the type and model of the cache storage director and device being addressed by this command.

The format of the sense bytes is as follows:

Byte 0 contains all 1's (X'FF').

Bytes 1 and 2 contain the control unit machine-type number (X'3880').

Byte 3 contains the control unit model identifier (X'49').

Bytes 4 and 5 contain the device machine-type number (X'3380').

Byte 6 contains the device model number (X'02').

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.

Sense Path Group ID

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0011 0100 '34'	Specifies the main storage location where the first byte of path identification information is to be transferred	Used at the discretion of programmer	00		12

Function

The Sense Path Group ID command transfers 12 bytes of path identification information from the cache storage director to processor storage.

Chaining Requirements

The Sense Path Group ID command must be the only command in the chain.

Status

Initial status is normally zero. Channel end and device end are presented after the path ID information has been transferred.

If the Sense Path Group ID command is not the only one in the chain, it is rejected with unit check in the ending status. If any command is chained from Sense Path Group ID, that command is rejected with unit check in the initial status for that command. The rejection of the command has no effect on the execution of the Sense Path Group ID command.

Description

The 12 bytes of information transferred to main storage are the path state byte (byte 0) and the path group identification bytes (bytes 1 through 11).

Byte 0—Path State Byte

Byte 0 contains the following format:

Bits 0 and 1	Description
00	No Set Path Group ID command was executed on the interface for any device since the last system reset.
10	A valid ID exists for this interface and the addressed device does not belong to a group.
11	A valid ID exists for this device on this interface and the device is shared by a group.

Bits 2 and 3	Description
00	The addressed device is not currently reserved.
01	The addressed device is not currently reserved but there is contingent allegiance to this system.
10	The addressed device is reserved to another interface.
11	The device is reserved to this interface and to other members of the interface group (if they exist).

Bits 4 through 7	Description
0000	Must be zeros

Bytes 1 through 11

Bytes 1 through 11 contain the current path group ID associated with the addressed device. If no Set Path Group ID command has been issued to this interface since the last system reset, bytes 1 through 11 contain all zeros. If a valid ID exists for this interface, even if it had not been addressed to this particular device, it will be returned in this field.

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

The Sense Subsystem Counts command transfers the subsystem performance data from the cache storage director to the channel.

Chaining Requirements

None

Status

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

Description

Upon receipt of the Sense Subsystem Counts command, the cache 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 the channel. The contents of the subsystem performance accumulators associated with the addressed device are not changed.

If the CCW count is greater than 80, only 80 bytes are transferred. If the CCW count is less than 80, only the specified number of bytes is transferred. If the CCW count is not equal to 80, the SLI bit must be on to prevent incorrect length indication.

The performance data bytes have the following format:

- Byte 0—Storage director identification

  This byte contains the storage director identification.

- Byte 1—Device identification

  This byte contains the address specified by the channel program.

- Bytes 2 through 3—Must be zeros

- Bytes 4 through 7—Search/Read Normal I/O Requests

  This is the number of command chains that:

  - Contained no write commands.
  - Was executed in normal cache replacement mode (that is, no Define Extent command or a Define Extent with the normal cache replacement attribute specified).

- Bytes 8 through 11—Search/Read Normal I/O Request Hits

  This is the number of command chains that:

  - Contained no write commands
  - Was executed in normal cache replacement mode (that is, no Define Extent command, or a Define Extent command with the normal cache replacement attribute specified).
  - Did not cause a transfer of any data to or from DASD.

- Bytes 12 through 15—Write Normal I/O Requests

  This is the number of command chains that contained a write command that was executed in normal cache replacement mode.

- Bytes 16 through 19—Write Normal I/O Request Hits

  This is the number of command chains that contained a write command, which was executed in normal cache replacement mode, and was completed without transferring any data from DASD to the cache or to the channel.

- Bytes 20 through 23—Search/Read Sequential I/O Requests

  This is the number of command chains that:

  - Contained no write commands.
  - Included a Define Extent command with the sequential access attribute specified and no write commands.

- Bytes 24 through 27—Search/Read Sequential I/O Request Hits

  This is the number of command chains that:

  - Contained no write commands.
  - Included a Define Extent command with the sequential access attribute specified.
  - Were completed without transferring data from DASD to the cache or to the channel.

- Bytes 28 through 31—Write Sequential I/O Requests

  This is the number of command chains that contained a Define Extent command with the sequential access attribute specified, and at least one write command.

- Bytes 32 through 35—Inhibit Cache Loading I/O Requests

  This is the number of command chains that contained a Define Extent command with the inhibit cache loading attribute specified.

- Bytes 36 through 39—Search/Read I/O Requests to Bound Tracks

  This is the number of command chains that contained a read or search command that specified a track that was bound in cache, and contained no write commands.

- Bytes 40 through 43—Write I/O Requests to Bound Tracks

  This is the number of command chains that contained a write command that specified a track that was bound in cache.

- Bytes 44 through 47—DASD to Cache Transfer Operations

  This is the number of internal command chains that successfully transferred data from DASD to cache.

- Bytes 48 through 51—Cache to Channel Data Transfer

  This is the total number of data bytes transferred from cache to the attached channels.

- Bytes 52 through 55—DASD to Channel Data Transfer

  This is the total number of data bytes transferred from DASD to the attached channels.

- Bytes 56 through 59—Cache to DASD Data Transfer

  This is the total number of bytes transferred from cache to DASD.

- Bytes 60 through 63—DASD to Cache Data Transfer

  This is the total number of bytes transferred from DASD to cache.

- Bytes 64 through 79—Not used

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 information 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.

Chaining Requirements

Sense Subsystem Status must be the only command in the chain.

Status

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

If the Sense Subsystem Status command is not the only command in the chain, it is rejected with unit check in the ending status. Any command chained from this command is rejected with unit check in the initial status, but the rejection has no effect on the execution of the Sense Subsystem Status command.

Description

Upon receipt of the Sense Subsystem Status command, the cache 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 Sense Subsystem Status command is issued while the cache storage director is executing a Set High Performance Storage Limits command, the data returned by the cache storage director is unpredictable.

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 identification

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

- Bytes 2 and 3—Must be zeros

- Bytes 4 and 5—Overall caching status

  These bytes indicate whether any cache operations have been terminated for all devices. They also indicate whether the termination is the result of a subsystem failure or is an explicit processor request.

  Only bits 0 and 1 are used and have the following meanings:

Bits 0-1	Function
00	Cache operations are active. The subsystem storage is online.
01	An internal subsystem error has terminated the cache operations. The subsystem storage is offline.
10	Cache operations have terminated as a result of an explicit processor request. The subsystem storage is offline.
11	Not used.

  Bits 2 through 15 are always zeros.

- Bytes 6 through 9—Device caching status

  These bytes make up a bit map of 32 positions that correspond to the addresses of all possible devices within the 3880 Model 13 subsystem. Each device for which the cache function is deactivated by a explicit processor request has a "0" in the appropriate bit position. All other devices, whether or not they are attached, are identified by a "1."

- Bytes 10 through 13—Configured subsystem storage capacity

  These bytes contain the configured subsystem storage capacity in bytes.

- Bytes 14 through 17—Available subsystem storage capacity

  These bytes contain the quantity of subsystem storage, in bytes, that is currently available to the cache storage director for allocation as storage space.

- Bytes 18 through 21—Bound subsystem storage capacity

  These bytes contain the quantity, in bytes, of subsystem storage currently occupied by tracks that are bound to the cache within one or more high-performance storage areas. This value may be less than expected if only explicit binding or unbinding is considered. See the Set High-Performance Storage Limits command description for information on implicit unbinding of tracks.

- Bytes 22 through 25—Offline subsystem storage capacity

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

- Bytes 26 through 39—Must be zeros.

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 reserves the device to the issuing path group even if the device is currently in use or reserved by another path group.

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 end are presented after the 24 sense bytes are transferred.

Description

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 issuing path group even when the device was reserved or in use through another path group. The reservation or the information in use for the other path is reset in the device and the cache storage director through which the command was issued. It does not reset information in the cache storage director that is not now operational.

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 channel 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 is lost.
- If the device is active when the command is executed, a recoverable equipment check is 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 be 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 tag (condition code 3) or there is a preselection check as indicated by unit check and equipment check in sense byte 0.

Note: In configurations with dynamic path selection, execution of an Unconditional Reserve command on one of the cache storage directors and devices can abort an unrelated operation on the other cache storage director and devices.

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

Write Commands

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

The following chart lists the write commands.

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

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

The command must be chained from a Write R0, Write CKD, or Search ID Equal, or Search Key Equal command. The search commands must have compared equal on all bytes. It must also be preceded by a Set File Mask command that allows format write commands.

> **Note:** A Read Data, Read Key and Data, Write Data, or Write Key and Data may be inserted between the Search ID Equal and Erase commands. A Read Data or Write Data command may be inserted between the Search Key Equal and Erase commands.

Status

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

Description

Following the presentation of initial status, the cache storage director writes zeros on the remaining portion of the track. Although data is transferred from the channel, the erased record and all subsequent data on the track is not recoverable.

When operating directly with DASD, channel end and device end are presented after completion of the erase operation.

When operating with cache, the track in the cache is erased and channel end is presented when that operation is completed. The erase operation is then performed on DASD. When that operation is completed, device end is then presented to the channel.

The Erase command can be used to determine the amount of space remaining on a track. This is done by performing a search operation on the final record followed by an Erase command that has a CCW count greater than the track size. The remaining space is then calculated by subtracting the CSW residual count from the original CCW count of the Erase command.

Write Count, Key, and Data (CKD)

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 bytes

Function

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

Chaining Requirements

The Write CKD command must be chained from a Write R0, Write CKD, Search Key Equal, or a Search ID Equal command. It must also be preceded by a Set File Mask command that allows format write commands. The search commands must have compared equal on all bytes of the searched field.

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

Status

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

Description

The count, key, and data areas of a record are transferred from processor storage and written in the cache or on the addressed device. The first eight bytes of data transferred are the count area: cylinder number (two bytes), head number (two bytes), record number (one byte), key length (one byte), and data length (two 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 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.

When operating directly with DASD, channel end and device end are presented after the data transfer is complete.

When operating with cache, channel end is presented after the data transfer to cache is complete. The write operation is then performed on DASD. Device end is presented after the data transfer to DASD is complete.

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, either in the cache or on the device.

Chaining Requirements

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.

Status

Initial status is normally zero.

Description

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 cache 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 cache storage director then writes the correction code bytes after the data area.

When operating directly with DASD, channel end and device end are presented after the data transfer is complete.

When operating with cache, channel end is presented after the data transfer to cache is complete. The write operation is then performed on DASD. Device end is presented after the data transfer to DASD is complete.

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

Function

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

Chaining Requirements

The Write Home Address command must be chained from a successful Search Home Address command with a CCW count of 4 or more. It must be preceded by a Set File Mask command that allows writing the home address.

Status

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

Description

One home address is written on each track to establish track identity—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.

The cylinder and head numbers from main storage must match the value stored by the cache 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 a Write R0 is chained from this command, it is executed after the track is erased. Because reconnection may not occur until some time after index is passed, the next command will not be oriented.

The home address area of the 3380 consists of a flag (one byte), cylinder number (two bytes), and a head number (two bytes). If the CCW count is less than 5, or if the cylinder number and head number do not agree with the preceding Seek command, this command is rejected. Bits 0 through 5 of the flag byte are generated by the cache storage director before the flag byte is transferred to the device. If the CCW count is greater than 5, only five bytes are written.

> **Note:** Although the 3380 home address is longer than five bytes, only five bytes are transferred.

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 '0D'	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 that is in cache or on the device.

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. If chaining requirements are not met, the command is rejected with unit check in the ending status.

Description

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 cache 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 cache storage director then writes the correction code bytes after the key and data areas.

When operating directly with DASD, channel end and device end are presented after the data transfer is complete.

When operating with cache, channel end is presented after the data transfer to cache is complete. The write operation is then performed on DASD. Device end is presented after the data transfer to DASD is complete.

Write Record Zero (R0)

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 0 to be transferred from main storage and written on the drive.

Chaining Requirements

The Write R0 command must be preceded by a Set File Mask that allows writing record 0.

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. If the chaining requirements are not met, the command is rejected with unit check in the ending status.

Description

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 (two bytes), head number (two bytes), record number (one byte), key length (one byte), and data length (two 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 (8+KL+DL), 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. Because reconnection may not occur until some time after index is passed, the next command will not be oriented.

Note: Record 0 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 require a key length of 0 and an eight-byte data field.

Diagnostic Commands

Diagnostic commands are used to transfer diagnostic information between the channel and the cache storage director. The commands are used for maintenance purposes only. Any use other than that provided by IBM diagnostic programs yields unpredictable results.

The following chart lists the diagnostic commands.

Commands	Command Code
Diagnostic Read Home Address	0A
Diagnostic Sense/Read	C4
Diagnostic Write Home Address	09

Diagnostic Read Home Address

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	 39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 1010 '0A'	Specifies the main storage location where the first byte of home address is to be stored	Used at the discretion of programmer	00		28

Function

The Diagnostic Read Home Address command transfers the 28-byte home address area of a 3380 track to main storage.

Chaining Requirements

This command must be preceded by a Seek, Seek Cylinder, Read IPL, or Recalibrate command and a Set File Mask command that allows execution of Diagnostic Read Home Address commands.

Status

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

Description

The Diagnostic Read Home Address command transfers the skip control bytes, cell number, physical address bytes, flag, identifier bytes (CCHH), key length, and data length bytes of the home address area to the channel. The validity of the data read is verified by the correction code bytes following the home address area.

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

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

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		8,192 (maximum)

Function

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

Chaining Requirements

None

Status

Initial status is normally zero. Channel end and device are presented after the contents of the trace/dump buffer has been transferred to the channel. If the trace/bump buffer content is not valid, unit exception is presented with channel end and device end in the ending status.

Description

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 yields unpredictable results.

Diagnostic Write Home Address

COMMAND CODE 0 7	DATA ADDRESS 8 31	FLAGS 32 37	39	NOT USED 40 47	COUNT (DECIMAL) 48 63
0000 1001 '09'	Specifies the main storage location of home address bytes	Used at the discretion of programmer	00		28

Function

The Diagnostic Write Home Address command causes the 28-byte home address area to be transferred from main storage to the 3380.

Chaining Requirements

Diagnostic Write Home Address must be preceded by a Seek or Seek Cylinder command, and a Set File Mask command that allows execution of the Diagnostic Write Home Address command.

Status

Initial status is normally zero. Channel end and device are presented after the home address has been checked for validity and the correction code bytes have been written after the home address area.

Description

The Diagnostic Write Home Address command is used by the Device Support Facilities program to define any new surface defects that might have occurred on a track. The 28 bytes transferred by this command are used to rewrite the home address area. The home address area is formatted as follows:

Byte	Description
0 - 13	Skip control
14 - 15	Segment number
16 - 18	Physical address
19	Flag
20 - 21	Cylinder number
22 - 23	Head number
24 - 27	Not used

After checking the validity of the home address, the cache storage director instructs the drive to orient itself on index, write gap G1, and then write the home address and correction code bytes. Bits 0 through 5 of the flag byte are reset to zero before being transferred to the device.

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

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

Error Recovery Procedures

The error recovery procedures contain the error condition table and the error recovery actions for the 3380s that attach to the 3880 Model 13. 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. These actions describe the specific steps for recovering from that error condition. The error condition tables and the recovery action procedures are provided later in this manual.

Console Error Message

The console error messages printed for all permanent errors 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 error recovery action table uses the error correction function as a step in recovering from data errors. The error correction function is used when the cache 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 3380s are corrected internally by the cache 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 23 provide the error pattern and displacement. Error correction is accomplished by aligning the error pattern provided in sense bytes 20 through 23 in format 5 with the erroneous data in main storage and Exclusive ORing the error pattern with the 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 cache storage director specifies the location of the error bytes, relative to the first byte transferred in the operation that encountered 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 is 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 had occurred in the operation that posted the correctable error, the forward displacement may refer to 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 using the error correction function, determine whether one of the following occurred:

- Error bytes were not transferred because the skip bit was on
- There was a short count in the CCW
- 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 main storage because of a short CCW count, the error correction function cannot be used for the bytes that were not transferred.

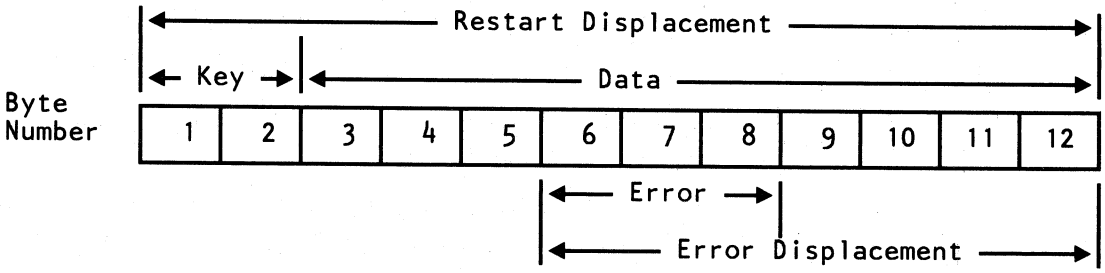
If the error pattern covers nonadjacent main storage boundaries because of data chaining, the error correction function must be selectively applied to the separate storage locations.

If the error displacement in sense bytes 18 and 19 is less than 4, the error is partially or totally contained in the correction code bytes. The error pattern in sense bytes 20 through 23 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 zeros by the error recovery procedures.
2. If the error displacement is 1, the three low-order error pattern bytes (bytes 21 through 23) must be set to zeros by the error recovery procedures. The high-order bytes contain the correction syndrome.
3. If the error displacement is 2, the low-order pattern bytes (bytes 22 and 23) must be set to zeros by the error recovery procedures. The high-order bytes contain the correction syndrome.
4. If the error displacement is 3, the low-order pattern byte must be set to zeros 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. The 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 (-) represents a correct bit and X represents an incorrect bit.

In this 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

Using the error correction function results in the following system recovery action.

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

Restart CCW's

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 procedures specify the restart CCW required—either CCW 1 or CCW 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 1 must be used.

If a write operation was in progress, the data address must specify a byte containing X'00'. If a read operation 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 the restart CCW 2 count to 1. Go to step 3 and include the skip bit in restart CCW flags.
   f. Set the restart CCW 2 count equal to the result of the subtraction in step b. Go step 3.
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 occurs 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 cache storage director procedure that causes an improperly executed or not currently executable command in a channel program to be automatically reexecuted. Command retry is requested when the cache storage director sends unit check with channel end and/or device end and status modifier to the channel. Command retry procedures are device dependent and are not implemented in the same manner for all devices. In some applications,

command retry is performed but the retry status is used to orient the CCW address to the correct main storage location for system error recovery procedures.

On the 3380, 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 3380 devices.
- When a correctable data error occurs in the data area of a record on a 3380, 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 cache 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 cache 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 cache storage director initiates a retry of the last command.
- When a data overrun occurs, the command is reexecuted (unless the data overrun occurred 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 Set Sector, Space Count, Write Home Address, read or search command is received, the cache storage director disconnects from the channel, seeks to the specified track, and reissues the command.
- When data must be transferred from DASD to cache to allow the command chain to continue.
- When the cache storage director must orient the device before continuing the command chain, because the required data is not in cache or the command is not one that operates in cache, and the device is not oriented.

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

- A CCW containing a PCI may, if reexecuted because of command retry, cause multiple PCI interruptions to occur.
- A channel program consisting of a single, unchained CCW specifying an immediate command may cause a condition code of 0 rather than 1 to be set. This condition code is set if the cache 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.

Error Condition Table—3380

Byte	Bit	Name	General Description	Action	Logged
0	0	Command reject	Programming error	2	No
0	1	Intervention required	Drive offline or not installed	3	Yes
0 2	1 3	Intervention required Environmental data present	Device offline (not related to current operation)	4B	No
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—cache storage director retry count exhausted or undesirable	1	Yes
0 1	3 3	Equipment check Message to operator	Permanent equipment malfunction of the alternate cache storage director, a state table save operation in the reporting cache storage director, or the subsystem storage is unusable because of previous failures	4	Yes
0 1 1 2	3 0 3 3	Equipment check Permanent error Message to operator Environmental data present	Subsystem storage failure or communication failure with other cache storage director on internal operation—cache storage director retry count exhausted.	4A	Yes
0 1 2	3 0 3	Equipment check Permanent error Environmental data present	Equipment malfunction—cache storage director retry exhausted or undesirable (not related to current operation)	4A	Yes
0 4	3 2	Equipment check Permanent path error	Permanent equipment check in the path to the addressed device	9	Yes
0	4	Data check	Data check not correctable with a Read Multiple CKD command	4	Yes
0 1	4 0	Data check Permanent error	Uncorrectable data check, storage control retry exhausted (error related to current channel program)	4	Yes
0 1 2	4 0 3	Data check Permanent error Environmental data present	Uncorrectable data check, storage control retry exhausted (Error unrelated to current channel program)	4A	Yes

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

Byte	Bit	Name	General Description	Action	Logged
0 2	4 1	Data check Correctable	Correctable data check in the data area	5	No
0	5	Overrun	Command retry exhausted on a service overrun	4	Yes
1	1	Invalid track format	Track capacity exceeded	2	No
1	2	End of cylinder	Cylinder boundary detected during a multitrack operation	6	No
1 2	3 3	Message to operator Environmental data present	Exit from soft error log mode or subsystem storage availability threshold crossed	4A	Yes
1	4	No record found	Record not found during command sequence	2	No
1	5	File protected	The Seek command or the read/search multitrack operation has violated the file mask or the extent limits	7	No
2 2	2 3	First error log Environmental data present	Soft error logging has been initiated for the device, controller, or subsystem storage	4A	Yes
2	3	Environmental data present	Statistical usage/error log information is present or error log information requires transfer to OBR	4A	Yes

Error Recovery Actions

Action	Explanation
1	a. Print basic console error message. b. If sense format F, print additional console message as defined by sense byte 7.
2	Exit with programming error or unusual condition indication.
3	Repeat the operation. If the error condition occurs a second time, 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 (byte 1, bit 3) is set, 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 basic console message as defined for action 1. b. Repeat the operation. c. If error persists after 256 retries, perform action 1.

5	a. Perform the error correction function.
	
	b. Examine bit 7 of the file mask. If off, 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 the command is a Read Multiple CKD (5E), perform action 5B; otherwise continue. If the CCW chain is not complete, examine the next non-TIC command in the chain. If the CCW is a 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 or (same as original)`
	`Define Extent`
	`Read Home Address (skip bit on)`
	`Search ID Equal (CCHHR from sense bytes 8-12)`
	`TIC-8`
	`TIC (address from 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 through 7 of sense byte 6.

5A

a. Continue the user's chain by executing:

```
Seek                  (see note below)
Set File Mask or      (same as original)
Define Extent
Read Home Address     (skip bit on)
Search ID Equal       (CCHHR from sense bytes 8-12)
TIC-8
Read Count            (skip bit on)
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 through 7 of sense byte 6.

5B

a. 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:

- Construct restart CCW 2.
- Set command code to '5E'.

b. Restart the operation by executing:

```
Seek                  (see note below)
Set File Mask or      (same as original)
Define Extent
Read Home Address     (skip bit on)
Search ID Equal       (CCHHR from sense bytes 8-12)
TIC-8
Read Multiple CKD     (from step 1)
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 through 7 of sense byte 6.

6

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:

```
Seek                  (argument from step a)
Set File Mask or      (same as original)
Define Extent
Set Sector            (argument 0)
Read Home Address     (skip bit is on)
TIC                   (CSW-8)
```

7

a. Determine if the interrupted command is a Seek, Seek Cylinder, or Seek Head. If it is, go to step b. If not, perform action 8. If the seek argument is not within the user's extent, IOS must supply the correct seek argument before issuing the Seek command. If that is impossible, perform action 2.

b. Continue the operation by executing:

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

8

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 command. If that is impossible, IOS must perform action 2.

b. Continue the operation by executing:

Seek	(argument from step a)
Set File Mask or Define Extent	(same as original)
Set Sector	(argument 0)
Read Home Address	(skip bit is on)
TIC	

9

a. Inform IOS that the path is unavailable.

b. Print console message as follows:

1. If sense byte 7 contains X'75', print console message "Path xxx to device SS-CC-DD unavailable, data path switch may be open."

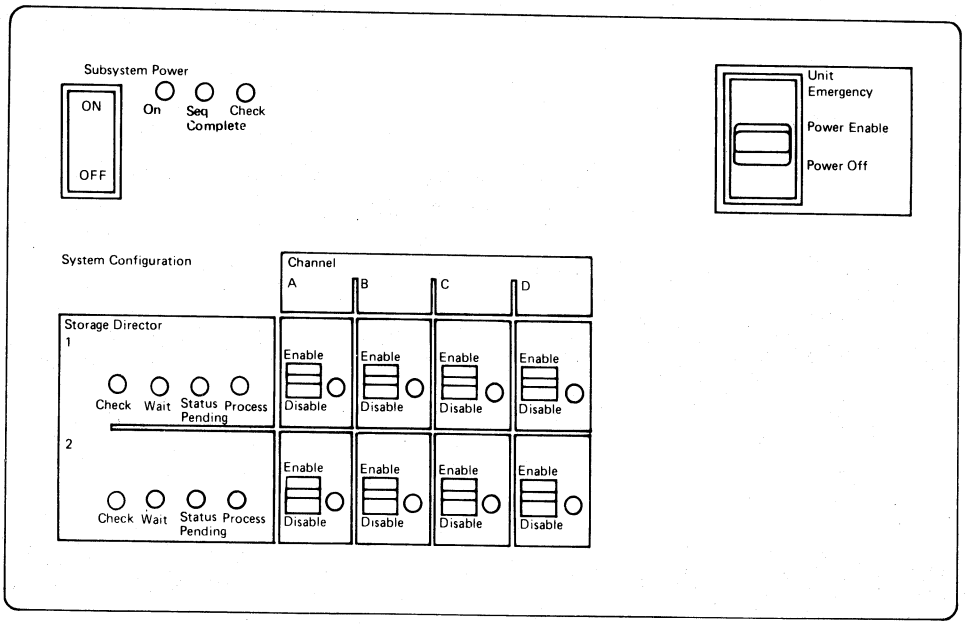
2. If sense byte 7 does not contain X'75', print console message "Path xxx to device SS-CC-DD unavailable."

c. Try any alternate path to the device.

d. If no alternate path is available, print console message "No path to device SS-CC-DD available."

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 complete.

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 information 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 - 3380

Sense information (24 bytes) for the 3380 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 cache 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
- 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 0 count field of a defective track that points to itself instead of to the alternate track
- A received diagnostic command that violated the file mask

Bit 1 - Intervention Required

Bit 1 is set by:

- Addressing a device that is not attached to the system
- Addressing a device that is not ready

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, either cache storage director, subsystem storage, or device. The condition is further defined in sense bytes 7 through 23.

The cache storage director reports this condition when:

- A hardware problem prevents successful completion of an active channel command chain. If retry is not desirable, permanent error (byte 1, bit 0) is also set.

- A hardware problem prevents successful completion of an internal operation (not related to the channel program). Permanent error (byte 1, bit 0) and environmental data present (byte 2, bit 3) are also set.
- The microcode detected that a device has not responded with completion status of a data transfer between cache and DASD. Permanent error (byte 1, bit 0) is also set.
- The cache-to-DASD data transfer is not complete. Environmental data present (byte 2, bit 3) is also set.
- A permanent failure of the other cache storage director is being reported. Message to operator (byte 1, bit 3) is also set.
- Cache operations are terminated because of previously reported failures. Message to operator (byte 1, bit 3) is also set.
- A trace table save operation in the cache storage director is required. Message to operator (byte 1, bit 3) is also set.

Bit 4 - Data Check

Bit 4 is set when the cache storage director encounters:

- A data error in the information received from the device. If correctable (byte 2, bit 1) is also set, the data error is correctable and bytes 20 through 23 provide correction information.
- An uncorrectable data error. Sense byte 7 defines the specific nature of this condition.

  If a DASD-to-cache data transfer operation is not complete, permanent error (byte 1, bit 0) and environmental data present (byte 2, bit 3) are also set.
- A track accessed by a search- or read-type command, or by a Space Count command that does not have a home address and orientation on home address is being attempted as part of the command execution.

Bit 5 - Overrun

Bit 5 is set when the cache 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 commands that result in data overrun conditions are reexecuted by the cache storage director except those that occur during a format write operation, or those that occur during a Read Multiple Count, Key, and Data command.

The cache storage director posts an overrun only if the condition occurs more than 10 times while executing a CCW chain, or if the overrun occurs during one of the above command operations not being reexecuted.

Operations that result in command overruns are also reexecuted by the cache storage director and do not cause an overrun to be posted.

Bits 6 and 7

These bits are not used and are set to zeros.

Sense Byte 1

Bit 0 - Permanent Error

Bit 0 is set, in combination with one or more other sense bits, to indicate that internal error recovery has been attempted and failed, or that internal recovery was not possible or desirable.

Permanent error is set when:

- A hardware equipment check is detected that prevents completion of the channel program. Internal retry has been exhausted or is undesirable. Equipment check (byte 0, bit 3) is also set.

  If the error is not related to the current operation, environmental data present (byte 2, bit 3) is also set.

- The microcode detects that a device has not responded with completion status of a data transfer between the cache and DASD. Equipment check (byte 0, bit 3) is also set.

  If the error is not related to the current operation, environmental data present (byte 2, bit 3) is also set.

- An uncorrectable data check was detected and internal retry has been exhausted. Data check (byte 0, bit 4) is also set.

  If the error is not related to the current operation, environmental data present (byte 2, bit 3) is also set.

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 that exceeded track capacity; this operation resulted in a record being written over the 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 that was successfully written on the track. However, a Search ID command will be executed on any count field written successfully 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.

Bit 3 - Message to Operator

Bit 3 is set when a message, defined by sense byte 7, is sent to the operator console.

The console messages are:

Byte 7	Console Message
01	SENSE DATA LOGGED FOR DEVICE SS-CC-DD
02	SENSE DATA LOGGED FOR CONTROLLER SS-CC-DD
0F	SENSE DATA LOGGED FOR SUBSYSTEM STORAGE SS-XX-XX
F1	MICROCODE LOGICAL ERROR - FAULT CODE = cccc -cuu
F2	SUBSYSTEM STORAGE EQUIPMENT CHECK - FAULT CODE = cccc - cuu
F3	SUBSYSTEM STORAGE AVAILABILITY THRESHOLD CROSSED - cuu
F4	SUBSYSTEM STORAGE UNUSABLE - FAULT CODE = cccc - cuu
F8	STORAGE DIRECTOR COMMUNICATION FAILED - FAULT CODE = cccc - cuu

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 Count or other read operation in the home address area or the data area, or without an intervening write, sense, or control command.

When operating with the device, the cache storage director always verifies that the actuator is positioned correctly before reporting this condition.

Bit 5 - File Protected

Bit 5 is set when:

- A Seek command has violated the file mask or extent limits.
- A multitrack read or search has violated the file mask or extent limits.

Bits 6 and 7

Bits 6 and 7 are not used and are set to zeros.

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 is correctable.

Bit 2 - First Logged Error

Bit 2 is set when the device or subsystem enters logging mode for the soft error indicated by the sense data. Environmental data present (byte 2, bit 3) is also set.

Bit 3 - Environmental Data Present

Bit 3 is set when:

- One of the device buffered log counters or soft error thresholds forces the transfer of usage or error statistics or error log information. Byte 7 indicates the format for bytes 8 through 23.
- An internal operation fails and the error is not related to the current operation. This bit is set along with the appropriate error bit, such as equipment check (byte 0, bit 3) or data check (byte 0, bit 4).

Bits 4 through 7

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

Sense Byte 3 - Controller Identification

This byte contains the controller identification for formats 1, 2, 6, 7, and 8. It identifies the controller for which the sense data is reported.

For formats 0, 3, 4, 5, and F, the byte contains all zeros.

Sense Byte 4 - Device Identification

This byte identifies the physical device for which the sense data is being reported.

When the sense data collected pertains to subsystem storage errors, this byte identifies the device addressed by the command chain as follows:

- Bit 0 indicates that the controller has the dynamic path selection function.
- Bit 1 is not used.
- Bit 2 indicates a permanent path error (Used in format 7 only, otherwise, it is zero).
- Bit 3 is not used.
- Bits 4 through 7 contain the device address.

For format F message codes 1, 2, 3, 4, and 8, this byte contains all zeros.

Sense Byte 5

This byte contains different types of information depending up the format being reported in sense byte 7 as follows:

- 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.
- If formats 0, 1, 2, 4, 5, 7, 8, or 3 with message code 8 are indicated, this byte identifies 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

- 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 communication failure occurred between cache storage directors during IML as follows:

  Bit 0 indicates a communication failure during an IML
  Bit 1 is not used
  Bits 2-4 contain the number of diskette seek checks
  Bits 5-7 contain the number of diskette read checks

If format F is indicated, this byte contains all zeros.

Sense Byte 6

This byte contains different types of information depending on the format being reported in sense byte 7 as follows:

- If format 3 and not message code 8 are indicated, this byte contains the low-order byte of the instruction address register at the time the error occurred.
- If formats 0, 1, 2, 4, 5, 7, or 8, or 3 with message code 8 are indicated, this byte contains 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, as follows:

  Bits 0-1 are not used
  Bit 2 indicates cylinder 512
  Bit 3 indicates cylinder 256
  Bits 4-7 contain the head address

- If format 6 is indicated, this byte identifies the cache storage director.
- If format F is indicated, this byte contains all zeros.

Sense Byte 7

Bits 0 through 3 - Format

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

Bits 0-3	Meaning
0000	Format 0 - Program or system checks
0001	Format 1 - Device check 2
0010	Format 2 - Cache storage director equipment check
0011	Format 3 - Cache storage director control check
0100	Format 4 - Uncorrectable data checks
0101	Format 5 - Correctable data checks
0110	Format 6 - Usage statistics/overrun errors
0111	Format 7 - Controller check 1
1000	Format 8 - Controller check 2 and device check 1
1111	Format F - Subsystem storage errors

Note: Format 5 may also be presented on errors that are not ECC correctable but 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 through 23 contain the following data:

Bytes 8 through 19

Bytes 8 through 19 are not used and are set to zeros.

Byte 20

Byte 20 contains the controller physical identifier if message to operator (byte 1, bit 3) is set.

Byte 21

Byte 21 contains the storage director physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format 0

If message to operator (byte 1, bit 3) is zero, the messages for format 0 are as follows:

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	No message. No additional information is required.
0001	1	Invalid command was issued to the 3880.
0010	2	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.
0101	5	A diagnostic command was issued when not permitted by the file mask.
0110	6	Retry status was presented and the channel did not indicate chaining.
0111	7	The command code of the CCW returned after a retry sequence did not match the command for which the retry was signaled.
1000-1010	8-A	Not used.
1011	B	The alternate track pointer of a defective track pointed to the defective track.
1100	C	The Dynamic path selection function not installed in both 3380 storage facilities.
1101-1110	D-E	Not used.
1111	F	The Set High-Performance Storage Limits command failed.

If message to operator (byte 1, bit 3) is 1, the messages for format 0 are as follows:

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	No message. No additional information is required.
0001	1	Sense data has been logged for the device.
0010	2	Sense data has been logged for the controller.
0011-1110	3-E	Not used.
1111	F	Sense data has been logged for subsystem storage.

Format 1 - Device Check 2

Format 1 is generated when:

- A device, device interface, or a controller equipment check is detected. Equipment check (byte 0, bit 3) is set.
- A permanent device seek check is detected. Equipment check (byte 0, bit 3) and permanent error (byte 1, bit 0) are set. The message bits in sense byte 7 indicate a seek error.

  If the error is not associated with the current operation, environmental data present (byte 2, bit 3) is also set.
- A permanent device equipment check, permanent device interface check, or permanent controller equipment was detected during a DASD to cache data 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. Equipment check (byte 0, bit 3) is set.
- Error log information is off-loaded after successfully reexecuting a command that resulted in a seek check during error logging. Environmental data present (byte 2, bit 3) is set and the message code in byte 7 indicates a seek error.
- Online (byte 8, bit 4) is not found in drive status. Intervention required (byte 0, bit 1) is set.

Bytes 8 through 23 contain the following data:

Byte 8 - DDC Bus Out

Byte 8 contains the command code for messages 1, 4, 5, 6, 8, D, and F.

Byte 9 - DDC Bus In

Byte 9 contains the end operation code for message 0, and the response to the command for messages 1, 4, 5, 6, 8, D, and F.

Byte 10 - Device Power Status

Bit	Description
0	Not used
1	Motor thermal
2	No air flow
3	Device sequence complete
4	Motor run latch on
5	Motor contactor active
6	Motor brake latch on
7	Brake applied

Byte 11 - Device Check Register

Bit	Description
0	Device Sequencer check
1	Servo control check
2	RPS check
3	Check point check
4	Not used
5	Power card check
6	Read/write check
7	Not used

Byte 12 - Read/Write Status 1

Bit	Description
0	Matrix error (right actuator)
1	Matrix error (left actuator)
2-4	Matrix sense
5	Write data cable check
6	Read/write PLO cable check
7	Data detector voltage check

Byte 13 - Read/Write Status 2

Bit	Description
0	Matrix selection check
1	Padding check
2	Write sequence check
3	Read sequence check
4	Read/write control check
5	Write overrun check
6	Read/write servo check
7	HAR parity check

Byte 14

This byte is not used.

Byte 15 - Checkpoint Log

Bit	Description
0	Error detected
1-7	Checkpoint log

Byte 16 - Track Physical Address Read or Expected Status

Byte 16 contains the physical address (0 to 255) of the track that was read for messages 7, A, and E, or the expected device status 1 for message 1.

Byte 17 - Track Physical Address Read

Byte 17 contains the physical address of the track that was read for messages 7, A, and E.

Bit	Description
0-1	Not used
2	Cylinder address 512
3	Cylinder address 256
4-7	Head address

Byte 18

Byte 18 is not used.

Byte 19 - Device Status 1

Bit	Description
0	Pad in progress
1	Servo inhibited
2	Seek incomplete
3	Set sector incomplete or drive check 2
4	Online
5	HDA attention
6	Device busy
7	Seek or Set Sector interrupt or sector search

Byte 20 - Device Status 2

Bit	Description
0	Device logic disabled
1	Surge incomplete
2	Offset active
3	Drive motor switch
4	Access mechanism logic exchanged
5	Not used
6	Right access mechanism selected
7	Left access mechanism selected

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format 1

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	No message. No additional information is required.
0001	1	Device status 1 was not as expected.
0010	2	Not used.
0011	3	Missing index.
0100	4	Interrupt not resettable.
0101	5	Device does not respond to selection.
0110	6	Device check 2 or set sector was incomplete.
0111	7	Head address did not compare.
1000	8	Invalid device status 1.
1001	9	Device is not ready to do customer work
1010	A	Track physical address did not compare while oriented.
1011	B	Not used.
1100	C	Drive motor switch was sensed off.
1101	D	Seek was incomplete.
1110	E	Cylinder address did not compare.
1111	F	Offset active is not resettable.

Format 2 - Cache Storage Director Equipment Check

Format 2 is generated to provide sense information when the microcode detects an error condition in the cache storage director.

Bytes 8 through 23 contain the following data:

Byte 8

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

Byte 9

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

Byte 10

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

Byte 11

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

Byte 12

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

Byte 13

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

Byte 14

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

Byte 15

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

Byte 16

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

Byte 17

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

Byte 18

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

Byte 19

Byte 19 is not used.

Byte 20

Byte 20 contains the microcode detected error code for message F.

The error codes are as follows:

X'10' = CTL-I tag out sequence check
X'20' = CTL-I bus out check

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format 2

Sense Byte 7, Bits 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 byte 20.

Format 3 - Storage Director Control Check

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

If sense byte 7 contains format 3 message code 8, bytes 8 through 23 contain the following data:

Byte 8

Byte 8 contains the contents of field replaceable unit (FRU) register 2.

Byte 9

Byte 9 contains the contents of the check register 1.

Byte 10

Byte 10 contains the contents of the check register 2.

Byte 11

Byte 11 contains the contents of the check register 3.

Bytes 12 to 14

Bytes 12 to 14 are not used.

Byte 15

Byte 15 contain the contents of FRU register 3.

Byte 16

Byte 16 contain the contents of FRU register 4.

Bytes 17 through 20

Bytes 17 through 20 are not used.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

If sense byte 7 does not contain format 3 message code 8, bytes 8 through 23 contain the following data:

Byte 8

Byte 8 is not used.

Byte 9

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

Byte 10

Byte 10 contains the contents of the check register.

Byte 11

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

Byte 12

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

Byte 13

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

Byte 14

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

Byte 15

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

Byte 16

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

Byte 17

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

Byte 18

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

Byte 19

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

Byte 20

Byte 20 contains the last interrupt level. If the symptom code in bytes 22 and 23 is X'3F2X', this byte contains an interval timer message code.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format 3

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000-0111	0-7	Reserved
1000	8	Clock stopped (check 1).
1001	9	Channel check 1 or cache storage director timeout occurred.
1010	A	Trace table saved in this cache storage director.
1011-1111	B-F	Reserved.

Format 4 - Uncorrectable Data Checks

Format 4 is generated when:

- Errors that were not correctable by the ECC are detected after retry has been unsuccessful. Permanent error (byte 1, bit 0) and data check (byte 0, bit 4) are set.

  If the error is not related to the current operation, environmental data present (byte 2, bit 3) 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. Environmental data present (byte 2, bit 3) is set.

Bytes 8 through 23 contain the following data:

Bytes 8 through 12 - Record Identification

Bytes 8 through 12 contain the record ID obtained from the count field of the record in which the error occurred. The record number in byte 12 is zero if the message code is 0 to 4.

These bytes may be unreliable after a Space Count command, if no sync byte is found in the count area, or if the message code in byte 7 is 0, 1, 4, 5, 8, 9, C, or D.

Byte 13 - Sector Number

Byte 13 contains the sector number of the record in error.

Byte 14 - Controller Identification

Byte 14 contains the controller physical identifier.

Byte 15 - Head Offset

If environmental data present (byte 2, bit 3) is set, this byte contains the head offset last used for retrying a data check.

Bytes 16 through 20

Bytes 16 through 20 are used.

Byte 21

Byte 21 contains the cache storage director physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format 4

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	An error occurred in the home address area and could not be corrected by the ECC.
0001	1	An error occurred in the count area and could not be corrected by the ECC.
0010	2	An error occurred in the key area and could not be corrected by the ECC.
0011	3	An error occurred in the data area and could not be corrected by the ECC.
0100	4	Data synchronization on the home address area was unsuccessful.
0101	5	Data synchronization on the count area was unsuccessful.
0110	6	Data synchronization on the key area was unsuccessful.
0111	7	Data synchronization on the data area was unsuccessful.
1000	8	An error occurred in the home address area and could not be corrected by the ECC (access offset active).
1001	9	An error occurred in the count area and could not be corrected by the ECC (access offset active).
1010	A	An error occurred in the key area and could not be corrected by the ECC (access offset active).
1011	B	An error occurred in the data area and could not be corrected by the ECC (access offset active).
1100	C	Data synchronization on the home address area was unsuccesful with access offset active.
1101	D	Data synchronization on the count area was unsuccessful with access offset active.
1110	E	Data synchronization on the key area was unsuccessful with access offset active.
1111	F	Data synchronization on the data area was unsuccessful with access offset active.

Format 5 - Correctable Data Checks

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 and the file mask specified PCI fetch mode. 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. The message code in byte 7 indicates the area which contained the error. Environmental data present (byte 2, bit 3) is set.
- Data checks are detected while processing a Read Multiple Count, Key, and Data command. Data check (byte 0, bit 4) and correctable (byte 2, bit 1) are set.
- An ECC correctable data check is encountered in the home address area when retry is inhibited by the file mask. Data check (byte 0, bit 4) and correctable (byte 2, bit 1) are set.

Bytes 8 through 23 contain the following data:

Bytes 8 through 12 - Record Identification

Bytes 8 through 12 contain the record identification (CCHHR) obtained from the count field of the record in which the error occurred. These bytes may be unreliable after a Space Count command or if the message code in byte 7 is 0, 1, 8, or 9. The record (R) number in byte 12 is zero if the error is in the home address.

Byte 13 - Sector Number

Byte 13 contains the sector number of the record in error.

Byte 14 - Controller Identification

Byte 14 contains the controller physical identifier.

Bytes 15 through 17

If byte 2, bit 3 (environmental data present) is zero, bytes 15 through 17 contain the restart displacement.

If byte 2, bit 3 is a 1, the format is as follows:

Byte 15 contains the head offset.
Byte 16 contains the cache storage director physical identifier.
Byte 17 is not used.

Bytes 18 and 19

Bytes 18 and 19 contain the error displacement.

Bytes 20 through 23

Bytes 20 through 23 contain the error correction pattern.

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	Home address correctable data check occurred.
0001	1	Count area correctable data check occurred.
0010	2	Key area correctable data check occurred.
0011	3	Data area correctable data check occurred.
0100-0111	4-7	Not used.

The following messages apply only when environmental data present (byte 2, bit 3) is set.

Sense Byte 7, Bits 4-7 =	Message Code	Message
1000	8	Correctable home address data check with offset active.
1001	9	Correctable count area data check with offset active.
1010	A	Correctable key area data check with offset active.
1011	B	Correctable data area data check with offset active.
1100-1111	C-F	Not used.

Format 6 - Usage Statistics/Overrun Errors

Format 6 is generated when:

- A Read and Reset Buffered Log command is executed.
- Usage/error statistics require offloading due to counter overflow.

Bytes 8 through 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 cache 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 through 15

Bytes 12 through 15 are not used.

Bytes 16 and 17 - Number of Seeks

Bytes 16 and 17 contain the number of access motions processed by the cache storage director. The number does not include access motions due to the Recalibrate and retried Seek commands.

Byte 18

Byte 18 is not used.

Byte 19 - Command Overruns

Byte 19 contains the number of command overruns that occurred on the channel specified by the message in byte 7. The number does not include number of channel retries.

Byte 20 - Data Overruns

Byte 20 contains the number of data overruns that occurred on the channel specified by the message in byte 7. The number does not include the number of channel retries nor any suppressible errors.

Byte 21

Byte 21 contains the cache storage director physical identifier.

Bytes 22 and 23

Bytes 22 and 23 are not used.

Message Table - Format 6

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000-0111	0-7	Reserved for other types of storage control units.
1000	8	Channel A overruns occurred (bytes 19 and 20).
1001	9	Channel B overruns occurred (bytes 19 and 20).
1010	A	Channel C overruns occurred (bytes 19 and 20).
1011	B	Channel D overruns occurred (bytes 19 and 20).
1100	C	Channel E overruns occurred (bytes 19 and 20).
1101	D	Channel F overruns occurred (bytes 19 and 20).
1110	E	Channel G overruns occurred (bytes 19 and 20).
1111	F	Channel H overruns occurred (bytes 19 and 20).

Format 7 - Controller Check 1

Format 7 is generated to provide sense information when a controller type 1 (Check 1) error occurs. This format also indicates that a path error exists between the cache storage director and the 3380 controller.

Bytes 8 to 23 contain the following data:

Byte 8 - DDC Bus Out

Byte 8 contains the command code for messages 8 and 9. At other times this byte contains the DDC bus out contents when an RCC sequence is executed.

Byte 9 - DDC Bus In

Byte 9 contains the 3380 response to initial selection for message 5. At other times this byte contains the DDC bus in contents when a RCC sequence is executed.

Byte 10 - DTI/XES Registers

Byte 10 contains the cache storage director device tag in (DTI) and transfer error status (XES) register contents.

Bit	Description
0	Connection check alert
1	Tag in check
2	Sync in check
3	DDC bus in parity check
4	Tag in—null disconnect (00)
5	Tag in—valid/sync in (01)
6	Tag in—selected null (11)
7	Tag in—end operation (10)

Byte 11 - Controller Check Alert

Bit	Description
0	Controller 0 connection check alert (CCA)
1	Controller 1 connection check alert (CCA)
2	Controller dynamic path selection unconditional reserve/release controller 0
3	Controller dynamic path selection unconditional reserve/release controller 1
4	Controller 0 power on
5	Controller 1 power on
6-7	Not used

Byte 12 - Controller 0, Check 1

Bit	Description
0-2	I/O control 1 card checks
3	DDC Bus out parity check
4	Controller clock check
5	Controller sequencer check
6	DDC bus in parity check
7	I/O control card 2 check 1

Byte 13 - Controller 0, Check 1

Bit	Description
0	DDC tag out sequence check
1	Extended tag command sequence check
2	Sequencer detected check
3	Controller gate DDC drivers check
4	RCC clock check
5-7	Not used

Bytes 14 and 15 - Controller 1, Check 1

Same as bytes 12 and 13 for controller 1.

Byte 16 - Controller 0, Sequencer Address

Bit	Description
0	Address 2048
1	Address 1024
2	Address 512
3	Address 256
4	Address 128
5	Address 64
6	Address 32
7	Address 16

Byte 17 - Controller 0, Sequencer Address

Bit	Description
0	Address 8
1	Address 4
2	Address 2
3	Address 1
4	Power on complete
5	Check 2 active
6	Successful transfer complete
7	Always 0

Bytes 18 and 19 - Controller 1, Sequencer Address

Same as bytes 16 and 17 for controller 1.

Byte 20

Byte 20 is not used.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contains the symptom code.

Message Table - Format 7

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	RCC initiated by a connection check alert (CCA).
0001	1	RCC1 sequence not successful.
0010	2	RCC1 and RCC2 sequence not successful.
0011	3	Invalid tag in during selection sequence.
0100	4	Extra RCC required.
0101	5*	Invalid DDC selection response or cache storage director timeout.
0110	6	Missing end operation, transfer was complete.
0111	7	Missing end operation, transfer was incomplete.
1000	8	Invalid tag in on immediate command sequence.
1001	9	Invalid tag in on extended command sequence.
1010	A	Timeout on deselection.
1011	B	No response to selection after a poll interrupt.
1100	C	Controller not available.
1101	D	Controller not available on disconnected command chain.
1110-1111	E-F	Not used.

*If a cache storage director has had previous communications with a controller that can not now be selected, equipment check (byte 0, bit 3) and message to operator (byte 1, bit 3) are set and message 5 indicates the condition. If there had been no previous communications with the controller, condition code 3 is returned and the console message DATA PATH SWITCH MAY BE OPEN is displayed. This indicates a condition that possibly can be corrected by the user.

Format 8 - Controller Check 2 and Device Check 1

Format 8 is generated to provide sense information when a controller check 2 and device check 1 occurs.

Bytes 8 to 23 have the following data:

Byte 8 - DDC Bus Out

Byte 8 contains the command code.

Byte 9 - DDC Bus In

Byte 9 contains the 3380 end of operation response for messages 3, 4, and 5, or if sense byte 10, bit 7 is a 1.

Byte 10 - DTI/XES Registers

Byte 10 contains the storage director device tag in (DTI) transfer error status (XES) register contents.

Bit	Description
0	Connection check alert
1	Tag in check
2	Sync in check
3	DDC bus in parity check
4	Tag in—null disconnect (00)
5	Tag in—valid/sync in (01)
6	Tag in—selected null (11)
7	Tag in—end operation (10)

Byte 11 - Controller Fault Log A

Bit	Description
0	SERDES shift or load check
1	Write encode failure
2	Data handling PLO multi-select check
3	DHPLO non-drive check
4	Multiplexer parity check
5	Not used
6	CDP multiport selection check
7	Device address response check

Byte 12 - Controller Fault Log B

Bit	Description
0	SERDES control check
1	Serial data check
2	Data handling PLO failed to lock check
3	Read/write cable check
4	CDP register check
5	I/O control card 2 check
6	Precompensation check
7	Selected device check 1

Byte 13 - Controller Fault Log C

Bit	Description
0	ECC logic check 1
1	DXB SERDES parity check
2	DXB to SERDES parity check
3	ECC logic check 2
4	String configuration 0
5	String configuration 1
6	CDP bus parity check
7	CDP active drivers

Byte 14 - Controller Fault Log D

Bit	Description
0	Device A check 1
1	Device B check 1
2	Device C check 1
3	Device D check 1
4	Drive clock check
5	Isolation bit
6	Port selection bit
7	Port selection bit

Byte 15 - Controller Fault Log E

Bit	Description
0	DPS A-bus multiplexer check
1	DPS internal check
2	DPS array not equal
3	DPS alternate check
4	DPS storage address check
5	DPS bus out, tag out, or command bus check
6	DPS lock bus check
7	Gap 3 control check

Byte 16 - Controller Sequencer Address

Bit	Description
0	Address 2048
1	Address 1024
2	Address 512
3	Address 256
4	Address 128
5	Address 64
6	Address 32
7	Address 16

Byte 17 - Controller Sequencer Address

Bit	Description
0	Address 8
1	Address 4
2	Address 2
3	Address 1
4	Power on complete
5	Check 2 active
6	Successful transfer complete
7	Always 0

Byte 18 - Controller Fault Log F

Bit	Description
0	DXB bus out parity check
1	DXB bus in parity check
2	DXB control check
3	R/W gate DDC driver check
4	DHPLO delta frequency check
5-7	Not used

Byte 19 - Device Status 1

Bit	Description
0	Pad in progress
1	Servo inhibited
2	Seek incomplete
3	Check 2 or Set Sector incomplete
4	Online
5	HDA attention
6	Device busy
7	Seek or Set Sector interrupt or sector search

Byte 20 - Device Status 2

Bit	Description
0	Device logic inactive
1	Surge incomplete
2	Offset active
3	Drive motor switch
4	Access mechanism logic exchanged
5	Not used
6	Right access mechanism selected
7	Left access mechanism selected

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format 8

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	No message. No additional information required.
0001	1	ECC hardware check.
0010	2	Not used.
0011	3	Unexpected end operation response code received.
0100	4	End operation received with transfer count not equal to zero.
0101	5	End operation received with transfer count equal to zero.

Sense Byte 7, Bits 4-7 =	Message Code	Message
0110	6	Dynamic path selection cleanup stopped after a channel or system reset.
0111	7	Dynamic path selection array cannot be initialized.
1000-1111	8-F	Not used

Format F - Subsystem Data

Format F is generated when:

- A microcode logic error is detected by the cache storage director microcode.
- An equipment check or microcode detected equipment failure is detected in subsystem storage.
- The amount of subsystem storage space decreased across a reporting boundary.
- Cache operations are suspended because of insufficient space or because of a subsystem storage failure.
- Cache operations are suspended because of communication failures between cache storage directors or because subsystem storage failures occurred that prevented subsystem storage initialization.

The format of sense bytes 8 through 23 depend on the message received.

Bytes 8 through 23 - Message 0

Bytes 8 through 23 contain the following for message 0.

Bytes 8 through 20

Bytes 8 through 20 are not used.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Bytes 8 through 23 - Message 1

Bytes 8 through 23 contain the following format for message 1.

Byte 8

Byte 8 contains the microcode logic error code.

Byte 9

Byte 9 contains the high-order byte of the instruction address register.

Byte 10

Byte 10 contains the low-order byte of the instruction address register.

Byte 11

Byte 11 contains the mark stack high.

Byte 12

Byte 12 contains the mark stack low.

Byte 13

Byte 13 has the contents of the IRG register.

Bytes 14 through 20

Bytes 14 through 20 are not used.

Byte 21

Byte 21 contains the cache storage director's physical identifier

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Bytes 8 through 23 - Message 2

Bytes 8 through 23 contains the following for message 2.

Byte 8

Byte 8 contains the contents of the external port check register.

Bit	Description
0	Always zero
1	Invalid operation code
2	Port check
3	Data transfer check
4	EPC data in check
5	EPC data out check
6	EPC control check
7	Run sequence check

Byte 9

Byte 9 contains the contents of the external port status register.

Bit	Description
0	Port data ready
1	Operation complete
2	Summary check
3	Run active
4	Degate channel active
5	Degate device active
6	Data transfer complete
7	Timer overflow

Byte 10

Byte 10 contains the contents of the address operations register.

Bit	Description
0-2	SSAR address
3	Address extension
4-7	Operation code

Bytes 11 through 13

Bytes 11 through 13 contain the port identification and failing address of subsystem storage.

Byte 14

Byte 14 contains subsystem storage sense byte 2.

Bit	Description
0	CRC parity check
1	General error
2	Port data in check
3	Port data out check
4	CRC storage check
5	EPC address bus parity check
6	Byte counter parity check
7	AOR parity check

Byte 15

Byte 15 contains subsystem storage sense byte 3.

Bit	Description
0	Double bit ECC check
1	Storage address parity check
2	Port bus out parity check (high)
3	Single bit ECC correction
4	Refresh counter parity check
5	Port bus out parity check (low)
6	SSAR write/load/data check
7	SSAR address check

Byte 16

Byte 16 contains subsystem storage sense byte 4.

Bit	Description
0	Storage bus odd bytes parity check
1	Storage bus even bytes parity check
2	ECC odd bytes parity check
3	ECC even bytes parity check
4	Invalid address check
5	Refresh address parity check
6-7	Always zero

Byte 17

Byte 17 contains subsystem storage sense byte 5.

Bit	Description
0	Always zero
1	ECC control odd (active)
2	ECC control even (active)
3	Channel speed
4	CRC inhibit/accumulate active
5	Force SSAR check active
6-7	Always zero

Bytes 18 through 20

Bytes 18 through 20 are not used.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Bytes 8 through 23 - Messages 3 and 4

Bytes 8 through 23 contain the following for messages 3 and 4.

Bytes 8 through 11

Bytes 8 through 11 contain the amount, in bytes, of subsystem storage capacity available.

Bytes 12 through 15

Bytes 12 through 15 contain the amount, in bytes, of subsystem storage capacity offline.

Bytes 16 through 19

Bytes 16 through 19 contain the amount, in bytes, of subsystem storage capacity that is bound.

Byte 20

Byte 20 contains the amount, in megabytes, of configured subsystem storage capacity.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Bytes 8 through 23 - Message 8

Bytes 8 through 23 contain the following for message 8.

Byte 8

Byte 8 contains the following error codes.

X'02' = No response from other cache storage director

X'03' = DPS array lock timeout

X'06' = No controller available

X'0D' = Internal command chain timeout error

X'0E' = Internal command chain logical error

Bytes 9 through 19

Bytes 9 through 19 contain all zeros.

Byte 20

Byte 20 contains physical identifier of the controller.

Byte 21

Byte 21 contains the cache storage director's physical identifier.

Bytes 22 and 23

Bytes 22 and 23 contain the symptom code.

Message Table - Format F

Sense Byte 7, Bits 4-7 =	Message Code	Message
0000	0	Operation terminated.
0001	1	Microcode logic error.
0010	2	Subsystem storage equipment check.
0011	3	Availability threshold crossed.
0100	4	Cache operations terminated.
0101-0111	5-7	Not used.
1000	8	Cache storage director communication failure.
1001-1111	9-F	Not used.

Appendix—Device Addressing

The following table lists all the valid device addresses that can be used on both cache storage directors of the Model 13.

Note: The address switches on the 3880 channel interface card, numbered 1 through 8, correspond to bit positions 0 through 7. Therefore, bits 3 and 4 correspond to switches 4 and 5.

CONFIGURATION	VALID ADDRESSES (HEXADECIMAL)			
1 string of 3380s	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
2 strings of 3380s	00-1F 20-3F	40-5F 60-7F	80-9F A0-BF	C0-DF E0-FF

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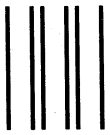

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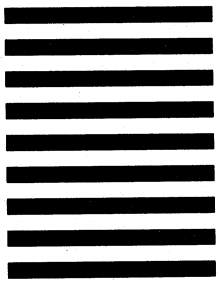

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