**Reference Manual for
IBM 3830
Storage Control Model 2**

Systems

IBM

PREFACE

The IBM 3830 Storage Control Model 2 (3830-2) and its attached disk storage devices provide high speed direct-access storage for general purpose data storage and system residence. Attached to the central processing unit through a block multiplexer or selector channel, the 3830-2 operates under direct program control of the CPU.

For experienced programmers, this manual provides readily accessible reference material related to channel command words, sense bytes, and error recovery.

Less experienced programmers will find sufficient.information to create channel programs to best utilize the standard and special features of the 3830 Storage Control Model 2.

This manual is organized by the following topics:

- INTRODUCTION — describes the basic units and lists highlights and functions.
- INPUT/OUTPUT — describes operation between the channel and the storage control.
- CHANNEL COMMANDS — lists each command and describes its use.
- CHANNEL PROGRAM EXAMPLES — gives programming examples and command usage.

- STANDARD FEATURES — describes command retry, rotational position sensing (with formula for calculating sector positions), and other standard features.
- SPECIAL FEATURES — describes two channel switch and two channel switch additional operation.
- ERROR RECOVERY PROCEDURES — explains the error correction function and construction of Restart channel command words.
- OPERATING INSTRUCTIONS — gives a complete description of switches and indicators on the 3830-2 operator panel for systems installation operators.

A complete summary of sense information is contained in Appendix A.

Programmers should be familiar with the information contained in *IBM System/360 Principles of Operation,* Order No. GA22-6821, and *IBM System/370 Principles of Operation,* Order No. GA22-7000. Operators should be familiar with the material presented in the system summary for the parent system. Order numbers for system summary and other related publications can be found in *IBM System/360 and System/370 Bibliography,* Order No. GA22-6822.

For definitions of terms used in connection with direct-access storage devices, see *Data Processing Glossary,* Order No. GC20-1699.

CONTENTS

INTRODUCTION

The IBM 3830 Storage Control Unit (3830-2) provides the logical capabilities necessary to operate and control IBM 3330 Series and 3340 disk storage modules.

The 3830-2 can be attached to an IBM System/360 Model 195 or to IBM System/370 Models 135, 145, 155-II, 158, 165-II, 168, and 195. Attachment to the System/360 Model 195 and System/370 Models 165-II, 168, and 195 is made via an IBM 2880 Block Multiplexer Channel. Attachment to System/370 Models 135, 145, 155-II, and 158 is made via the system block multiplexer channel or system selector channel.

The 3330 series and 3340 disk storage can be attached in the following configurations:

3330 Series	3340
1 to 2 IBM 3333 Disk Storage and Control or 1 to 4 IBM 3333 Disk Storage and Control with 32 Drive Expansion Feature	1 to 2 IBM 3340-A2 Disk Storage and Control or 1 to 4 IBM 3340 Disk Storage and Control with 32 Drive Expansion Feature
1 to 3 IBM 3330 Disk Storage modules per 3333	1 to 3 IBM 3340-B1/B2 Disk Storage per 3340-A2

FEATURES

The 3830-2 storage control provides or supports the following standard features:

- Command Retry
- Multiple Requesting
- Multiple Track Operation
- Record Overflow
- End-of-File
- Rotational Position Sensing

These special features are also available:

- Two Channel Switch
- Two Channel Switch Additional
- 32 Drive Expansion
- 3330/3340 Intermix
- String Switch

Note: Two channel switch additional, with string switch, 32 drive expansion, and 3330/3340 intermix require control store extension as a prerequisite. Control store extension adds control storage for microprogram use.

Command Retry (3330 series only)

Command retry is a channel/storage control procedure that causes an improperly executed command in a channel program to be automatically retried. The re-execution does not cause an I/O interrupt, and programmed error recovery procedures are not required.

Multiple Requesting

Use of block multiplexer channels and disk drives with rotational position sensing capabilities allows the 3830-2 and its attached drives to disconnect from the channel during mechanical delays resulting from execution of arm positioning Seek or Set Sector commands. Reconnection is attempted when the access mechanism is positioned at the desired track or when the specified rotational position has been reached.

During the time the channel and 3830-2 are disconnected, the CPU is free to initiate I/O operations on other drives attached to the 3830-2, even though the disconnected channel program is not completed. Thus, separate channel programs may be operating simultaneously on each drive attached to the storage control.

Multiple Track (MT) Operation

On all Search and most Read commands, the 3830-2 can automatically select the next sequentially numbered head on a drive. This eliminates the need for Seek Head commands in a chain of Read or Search commands.

Record Overflow

The record overflow function provides a means of processing logical records that exceed the capacity of a track. When using overflow records, the factor limiting the size of the record is the cylinder boundary.

A special channel command (Write Special Count, Key, and Data) is used to format the disk pack for record overflow operation.

End-of-File

An end-of-file record, used to define the end of a logical group of records, is written by executing a Write Count, Key, and Data command with a data length of zero. Execution of this command causes the 3830-2 to direct the addressed drive to write a data area consisting of one byte of zeros.

When the end-of-file record is processed, detection of the zero data length causes unit exception status to be generated.

Two Channel Switch

The two channel switch special feature provides the ability for the IBM 3830-2 Storage Control to be shared by two channels. The channels may be attached to either the same

- Issues I/O instructions.
- Stores data.
- Stores status.
- Stores channel program.

- Fetches channel address word.
- Fetches channel commands.
- Controls transfer of data between 3830-2 and CPU.

Channel

CPU

I/O Instructions
Data
Status

I/O Commands
Data
Status
Command Retry

Disk Storage and Control
Data
I/O Commands
Status

Disk Storage

3830-2

- Interprets and executes commands from channel.
- Controls channel and disk storage interfaces.
- Furnishes status to system.
- Performs diagnostic evaluation of storage control and drives.

- Responds to commands from 3830-2.
- Positions access mechanism.
- Selects head.

- Reads or writes data.
- Serializes and deserializes data.
- Performs both error detection and error correction.

Figure 1. Functional Description

or different central processing units. Individual drives may be reserved for the exclusive use of either of the channels. Channel switching and device reservation are controlled by the channel program. Two special commands are associated with two channel switch operation: Device Reserve and Device Release.

Two Channel Switch Additional

The two channel switch additional special feature permits the 3830-2 to be accessed by up to four channels, two of which may be on the same CPU. Individual drives attached to the 3830-2 may be reserved for the exclusive use of any of the four channels. Channel switching and device

reservation are controlled by the channel program. The two channel switch commands (Device Reserve and Device Release) are also used with this feature. Two channel switch is a prerequisite and control store extension is a prerequisite if string switch is included.

32 Drive Expansion

The 32 drive expansion feature allows up to four disk storages and control or a maximum of 32 drives to be attached to the 3830-2. The basic 3830-2 can operate two disk storages and control; an additional two are possible with 32 drive expansion. Control store extension is a prerequisite for 32 drive expansion.

3330/3340 Intermix

The 3340/3340 intermix feature permits the mixing of 3330 and 3340 disk storage on the 3830-2. Control store extension is a prerequisite.

Consult your IBM Sales Representative for details.

String Switch Feature

The string switch feature allows a 3333 disk storage and control and its attached string of 3330 disk storage modules or a 3340-A2 disk storage and control and its attached string of 3340 disk storage modules to be dynamically shared by various storage control attachments.

The string switch is similar to the two channel switch feature for the 3830 storage control.

ERROR DETECTION AND CORRECTION

CPU Parity

To check data accuracy, a parity bit is associated with each byte within the CPU and channel. When a byte is formed, the parity bit is set to either 1 or 0 to maintain an odd number of 1-bits within the byte (that is, odd parity). Each byte of data to be written is checked for correct parity as it is received by the IBM 3830-2.

Error Correction Code

As data is transferred from the channel to disk storage (Write operation), the 3333 or 3340-A2 removes the parity bit associated with each byte. It then computes the error correction code bytes, which are written after each recorded area. The correction code bytes, coded to represent the data in the recorded area, are used for both error detection and correction.

As data is transferred from disk storage to the channel (Read operation), each area is inspected and the error correction code bytes are recalculated for each area. The correction code provides for detection and correction of single burst errors.

With 3330 series devices, if a correctable data error is detected in the home address, count, or key areas, the storage control internally executes the error correction function through the use of command retry. (See "Command Retry.") With either 3330 or 3340 series devices, if an uncorrectable data error is detected, or if a correctable data error is detected in a data area, the correction function is determined by the system error recovery procedures. (See "Error Recovery Procedures.")

The correction code bytes are removed and proper parity is generated by the Disk Storage and Control before the data is transferred to the 3830-2.

Data Integrity

Unless corrected immediately, undetected write errors cause read errors. Therefore, where data integrity is required, verification should be incorporated within the program. Thus, in the event of write errors, the record can be rewritten and verified before the original data is destroyed.

Either of two verification methods may be used: full read-back check or correction code check.

FULL READ BACK CHECK: All of the data just written is read back into main storage and compared, byte-for-byte, with the original information.

CORRECTION CODE CHECK: A Read operation is performed with the skip bit on. This method causes the storage control to check the validity of the record using the error correction code bytes.

Statistical Usage/Error Recording

The 3830-2 maintains a statistical data record of usage and error information for each attached logical device. The usage information provides accumulated counts as follows:

- For all drives, the number of access motions and the total number of bytes processed.
- For 3330 series only, the total number of Seek errors, correctable data errors, and uncorrectable data errors that were recovered by the retry procedure.

Also included in the error information is the total number of command and data overrun conditions which were retried.

The usage/error information is sent to the system log area periodically. The transfer takes place on the next start I/O issued to the device having outstanding usage/error information. Each of the usage/error counters is reset to zero after the counter information is transferred to the channel.

Storage Control Diagnostics

To provide maximum facility availability, the 3830-2 can execute diagnostic tests on a drive, concurrent with normal system operation on the remaining drives. This mode of operation allows the customer engineer to diagnose and repair most drive failures while the facility continues to operate other attached drives. The 3830-2 provides a transient block of 512 bytes (128 words) of control storage to allow temporary residence for a specific diagnostic test.

The transient area is loaded by the system under control of the On-Line Test Executive Program (OLTEP) or the On-Line Test Standalone Executive Program (OLTSEP). A special command (Diagnostic Write) loads a selected test into control storage and instructs the storage control to execute the test. This loading and execution may also be initiated from the CE panel of the 3333 or 3340-A2.

After the test, error message information or test results are transferred from the 3830-2 to main storage by a Read Diagnostic Status-1 command. If the CE panel is used, the test results are displayed on the CE panel indicators in the 3333 or 3340-A2.

Surface Defect Skipping (3340 series only)

Defect skipping allows data to be written before and after a surface defect. Thus, all of the track can be used except for that portion that has the defect. This also eliminates the access time that was formerly required to move the read/write heads to an alternate track.

INPUT/OUTPUT OPERATIONS

GENERAL DESCRIPTION

I/O operations, initiated by I/O instructions in the CPU program, are controlled by commands fetched from main storage by the channel. Arithmetical and logical decision 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 and the new PSW has the problem state bit off. The status of the system existing at the time of the change is stored in the old program status word. (See "Program Status Word.")

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

1. Start I/O — Initiates an I/O operation if the addressed channel, storage control, and disk drive are available.

2. Start I/O Fast Release — Initiates an I/O operation if the addressed channel is available. The storage control and disk drive are assumed to be available. If the storage control or drive is not available, the CSW deferred condition code bits, 6 and 7, are set to indicate the appropriate condition.

3. Halt I/O — Terminates the operation in progress at the channel, and the storage control is disconnected from the channel.

4. Halt Device — Terminates the operation in progress at the storage control without interfering with other I/O operations at the channel. This instruction should be used instead of Halt I/O to terminate an operation on a device attached to IBM Block Multiplexer channels.

5. Test I/O — Sets the condition code in the program status word to indicate the status of the addressed channel, subchannel, storage control, and disk drive.

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

The format for I/O instructions is shown in Figure 2.

I/O Instruction Format

Bit Position	Field Designation	Function
0 -7	Operation (OP) Code	Designates the operation to be performed.
8 - 14	Not Used	
15		Set to 1 for start I/O fast release and halt device.
16 - 19	Base Address Register Location (B_1)	Designates the address of a general register in the CPU. The register is 32 bits in length, but only the 'ow-order 24 bits are used.
20 - 31	Displacement (D_1)	Bits 16-31 of the sum obtained by the addition of the contents of the register at B_1 and the contents of the D_1 field identifies the channel and the device addressed by the instruction. The result has the following format:
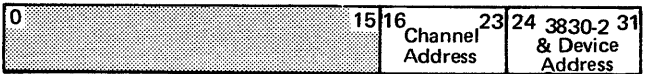
Bit Position	Field Designation
0 - 15	Not Used
16 - 19	Must be Zero
20 - 23	Channel Address
24-31	3830-2 & Device Address

Figure 2. I/O Instruction Format

CHANNEL OPERATION

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

Channel Address Word

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

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

Fetching of channel address words is a channel hardware function. The information must be set up in main storage location 72 prior to issuing the I/O instruction.

The format for the channel address word (CAW) is shown in Figure 3.

Channel Address Word (CAW)

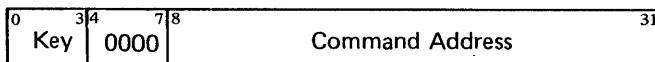| 0 3	4 7	8 31
Key	0000	Command Address

CAW fields are allocated for the following purposes:

CAW Bit Position	Field Designation	Function
0-3	Protection Key	Provides the storage protection key for all commands associated with Start I/O. This key must match the storage key.
4-7		Always zero.
8-31	Command Address	Designates the location of the first CCW in main storage.

Figure 3. Channel Address Word

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 main storage locations 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 channel command word is sent to the storage control, which responds with an initial status byte to the channel.

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

The format for the channel command word is shown in Figure 4.

Channel Status Word

The channel status word (CSW), stored at main 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.

The format for the channel status word is shown in Figure 5.

STATUS PRESENTATION

Status is presented twice (initial status and ending status) for all commands except those Seek commands that require access motion, and immediate commands not chained from Write commands.

Seek and Seek Cylinder commands present initial status, channel end status (after transfer of the seek address), and device end status (after the access is positioned).

Note: For format Write commands, channel end status, and device end status are presented separately for the 3330 Model 11.

0 Command Code 7	8 Data Address 31	32 Flags 36	37 1A	38-39 00	40 47	48 Count 63
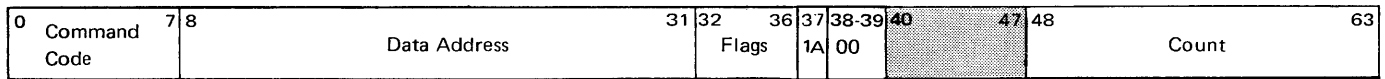
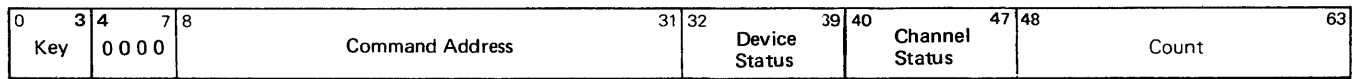| CCW Bit Position	Field Designation	Function	CCW Bit Position	Field Designation	Function
0-7	Command Code	Specifies the operation to be performed. The two low-order bits, or when these bits are 00, the four low-order bits of the command code identify the operation to the channel. The channel distinguishes the operations: Write, Control, Read, Sense, or Transfer in Channel. Commands that initiate I/O operations cause all 8 bits to be transferred to the storage control.	35	Skip Flag	Specifies suppression of a transfer of information to storage during a Read or Sense operation when set to one. Checking takes place as though the information had been placed in storage. When bit 35 is zero, normal transfer of data takes place.
8-31	Data Address	Specifies the address of the area associated with data transfer operations.	36	Program Control-Interruption	Causes the channel to generate an interruption condition upon fetching the CCW when set to one. When bit 36 is zero, normal operation takes place.
32	Chain Data	Specifies chaining of data when set to one. Make sure the data rate of the I/O device permits chaining by the particular system model before using.	37	Indirect Data Addressing	Causes 8–31 of CCW to specify location of first Indirect Address Word (IDAW).
33	Chain Command (CC) Flag	Specifies chaining of commands when set to one, and when the CD flag is zero. It causes the operation specified by the command code in the next CCW to be initiated on normal completion of the current operation.	38-39		Bit positions 38-39 of every CCW other than one specifying transfer in channel must contain zeros. Violation of this restriction generates the program-check condition.
34	Suppress Length Indicator (SLI)	Specifies an incorrect length condition is to be suppressed when set to one, (except when the CCW count is not exhausted, channel end is present and data chaining is indicated). Should be set to one for Restore, Recalibrate, NO-OP and some Space Count commands.	40-47	Not used	
			48-63	Count	Specifies the number of 8-bit byte locations in the storage area designated by the data address.

Figure 4. Channel Command Word

Channel Status Word

0 3	4 7	8 31	32 39	40 47	48 63
Key	0 0 0 0	Command Address	Device Status	Channel Status	Count

CSW Bit Position	Field Designation	Function
0-3	Protection Key	Provides the storage protection key used in the chain of operations.
4-7	Not Used	Always zero.
8-31	Command Address	Provides an address eight positions higher than the address of the last CCW used.
32	Attention	Not used by 3830-2.
33	Status Modifier	Set whenever a Search High, Search Equal, or a Search High or Equal command has been executed and the condition satisfied. The status modifier is also set whenever the control unit is busy. This bit, in conjunction with the busy bit, signifies control unit busy. Status modifier set with unit check and channel end (or channel end and device end) indicates that a retriable error has been encountered. The storage control automatically retries the command.
34	Control Unit End	Set if a storage control Busy status has been generated previously and the busy condition has been terminated. The device address associated with Control Unit End may be any device recognized by the storage control.
35	Busy	Indicates that the selected device is busy. In conjunction with the status modifier bit, indicates the control unit is busy. It is set when a new command chain is initiated

CSW Bit Position	Field Designation	Function
		while the storage control causes a track to be erased following a Format Write command.
36	Channel End	Set at the end of each channel command.
37	Device End	Indicates that an access mechanism is free to be used.
38	Unit Check	Set whenever an unusual or error condition is detected. A Sense I/O command must then be used to identify the condition.
39	Unit Exception	Indicates an end-of-file has been detected during a Read R0, Read IPL, Read CKD, Read KD, Read D, Write KD, or a Write D operation. It results from a data length of zero being detected in the count area of a record. When this condition is detected, no data is transferred from the data area. If the key length is not zero, the key area is transferred.
40-47	Channel Status	Indicates channel conditions as follows:

Bit	Designation
40	Program-controlled interruption
41	Incorrect length
42	Program check
43	Protection check
44	Channel data check
45	Channel control check
46	Interface control check
47	Chaining check

CSW Bit Position	Field Designation	Function
48-63	Count	The residual count from the last CCW used.

Figure 5.   Channel Status Word

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

- Storage control is busy.

- A status condition is pending. See "Pending Status."

- A unit check occurred.

- Initial status indicated command retry. See "Command Retry."

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

ENDING STATUS: In most cases, channel end and device end are presented as the normal ending sequence for an operation. The exceptions are noted in the individual command descriptions. See "Channel Commands."

If an error occurred during the operation, unit check will accompany the channel end, device end status.

PENDING STATUS: A pending status condition may exist for either the storage control or a disk drive.

Status is pending for the storage control if:

- A disconnect was signaled after a command was issued, but before channel-end status was accepted.

- Busy, channel-end, or unit check status was stacked by the channel.

- Zero status, in response to a Test I/O, was stacked by the channel.

- Control-unit-busy was presented to the channel.

- Unit check was detected for an operation after device end had been cleared.

- Device-end status for a Set Sector command was stacked by the channel.

Pending status for the storage control causes the storage control to appear busy for all devices except the device for which the status condition exists. Unless it is busy, the storage control will request service to clear the pending status condition. Status is cleared when presented to, and accepted by, the channel.

Status is pending for a drive if:

- Channel end appears alone.

- Busy status is presented.

- The drive has gone from not ready to ready.

Pending status for a drive causes the storage control to request service when both the storage control and drive are not busy. The status is cleared when presented to, and accepted by, the channel.

CONTINGENT CONNECTION: A contingent connection is established in the storage control after the channel accepts a status byte containing unit check. The connection lasts until: (a) a command (other than test I/O or NO-OP) receives an initial status byte of zero for the storage control and device address that generated the unit check or, (2) a selective or system reset occurs.

During the contingent connection state, the storage control appears busy to all storage control and device addresses other than the address for which the contingent connection was established.

Program Status Word

Two program status words (PSW) are associated with 3830-2 interrupt conditions: an "old" PSW that contains the status information of the system existing at the time on of the interrupt, and a current or "new" PSW that is used to control instruction sequencing and hold the status of the system in relation to the program being executed.

Two modes are provided for formatting and use of control and status information: (1) basic control (BC) mode and (2) extended control (EC) mode. The mode is specified by the contents of bit position 12 of the program status word.

By storing the current PSW during an interruption, CPU status is preserved for subsequent inspection by the program. Loading a new PSW causes the state of the CPU to be initialized or changed to "branch to a new instruction sequence." If, at the conclusion of an interrupt routine, an instruction is executed which restores the old PSW as the current PSW, the system is restored to the state existing prior to the interruption, and the interrupted routine continues.

The formats for the program status word modes are shown in Figure 6.

Command Chaining

The 3830-2 has the ability to execute a series of channel commands as a result of a single Start I/O instruction; this method of operation is called command chaining. Command chaining is initiated by turning on bit 33 in the channel command word. The channel fetches a new CCW (specifying a new I/O operation) upon completion of the current CCW. The new I/O operation is automatically executed when the disk storage has completed the current operation and signaled device end to the channel.

The completion of the current CCW does not cause an I/O interrupt, and the count, indicating the amount of transferred data, is not available to the program.

Command chaining is normally used with all 3830-2 channel programs. Time is available to execute command chaining functions in the gap area between record areas.

PROGRAM STATUS WORD (Basic Control Mode)

0 6	7 E	8 Protection Key 11	12 CMWP 15	16 Interruption Code 23	24 31

32 ILC	34 CC	36 Program Mask 39	40 47	48 Instruction Address 55	56 63

0-5	Channel 0 to 5 masks	32-33	(ILC) Instruction length code
6	Mask for channel 6 and up	34-35	(CC) Condition code
7	(E) External mask	36	Fixed-point overflow mask
12	(C = 0) Basic control mode	37	Decimal overflow mask
13	(M) Machine-check mask	38	Exponent underflow mask
14	(W = 1) Wait state	39	Significance mask
15	(P = 1) Problem state		

PROGRAM STATUS WORD (Extended Control Mode)

0 0R00 0TIE 7	8 Protection Key 11	12 CMWP 15	16 00	18 CC	20 Program Mask 23	24 0000 0000 31

32 0000 0000 39	40 47	48 Instruction Address 55	56 63

1	(R) Program event recording mask	15	(P = 1) Problem state
5	(T = 1) Translation mode	18-19	(CC) Condition code
6	(I) Input/output mask	20	Fixed-point overflow mask
7	(E) External mask	21	Decimal overflow mask
12	(C = 1) Extended control mode	22	Exponent underflow mask
13	(M) Machine-check mask	23	Significance mask
14	(W = 1) Wait state		

Figure 6. Program Status Word

Certain restrictions regarding command sequence within a chain do exist. These restrictions, together with the individual command descriptions, are discussed in the "Channel Commands" section of this manual.

Data Chaining

Data transferred between main storage and disk storage may be chained, which permits blocks of data to be transferred to or from noncontiguous areas of main storage.

Data chaining may be used to rearrange information as it is transferred between main storage and disk storage. It may also be used in conjunction with the skip flag to enable the program to place selected portions of a block of data in main storage.

When data chaining is specified (that is, when bit 32 of the channel command word is on), the channel fetches a new CCW (which specifies a new storage location) upon comple-

tion of data transfer for the current channel command. Unless the command code specifies Transfer In Channel, the new CCW command code is ignored.

Data chaining occurs immediately after the last byte of data designated by the current CCW has been transferred to main storage or accepted by the disk storage device.

If both data chaining and command chaining are indicated in the channel command word, data chaining takes precedence and command chaining is ignored.

Note: Data chaining capabilities are dependent on several variable factors including system type, I/O configuration, channel loading, etc. Because of these dependencies, read or write data chaining within record areas may cause unpredictable overruns or chaining checks. If these conditions are encountered or suspected, consult your IBM representative.

Branching in Channel Programs

Normally, the next CCW in a chain of channel commands is taken from an address eight positions higher than the address of the current CCW. This sequence can be modified in either of two ways:

1. If command chaining is specified in a Search command, and execution of the command results in a status modifier indication (search satisfied), the channel fetches the next CCW from a main storage location sixteen positions higher than the current channel command.
2. The Transfer In Channel command (TIC) may be used to modify the sequence of a chain of commands. The data address portion of the TIC CCW specifies the main storage location of the next channel command word. Therefore, the next CCW may be fetched from any valid main storage location.

These methods of modifying the sequence of a CCW chain provide branching capabilities within a channel program.

Unit Selection and Device Addressing

The I/O address of the 3830-2 and its attached drives is designated by an 8-bit binary number in an I/O instruction. This address consists of three parts: (1) The 3830-2 address (determined by the customer engineer when the unit is initially installed), (2) the address of the 3333 or 3340-A2 disk storage and control, and (3) the addresses of the attached disk storage modules. The complete I/O address is specified in bits 16 through 31 of the I/O instruction (see Figure 2). The address bit assignments are shown below:

Basic Addressing

0 3830-2 Address 3	4 3333/ 3340-A2 Address	5 3330/3340-B1 or B2 Address 7

32 Drive Expansion Addressing

0 3830-2 Address 2	3 3333/3340-A2 Address 4	5 3330/3340-B1 or B2 Address 7

Note: If less than the maximum configuration of drives is attached, all drive addresses (bits 4 through 7 — basic addressing, or bits 3 through 7 — 32 Drive Expansion) are still required for 3830-2 operation. Unused addresses cannot be assigned to other devices not attached to the 3830-2.

The 3830-2 accepts any drive address from 0000 through 1111 (00000 through 11111 for 32 Drive Expansion). If the specified drive is either not attached or offline, the attempted operation is terminated with unit check in initial status. Multiple responses to an address due to duplicate logical address plugs or hardware failures also cause the operation to be terminated.

Note: The addressing options provided in the 3830-2, coupled with addressing options provided by external switches, can cause difficulty in drive identification. For example, the same drive could be called 1A1, 2B1, 3C1, and 4C1 by system messages. This difficulty can be avoided by careful installation planning which will allow the CE installing the system to wire all interfaces identically. This causes addresses in the foregoing example to be the same — that is, 1A1, 2A1, 3A1, and 4A1.

CONTROL COMMANDS

Control commands do not involve a transfer of data records between the storage control and main storage. However, in certain operations control bytes are transferred from main storage to the storage control. These bytes enable the operation to take place and are parity-checked during transfer.

SEARCH COMMANDS

During the execution of Search commands, the channel operates in write mode while the disk storage operates in read mode. The storage control compares the data coming from main storage against that coming from the drive. When the search criteria has been satisfied (for example, compared equal, high, etc.), the storage control returns a status modifier bit with channel end and device end. This bit causes the channel to skip the next CCW in the chain and fetch the next command from a storage location 16 positions higher than the current CCW.

Each Search command operates on one record at a time. To search another record, the command must be reissued. This is normally done by chaining a TIC command to the Search command, as follows:

Search Key Equal
TIC*–8
Read Data

If the search is unsuccessful, the TIC command following the Search command causes the search to be repeated. When a search is successful, the status modifier causes the TIC command to be skipped and the Read Data command is executed.

At the end of every field searched, data validity is verified by the correction code bytes following the searched field. After the correction code check, the appropriate ending status is generated and presented to the channel.

If a data overrun or data check is detected, the storage control attempts recovery through use of command retry. If command retry is unsuccessful, channel end, device end, and unit check status are presented.

READ COMMANDS

A Read command is used to transfer information from disk storage to the central processing unit. Read commands may operate in either single track or multiple track mode.

Note: Read IPL and Read Sector do not operate in multitrack mode.

After the correction code check, the storage control sends an ending status byte of channel end and device end to the channel.

If a data overrun or data check is detected, the storage control normally attempts recovery through use of command retry. If command retry is unsuccessful or not used, channel end, device end, and unit check are presented to the channel.

WRITE COMMANDS

Format Write Commands

Format Write commands are used to initialize tracks and records and establish the length of the areas within each record.

The format Write commands are:

- Write Home Address. (See Note in Write Home Address Channel Command Description).

- Write R0. (See Note in Write R0 Channel Command Description).

- Write Count, Key, and Data.

- Write Special Count, Key, and Data.

- Erase.

The command prerequisites and file mask settings for these commands are explicit; any violation prevents command execution.

Format Write commands may be chained together if
each satisfies the required prerequisites. After the last
format Write command in a chain has been completed,
the storage control causes the remaining portion of the
track to be erased.

If a command (other than a format Write command) is
chained from a format Write command, it is executed
after the track has been erased. If the command is a con-
trol type command, the storage control utilizes the command
retry function to free the channel while the track is being
erased. If a new command chain is attempted before the
end of the track is reached, a control unit busy sequence
(busy and status modifier bits) is presented to the channel.
In this case, a control unit end signal is generated at the end
of the track.

Update Write Commands

Update (non-format) Write commands are used to update
existing records and must operate on previously formatted
tracks.

The update Write commands are:

● Write Data.

● Write Key and Data.

If a data overrun occurs during an update Write opera-
tion, (excluding the second and subsequent segments of an
overflow record), the storage control attempts recovery

through the use of command retry. If the retry is un-
successful, channel end, device end, and unit check status
are presented to the channel.

SENSE/TEST I/O COMMANDS

These commands are used to determine the status of the
IBM 3830-2 facility and identify the specific nature of
errors or unusual conditions that have occurred.

*Note: Since the Test I/O command is not the
result of the channel executing a CCW, its opera-
tion is explained at this time instead of with the
other channel commands. A Test I/O command
(command code 0000 0000) is not written by the
programmer. A command code of all 0s is con-
sidered invalid and causes a program check.*

The Test I/O command is generated automatically by the
channel when the channel requires status information, or it
is the result of processing a Test I/O instruction. In either
case, it appears to the storage control as a command byte of
all 0s and is treated as an immediate command. Test I/O re-
quests the storage control to send all outstanding status in-
formation to the channel and, normally, presents an all-zero
status byte. Stacked or pending status (if any) is presented
in initial status.

CHANNEL COMMAND DESCRIPTIONS

| COMMAND | COMMAND CODE | | | |
| | Multiple Track OFF | | Multiple Track ON (if applicable) | |
	Hexadecimal	Binary	Hexadecimal	Binary
CONTROL				
No Operation	03	0000 0011		
Recalibrate	13	0001 0011		
Seek	07	0000 0111		
Seek Cylinder	0B	0000 1011		
Seek Head	1B	0001 1011		
Space Count	0F	0000 1111		
Set File Mask	1F	0001 1111		
Set Sector	23	0010 0011		
Restore	17	0001 0111		
Transfer in Channel	x8	xxxx 1000		
Diagnostic Load	53	0101 0011		
Diagnostic Write	73	0111 0011		
SEARCH				
Home Address Equal	39	0011 1001	B9	1011 1001
Identifier Equal	31	0011 0001	B1	1011 0001
Identifier High	51	0101 0001	D1	1101 0001
Identifier Equal or High	71	0111 0001	F1	1111 0001
Key Equal	29	0010 1001	A9	1010 1001
Key High	49	0100 1001	C9	1100 1001
Key Equal or High	69	0110 1001	E9	1110 1001
READ				
Home Address	1A	0001 1010	9A	1001 1010
Count	12	0001 0010	92	1001 0010
Record 0	16	0001 0110	96	1001 0110
Data	06	0000 0110	86	1000 0110
Key and Data	0E	0000 1110	8E	1000 1110
Count, Key, and Data	1E	0001 1110	9E	1001 1110
IPL	02	0000 0010		
Sector	22	0010 0010		
SENSE				
Sense I/O	04	0000 0100		
Read and Reset Buffered Log	A4	1010 0100		
Device Release	94	1001 0100		
Device Reserve	B4	1011 0100		
Read Diagnostic Status 1	44	0100 0100		
WRITE				
Home Address	19	0001 1001		
Record 0	15	0001 0101		
Erase	11	0001 0001		
Count, Key, and Data	1D	0001 1101		
Special Count, Key, and Data	01	0000 0001		
Data	05	0000 0101		
Key and Data	0D	0000 1101		

Notes:

x Not significant (data addresses should not exceed storage capacity).

Use of command codes other than those listed above presents unit check in initial status. A subsequent Sense operation indicates command reject.

NO-OP

0 Command 7	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary 0000 0011 Hex 03	Not checked for validity; should not exceed addressing capacity.	SLI flag (bit 34) should be on.			Must be non-zero; zero count causes a program check.

CHAINING AND SPECIAL REQUIREMENTS: See the following description.

NO-OP, an immediate command; causes no action at the addressed device.

CHANNEL END is presented in initial status.

DEVICE END is presented in initial status.

INDISCRIMINATE USAGE must be avoided; a NO-OP resets orientation information causing all or part of the records to be skipped.

> **EXAMPLE:** a NO-OP inserted between read count and read data causes the data area of a subsequent record to be read.

> **EXAMPLE:** a NO-OP inserted between a command that reads the data field of record 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.

NO-OP CCW; count field must not be zero.

SLI FLAG must be on to avoid an incorrect length indication.

ZERO COUNT sets the program check bit (bit 42) in the CSW.

RECALIBRATE

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0001 0011** Hex **13**	Not checked for validity, but should not exceed addressing capacity.	SLI flag (bit 34) should be on.			Must be non-zero. A zero count causes a program check.

CHAINING AND SPECIAL REQUIREMENTS: File mask must allow Seek commands.

RECALIBRATE causes addressed drive to seek to cylinder-zero/head-zero.

INITIAL STATUS BYTE normally zero; not processed as an immediate command.

CHANNEL END presented in ending status.

DEVICE END presented when drive positions access mechanism to cylinder-zero/head-zero.

FILE MASK must be set to allow Seek commands.

SLI BIT must be on in Recalibrate CCW to avoid incorrect length indication.

SEEK

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0000 0111 Hex 07	Specifies main storage location of the seek address.	Used at discretion of programmer.			Six

CHAINING AND SPECIAL REQUIREMENTS: File mask must allow Seek commands.

SEEK transfers the 6-byte seek address from channel to storage control.

INITIAL STATUS normally zero.

STORAGE CONTROL selects drive, moves access to proper cylinder and selects proper head.

ACCESS MOTION, if any, initiated after transfer of seek address

	3330		3340	
	Models 1 & 2	Model 11	35 Mb	70 Mb
Bytes 0, 1, and 4 must be:	0	0	0	0
Bytes 2 and 3 must not exceed (decimal):	410	814	348	697
Byte 5 must not exceed (decimal):	18	18	11	11

CCW COUNT > SIX: transfers six bytes of address information.

CCW COUNT < SIX: Seek command is not executed; unit check, channel end, and device end are presented in ending status. A subsequent Sense command indicates command reject.

VALID SEEK ADDRESS checked by storage control.

INVALID SEEK ADDRESS: Seek command is not executed; unit check, channel end, and device end are presented in ending status. A subsequent Sense command indicates command reject.

PARITY ERROR detected in transfer of seek address: command is not executed; unit check, channel end and device end are presented in ending status. A subsequent sense command indicates bus-out parity error.

COMMAND EXECUTION does not require preceding CCW.

FILE MASK must be set to allow seeks, or unit check is presented in initial status.

CHANNEL END presented after transfer of seek address.

DEVICE END presented with channel end if no movement required.

DEVICE END presented after access is positioned if movement is required.

> *NOTE: Several successive seeks, without an intervening data read or write, may cause a seek incomplete condition in the storage control. The storage control uses its internal error recovery procedures to correct the failure. If it cannot correct the failure, unit check (with equipment check and permanent error in the sense bytes) is posted.*

SEEK CYLINDER

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 1011** Hex **0B**	Specifies main storage location of the seek address.	Used at discretion of programmer.			Six .

CHAINING AND SPECIAL REQUIREMENTS: File mask must be set to allow Seek commands.

SEEK CYLINDER transfers the 6-byte seek address from channel to storage control.

INITIAL STATUS normally zero.

STORAGE CONTROL selects drive, moves access to proper cylinder, and selects proper head.

ACCESS MOTION, if any, initiated after transfer at seek address.

CCW COUNT > SIX transfers six bytes of address information.

CCW COUNT < SIX: Seek Cylinder command is not executed; unit check, channel end, and device end are presented in ending status. A subsequent Sense command indicates command reject.

VALID SEEK ADDRESS checked by storage control.

	3330		3340	
	Models 1 & 2	**Model 11**	**35 Mb**	**70 Mb**
Bytes 0, 1, and 4 must be:	0	0	0	0
Bytes 2 and 3 must not exceed (decimal):	410	814	348	697
Byte 5 must not exceed (decimal):	18	18	11	11

INVALID SEEK ADDRESS: Seek Cylinder command is not executed; unit check, channel end, and device end are presented in ending status. A subsequent Sense command indicates command reject.

PARITY ERROR detected in transfer of seek address: command is not executed; unit check, channel end, and device end are presented in ending status. A subsequent Sense command indicates bus-out parity error.

COMMAND EXECUTION does not require preceding CCW.

FILE MASK must be set to allow seeks, or unit check is presented in initial status.

CHANNEL END presented after transfer of seek address.

DEVICE END presented with channel end if no movement is required.

DEVICE END presented after access is positioned if movement is required.

> *NOTE: Several successive seeks, without an intervening data read or write, may cause a seek incomplete condition in the storage control. The storage control uses its internal error recovery procedures to correct the failure. If it cannot correct the failure, unit check (with equipment check and permanent error in the sense bytes) is posted.*

C
O
N
T
R
O
L

SEEK HEAD

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary **0001 1011** Hex **1B**	Specifies main storage location of seek address.	Used at discre-tion of pro-gram-mer.			Six

CHAINING AND SPECIAL REQUIREMENTS: File mask must be set to allow Seek Head commands.

SEEK HEAD transfers Seek address from channel to storage control.

INITIAL STATUS normally zero.

STORAGE CONTROL selects drive and proper head.

VALID SEEK ADDRESS required; however, only the head address specified in the sixth byte is significant (that is, another cylinder address is ignored).

	3330		3340	
	Models 1 & 2	**Model 11**	**35 Mb**	**70 Mb**
Bytes 0, 1, and 4 must be:	0	0	0	0
Bytes 2 and 3 must not exceed (decimal):	410	814	348	697
Byte 5 must not exceed (decimal):	18	18	11	11

INVALID SEEK ADDRESS: Seek Head command is not executed; unit check, channel end, and device end are presented in ending status. A subsequent Sense command indicates command reject.

PARITY ERROR detected in transfer of seek address; command is not executed; unit check, channel end, and device end presented in ending status. A subsequent Sense command indicates bus-out parity error.

COMMAND EXECUTION does not require preceding CCW.

FILE MASK must be set to allow head seeks, or unit check is presented in initial status.

CHANNEL END/DEVICE END presented after transfer of seek address.

SPACE COUNT

0　　　　　7	8	31	32　　36	37　39	40　　　47	48　　　　63
Command Code	Data Address		Flags	000		Count
Binary **0000 1111** Hex **0F**	Specifies main storage location of the key and data lengths of record to be recovered.		Used at discretion of programmer.			Three

CHAINING AND SPECIAL REQUIREMENTS:

1. Cannot be chained from a format Write or Erase command.
2. Command Reject is posted if a Write, Erase, Set File Mask, Device Reserve, or Device Release is issued in the same CCW chain following the space count.

SPACE COUNT allows bypassing of a defective count area on a track for recovering data in key and/or data areas following the defective area.

Chained from Read, Write, Search or Space Count command

No

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

Using the above:
　a. Space count followed by a read key and data recovers or bypasses defective R0 count area.
　b. Space count followed by a Read CKD causes R1 to be read.

Yes

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

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

(a)	Set Sector Search ID (record n-1) TIC* -8 Space Count (Must specify correct key and data lengths) Read KD	(b)	Set Sector Search ID (record n-1) TIC* -8 Space Count (Must specify correct key and data lengths) Read CKD

DATA TRANSFERRED FROM CHANNEL is used by the storage control as the key length (first byte) and data length (last two bytes) of the record to be recovered.

CCW COUNT > THREE: three bytes are transferred.

CCW COUNT < THREE: specified number of bytes is transferred.

NO BYTES TRANSFERRED: storage control assumes a value of zero. Read Data and Read Key and Data commands receive unit exception status, and Read CKD commands may detect data checks.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CONTROL

SET FILE MASK

0 Command Code 7	8 Data Address 31	32 Flags 36	37 000 39	40 //// 47	48 Count 63
Binary **0001 1111** Hex **1F**	Specifies main storage location of mask byte.	Used at discretion of programmer.			One

CHAINING AND SPECIAL REQUIREMENTS:
1. One Set File Mask command permitted in a CCW chain.
2. Should not be used in the same CCW chain with a Space Count command.

SET FILE MASK sets the write and seek masks which provide protection for the recorded data and defines command retry-PCI interaction.

Bit 0	Bit 1	Function	Bit 3	Bit 4	Function	Bit 5	Function	Bit 7	Function
0	0	Inhibit Write Home Address and Write R0.	0	0	Permit all Seek commands.	0	Inhibit diagnostic Write commands.	0	Not PCI fetch mode.
0	1	Inhibit all Write commands.	0	1	Permit Seek Cylinder and Seek Head.	1	Permit diagnostic Write commands.	1	PCI fetch mode. (The storage control presents unit check if command retry is used to recover from ECC uncorrectable data errors.)
1	0	Inhibit all format Write commands.	1	0	Permit Seek Head.				
1	1	Permit all Write commands.	1	1	Inhibit all Seek commands and head switching.				

Bits 2 and 6 must be zero, or unit check channel end and device end are presented. Bit 7 is ignored by the 3340 when it is attached.

COMMAND EXECUTION is allowable only once within a CCW chain. An attempt to issue more than one Set File Mask or a Set File Mask and a Space Count in the same CCW chain causes a unit check in initial status.

COMMAND REJECT is indicated by a subsequent Sense command.

FILE MASK RESET to 0s at end of CCW chain.

WRITE COMMANDS that violate file mask are not executed.

UNIT CHECK is presented in initial status.

COMMAND REJECT is indicated by a subsequent Sense command.

SEEK COMMANDS that violate the file mask are not executed.

UNIT CHECK is presented in initial status.

FILE PROTECTED is indicated by a subsequent Sense command.

MULTITRACK/OVERFLOW operations that violate the file mask indicate unit check and file protected.

CHANNEL END/DEVICE END are presented to the channel after transfer of mask byte.

SYSTEM OR SELECTIVE RESET resets the file mask to 0s.

START I/O executed after a reset without a Set File Mask CCW permits Seek and Write commands (except Write Home Address and Write R0).

SET SECTOR

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0010 0011** Hex **23**	Specifies main storage location of desired sector.	Used at discre- tion of pro- gram- mer.			One

CHAINING AND SPECIAL REQUIREMENTS: None

SET SECTOR, used on block multiplexer channels, eliminates the necessity to maintain channel and storage control connection during rotational delay.

COMMAND EXECUTION transfers a sector number (128 possibilities for 3333; 64 possibilities for 3340) from main storage to storage control.

ANGULAR POSITIONS are checked for validity by the 3830-2.

*VALID ARGUMENT (0-127 or 0-63):
1. Storage control presents channel end and disconnects.
2. Device end is signaled when angular position is reached and channel reconnects to continue chain.
3. If reconnection does not occur, the storage control attempts reconnection on subsequent revolutions.

ZERO ARGUMENT:
Storage control attempts reconnection just prior to index.

ARGUMENT > 127 (or 63) < 255:
Channel end, device end and unit check presented in ending status. Command Reject indicated in a subsequent Sense command.

ARGUMENT = 255:
1. Command is treated as a NO-OP.
2. Channel end/device end presented in ending status.
3. Track orientation is destroyed.

*All valid arguments are adjusted by the storage control to compensate for channel reselection delay.

Programming Note:

1. The Set Sector command does not guarantee record orientation. The Search commands must still be used for this function.
2. Indiscriminate use of Set Sector with multitrack search may result in missing the desired record. A Set Sector 0, Read HA, Search M/T sequence will avoid this exposure.
3. If a 3340 without the Rotational Position Sensing feature is addressed, the Set Sector command returns Channel End and Device End in final status. No operation is performed and track orientation is not main- tained.

C O N T R O L

RESTORE

0 Command Code 7	8 Data Address 31	32 Flags 36	37 000 39	40 47	48 Count 63
Binary **0001 0111** Hex **17**	Not checked for validity; must not exceed addressing capacity.	SLI flag (bit 34) should be on.			Must be non-zero. Zero count causes a program check.

CHAINING AND SPECIAL REQUIREMENTS: None

RESTORE is maintained primarily for compatibility with other IBM direct-access storage devices and causes no action to be performed.

INITIAL STATUS normally zero.

CHANNEL END/DEVICE END immediately follows initial status.

SLI BIT must be on in the restore CCW to avoid incorrect length indication.

TRANSFER IN CHANNEL (TIC)

0 Command Code	8 Data Address 31	32 Flags 36	37 000 39	40 ░░░░ 47	48 Count 63
Binary **XXXX 1000** Hex **X8**	Specifies storage location from which next CCW will be taken.	Ignored			Ignored

CHAINING AND SPECIAL REQUIREMENTS: 1. Cannot be first CCW designated by channel address word.
2. One TIC command cannot transfer directly to another.

TRANSFER IN CHANNEL provides chaining capabilities for CCWs not located in adjacent main storage locations.

TIC DATA ADDRESS FIELD specifies next CCW to be fetched.

COMMAND EXECUTION does not initiate I/O operations or signal I/O device.

PROGRAM CHECK SIGNAL is generated when chaining requirements are not met or an invalid address is specified. (TIC CCW data address field does not specify a doubleword boundary.)

ERROR DETECTION terminates chaining operations.

BIT POSITIONS 0-3 and 32-63 are ignored; bits 29-31 must be zero for doubleword boundary requirements.

> *NOTE: TIC is the only CCW that allows a zero count field; an incorrect length indication cannot occur since flags and count are ignored.*

ASSEMBLER LANGUAGE notation TIC* −8 indicates an unconditional branch to the TIC storage address (*) minus a count of eight. TIC* −16 indicates an unconditional branch to the TIC storage address (*) minus a count of 16.

DIAGNOSTIC LOAD

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0101 0011** Hex **53**	Specifies main storage location of control byte.	Used at discre- tion of pro- gram- mer.			One

CHAINING AND SPECIAL REQUIREMENTS: None

DIAGNOSTIC LOAD transfers a 512-byte block of data from storage control read-only storage to storage control buffer.

DATA BLOCK transferred is a functional microprogram diagnostic test.

INITIAL STATUS normally zero.

CONTROL BYTE specifying diagnostic microprogram ID number is transferred from main storage to storage control.

> *TRACK ADDRESS (0-31) is specified by bits 0-4.

> *SECTOR NUMBER (0-7) is specified by bits 5-7.

VALID CONTROL BYTE presents channel end in ending status.

STORAGE CONTROL disconnects from channel and transfers diagnostic test to buffer.

DATA TRANSFER COMPLETE causes storage control to request service and present device end when polled.

COMMAND EXECUTION allows any drive address to be used with the storage control address.

READ DIAGNOSTIC STATUS 1 command transfers the diagnostic test from storage control buffer to main storage.

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

*Track address and sector number are references to the read only storage device attached to the 3830-2, not to a 3330 or 3340 disk drive.

DIAGNOSTIC WRITE

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary **0111 0011** Hex **73**	Specifies main storage location of diagnostic test.	Used at discre-tion of pro-gram-mer.			512

CHAINING AND SPECIAL REQUIREMENTS: File mask must be set to allow diagnostic Write command (bit 5 = 1).

DIAGNOSTIC WRITE transfers a 512-byte diagnostic test from main storage to storage control.

INITIAL STATUS normally zero.

DATA TRANSFER COMPLETE: test execution begins.

TEST COMPLETE: 16-byte error code message is stored in storage control buffer.

COMPATIBILITY is verified by storage control comparing a key within the diagnostic test against the engineering level of the microprogram.

INVALID COMPARISON causes command termination; channel end, device end, and unit check are presented in ending status.

CCW COUNT > 512: only 512 bytes are transferred.

CCW COUNT < 512: only the specified number of bytes is transferred; command is terminated; and channel end, device end, and unit check are presented in ending status.

ERROR CODE MESSAGE (16 bytes) is transferred from storage control buffer to main storage by a subsequent Read Diagnostic Status-1 command.

CHANNEL END presented after transfer of diagnostic test to the storage control.

DEVICE END presented after test is complete.

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

SEARCH HOME ADDRESS EQUAL

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0011 1001** Hex **39** MT Binary **1011 1001** **B9**	Specifies main storage location of a cylinder number (CC) and head number (HH).	Used at discretion of programmer.			Four

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH HOME ADDRESS EQUAL causes storage control to search for index.

INITIAL STATUS normally zero.

CYLINDER/HEAD NUMBERS from main storage and track home address area are compared by storage control when index is detected.

FLAG BYTE is not transferred or compared during command execution.

COMPARISON EQUAL: channel end/device end/status modifier are presented to the channel.

COMPARISON UNEQUAL: channel end/device end presented to the channel.

CCW COUNT > FOUR: only first four bytes used.

> **CHANNEL END/DEVICE END** presented to terminate the command.
>
> > **STATUS MODIFIER** presented if comparison was equal.

CCW COUNT < FOUR: comparison of main storage and track data continues until CCW count is zero.

> **CHANNEL END/DEVICE END** presented when home address is read and correction code check is finished.
>
> > **STATUS MODIFIER** presented if search is satisfied on short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command) until search condition is satisfied or two index points are detected.

> **CHANNEL END/DEVICE END/UNIT CHECK** presented to channel upon detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically increments at index until search condition is satisfied or end of cylinder is reached.

> **CHANNEL END/DEVICE END/UNIT CHECK** presented to channel upon detection of end of cylinder.

SEARCH ID EQUAL

0 Command Code	7	8 Data Address	31	32 Flags	36	37 000	39	40	47	48 Count	63
Binary **0011 0001** Hex **31** MT Binary **1011 0001** **B1**		Specifies main storage location of a 5-byte record identifier (CC HH R).		Used at discre-tion of pro-gram-mer.						Five	

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH ID EQUAL compares the main storage ID and the count area ID. ID to be compared is next ID on the track (including R0).

INITIAL STATUS normally zero.

COMPARISON EQUAL: channel end/device end/status modifier presented to the channel.

COMPARISON UNEQUAL: channel end/device end presented to the channel.

CCW COUNT > FIVE: only first five bytes used.

> **CHANNEL END/DEVICE END** presented to terminate command.

> > **STATUS MODIFIER** presented if comparison was equal.

CCW COUNT < FIVE: comparision of main storage and track data continues until CCW count is zero.

> **CHANNEL END/DEVICE END** presented to channel when ID and correction code bytes are read and checked.

> > **STATUS MODIFIER** presented if search is satisfied on the short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command) until search condition is satisfied or two index points are detected.

> **CHANNEL END/DEVICE END/UNIT CHECK** presented to channel on detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically increments at index until search condition is satisfied or end of cylinder is reached.

> **CHANNEL END/DEVICE END/UNIT CHECK** presented to channel upon detection of end of cylinder.

SEARCH ID HIGH

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary 0101 0001 Hex 51 MT Binary 1101 0001 D1	Specifies main storage location of a 5-byte record identifier (CC HH R).	Used at discretion of programmer.			Five

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH ID HIGH compares the main storage ID and the disk drive count area ID. ID to be compared is next ID on the track (including R0).

INITIAL STATUS normally zero.

COMPARISION HIGH: channel end/device end/status modifier presented to the channel. ID on drive is higher than ID in main storage.

COMPARISON NOT HIGH: channel end/device end presented to the channel.

CCW COUNT > FIVE: only first five bytes used.

    CHANNEL END/DEVICE END presented to terminate command.

        STATUS MODIFIER presented if comparison was equal.

CCW COUNT < FIVE: comparison of main storage and track data continues until CCW count is zero.

    CHANNEL END/DEVICE END presented to channel when ID and correction code bytes are read and checked.

        STATUS MODIFIER presented if search is satisfied on the short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command) until search condition is satisfied or two index points are detected.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel on detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically increments at index until search condition is satisfied or end of cylinder is reached.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of end of cylinder.

SEARCH ID EQUAL OR HIGH

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary **0111 0001** Hex **71** MT Binary **1111 0001** **F1**	Specifies main storage location of 5-byte record identifier (CC HH R).	Used at discre-tion of pro-gram-mer.			Five

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH ID EQUAL OR HIGH compares the main storage ID and the disk drive count area ID. ID to be compared is next ID on the track (including R0).

INITIAL STATUS normally zero.

COMPARISON EQUAL OR HIGH: channel end/device end/status modifier presented to the channel. ID on drive is equal to or higher than ID in main storage.

COMPARISON NOT EQUAL OR HIGH: channel end/device end presented to the channel.

CCW COUNT > FIVE: only first five bytes used.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel on detection of second index.

        STATUS MODIFIER presented if comparison was equal.

CCW COUNT < FIVE: comparison of main storage and track data continues until CCW count is zero.

    CHANNEL END/DEVICE END presented to channel when ID and correction code bytes are read and checked.

        STATUS MODIFIER presented if search is satisfied on the short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command) until search condition is satisfied or two index points are detected.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically increments at index until search condition is satisfied or end of cylinder is reached.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of end of cylinder.

S
E
A
R
C
H

SEARCH KEY EQUAL

0 7	8 31	32 36	37 39	40 47	48 63
Command Code	Data Address	Flags	000		Count
Binary **0010 1001** Hex **29** MT Binary **1010 1001** **A9**	Specifies main storage locations to which key is compared.	Used at discretion of programmer.			Equal to length of argument.

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH KEY EQUAL compares main storage key to key area read from track. Key to be compared is next
key on track (excluding R0).

> *NOTE: When command is chained from Search ID or Read Count, key compared is in same record as ID or Count.
> Search Key Equal bypasses R0 unless chained from Search ID command which searched R0 ID.*

INITIAL STATUS normally zero.

COMPARISON EQUAL: channel end/device end/status modifier presented to the channel.

COMPARISON UNEQUAL: channel end/device end presented to the channel.

CCW COUNT > KL: search operation completed when key area is read.

    CHANNEL END/DEVICE END terminates command.

        STATUS MODIFIER presented if comparison was equal.

CCW COUNT < KL: track and main storage data comparison continues until CCW count is zero.

    CHANNEL END/DEVICE END presented after key area and the following correction code bytes are read
        and checked.

        STATUS MODIFIER presented if search was satisfied on the short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command)
    until search condition is satisfied or two index points are detected.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel on detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically
    increments at index until search condition is satisfied or end of cylinder is reached.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of end of cylinder.

COMMAND EXECUTION on a record with zero KL does not set a status modifier. If followed by a chained Read
    Data command, the data area read is that of the next record.

SEARCH KEY HIGH

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0100 1001** Hex **49** MT Binary **1100 1001** **C9**	Specifies main storage location to which key is compared.	Used at discretion of programmer.			Equal to length of argument.

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH KEY HIGH compares main storage key to key area read from track. Key to be compared is next key on track (excluding R0).

> *NOTE: When command is chained from Search ID or Read Count, key compared is in same record as ID or Count. Search Key Equal bypasses R0 unless chained from Search ID command which searched R0 ID.*

INITIAL STATUS normally zero.

COMPARISON HIGH: channel end/device end/status modifier presented to the channel. Key on drive is higher than main storage argument.

COMPARISON NOT HIGH: channel end/device end presented to the channel.

CCW COUNT > KL: search operation completed when key area is read.

   CHANNEL END/DEVICE END terminates command.

      STATUS MODIFIER presented if comparison was equal.

CCW COUNT < KL: track and main storage data comparison continues until CCW count is zero.

   CHANNEL END/DEVICE END/UNIT CHECK presented to channel on detection of second index.

      STATUS MODIFIER presented if search was satisfied on the short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command) until search condition is satisfied or two index points are detected.

   CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically increments at index until search condition is satisfied or end of cylinder is reached.

   CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of end of cylinder.

COMMAND EXECUTION on a record with zero KL does not set a status modifier. If followed by a chained Read Data command, the data area read is that of the next record.

SEARCH KEY EQUAL OR HIGH

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0110 1001** Hex **69** MT Binary **1110 1001** **E9**	Specifies main storage locations to which key is compared.	Used at discre·tion of pro-gram-mer.			Equal to length of argument.

CHAINING AND SPECIAL REQUIREMENTS: None

SEARCH KEY EQUAL OR HIGH compares main storage key to key area read from track. Key to be compared is next key on track (excluding R0).

> *NOTE: When command is chained from Search ID or Read Count, key compared is in same record as ID or Count. Search Key Equal bypasses R0 unless chained from Search ID command which searched R0 ID.*

INITIAL STATUS normally zero.

COMPARISON EQUAL OR HIGH: channel end/device end/status modifier presented to the channel. Key on drive is equal to or higher than main storage argument.

COMPARISON NOT EQUAL OR HIGH: channel end/device end presented to the channel.

CCW COUNT > KL: search operation completed when key area is read.

    CHANNEL END/DEVICE END terminates command.

        STATUS MODIFIER presented if comparison was equal.

CCW COUNT < KL: track and main storage data comparison continues until CCW count is zero.

    CHANNEL END/DEVICE END presented after key area and the following correction code bytes are read and checked.

        STATUS MODIFIER presented if search was satisfied on the short field.

MULTITRACK NOT USED: search is confined to one track; search continues (as long as channel repeats command) until search condition is satisfied or two index points are detected.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel on detection of second index.

MULTITRACK USED: causes search to continue (as long as channel repeats command); head number automatically increments at index until search condition is satisfied or end of cylinder is reached.

    CHANNEL END/DEVICE END/UNIT CHECK presented to channel upon detection of end of cylinder.

COMMAND EXECUTION on a record with zero KL does not set a status modifier. If followed by a chained Read Data command, the data area read is that of the next record.

READ HOME ADDRESS

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary **0001 1010** Hex **1A** MT Binary **1001 1010** **9A**	Specifies main storage location where home address is to be stored.	Used at discre-tion of pro-gram-mer.			Five

CHAINING AND SPECIAL REQUIREMENTS: None

READ HOME ADDRESS transfers the F CC HH bytes of the home address area to main storage.

INITIAL STATUS normally zero.

DATA VALIDITY is verified by correction code bytes following the home address area.

DATA OVERRUN/DATA CHECK, if detected, causes storage control to attempt recovery by command retry.

COMMAND RETRY, if unsuccessful, signals unit check to the channel.

PARITY BIT is added to each byte prior to transferring byte to the channel.

CHANNEL END/DEVICE END presented to channel after correction code check at home address.

R
E
A
D

READ COUNT

0 Command Code 7	8 Data Address 31	32 Flags 36	37 000 39	40 47	48 Count 63
Binary **0001 0010** Hex **12** MT Binary **1001 0010** **92**	Specifies main storage location where first byte of count data is to be transferred.	Used at discretion of programmer.			Eight

CHAINING AND SPECIAL REQUIREMENTS: None

READ COUNT transfers the eight bytes (CC HH R KL DL DL) of the next count area encountered on the track (excluding R0) from disk storage to main storage.

INITIAL STATUS normally zero.

DATA VALIDITY is verified by correction code bytes following the count area.

DATA OVERRUN/DATA CHECK, if detected, initiates a storage control recovery attempt by command retry.

COMMAND RETRY, if unsuccessful, signals unit check to the channel.

PARITY BIT is added to each byte prior to transferring the byte to the channel.

CHANNEL END/DEVICE END are signaled to the channel at completion of the correction code check.

READ R0

0 7	8 31	32 36	37 39	40 47	48 63
Command Code	Data Address	Flags	000		Count
Binary 0001 0110 Hex 16 MT Binary 1001 0110 96	Specifies main storage location where first byte of R0 count data is to be transferred.	Used at discretion of programmer.			Specifies number of count, key, and data bytes to be read.

CHAINING AND SPECIAL REQUIREMENTS: None

READ R0 transfers count, key, and data areas of R0 from disk storage to the channel.

INITIAL STATUS normally zero.

STORAGE CONTROL searches for index, clocks through gap 1, home address, and gap 2.

DATA TRANSFER of the R0 count area is initiated by storage control.

DATA VALIDITY is verified by correction code bytes following each area.

DATA OVERRUN/DATA CHECK, if detected, initiates a storage control recovery attempt by command retry.

> *NOTE: If a correctable data error (error burst of 11 bits or less) is detected in the data area, unit check is signaled to the channel.*

COMMAND RETRY, if unsuccessful, signals unit check to the channel at the end of the area in which the error occurred.

PARITY BIT is added to each byte prior to transferring byte to the channel.

COMMAND EXECUTION is accomplished immediately if Read R0 is chained from a Search Home Address or Read Home Address command; the storage control will not search for index in these cases.

CHANNEL END/DEVICE END are presented to the channel at completion of the correction code check of the data area.

R
E
A
D

READ DATA

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 0110** Hex **06** MT Binary **1000 0110** **86**	Specifies main storage location where first byte of data is to be transferred.	Used at discretion of programmer.			Specifies number of bytes to be read.

CHAINING AND SPECIAL REQUIREMENTS: None

READ DATA transfers the data area of a record from disk storage to main storage. The data read is:
1. Data area of record read by Search ID or Search Key command from which Read command is chained.
2. Data area of record read by Read Count command from which command is chained.
3. Data area of record following next count area on the track (excluding R0).

INITIAL STATUS normally zero.

DATA VALIDITY is verified by correction code bytes following each area.

DATA OVERRUN/DATA CHECK, if detected, initiates a storage control recovery attempt by command retry.

> *NOTE: If a correctable data error (error burst of 11 bits or less) is detected in the data area, unit check is signaled to the channel.*

COMMAND RETRY, if unsuccessful, signals unit check to the channel.

PARITY BIT is added to each byte prior to transferring byte to the channel.

CHANNEL END/DEVICE END are presented to the channel at completion of the correction code check of the data area.

R
E
A
D

READ KEY and DATA

0　　　　　　　7 Command Code	8 31 Data Address	32　　　36 Flags	37　39 000	40　　　　47	48 63 Count
Binary **0000 1110** Hex **0E** MT Binary **1000 1110** **8E**	Specifies main storage location where first byte of key data is to be transferred.	Used at discre- tion of pro- gram- mer.			Specifies the number of key and data area bytes to be read.

CHAINING AND SPECIAL REQUIREMENTS: None

READ KEY AND DATA transfers key and data areas of a record from disk storage to main storage. The key and data are:
1. Key and data areas of record read by Search ID command from which Read Key and Data command is chained.
2. Key and data areas of record read by Read Count command from which Read Key and Data command is chained.
3. Key and data areas of record following next count area on the track (excluding R0).

INITIAL STATUS normally zero.

DATA VALIDITY is verified by correction code bytes following each area.

DATA OVERRUN/DATA CHECK, if detected, initiates a storage control recovery attempt by command retry.

> *NOTE: If a correctable data error (error burst of 11 bits or less) is detected in the data area, unit check is signaled to the channel.*

COMMAND RETRY, if unsuccessful, signals unit check to the channel at the end of the area in which the error occurred.

KEY LENGTH = ZERO: command operates as a Read Data command.

PARITY BIT is added to each byte prior to transferring byte to the channel.

CHANNEL END/DEVICE END are presented to the channel at completion of the correction code check of the data area.

R
E
A
D

READ COUNT, KEY, and DATA

0 Command 7	8 Data Address 31	32 36	37 39	40 47	48 Count 63
Code		Flags	000		
Binary **0001 1110** Hex **1E** MT Binary **1001 1110** **9E**	Specifies main storage location where first byte of count data is to be transferred.	Used at discretion of programmer.			Specifies the number of count, key, and data bytes to be read.

CHAINING AND SPECIAL REQUIREMENTS: None

READ COUNT, KEY, AND DATA transfers the next record encountered on the track from disk storage to main storage (excluding R0).

INITIAL STATUS normally zero.

DATA VALIDITY is verified by correction code bytes following each area.

DATA OVERRUN/DATA CHECK, if detected, initiates a storage control recovery attempt by command retry.

> *NOTE: If a correctable data error (error burst 11 bits or less) is detected in the data area, unit check is signaled to the channel.*

COMMAND RETRY, if unsuccessful, signals unit check to the channel at the end of the area in which the error occurred.

PARITY BIT is added to each byte prior to transferring the byte to the channel.

CHANNEL END/DEVICE END are signaled to the channel at completion of the correction code check of the data area.

READ IPL

0 Command 7	8 Data Address 31	32 36	37 39	40 47	48 Count 63
Command Code	Data Address	Flags	000		Count
Binary **0000 0010** Hex **02**	Specifies main storage location where first byte of data is to be transferred.	Used at discretion of programmer.			Specifies number of bytes to be transferred.

CHAINING AND SPECIAL REQUIREMENTS: Must not be preceded by a Set File Mask in the same chain.

READ INITIAL PROGRAM LOAD causes storage control to recalibrate to cylinder 0, head 0, of selected drive and search for index.

DATA AREA read, after index is detected, is the first record after R0.

COMMAND INITIATION is normally accomplished by setting the direct access storage device address in the load unit switches and pressing IPL key on console.

DATA VALIDITY is verified by correction code bytes following the data area.

DATA OVERRUN/DATA CHECK, if detected, initiates a storage control recovery attempt by command retry.

> *NOTE: If a correctable data error (error burst 11 bits or less) is detected in the data area, unit check is signaled to the channel.*

COMMAND RETRY, if unsuccessful, signals unit check to the channel.

PARITY BIT is added to each byte prior to transferring the byte to the channel.

CHANNEL END/DEVICE END are signaled to the channel at completion of the correction code check of data area of record one.

R
E
A
D

READ SECTOR

0 Command ⁷ Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary **0010 0010** Hex **22**	Specifies the main storage location where sector number is to be stored.	Used at discretion of programmer.			One

CHAINING AND SPECIAL REQUIREMENTS: None

READ SECTOR transfers one byte of data from storage control to main storage.

INITIAL STATUS normally zero.

BYTE TRANSFERRED contains sector number required to access the last record processed.

> *NOTE:*   *For 3330 — If a drive power-on sequence or system reset occurred, or a Seek or Set Sector command was executed after a record was processed, this byte is zero. If the last record processed was an overflow record, the angular position is that of the last segment.*

> *For 3340 — The byte transferred to the channel contains the angular postion number required to access the last record processed on the drive, or the value of the last Set Sector command minus 3 if no record has been processed. The byte is zero if the Read Sector command follows a Power On Reset.*

COMMAND EXECUTION resets orientation information in the storage control.

> *NOTE: If a 3340 without the Rotational Position Sensing feature is addressed, the Read Sector command returns a byte of zero to the system.*

CHANNEL END/DEVICE END presented after sector number is transferred.

SENSE I/O

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 0100** Hex **04**	Specifies storage location where bytes are to be transferred.	Used at discretion of programmer.			Twenty-four

CHAINING AND SPECIAL REQUIREMENTS: None

SENSE I/O transfers 24 bytes of sense information from storage control to the channel.

INITIAL STATUS normally zero.

DESCRIBES:

    UNIT CHECK STATUS

    CURRENT STATUS of the device that performed the operation, and

    SYSTEM ERROR RECOVERY information.

UNIT CHECK should always be followed by a Sense command, whether or not sense information is used; otherwise, expected future interrupts may not occur and some I/O access paths may be unavailable.

CHANNEL END/DEVICE END presented after sense bytes are transferred.

See Sense Bytes in Appendix A for a description of the sense information pertaining to 3830-2 operations.

S
E
N
S
E

READ AND RESET BUFFERED LOG

| 0   Command   7 | 8   Data Address   31 | 32   36 | 37   39 | 40   47 | 48   Count   63 |
Code		Flags	000		
Binary **1010 0100** Hex **A4**	Specifies main storage location of first error byte or usage information.	Used at discre- tion of pro- gram- mer.			Twenty-four

CHAINING AND SPECIAL REQUIREMENTS: None

READ AND RESET BUFFERED LOG transfers 24 bytes of usage or error information from storage control to the channel.

INITIAL STATUS normally zero.

USAGE/ERROR INFORMATION, generated and available when their respective counters overflow; pertains to the storage control addressed by start I/O and the disk storage drive identified in sense byte 4.

COUNTERS reset after data transfer.

CHANNEL END/DEVICE END presented after data transfer.

See "Statistical Usage/Error Recording"

DEVICE RELEASE

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **1001 0100** Hex **94**	Specifies main storage location where sense bytes are to be transferred.	Used at discretion of programmer.			Twenty-four

CHAINING AND SPECIAL REQUIREMENTS: Must not be preceded by a Set File Mask in the same chain.

DEVICE RELEASE terminates reservation of the addressed drive if two channel switch, or two channel switch additional feature is installed, or a 3333 (3340) with string switch feature is attached.

INITIAL STATUS normally zero.

SENSE I/O command functions are performed by a device release command, that is, 24 bytes of sense information are transferred to the channel.

NORMAL BUSY conditions cause command rejection; busy bit is set in the CSW.

ABNORMAL FILE status conditions (file unsafe, offline, etc.) do not halt command execution.

CHANNEL END/DEVICE END presented after sense bytes are transferred.

UNIT CHECK, causing command rejection, is presented if:
1. Set File Mask precedes command in the same chain.
2. The 3333/3340-A2 string switch assignment cannot be reset.

S
E
N
S
E

DEVICE RESERVE

0 Command 7	8 31	32 36	37 39	40 47	48 63
Command Code	Data Address	Flags	000		Count
Binary **1011 0100** Hex **B4**	Specifies main storage location where sense bytes are to be transferred.	Used at discretion of programmer.			Twenty-four

CHAINING AND SPECIAL REQUIREMENTS: Must not be preceded by a Set File Mask in the same chain.

DEVICE RESERVE command reserves the addressed drive to the channel issuing the command, if a two channel switch, or two channel switch additional feature is installed, or a 3333 (3340) with string switch feature is attached.

INITIAL STATUS normally zero.

RESERVATION MAINTAINED until either a Device Release command or a system reset is performed by the channel.

SENSE INFORMATION (24 bytes) is transferred to the channel.

NORMAL BUSY CONDITIONS cause a command reject; busy bit is set in the CSW.

ABNORMAL FILE STATUS conditions (for example, file unsafe, offline, etc.) do not halt command execution.

CHANNEL END/DEVICE END presented after sense byte transfer.

UNIT CHECK, causing command rejection, is presented if:
1. Set File Mask precedes command in same chain.
2. The 3333/3340–A2 string switch assignment cannot be set.

READ DIAGNOSTIC STATUS 1 (Diagnostic Sense)

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0100 0100 Hex 44	Specifies main storage location where data accumulated during prior Diagnostic Load or Diagnostic Write is to be stored.	Used at discretion of programmer.			16 or 512

CHAINING AND SPECIAL REQUIREMENTS: None

READ DIAGNOSTIC STATUS 1 may perform either of two functions:

COMMAND FOLLOWS A DIAGNOSTIC WRITE COMMAND:

ERROR CODE MESSAGE (16 bytes) transferred from storage control buffer to main storage.

CCW COUNT FIELD should specify 16 bytes.

CHANNEL END/DEVICE END presented after transfer.

COMMAND FOLLOWS A DIAGNOSTIC LOAD COMMAND:

DIAGNOSTIC TEST (512 bytes) transferred from storage control buffer to main storage.

CCW COUNT FIELD should specify 512 bytes.

CHANNEL END/DEVICE END presented after transfer.

INITIAL STATUS normally zero.

DIAGNOSTIC LOAD/DIAGNOSTIC WRITE must precede the Read Diagnostic Status 1 command; otherwise 16 bytes of data are transferred from the storage control buffer area, which normally contains the error message.

CHANNEL END/DEVICE END are presented after data transfer.

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

SENSE

WRITE HOME ADDRESS

0 Command Code 7	8 Data Address 31	32 Flags 36	37 000 39	40 ▓▓▓ 47	48 Count 63
Binary **00001 1001** Hex **19**	Specifies main storage location of home address bytes F CC H H (3333) or SD SD F CC H H (3340).	Used at discretion of programmer.			Five (3333) Seven (3340)

CHAINING AND SPECIAL REQUIREMENTS:	Must be preceded by a Set File Mask permitting Write Home Address commands.
3340 ONLY:	Also must be chained from a satisfied Search HA Equal CCW (with a CCW count of four or more) unless the home address being written is to flag the defective track.

WRITE HOME ADDRESS establishes track identity, a prerequisite for data operations on that track.

INITIAL STATUS normally zero.

STORAGE CONTROL orients on index, writes gap 1, home address, and ECC bytes.

FLAG BYTE, transferred from main storage. (Bit 5 must be zero).

3333 CCW COUNT < 5: 3830-2 records 0s until 5 bytes are written.

3340 CCW COUNT < 7, but > 3: 3830-2 records 0s until 7 bytes are written.

3340 CCW COUNT < 3: Command Reject is presented.

3333 (3340) CCW COUNT $> 5(7)$: First 5 (7) bytes are written.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CHANNEL END/DEVICE END presented after ECC bytes are written. When using a 3330 Model 11, channel end is presented after ECC bytes; device end is presented after padding to index is completed.

> *NOTE: Home address is normally prewritten at the IBM plant. The use of this command should be limited to identifying defective tracks and assigning alternate tracks. For the 3340, improper use of the Write HA command can cause the destruction of surface defect skipping information recorded at the time of data module manufacture. Loss of this information disables defect skipping on that track. Utility programs are available to perform the Write HA functions.*

WRITE R0

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0001 0101** Hex **15**	Specifies main storage location of R0 count, key, and data bytes.	Used at discretion of programmer.			Specifies total number of bytes in R0 count, key, and data areas.

CHAINING AND SPECIAL REQUIREMENTS: Must be chained from a successful Write Home Address or Search Home Address Equal command.

WRITE R0 causes specified data in main storage to be written on selected drive.

INITIAL STATUS normally zero.

COUNT AREA is made up of the first 8 bytes from main storage.

> *NOTE: The flag byte is generated by the storage control; the remaining data is written in the key and data areas as specified by the KL and DL bytes in the count area.*

CORRECTION CODE BYTES are written at the end of each record area.

CCW COUNT FIELD specifies the number of bytes (8 + KL + DL) to be transferred from main storage to drive.

> **CCW COUNT < 8 + KL + DL:** storage control writes 0s in remainder of record.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CHANNEL END/DEVICE END is signaled after ECC bytes are written for the data area. When using a 3330 Model 11, channel end is presented after ECC bytes; device end is presented after padding to index is completed.

> *NOTE: Record zero is normally written on the disk pack at the IBM plant. The use of this command should be limited to assigning alternate tracks. Utility programs are available to perform this function.*

W
R
I
T
E

ERASE

0 7	8 31	32 36	37 39	40 47	48 63
Command Code	Data Address	Flags	000		Count
Binary **0001 0001** Hex **11**	Specifies main storage location where count, key, and data areas of the record are located.	Used at discretion of programmer.			Specifies number of bytes in count, key, and data areas of the record.

CHAINING AND SPECIAL REQUIREMENTS: Must be chained from either Write R0, Write CKD, *Search ID Equal, or *Search Key Equal.

ERASE writes count, key, and data areas on selected drive.

ZEROS are written in each area.

CHANNEL END/DEVICE END are signaled at the end of the data area. Remainder of track is padded with 0s. When using a 3330 Model 11, channel end is presented after ECC bytes and device end is presented after padding to index is completed.

ERASED RECORD and all records that follow on the track are unrecoverable.

READ DATA, READ KEY AND DATA may be inserted between Search CCW and Erase CCW.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

FORMAT WRITE command must not be chained from an erase command.

*Search commands must compare equal on all bytes of the searched field.

WRITE COUNT, KEY, and DATA

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0001 1101** Hex **1D**	Specifies main storage location where count, key, and data bytes of the record are located.	Used at discre- tion of pro- gram- mer.			Specifies total number of bytes in count, key, and data areas.

CHAINING AND SPECIAL REQUIREMENTS: Must be chained from either Write R0, Write CKD, *Search ID Equal or *Search Key Equal.

WRITE COUNT, KEY, AND DATA causes specified data in main storage to be written on selected drive.

INITIAL STATUS normally zero.

COUNT AREA is made up of the first 8 bytes from main storage.

> **FLAG BYTE** is generated by storage control; the remaining data is written in the key and data areas as specified by the KL and DL bytes in the count area.

CORRECTION CODE BYTES are written at the end of each record area.

CCW COUNT FIELD specifies the number of bytes (8 + KL + DL) to be transferred from main storage to the drive.

> **CCW COUNT < 8 + KL + DL:** storage control writes 0s in the remainder of the record.

READ DATA/READ KEY AND DATA may be inserted between Search CCW and Write CKD CCW.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CHANNEL END/DEVICE END are signaled to the channel after correction code bytes are written for the data area. When using a 3330 Model 11, channel end is presented after ECC bytes; device end is presented after padding to index is completed.

UNIT CHECK, which causes command rejection, is presented if:
Write CKD is attempted after Write R0 on a track flagged as defective.

*Search commands must compare equal on all bytes of the searched field.

W
R
I
T
E

WRITE SPECIAL COUNT, KEY, and DATA

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 0001** Hex **01**	Specifies main storage location where count, key, and data areas of the record are located.	Used at discretion of programmer.			Specifies number of bytes in the count, key, and data areas of the record segment.

CHAINING AND SPECIAL REQUIREMENTS: Must be chained from a Write R0, Write CKD, *Search ID Equal or *Search Key Equal command.

WRITE SPECIAL COUNT, KEY, AND DATA formats a segment of an overflow record; last segment is written by a normal Write CKD command.

INITIAL STATUS normally zero.

COUNT AREA is made up of the first 8 bytes from main storage.

> **FLAG BYTE** contains a 1 in bit position 4; generated and written by the storage control, this bit indicates that another part of the record is located on the next track.

CORRECTION CODE BYTES are written at the end of each record area.

CCW COUNT FIELD specifies the number of bytes (8 + KL + DL) to be transferred from main storage to the drive.

CCW COUNT < 8 + KL + DL: storage control writes 0s in the remainder of the record.

READ DATA/READ KEY AND DATA may be inserted between Search CCW and Write Special CKD CCW.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CHANNEL END/DEVICE END are signaled to the channel after correction code bytes are written for the data area. When using a 3330 Model 11, channel end is presented after ECC bytes; device end is presented after padding to index is completed.

UNIT CHECK, which causes command rejection, is presented if:
Write Special CKD is attempted after Write R0 on a track flagged as defective.

*Search commands must compare equal on all bytes of the searched field.

WRITE DATA

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 0101** Hex **05**	Specifies main storage location of data used to update record.	Used at discretion of programmer.			Specifies number of data bytes to be written.

CHAINING AND SPECIAL REQUIREMENTS: Must be chained from a *Search ID Equal or *Search Key Equal command.

WRITE DATA performs normal record updating after track formatting.

INITIAL STATUS normally zero.

COMMAND EXECUTION causes specified data in main storage to be written in data area of selected record.

NUMBER OF BYTES WRITTEN:
1. Specified in the count field of the Write Data CCW.
2. May be less than data length specified in formatted record.

CORRECTION CODE BYTES are written at the end of the data area.

CCW COUNT < COUNT AREA DL: Storage control writes 0s in remaining data area, writes ECC bytes and presents channel end/device end to channel.

CCW COUNT > COUNT AREA DL: Storage control writes only the number of bytes indicated in the count area DL, then writes ECC bytes.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CHANNEL END/DEVICE END are signaled to the channel after the correction code bytes are written for the data area.

*Search commands must compare equal on all bytes at the searched field.

WRITE KEY and DATA

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 ▨ 47	48 Count 63
Binary **0000 1101** Hex **0D**	Specifies main storage location of data to be used to update record.	Used at discretion of programmer.			Specifies number of key and data bytes to be written.

CHAINING AND SPECIAL REQUIREMENTS: Must be chained from a *Search ID Equal command.

WRITE KEY AND DATA is used for record updating after track formatting.

INITIAL STATUS normally zero.

COMMAND EXECUTION causes data from main storage to be written in key and data area of selected record.

NUMBER OF BYTES WRITTEN:
1. Specified in the count field of the Write Key and Data CCW.
2. May be less than key and data length specified in formatted record.

CORRECTION CODE BYTES are written at the end of each area.

CCW COUNT < KL/DL BYTE COUNT: Storage control writes 0s in the remaining areas, writes ECC bytes, and presents channel end/device end to channel.

CCW COUNT > KL/DL BYTE COUNT: Channel end/device end are presented after the number of bytes indicated in the count area KL/DL and ECC bytes are written.

CHAINING REQUIREMENTS must be met; otherwise unit check is presented in initial status.

CHANNEL END/DEVICE END presented after ECC bytes have been written for the data area.

*Search command must compare equal on all bytes of the searched field.

The following channel programs are typical examples of how CCWs are arranged to format read, and write records using a 3830-2 and a 3330 series (or 3340 with RPS feature) disk storage module. The examples given do not include the CPU program, which would be used to initiate the channel program.

Unless otherwise noted, all numbers used are hexadecimal.

Example 1: Format track 6A on head 8 with home address, record 0, and records R1, R2 and R3 for customer records. Assume R0 has a key length of zero and a data length of 8 bytes, and that R1, R2 and R3 have a key length of 6 bytes and a data length of 03E8 (1000 bytes).

The channel program used is:
Seek
Set File Mask
Set Sector
Write Home Address
Write Record Zero
Write CKD
Write CKD
Write CKD

SEEK

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0000 0111 Hex 07	C C H H 03E8 = 00 00 00 6A 00 08	01000	000		0006

Comments: The Seek command is used to positon the access at the desired cylinder and to select the proper head. All Seek commands transfer six bytes of data from main storage to the storage control. (Thus the byte count of six.) The first two bytes of the seek address are always 0s, the cylinder number (6A) is specified in the third and fourth bytes, and bytes five and six specify the desired head (00 08 at 03EC and 03ED).

SET FILE MASK

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0001 1111 Hex 1F	03EE = C0	01000	000		0001

Comments: The Set File Mask command is used to specify the types of operations that can be performed in this channel program. The mask byte in this case (1100 000 at address 03EE) permits all Write and Seek commands. The mask is reset to zero at the beginning of each chain of commands.

SET SECTOR

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0010 0011	1390 = 00	01000	000		0001
Hex 23					

Comments: Execution of a Set Sector command, with an argument at zero, orients the track to index. During the time that the 3830-2 is waiting for index, the channel is available to perform other operations on other drives. If Set Sector is attempted on a 3340 without RPS, the result is the same as a NO-OP. A Read Sector returns a value of zero.

WRITE HOME ADDRESS

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0001 1001	3330: 03EF = F C C H H 00 00 6A 00 08	01000	000		0005 for 3330
Hex 19					
	3340: 03EF = SD SD F C C H H 00 00 00 00 6A 00 08				0007 for 3340

Comments: The Write Home Address command creates the home address area on the track. When formatting tracks, the flag byte is normally zero. The cylinder number is in the CC bytes, and the head number is in the HH bytes.

Write Home Address is the only Write command in which the flag byte is transferred from main storage. The flag byte is generated automatically by the 3830-2 for other write commands. See note in Write Home Address command. The zero SD bytes for the 3340 indicate that the track has no defect. If there is a defect, the SD bytes are used to locate the defect.

WRITE R0

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary 0001 0101	C C H H R KL DL DL 07D0 = 00 6A 00 08 00 00 00 08 07D8 = 00 00 00 00 00 00 00 00	01000	000		0010
Hex 15					

Comments: Following the home address area is record 0. The Write R0 command writes a count area, a key area (if the key length specified is not zero), and a data area whose length is dependent on the value specified in the DL bytes of the count area. In this example, the data address is at 07D0 and a byte count of sixteen is specified.

Since the key length specified is zero, address 07D5 is coded 00 and no key area is written. The data length is eight bytes so addresses 07D6 and 07D7 are coded 00 08, and the data in the following eight main storage locations is written in the data area.

Note that the byte count in the Write R0 command is sixteen and the 3830-2 requested sixteen bytes (eight for the count area and eight for the data area). Therefore no incorrect length error is generated.

The flag byte preceding the count area is generated by the storage control and is not included in the CCW count. See note in Write R0 command.

WRITE CKD

0 Command Code 7	8 Data Address 31	32 Flags 36	37 000 39	40 47	48 Count 63
Binary **0001 1101** Hex **1D**	R1 0BB8 = 00 6A 00 08 01 06 03 E8	01100	000		0008
	R2 0FA0 = 00 6A 00 08 02 06 03 E8	01100	000		0008
	R3 1388 = 00 6A 00 08 03 06 03 E8	00100	000		0008

Above the Data Address rows the column headers read: C C H H R KL DL DL

Comments: Execution of the Write CKD commands causes a count area, key area (if the key length specified is not zero), and a data area whose length is dependent on the value specified in the DL bytes of the count area, to be written on the disk.

The main storage locations specified in the data address are coded with the cylinder number, head number, record number, key length, and data length of each record. Since the key length specified is six, a key area of six bytes long will be created. The data length specified is 03E8 (1000 bytes). Although the CCW byte count is only eight, and the channel byte count will go to zero after eight bytes have been written, the 3830-2 is committed to writing a key area six bytes long and a data area 1000 bytes long. Therefore the 3830-2 inserts 0s in the applicable positions on the track until the 3830-2 byte count reaches zero.

The difference in the channel byte count and the 3830-2 byte count will cause an incorrect length indication. Therefore the SLI flag (bit 34) is on in the CCWs.

In this example, six bytes of 0s will be recorded in the key area followed by the error correction code bytes, a gap, 1000 bytes of 0s and more error correction code bytes. At a later time, data can be recorded in the key and data areas with the following CCW sequence.

Set Sector
Search ID Equal (R1)
TIC* – 8
Write Key and Data
Search ID Equal (R2)
etc.

Example 2: Update Frank Smith's payroll record. Assume:

1. The disk is organized by key areas.
2. Each key area contains a man number.
3. Frank Smith's man number is 656151.
4. This man number is located on track 0C head-04.
5. Key areas are 6 bytes long and data areas 64 (100_{10}) bytes long.
6. The 3330 is the device.

   Note: If a 3340 is attached, the procedure remains the same.

The channel program used is:

Seek
Search Key Equal
TIC* – 8
Write Data

SEEK

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 0111** Hex **07**	C C H H 03E8 = 00 00 00 0C 00 04	01000	000		0006

Comments: As explained in example 1, the Seek command transfers the track address to the storage control, moves the access mechanism, and selects the specified head.

SEARCH KEY EQUAL

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0010 1001** Hex **29**	(man number) 07D0 = F6F5F6F1F5F1	01000	000		0006

Comments: After locating the proper cylinder and track, it is necessary to find Frank Smith's record. Since the disk is organized by keys, a Search Key Equal command is executed. Execution of this command causes the 3830-2 to search the key field of the next record encountered on the track. If the key is not equal to Frank Smith's man number (main storage locations 07D0 to 07D5), the 3830-2 signals channel end and device end to the channel and the TIC command (back to search key equal) is executed. Subsequent key areas are searched until Frank Smith's record is found. The 3830-2 then signals channel end, device end, and status modifier to the channel. The status modifier bit in the ending status byte causes the channel to skip the next command (TIC) and execute the Write Data command.

TRANSFER IN CHANNEL (TIC)

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **XXXX 1000** Hex **X8**	Address of search key equal	XXXXX	XXX		XXXX

Comments: X = positions ignored.

WRITE DATA

0 Command Code 7	8 Data Address 31	32 Flags 36	37 39 000	40 47	48 Count 63
Binary **0000 0101** Hex **05**	(data to update record) 0BB8 = XX XX XX to 0C1C	00000	000		0064

Comments: The Write Data command transfers the data to update Frank Smith's payroll record from main storage locations 0BB8 to 0C1C to the disk.

NOTE: If Frank Smith's payroll record had not been on track 0C head 04, the program would loop between the search key equal and TIC until every key on the track had been searched. The 3830-2 would then signal unit check to the channel. A subsequent Sense I/O command would indicate no record found.

The data just written could be verified by chaining the following CCWs to the Write Data command:

Read Sector (store sector address)
Set Sector (locate sector)
Search Key Equal (locate record)
TIC* – 8
Read Data (verify data)

Example 3: Find and read Joe Brown's insurance policy number. Assume:

1. The disk is organized by ID – no keys.
2. Joe Brown's employee serial number is 12341.
3. The data length of each record is 00AA (170 bytes).
4. His policy number is in the data area.
5. The data set begins on cylinder 0A track 00.
6. The 3330 is the device.

   Note: If a 3340 is attached, the only difference would be the figures derived from the record capacity chart. The procedure remains the same.

Using the record capacity chart for the 3330 series disk storage module, it is known that 43 – 170-byte records can be written on a 3330 track. Since the disk is organized by ID (Joe Brown's = 12341) the track and record location can be determined by dividing the ID by the number of records per track. In this case:

$$\frac{12341}{43} = 287 \qquad \textit{NOTE: Add 1 to the remainder to establish the address of the specific record.}$$

Thus Joe Brown's ID is 287 tracks from the beginning of the data set. There is no remainder, so the first record on the track will be Joe Brown's.

The CC HH R for the seek command is then determined by converting the 287 tracks to cylinders and adding the results to the beginning of the data set.

	Cylinder	Track	Record	C	C	H	H	R
Starting Address:	10	00	0	00	0A	00	00	00
Displacement:*	15	02	1	00	0F	00	02	01
Result:	25	02	1	00	19	00	02	01

* = Determined by dividing 287 by 19.

The channel program used is:

Seek
Search ID Equal
TIC* – 8
Read Data

SEEK

0 7 Command Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary **0000 0111** Hex **07**	C CH H 03E8 = 00 00 00 19 00 02	01000	000		0006

Comments: The Seek command is executed to position the access mechanism at cylinder 19 (decimal 25) and select head 02.

SEARCH ID EQUAL

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary 0011 0001 Hex 31	C C H H R 05DC = 00 19 00 02 01	01000	000		0005

Comments: The Search ID Equal command causes the first ID encountered on the track to be compared with Joe Brown's ID. All unequal comparisons of IDs cause the 3830-2 to signal channel end, device end to the channel, and the TIC command (back to the Search ID Equal) is executed. When an equal comparison is encountered (ID of record 1), the 3830-2 signals channel end, device end, and status modifier to the channel. Status modifier causes the next command (TIC) to be skipped and the Read Data command is executed.

     If the search ID equal is not satisfied and index is passed twice, unit check is sent in the status byte. A subsequent Sense I/O command would indicate no record found. The course of action would then be determined by the error recovery procedures.

TRANSFER IN CHANNEL (TIC)

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary XXXX 1000 Hex X8	Address of search ID equal command.	XXXXX	XXX		XXXX

Comments: X = positions ignored.

READ DATA

0 Command 7 Code	8 Data Address 31	32 36 Flags	37 39 000	40 47	48 Count 63
Binary 0000 0110 Hex 06	(insurance policy number) 0BB8 = XX XX XX to 0C62	00000	000		00AA

Comments: Execution of the Read Data command causes the data area, containing Joe Brown's insurance policy number, to be read into main storage locations 0BB8 to 0C62.

STANDARD FEATURES

MULTIPLE TRACK (MT) OPERATION

On all Search and most Read commands, the storage control can automatically select the next sequentially numbered head on the disk drive under control of bit 0 of the command code. If bit 0 is a 1 and data transfer of the command has not been initiated, the next sequentially numbered head is selected at index. Thus, the need for Seek Head commands in a chain of Read or Search commands is eliminated.

Note: Channel end, device end, and unit check are signaled to the channel if the head switching operation crosses a file-protected boundary or exceeds the limits of the cylinder.

Discretion must be used when using the MT bit. For example, assume that during a multitrack search operation the desired record is on the first track searched and the search commences after that record is passed. The head number, therefore, is advanced to the next track without comparing on the desired record. Also, should a Set Sector command with a sector value of zero precede a multitrack command, head switching could occur before the desired record is reached. To avoid these conditions, a single track Read Home Address or Read R0 should be placed before the search, thus ensuring that the search commences at R0 or R1 of the track. (See Figure 7.)

Multitrack operations are not used on Read IPL, Read Sector, or Read Diagnostic Status-1 commands.

RECORD OVERFLOW

The record overflow function provides a means of processing logical records which exceed the capacity of a track. When

MULTIPLE TRACK OPERATION
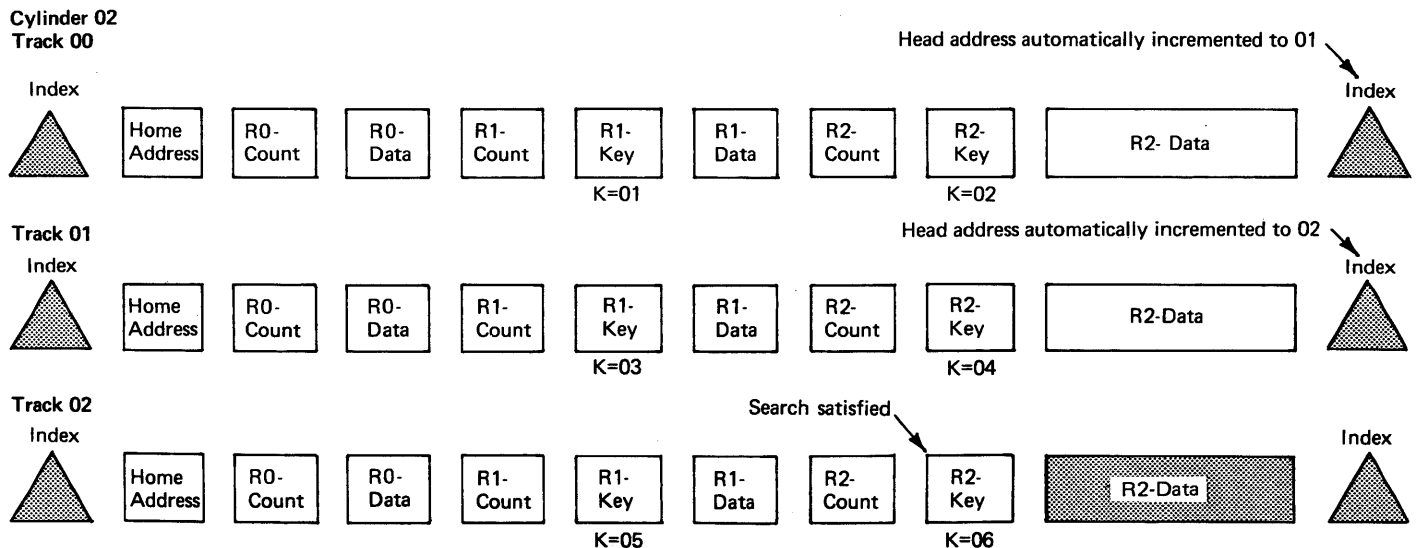
Channel program using multiple track search.

Object: Update John Doe's payroll record.
Assume: The disk is organized by keys, and the physical address of the record is unknown.
Set File Mask (allow write and seek commands).
Seek (cylinder 02, head 00).
Read Home Address (make sure all records are read).
Search Key Equal (MT bit on, argument = 06).
TIC* -8
Write Data (updates shaded area).

Figure 7. Multiple Track Operation

using overflow records, the factor limiting the size of the record is the cylinder boundary.

Format Overflow Records

That portion of an overflow record written on (or read from) one track is called a record segment. Each segment contains a count field, key field (optional), and a data field. The key and data lengths specified in the KL and DL bytes of the count field pertain only to that segment, not the entire overflow record. Since only the key field of the first segment has significance, overflow records are usually formatted without key fields (KL = 0).

Write Special Count, Key, and Data commands are used to format all segments of an overflow record except the last segment. As shown in Figure 8, the last segment is formatted with a normal Write Count, Key, and Data command.

Write special CKD commands cause a 1 to be written in flag byte bit position four of the record segment being written. This bit, which identifies the record as an overflow segment, indicates to subsequent record processing commands that the logical record continues on the following track.

No internally generated head switching is associated with formatting overflow records; all head seeking must be done by the formatting program (Figure 8). Head switching will not occur:

- In violation of the file mask.

- Past the end of the cylinder.

- To a defective track.

- To an alternate track.

OVERFLOW RECORD
Cylinder 02
Track 01
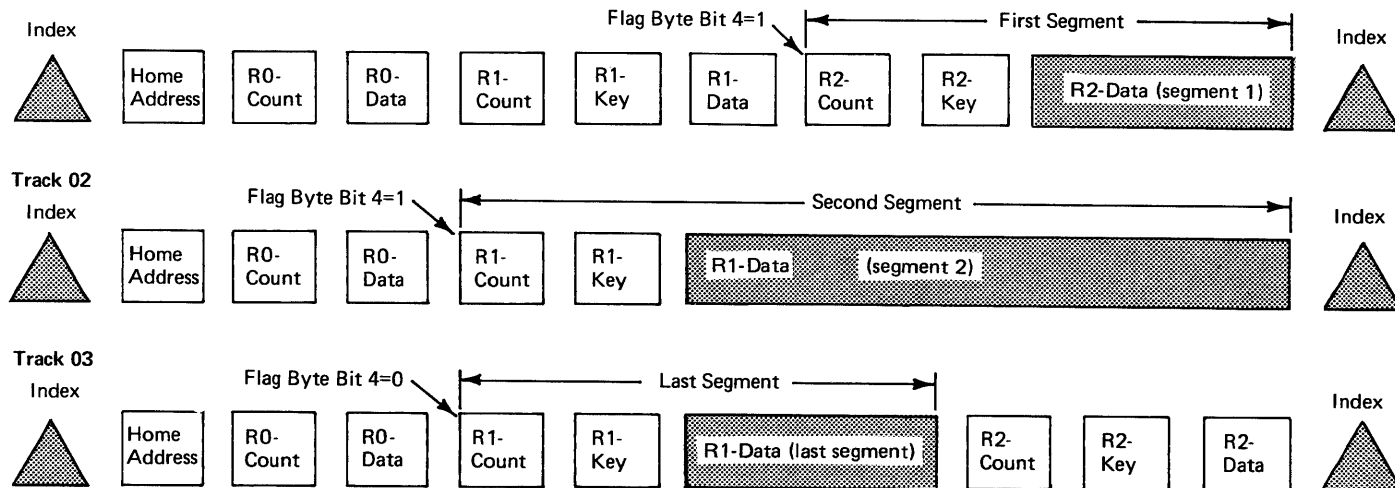
Typical channel programs for formatting, updating, and reading overflow records.

Formatting:
Set sector
Search ID R1 (track 1)
TIC* -8
Write special CKD (segment 1)
Seek head (next track)
Search ID R0 (track 2)
TIC* -8
Write special CKD (segment 2)
Seek head (next track)
Search ID R0 (Track 3)
TIC* -8
Write CKD (last segment)

Updating:
Set sector
Search ID R2 (segment 1)
TIC* -8
Write data (updates shaded areas)

Reading:
Set sector
Search ID R2 (segment 1)
TIC* -8
Read data (reads shaded areas)

Figure 8. Record Overflow

All segments of an overflow record, except the first, must be written immediately following R0; all segments, except the last, must be the last physical record on their respective tracks.

Processing Overflow Records

The following commands may be used to read or update previously formatted overflow records.

- Read Count, Key, and Data.

- Read Key and Data.

- Read Data.

- Write Key and Data.

- Write Data.

When any of the above are used to process an overflow record, the operation does not terminate at the end of a record segment when the segment is flagged with bit four (on) in the flag byte. Instead, the head address is incremented by 1 at index and the operation continues in the data field of record one on the next track. If this record segment is also flagged with bit four (on) in the flag byte, the operation continues on the next track. When a segment is found that is not flagged, the operation terminates at the end of the data field. The net effect of this procedure is that the data fields of all the record segments appear as a single logical data field.

If data overrun occurs during the first segment, the storage control attempts recovery through use of command retry. If a data overrun occurs during an operation involving the second (or subsequent) segments, unit check is signaled immediately during a read operation, or at the end of the associated segment during write operations.

If a data check or bus out parity error occurs, unit check is signaled at the end of the associated area.

Note: If a write operation is in progress, unit check is signaled at the end of the record segment.

If the CCW count is less than the number of bytes in the logical record, the operation continues to the end of the logical record before presenting ending status.

Spacing over overflow records does not occur automatically. The channel program must be written so that the entire logical record is spaced over, not just the first segment. For example, in the sequence:

    Set Sector
    Search ID (first segment)
    TIC* –8
    Read CKD (multitrack)

the read CKD does *not* read the next logical record on the cylinder. It commences reading the overflow record at the count field of the second segment. For example, the sequence:

    Set Sector
    Search ID (first segment)
    TIC* –8
    Read Key and Data (skip and SLI flags on)
    Read CKD (multitrack)

reads the count, key, and data of the next logical record.

Multiple track operations should not be confused with overflow record operations. Head switching, when processing overflow records, occurs regardless of whether the MT bit is on or off.

END-OF-FILE

An end-of-file record, used to define the end of a logical group of records, is written by executing a Write Count, Key, and Data command with the DL bytes in the count area set to zero. Execution of a Write CKD with a data length of zero causes the storage control to write a data area consisting of one byte of zeros followed by the error correction code bytes. (Figure 9.)

The KL portion of the count area can be either zero or non-zero. If KL equals zero, the end-of-file record contains only the contents of the count area and data area. If the key length is not zero, the key area is written as specified by the KL byte.

Detection of a zero data length causes unit exception status to be generated. No data from the data area is transferred to the channel. A Read R0, Read CKD, or Read KD transfers the key area (if any) to the channel.

The unit exception is generated during execution of Read IPL, Read R0, Read CKD, Read KD, Read data, Write KD, and Write Data commands.

Index
| Home Address | R0-Count | R0-Data | R1-Count | R1-Key | R1-Data | R2-Count | R2-Key | R2- Data |
Index

Track 01

Index

|◄──── End of File ────►|

| Home Address | R0-Count | R0-Data | R1-Count | R1-Key | R1-Data | R2-Count | R2-Key | 00000000 |
Index

DL DL=00
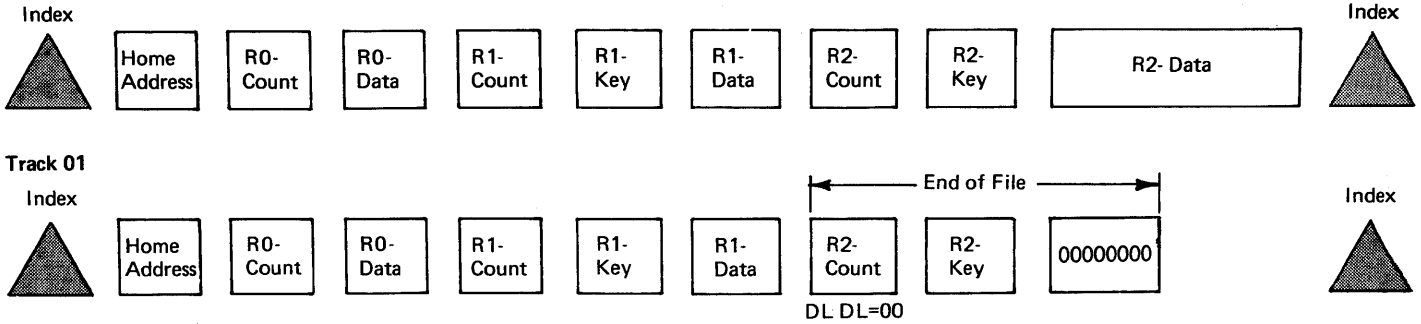
Set File Mask (allow seek and write)
Seek (cylinder 02, head 00)
Write Home Address
Write R0
Write CKD R1
Write CKD R2
Seek Head (Cylinder 02, head 01)
Write Home Address
Write R0
Write CKD R1
Write CKD R2 (data length = 00)

Figure 9. End of File

ROTATIONAL POSITION SENSING

Rotational position sensing (RPS) is a standard feature of the IBM 3330 Series Disk Storage and is an optional feature of the IBM 3340 Disk Storage. Rotational position sensing reduces the time the channel is busy searching for a record. This procedure permits a search command to be initiated just before the desired record is positioned under the read/write heads.

To accomplish this, a sector concept is employed. The tracks in each cylinder of a disk storage drive are divided into equally spaced sectors; each record on the track has a sector location as well as a record address. Although the sector location is not physically indicated on the tracks, the sector number is stored at the beginning of all Read, Write, and Search commands. When chained to a Read, Write, or Search CCW, the Read Sector command provides the sector number required to access the record processed by the previous command. A subsequent Set Sector command can be used to fetch the sector number from main storage to reposition the track at that record. This type of operation is particularly useful in write verification (Figure 10) and sequential disk processing.

The location of a sector in which a record is recorded is a function of the length of all records that precede it and its sequential position on the track.

The following formula may be used to calculate the sector corresponding to record n (n greater than or equal to 1). A standard R0 area (KL=0, DL=8) is assumed. The fractional portion of the calculated sector number should be ignored.

For 3330 series drives:

$$S(n) = \frac{1}{105} \left[237 + \sum_{i=1}^{n-1} (KL_i + DL_i + C) \right]$$

where

$C = 135$ if $KL=0$
$C = 191$ if $KL \neq 0$

For 3340 series drives:

$$S(n) = \frac{1}{140} \left[353 + \sum_{i=1}^{n-1} (KL_i + DL_i + C) \right]$$

where

$C = 167$ if $KL=0$
$C = 242$ if $KL \neq 0$

The following example shows some of the advantages of using rotational position sensing to locate and retrieve records.

Index

127 ▼ 0

ROTATION

D Set Sector

C Read Sector

Read/Write Head

End of Record n

Channel
Available

32

Start record n

Channel
Reselection Delay

*If channel does not
respond, connection
is tried on subsequent
revolutions.*

B 82

64

A Search ID Rn

Channel program for write verification of record n.

Seek

A Search ID Rn
TIC* -8

B Write Data Rn

C Read Sector (82)

D Set Sector (82)
After channel reselection:
Search ID Rn
TIC* -8

Read Data Rn

Note: *Example represents 3333
Disk Storage.*

Figure 10. Rotational Position Sensing

2314 Without RPS

Channel Program 1.

Command	Selector Channel and Storage Control Status
Seek	Available as soon as the storage control accepts the seek address.

Channel Program 2.

Command	Selector Channel and Storage Control Status
Search ID Equal	Busy (average 12.5 ms on the 2314).
TIC *–8 Read Data	Busy

3330 With RPS

When the sector address is known or can be calculated, the following channel program can be used:

Command	Block Multiplexer Channel and Storage Control Status
Seek	Available during access movement.
Set Sector	Available until sector is located.
Search ID Equal	Busy (average 250 μs on the 3330).
TIC *–8	Normally the first ID read is that of the desired record and the TIC is not executed.
Read Data	Busy

Note that with RPS only one channel program is required to locate the record and transfer the data. This eliminates a seek I/O interrupt and the I/O processing required to schedule a data transfer channel program.

Also, the channel and disk storage are available during access motion and rotational positioning, allowing seek and set sector operations to be overlapped with other I/O operations on the storage control and channel.

MULTIPLE REQUESTING

Use of block multiplexer channels and rotational position sensing enables the IBM 3830-2 to disconnect from the channel during mechanical delays resulting from execution of arm positioning Seek or Set Sector commands. Reconnection is attempted when the access mechanism is positioned at the desired track or when the specified rotational position has been reached.

During the time the channel and storage control are disconnected, the CPU is free to initiate I/O operations on other drives attached to the 3830-2 although the disconnected channel program is not completed. Thus, separate channel programs may be operating simultaneously on each drive attached to the storage control.

The storage control stores the file mask, seek, or set sector arguments required to successfully complete the disconnected chains.

COMMAND RETRY (3330 series only)

Command retry is a channel/storage control procedure that causes an improperly executed command in a channel program to be automatically retried. The re-execution does not cause an I/O interrupt, and programmed error recovery procedures are not required.

Command retry is used:

1. To recover from correctable data errors (error burst 11 bits or less) that occur during a search or read operation on a home address, count, or key area.

   During a search or read operation, the home address, count, or key read from the disk is placed in a buffer in the storage control. When a correctable data error occurs, the storage control corrects the data in the buffer and requests the channel to reissue the command which originally caused the error. During reorientation to the record, the storage control disconnects and frees the channel. When the failing Search or Read command is re-executed, the corrected data in the buffer is used, instead of the actual data from the track.

2. When an uncorrectable data error (an error burst longer than 11 bits) is detected on any position of a record during a read or search operation.

   The failing command is reissued by the storage control. If retry is successful, the channel program continues normally. If retry is unsuccessful, the storage control retries the operation again.

   If after any retry the error becomes correctable, the procedure outlined in 1 applies. If the error does not become correctable, the operation is terminated and the program is interrupted.

3. When a seek malfunction is detected.

   The storage control retries the command in an attempt to position the access mechanism correctly.

4. When an alternate or defective track condition is detected before data transfer begins.

The storage control determines the location of the alternate or defective track (from R0 on the track), initiates a seek to this track, orients on index, and reissues the original command.

5. When a command overrun (or late command chaining) condition occurs because of interference from another channel or the CPU.

The storage control initiates a retry of the command that was late.

6. When a data overrun occurs except:
   a. A data overrun occurring during a record overflow operation in the second or subsequent segments.
   b. A data overrun occurring during a format Write.

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

1. A CCW containing a PCI may, if retried because of command retry, cause multiple PCI interruptions to occur.

2. A channel program consisting of a single, unchained CCW specifying an immediate command may cause a condition code of zero rather than one to be set. This setting of the condition code occurs if the control unit signals command retry at the time initial status is presented to the command. The channel program then causes a later interruption upon completion of the operation.

3. If premature termination of the execution of a channel program occurs during the retry of a command, the residual count and command address field in the CSW may not necessarily indicate the extent of main storage used.

4. If a CCW used in an operation is changed before that operation has been successfully completed, the results are unpredictable.

USAGE METER

If the Enable/Disable switch on the 3830-2 operator panel is in the Enable position when a power-on sequence occurs, meter time will be recorded as long as the CPU meter is recording or until the usage meter and 3830-2 are disabled from the channel.

The usage meter and 3830-2 are disabled when the following conditions exist simultaneously:

● The Enable/Disable switch is in Disable.

● The CPU is in a stop or wait state.

● Command chaining is not in effect.

● The 3830-2 Channel Selection switch is not selected to that channel. (Only applies to 3830-2 having the two channel switch or two channel switch additional special feature.)

● The 3830-2 is not performing an operation.

● There is not any status pending.

The usage meter can then be enabled, provided:

● The CPU is in the stop or wait state.

● The Enable/Disable switch is in Enable.

TWO CHANNEL SWITCH AND TWO CHANNEL SWITCH ADDITIONAL

The two channel switch special feature provides the ability for the IBM 3830-2 Storage Control to be shared by two channels. Another special feature, two channel switch additional, is available with 3330 series subsystems and, with the two channel switch feature, permits the 3830-2 to be shared by four channels, two of which may be on the same central processing units. With appropriate programming or operator action, individual drives attached to the storage control may be reserved for the exclusive use of any of the channels. Channel switching and device reservation are controlled by the channel program. Two special commands are associated with the features: Device Reserve and Device Release. (See "Channel Commands.")

Channel Selection Switch

Channel selection is determined by a three or five position program-controlled switch in the 3830-2. When the switch is in neutral, the 3830-2 can be selected by any channel. The channel A position indicates that the storage control has been selected by channel A; the channel B position indicates that the storage control has been selected by channel B; and so on.

Once the 3830-2 has been selected by a channel, it is switched to that channel until the channel disconnects. The channel selection switch will then return to neutral unless:

- Chaining is indicated and device end is included in the status.

- Chaining is indicated without device end in the status, and the channel does not disconnect.

- Chaining is indicated without device end in the status, the channel disconnects, and the storage control becomes busy to allow:

  1. Execution of a storage control error recovery procedure.

  2. Execution of a Diagnostic Load or Diagnostic Write command.

  3. Completion of a format Write operation.

- Chaining is indicated and a format Write operation is in progress.

- The last status byte was part of a channel-initiated signal sequence and was stacked by the channel.

- A contingent connection is established.

- Ending status associated with an interface disconnect has not been accepted by the channel.

Device Status

Multitagged status: presented to all interfaces not partitioned from the storage control. Multitagged status conditions cause status to be generated for each of the attached channels. The status must be accepted by a channel for that channel to use the device.

Untagged status: not associated with any particular interface and is presented to only one channel, the first channel to accept the status from the device; other channels may be presented a status byte consisting of all zeros. This type of status transfer is accomplished by considering the status as multitag until one channel accepts the status; at that time the status condition is cleared for other channels.

Tagged status: associated with a particular interface and made available solely to that interface. The status remains pending until accepted over the interface identified by the tag.

When a device is busy for any reason (including reservation to channel A), any command from channel B, C, or D addressed to that device will be rejected with a busy status. This, in turn, causes the storage control to attempt to present to channel B, C, or D a status byte containing device end after the busy condition has been terminated. The address byte associated with this status byte will be the same as that associated with the busy status byte.

Device end status resulting from any channel command will be presented to the channel that issued the command.

Device end status resulting from a not-ready to ready transition will be presented under control of the multitagged/untagged switch.

Addressing

The base address (high-order bits) of the storage control on one channel is independent of the base address on the

other channel. However, the low-order address bits for any attached device must be the same on all channels.

Resets

A system reset may be initiated by any channel at any time. A system reset resets all reservations and status conditions stored in the storage control for the resetting channel, terminates all block multiplex command chains in progress on the resetting channel, and resets all device interrupts not associated with the other channels. Reservations, status, and device interrupts for the other channels, as well as block multiplex chains in progress on the other channels, are not affected. If a channel initiates a system reset while the selection switch is connected to the other channels, a machine reset is performed when the selection switch goes to neutral. A selective reset has no effect on device reservations or status.

32 DRIVE EXPANSION

The 32 drive expansion feature allows up to four disk storages and control or a maximum of 32 drives to be attached to the 3830-2. The basic 3830-2 can operate two disk storages and control; an additional two are possible with 32 drive expansion.

Control store extension is a prerequisite for 32 drive expansion.

3330/3340 INTERMIX

The 3330/3340 intermix feature permits the mixing of 3330 and 3340 disk storage on the 3830-2. Control store extension is a prerequisite.

STRING SWITCH FEATURE

The string switch feature allows a 3333 disk storage and control and its attached string of 3330 disk storage modules or a 3340-A2 disk storage and control and its attached string of 3340 disk storage modules to be dynamically shared by various storage control attachments.

The string switch is similar to the two channel switch feature for the 3830 storage control.

The 3333 or 3340-A2 has an Enable/Disable switch which allows either or both strings of drives to be partitioned from the storage control attachments.

Selection

Any storage control can select and reserve a drive using the Device Reserve CCW. Any conflicts that may occur when two storage control attachments attempt to reserve the same drive are resolved by hardware within the 3333 or 3340-A2. After the storage control has achieved selection of a drive, it may assign the drive for its exclusive use and continue extended operations such as Read and Write operations.

Note: If either the 3333 or 3340-A2 is powered-off or disabled when selection is attempted, the 3830-2 propagates selection, which results in a condition code 3 from the channel.

After the storage control completes its operation with the dedicated drive, and does not need to maintain its reservation, a Device Release CCW issued to the 3333 or 3340-A2 will release the drive and make it available to any other storage control attachment.

ERROR CORRECTION FUNCTION

The recovery action table uses an error correction function as a step in recovering from data errors. The error correction function is used when the storage control 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 are corrected internally by the storage control by using command retry. Data check and correctable sense bits are not posted for these errors, and do not cause a system interrupt.

When the correctable and data check sense bits are included in the sense information, sense bytes 18 through 22 provide the error pattern and displacement.

Error correction is accomplished by aligning the error pattern provided in sense bytes 20 through 22 with the erroneous data in main storage and exclusively ORing the error pattern and main storage bytes.

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

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

Prior to applying the error correction function, it must be determined whether any error bytes were not transferred, due to the skip bit being on, due to a short count in the

CCW, or if the error bytes are not contiguous in main storage due to data chaining between CCWs.

- If any of the error bytes are contained in data specified by a CCW that has the skip bit on, the error correction function must be bypassed for those bytes that were not transferred to main storage.

- If any of the error bytes are contained in data not transferred to main storage due to a short count in the CCW, the error correction function must be bypassed for those bytes that were not transferred to main storage.

- If no short count in the CCW is detected and bit 7 of sense byte 23 indicates channel truncation, the error correction function must be bypassed.

- If the error pattern spans noncontiguous main storage boundaries due to data chaining, the error correction function must be selectively applied to the noncontiguous storage locations.

- If the error displacement in sense bytes 18 and 19 is less than 3, the error is partially or totally contained in the correction code bytes. In this case, the error pattern in sense bytes 20-22 is constructed as follows:

  1. If the error displacement is zero, the error pattern must be set to zero by the error recovery programs (ERPs).

  2. If the error displacement is one, the two low-order error pattern bytes (bytes 21 and 22) must be set to zero by the ERPs. The high-order bytes contain the correction syndrome.

  3. If the error displacement is two, the low-order pattern byte must be set to zero by the ERPs. The high-order bytes contain the correction syndrome.

Note: Case 1 also occurs if the error is totally contained in the gap byte that immediately precedes the data area.

EXAMPLE (3330)

Assume the following:
Key length = 2
Data length = 10

The CSW-8 points to CCW 1 in the following chain:

CCW	Commands	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

```
        |<---------- RESTART DISPLACEMENT ----------->|
        |<-KEY->|<---------------- DATA ------------->|
Byte    |---|---|---|---|---|---|---|---|---|----|----|----|
Number  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
        |---|---|---|---|---|---|---|---|---|----|----|----|
                            |<-- Error -->|
                        |<-------- Error Displacement ----->|
```
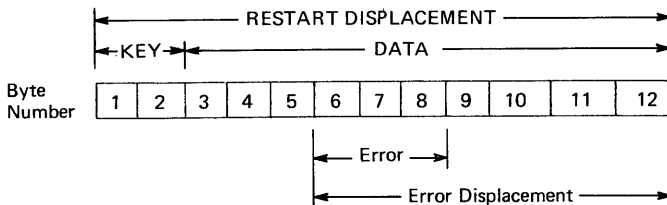
Suppose the error affected bytes 6, 7, and 8 as follows:

Byte 6 -------XX
Byte 7 XXX-----
Byte 8 X-------

   where (−) corresponds to correct bit
         (X) corresponds to incorrect bit

The illustrated condition generates a restart displacement of 12 and an error displacement of 7. The error pattern would be generated as follows:

Pattern byte 1 (sense byte 20)	0 0 0 0 0 0 1 1
Pattern byte 2 (sense byte 21)	1 1 1 0 0 0 0 0
Pattern byte 3 (sense byte 22)	1 0 0 0 0 0 0 0

Application of the error correction algorithm, as outlined in the preceding sections, would result in the following system recovery action.

1. Pattern byte 1 would not be applied to data byte number six, since this byte was not transferred to main storage due to the skip flag in the CCW 3.

2. Pattern byte 2 would be exclusively ORed to main storage location B, where data byte 7 resides.

3. Pattern byte 3 would not be applied to data byte 8, since this byte was not transferred to main storage due to a short count in CCW 4.

CONSTRUCTION OF RESTART CCWs

If operation incomplete (byte 1 − bit 7) is set in the sense information, it indicates that an error or unusual condition occurred during a logical operation after data transfer had been initiated. By constructing restart channel command words, the error recovery procedures are able to correct the unusual condition and continue the operation in progress from the point of interruption to the normal ending point.

Restart CCW 1

Restart CCW 1 is constructed as follows:

1. The command code byte is provided in sense byte 3.

2. The data address is that of the interrupted CCW, plus the count of that CCW, minus the residual count in the channel status word.

3. The flags (except PCI) are those of the interrupted CCW.

4. The count is the residual count in the CSW. If the residual count is zero, a count of one must be used. If a Write command was in progress, the data address should specify a byte containing 00. If a Read command was in progress, the skip bit should be on.

Restart CCW 2

Restart CCW 2 is constructed as follows:

1. The command code is provided in sense byte 3.

2. The count is constructed as follows:

   a. Fetch 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 (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, 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. Truncation occurred. Set the restart CCW 2 count equal to one. Go to Step 3 and include the skip bit in the restart CCW flags.

f. Set restart CCW 2 count equal to the result of the subtraction in step (b). Go to Step 3.

3. The flags (except PCI) are those of the CCW designated by the pointer in Step 2. The skip bit is also set if Step 2e was executed.

4. The data address is that 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 another "operation incomplete" occurs while executing the restart CCW, a new restart CCW may be generated from the old restart CCW.

Note: Be sure to avoid destroying the old Restart CCW before generating the new one.

3830 STORAGE CONTROL MODEL 2 OPERATOR PANEL

```
                CHANNEL  CHANNEL  CHANNEL  CHANNEL
                   A        B        C        D
                                                                    ┌──────────┐
                ENABLE   ENABLE   ENABLE   ENABLE   MULTITAG        │  POWER   │
                                                                    │   ON     │
   [0 0 0 0 0 0]   ⊙       ⊙Ⓐ⊙       ⊙       ⊙Ⓑ                    └──────────┘

                                                                       Ⓒ
                DISABLE  DISABLE  DISABLE  DISABLE    OFF             ┌──────────┐
                                                                     │  POWER   │
                                                                     │   OFF    │
                                                                     └──────────┘
```
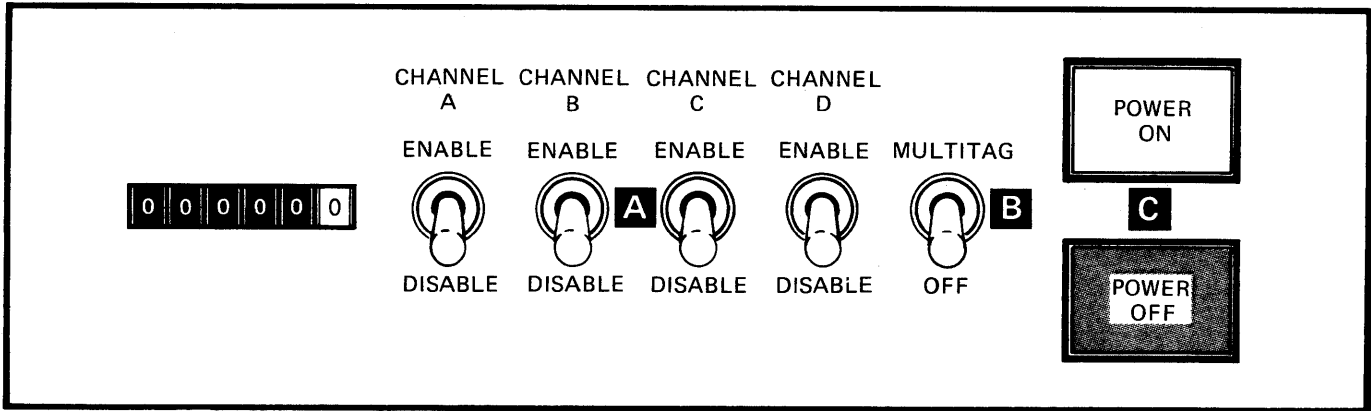
Ⓐ Toggle switch that must be in the Enable position before the 3830 model 2 storage control is available to the channel. If two channel switch or two channel switch, additional, feature is installed, a separate switch is provided for each channel.

Ⓑ Toggle switch that determines how the Device End generated by the drive, in a not-ready-to-ready sequence, is presented to the channel.

Multitag Position: A drive is available to a channel after it clears the Device End generated by the drive in a not-ready-to-ready sequence. Before any other channel can use the drive, it must also accept the not-ready-to-ready sequence Device End.

Off Position: A drive is made available to all channels after one of the channels clears the Device End generated by the drive in a not-ready-to-ready sequence.

Ⓒ **Power Off:** A momentary pushbutton that can be used to remove ac power from the 3830 model 2 and its attached drives.

If system power is on when the pushbutton is pressed, ac power is removed from the 3830 model 2 and its attached drives. If system power is later turned off, then on, ac power is reapplied to the 3830 model 2 and its attached drives; operation of the Power On pushbutton is not required.

Power On: A momentary pushbutton that can be used to reverse the effect of the Power Off switch. If system power is on, and the Power Off switch is pressed to remove ac power from the 3830 model 2 and its attached drives, then pressing the Power On switch will restore ac power to the 3830 model 2 and its attached drives.

Whenever system power is brought up, ac power is applied to the 3830 model 2 and its attached drives, regardless of what was previously done to the two pushbuttons.

See "Usage Meter" for meter operation.

The status and condition of the 3830-2 is reported in the sense bytes.' There are 24 bytes and seven different formats, 0–6. Four formats, 1, 4, 5, and 6 describe the disk storage (3330 or 3340). The remaining three formats, 0, 2, and 3 are associated with the 3830-2. Only the formats dealing with the 3830-2 are explained. Refer to the following manuals for formats 1, 4, 5, and 6.

- *Reference Manual for IBM 3330 Series Disk Storage* Order No. GA26-1615.

- *Reference Manual for IBM 3340 Disk Storage* Order No. GA26-1619.

SENSE BYTE SUMMARY

In all the formats, the first eight bytes, 0–7, give high-level information concerning status and condition. Sense byte 7 identifies the format in which the remaining bytes, 8 through 24, are arrayed as follows:

- Bits 0–3 = The format array of bytes 8–24.

0	1	2	3	Format
0	0	0	0	0
0	0	1	0	2
0	1	1	0	3

Byte 7

- Bits 4–7 = Define a message.

4	5	6	7	Message
0	0	0	0	0
↓	↓	↓	↓	↓
1	1	1	1	F

Each of the formats 0, 2, and 3 (including the possible messages) is summarized in the charts on the following pages.

SENSE BYTES WITH 3333

SENSE BYTE 0	
Bit 0 Command Reject	1. Invalid command code. 2. Invalid command sequence. 3. Invalid or incomplete argument transferred by a control command. 4. Track formatted without home address. 5. Write portion of file mask violated. 6. Record zero count field of a defective track points to itself instead of an alternate track. 7. A Write command has been issued with the Write Inhibit switch in read only position.
Bit 1 Intervention Required	1. Addressed device not physically attached to system. 2. Addressed device not ready. 3. Diagnostic Write or Diagnostic Load command issued and microdiagnostic is resident in control storage.
Bit 2 Bus Out Parity	The storage control has detected bad parity in data transferred from the channel.
Bit 3 Equipment Check	An unusual hardware condition originated in the channel, storage control, or drive. (Condition further defined in sense bytes 7 thru 23.)
Bit 4 Data Check	1. A correctable data error has been detected in information received from a disk drive. (Byte 2, bit 1 on, and correction information is provided in sense bytes 15 thru 22.) 2. An uncorrectable data error has been detected in information received from a disk drive. (Condition further defined in sense byte 7.)
Bit 5 Overrun See Note 1.	1. The storage control received a byte from a drive before the last byte read was accepted by the channel. 2. A data byte was received too late from the channel during a write operation.
Bit 6	NOT USED — SET TO 0.
Bit 7	NOT USED — SET TO 0.
Note 1: The storage control posts overrun only if the condition occurs: (1) more than ten times in a CCW chain, (2) in the second or subsequent segments of an overflow record, or (3) during a format Write operation. *Detection of an overrun immediately stops data transmission. When writing, the remaining portion of the record area is padded out with 0s. With the following two exceptions, all data overrun conditions are retried by the storage control:* *1. Data overruns that occur on the second or subsequent segments of an overflow record.* *2. Data overruns that occur during format Write operations.* *If the overrun condition exists after retry is exhausted, byte 1 bit 0 (permanent error) is posted with overrun.*	

SENSE BYTE 1	
Bit 0 Permanent Error	1. Storage control retry has been attempted and was unsuccessful. 2. A drive unsafe condition has been detected and retry should not be attempted.
Bit 1 Invalid Track Format	An attempt has been made to write data exceeding track capacity.
Bit 2 End of Cylinder	1. A multitrack Read or Search operation has attempted to continue beyond the addressable cylinder boundary. 2. An overflow operation has attempted to continue beyond the addressable cylinder boundary. (Byte 1 bit 7, operation incomplete, also set.)
Bit 3	NOT USED — SET TO 0.
Bit 4 No Record Found	1. Two index points sensed in the same command chain without an intervening Read operation in the home address area or in a data area. 2. Two index points sensed in the same command chain without an intervening Write, Sense, or Control command.
Bit 5 File Protected	1. A Seek command has violated the file mask. 2. A multitrack Read or Search operation has violated the file mask. 3. An overflow operation has violated the seek portion of the file mask. (Byte 1 bit 7, operation incomplete, also set.)
Bit 6 Write Inhibited	A Write command was issued to a drive with Write Inhibit switch in the Read Only position.
Bit 7 Operation Incomplete	One of the following conditions occurred during the processing of an overflow record: 1. Overflow to a file protected boundary. (Byte 1 bit 5, file protected, also set.) 2. Overflow past the cylinder boundary. (Byte 1 bit 2, end of cylinder, also set.) 3. A correctable data error was detected in a data field other than the last segment. (Byte 2 bit 1, correctable, also set.) 4. A correctable data check was detected in a home address or count area associated with a segment other than the first segment. 5. An uncorrectable data check was detected in any area associated with a segment other than the first segment. 6. A defective or alternate track condition was detected after initiation of data transfer. 7. A seek error was detected in the second or subsequent segment.

SENSE BYTE 2	
Bit 0	NOT USED – SET TO 0
Bit 1 Correctable	Indicates that the data check posted in sense byte 0 bit 4 is correctable. Sense bytes 15 thru 22 identify the error pattern and error pattern displacement.
Bit 2	NOT USED – SET TO 0.
Bit 3 Environmental Data Present	Indicates that sense bytes 8 thru 23 contain either usage/error statistics or error log information. Sense byte 7 identifies the format of bytes 8 thru 23.
Bits 4 thru 7	NOT USED – SET TO 0.

SENSE BYTE 3	
Bits 0 thru 7 Restart Command	When byte 1 bit 7 (operation incomplete) is set, this byte identifies the operation in progress when the interrupt occurred. 0000 0110 = A Read operation was in progress. 0000 0101 = A Write operation was in progress. When byte 1 bit 7 is zero, this byte is zero.

SENSE BYTE 4				
Bits 0 & 1 Storage Control Identification	Provides the physical identification of the storage control as specified by the customer engineer on the storage control/drive interface card.			
Bits 2 thru 7 Drive Identification	Provides the physical address of each disk drive as follows:			
	Drive G = 001110	Drive E = 011100	Drive C = 101010	Drive A = 111000
	Drive H = 000111	Drive F = 010101	Drive D = 100011	Drive B = 110001

SENSE BYTE 5	
Bits 0 thru 7 Cylinder-low	Identifies the low-order cylinder address of the most recent seek argument from the channel.

SENSE BYTE 6		
Bit 0	3330-1, 2 Reverse	Last seek (excluding retry seeks) was in reverse direction — towards track 00.
	3330-11	Not used — set to zero.
Bit 1	3330-1, 2 Cylinder — High	High-order bit (256) of cylinder address in sense byte 5.
	3330-11 Cylinder — High	High-order bit (512) of cylinder address in sense byte 5.
Bit 2	3330-1, 2 Difference	High-order bit of difference count in sense byte 16 format 1.
	3330-11 Cylinder — High	High-order bit (256) of cylinder address in sense byte 5.
Bits 3 thru 7 Head Address See Note 2		Identifies head address of last seek (excluding retry seeks). Head address is updated during multitrack and overflow operations.

Note 2: If an alternate track condition is detected and operation incomplete is posted during an overflow operation, byte 6 is set to the head address of the defective track plus 1. This information is used by the ERPs to construct the seek argument to continue the operation.

SENSE BYTE 7	
Bits 0 thru 3 Format	Specifies the format of sense bytes 8 thru 23 as follows: 0000 = Format 0 — Programming or system check.
	— — — — — CE information — — — — — 0001 = Format 1 — Disk drive equipment check. 0010 = Format 2 — Storage control equipment check. 0011 = Format 3 — Storage control-control check.
	0100 = Format 4 — Data checks not providing displacement information. 0101 = Format 5 — Data checks providing displacement information. 0110 = Format 6 — Usage/error statistics
Bits 4 thru 7 Message	Describes the specific nature of error conditions for each of the above formats. The Message Table that accompanies each format description specifies the function of the message bits for that format.

FORMAT 0 — PROGRAMMING OR SYSTEM CHECK

SENSE BYTES 8—23
NOT USED — SET TO 0

MESSAGE TABLE — FORMAT 0

Sense byte 7 —
bits 4 thru 7 =

0000	No message.
0001	Invalid command.
0010	Invalid sequence.
0011	CCW count less than required.
0100	Data value not as required.
0101	Diagnostic write not permitted by file mask.
0110	Channel discontinued retry operation.
0111	Channel returned with incorrect retry CCW.
1000	Read only storage — not ready.
1001	Read only storage — permanent seek check.
1010	Read only storage — permanent read check.
1011	Improper alternate track pointer.
1100	Not used.
1101	Index detected in gap of record.
1110	Not used.
1111	Not used.

FORMAT 2 – STORAGE CONTROL EQUIPMENT CHECK

SENSE BYTE 8 NOT USED – SET TO 0

SENSE BYTE 9 NOT USED – SET TO 0

SENSE BYTE 10 NOT USED – SET TO 0

SENSE BYTE 11 – CONTROL CHECK	
Bit 0	Channel buffer parity check.
Bit 1	Channel A or C check.
Bit 2	Channel B or D check.
Bit 3	Data transfer check.
Bit 4	CI check.
Bit 5	Load S registers.
Bit 6	Compare assist.
Bit 7	Multiconnect, channel C or D check.

SENSE BYTE 12 NOT USED – SET TO 0

SENSE BYTE 13 Contents of TA register for message code 4. Zero for other message codes.

SENSE BYTE 14 Contents of MA register for message code 4. Zero for other message codes.

SENSE BYTE 15 Contents of TD register for message code 4. Zero for other message codes.

SENSE BYTES 16–19 NOT USED – SET TO 0

SENSE BYTE 20 – 3333 or 3330 INTERFACE CHECK	
Bit 0	3333 check.
Bit 1	Select active check.
Bit 2	Buffer (bus in) parity check.
Bit 3	Unexpected end.
Bit 4	Tag bus parity check.
Bit 5	Bus out parity check.
Bit 6	CI transfer check.
Bit 7	Not used.

SENSE BYTES 21–23 NOT USED – SET TO 0

MESSAGE TABLE – FORMAT 2			
Sense byte 7 – bits 4 thru 7 =			
0000	No message.	0011	S Reg load check.
0001	Not used.	0100	CI Regs valid.
0010	Not used.	0101 – 1111	Not used.

FORMAT 3 – STORAGE CONTROL – CONTROL CHECK			
SENSE BYTE 8 – FAILING INSTRUCTION ADDRESS (1)			
Bits 0 thru 7	High-order address byte of control storage word addressed when error was detected.		
SENSE BYTE 9 – FAILING INSTRUCTION ADDRESS (2)			
Bits 0 thru 7	Low-order address byte of control storage word addressed when error was detected.		
SENSE BYTE 10 – ERROR LATCHES (1)			
Bit assignment is dependent upon the state of bit 0 as follows:			
Bit 0 on		**Bit 0 off**	
Bit 1	Clock error	Bit 1	Clock error
Bit 2	CA decode even	Bit 2	CS decode
Bit 3	CA decode odd	Bit 3	Zero
Bit 4	CB decode even	Bit 4	A register
Bit 5	CB decode odd	Bit 5	B register
Bit 6	Branch status	Bit 6	ALU
Bit 7	Special operation	Bit 7	Read only storage parity
SENSE BYTE 11 – ERROR LATCHES (2)			
Bit assignment is dependent upon the state of byte 10 bit 0 as follows:			
Byte 10, bit 0 on		**Byte 10, bit 0 off**	
Bit 0	Zero	Bit 0	Storage address bus 1 – 7.
Bit 1	Storage read multiple 0/1	Bit 1	Storage address bus 8 – 13.
Bit 2	Storage ECC multiple 2/3	Bit 2	Storage write bus 0/2
Bit 3	Not used	Bit 3	Storage write bus 1/3
Bit 4	Cycle control	Bit 4	Address bus 1 – 13 low
Bit 5	CD decode	Bit 5	Address bus 1 – 13 high
Bit 6	Not used	Bit 6	Read only storage not ready
Bit 7	Not used	Bit 7	Zero
SENSE BYTE 12 – STORAGE ERROR PATTERN			
Bits 0 thru 7	Identifies the failing bits of a control storage cycle.		
SENSE BYTE 13 – TC REGISTER (1)			
Bits 0 thru 7	Contains the contents of the TC register after an unsolicited selective reset. The TC register is reset if selective reset is in response to disconnect in from storage control.		
SENSE BYTE 14 – TG REGISTER (2)			
Bits 0 thru 7	Contains the contents of the TG register after an unsolicited selective reset. The TG register is reset if selective reset is in response to disconnect in from the storage control.		
SENSE BYTES 15 thru 21			
Reserved			

| SENSE BYTES 22, 23 |
NOT USED – SET TO 0
MESSAGE TABLE – FORMAT 3

Sense byte 7 —
bits 4 thru 7 =
| 0000 | No message. |
| 0001 – 1111 | Not used. |

SENSE BYTES WITH 3340

SENSE BYTE 0
Bit 0 **Command Reject**	1. Invalid command code. 2. Invalid command sequence. 3. Invalid or incomplete argument transferred by a control command. 4. Track formatted without home address. 5. Write portion of file mask violated. 6. A Write command has been issued with the Write Inhibit switch in read only position. 7. A format Write command is attempted after Write R0 on a track is flagged as defective.
Bit 1 **Intervention Required**	1. Addressed device not physically attached to system. 2. Addressed device not ready. 3. Diagnostic Write or diagnostic Load command issued and microdiagnostic is resident in control storage.
Bit 2 **Bus Out Parity**	The storage control has detected bad parity in data transferred from the channel.
Bit 3 **Equipment Check**	An unusual hardware condition originated in the channel, storage control, or drive. (Condition further defined in sense bytes 7 thru 23.)
Bit 4 **Data Check**	1. A correctable data error has been detected in information received from a disk drive. (Byte 2, bit 1 on, and correction information is provided in sense bytes 15 thru 21.) 2. An uncorrectable data error has been detected in information received from a disk drive. (Condition further defined in sense byte 7.)
Bit 5 **Overrun**	1. A channel response to a data transfer request was not received in time by the storage control. 2. A command was received too late from the channel to be properly executed.
Bit 6 **Track Condition Check**	1. Any command other than Search HA, Read HA, or Read R0 is switched or executed on a defective track. 2. Any multitrack command that switches from a storage control known defective or alternate track.
Bit 7 **Seek Check**	The selected drive has not been positioned correctly.

SENSE BYTE 1	
Bit 0	Permanent Error. Bit set by error recovery procedures (ERPs).
Bit 1 Invalid Track Format	An attempt has been made to write data exceeding track capacity.
Bit 2 End of Cylinder	1. A multitrack Read or Search operation has attempted to continue beyond the addressable cylinder boundary. 2. An overflow operation has attempted to continue beyond the addressable cylinder boundary. (Byte 1 bit 7, operation incomplete, also set.)
Bit 3	NOT USED – SET TO 0.
Bit 4 No Record Found	1. Two index points sensed in the same command chain without an intervening Read operation in the home address area or in a data area. 2. Two index points sensed in the same command chain without an intervening Write, Sense, or Control command.
Bit 5 File Protected	1. A Seek command has violated the file mask. 2. A multitrack Read or Search operation has violated the file mask. 3. An overflow operation has violated the seek portion of the file mask. (Byte 1 bit 7, operation incomplete, also set.)
Bit 6 Write Inhibited	Write command to a drive with Write Protect switch in Read Only position.
Bit 7 Operation Incomplete	One of the following conditions occurred during the processing of an overflow record: 1. Overflow to a file protected boundary. (Byte 1 bit 5, file protected, also set.) 2. Overflow past the cylinder boundary. (Byte 1 bit 2, end of cylinder, also set.) 3. A correctable data error was detected in a data field other than the last segment. (Byte 2 bit 1, correctable, also set.) 4. A defective or alternate track condition was detected after initiation of data transfer.

Appendix A. Sense Data   83

SENSE BYTE 2	
Bit 0 RPS Feature Present	The Rotational Position Sensing (RPS) feature is installed in the selected drive.
Bit 1 Correctable	Indicates that the data check posted in sense byte 0 bit 4 is correctable. Sense bytes 15 thru 22 identify the error pattern, error pattern displacement, and restart displacement.
Bit 2	NOT USED – SET TO 0.
Bit 3 Environmental Data Present	Indicates that the sense bytes 8 thru 23 contain either usage/error statistics or error log information. Sense byte 7 identifies the format of bytes 8 thru 23.
Bit 4	NOT USED – SET TO 0.
Bits 5, 6 and 7 Data Module Size	Define the size of the selected data module. DM Size Bit 5 Bit 6 Bit 7 35 Mb 0 0 1 70 Mb 0 1 0 Fixed Head 1 0 1

SENSE BYTE 3	
Bits 0 thru 7 Restart Command	When byte 1 bit 7 (operation incomplete) is set, this byte identifies the operation in progress when the interrupt occurred. 0000 0110 = A Read operation was in progress. 0000 0101 = A Write operation was in progress. When byte 1 bit 7 is zero, this byte is zero.

SENSE BYTE 4	
Bits 0 thru 7 Drive Identification	Provides the physical address of each disk drive as follows: Bit Drive Bit Drive 0 = A 4 = E 1 = B 5 = F 2 = C 6 = G 3 = D 7 = H

SENSE BYTE 5	
Bits 0 thru 7 Cylinder-low	Identifies the low-order cylinder address of the most recent seek argument from the channel.

SENSE BYTE 6	
Bit 0	NOT USED — SET TO 0.
Bit 1 Cylinder-high	High-order bit (512) of cylinder address in sense byte 5.
Bit 2 Cylinder-high	High-order bit (256) of cylinder address in sense byte 5.
Bit 3	NOT USED — SET TO 0.
Bits 4 thru 7 Head Address See Note	Identifies head address of last Seek (excluding retry Seeks). Head address is updated during multitrack and overflow operations.

Note: If an alternate track condition is detected and operation incomplete is posted during an overflow operation, byte 6 is set to the head address of the defective track plus 1. This information is used by the ERPs to construct the seek argument to continue the operation.

SENSE BYTE 7	
Bits 0 thru 3 Format	Specifies the format of sense bytes 8 thru 23 as follows: 0000 = Format 0 — Programming or system check. ┌ — — — — — CE information — — — — ┐ │ 0001 = Format 1 — Disk drive equipment check. │ │ 0010 = Format 2 — Storage control equipment check. │ │ 0011 = Format 3 — Storage control-control check. │ └ — — — — — — — — — — — — — — ┘ 0100 = Format 4 — Data checks not providing displacement information. 0101 = Format 5 — Data checks providing displacement information. 0110 = Format 6 — Usage/error statistics.
Bits 4 thru 7	Describes the specific nature of error conditions for each of the above formats. The Message Table that accompanies each format description specifies the function of the message bits for that format.

FORMAT 0 – PROGRAMMING OR SYSTEM CHECK
SENSE BYTES 8–21 NOT USED – SET TO 0
SENSE BYTES 22 and 23
1. If a Sense command is chained to a successful Read HA, these bytes contain SD bytes of the track. 2. Not valid for other conditions than (1).

MESSAGE TABLE – FORMAT 0

Sense byte 7 –
bits 4 thru 7 =

0000	No message.
0001	Invalid command.
0010	Invalid sequence.
0011	CCW count less than required.
0100	Data value not as required.
0101	Diagnostic write not permitted by file mask.
0110	Channel discontinued retry operation.
0111	Channel returned with incorrect retry CCW.
1000	Read only storage – not ready.
1001	Read only storage – permanent seek check.
1010	Read only storage – permanent read check.
1011	Command overrun.
1100	Data overrun.
1101	Defective track.
1110	Alternate track.
1111	Not used.

FORMAT 2 — STORAGE CONTROL EQUIPMENT CHECK

SENSE BYTE 8 NOT USED — SET TO 0

SENSE BYTE 9 NOT USED — SET TO 0

SENSE BYTE 10 NOT USED — SET TO 0

SENSE BYTE 11 — CONTROL CHECK	
Bit 0	Channel buffer read error.
Bit 1	Interface check channel A/C.
Bit 2	Interface check channel B/D.
Bit 3	Data transfer check.
Bit 4	CI check.
Bit 5	Load S registers.
Bit 6	Compare assist.
Bit 7	Multiconnect/channel C or D check.

SENSE BYTE 12 NOT USED — SET TO 0

SENSE BYTE 13
Contents of TA register for message code 4. Zero for other message codes.

SENSE BYTE 14
Contents of MA register for message code 4. Zero for other message codes.

SENSE BYTE 15
Contents of TD register for message code 4. Zero for other message codes.

SENSE BYTES 16—19 NOT USED — SET TO 0

SENSE BYTE 20 — DRIVE INTERFACE CHECK	
Bit 0	Control module check.
Bit 1	Select active check.
Bit 2	Buffer (bus-in) parity check.
Bit 3	Unexpected end.
Bit 4	Tag bus parity check.
Bit 5	Bus-out parity check.
Bit 6	Control interface transfer check.
Bit 7	Not used.

```
┌─────────────────────────────────────────────────────────────────────┐
│                          SENSE BYTES 21—23                          │
│                        NOT USED — SET TO 0                          │
├─────────────────────────────────────────────────────────────────────┤
│                                                                     │
│                     MESSAGE TABLE — FORMAT 2                        │
│                                                                     │
│  Sense byte 7 —                                                     │
│  bits 4 thru 7 =                                                    │
│  0000              No message.                                      │
│  0001              Not used.                                        │
│  0010              Not used.                                        │
│  0011              S Reg load check.                                │
│  0100              CI Regs valid.                                   │
│  0101 — 1111       Not used.                                        │
│                                                                     │
└─────────────────────────────────────────────────────────────────────┘
```

FORMAT 3 — STORAGE CONTROL — CONTROL CHECK

SENSE BYTE 8 — FAILING INSTRUCTION ADDRESS (1)

Bits 0 thru 7	High-order address byte of control storage word addressed when error was detected.

SENSE BYTE 9 — FAILING INSTRUCTION ADDRESS (2)

Bits 0 thru 7	Low-order address byte of control storage word addressed when error was detected.

SENSE BYTE 10 — ERROR LATCHES (1)

Bit assignment is dependent upon the state of bit 0 as follows:

Bit 0 on		**Bit 0 off**	
Bit 1	Clock error	Bit 1	Clock error
Bit 2	CA decode even	Bit 2	CS decode
Bit 3	CA decode odd	Bit 3	Zero
Bit 4	CB decode even	Bit 4	A register
Bit 5	CB decode odd	Bit 5	B register
Bit 6	Branch status	Bit 6	ALU
Bit 7	Special operation	Bit 7	Read only storage parity

SENSE BYTE 11 — ERROR LATCHES (2)

Bit assignment is dependent upon the state of byte 10 bit 0 as follows:

Byte 10, bit 0 on		**Byte 10, bit 0 off**	
Bit 0	Zero	Bit 0	Storage address bus 1 — 7
Bit 1	Storage read multiple 0/1	Bit 1	Storage address bus 8 —13
Bit 2	Storage ECC multiple 2/3	Bit 2	Storage write bus 0/2
Bit 3	Not used	Bit 3	Storage write bus 1/3
Bit 4	Cycle control	Bit 4	Address bus 1 — 13 low
Bit 5	CD decode	Bit 5	Address bus 1 — 13 high
Bit 6	Not used	Bit 6	Read only storage not ready
Bit 7	Not used	Bit 7	Zero

SENSE BYTE 12 — STORAGE ERROR PATTERN

Bits 0 thru 7	Identifies the failing bits of a control storage cycle.

SENSE BYTE 13 — TC REGISTER (1)

Bits 0 thru 7	Contains the contents of the TC register after an unsolicited selective reset. The TC register is reset if selective reset is in response to disconnect in from storage control.

SENSE BYTE 14 — TG REGISTER (2)

Bits 0 thru 7	Contains the contents of the TG register after an unsolicited selective reset. The TG register is reset if selective reset is in response to disconnect in from the storage control.

SENSE BYTES 15–21

Reserved.

SENSE BYTES 22 and 23
NOT USED – SET TO 0

MESSAGE TABLE – FORMAT 3

Sense byte 7 –
bits 4 thru 7 =
0000   No message.
0001 – 1111   Not used.

INDEX

READER'S COMMENT FORM

Reference Manual for IBM 3830
Storage Control Model 2

GA26-1617-3

● Your comments, accompanied by answers to the following questions, help us produce better publications for your use. If your answer to a question is "no" or requires qualification, please explain in the space provided. All comments and suggestions become the property of IBM.

	Yes	No	Explain
● Does this publication meet your needs?	☐	☐	_____
● Did you find the material:			_____
Easy to read and understand?	☐	☐	_____
Organized for convenient use?	☐	☐	_____
Complete?	☐	☐	_____
Well illustrated?	☐	☐	_____
Well indexed?	☐	☐	_____
Written for your technical level?	☐	☐	_____

● What is your occupation?_____

● How do you use this publication?	Yes	No		Yes	No
As an introduction to the subject?	☐	☐	As an instructor in a class?	☐	☐
For advanced knowledge of the subject?	☐	☐	As a student in a class?	☐	☐
For information about operating procedures?	☐	☐	As a reference manual?	☐	☐
Other_____					

● We would appreciate your other comments; please give specific page and line references where appropriate. If you wish a reply, be sure to include your name and address.

● Reply Requested   Yes ☐   No ☐   Name _____
                                           Address _____
                                                              _____ Zip ▶

● Thank you for your cooperation.   No postage stamp necessary if mailed in the U.S.A.

GA26-1617-3

Cut or Fold Along Line

Your comments, please . . .

This manual is part of a library that serves as a reference source for systems analysts, programmers, and operators of IBM systems. Your comments on the other side of this form will be carefully reviewed by the persons responsible for writing and publishing this material. All comments and suggestions become the property of IBM.

Fold   Fold

First Class
Permit 2078
San Jose
California

Business Reply Mail
No postage stamp necessary if mailed in the U.S.A.

Postage will be paid by:

International Business Machines Corporation
Department G24
Monterey & Cottle Rds.
San Jose, California
95193

Fold   Fold

IBM

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
(U.S.A. only)

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
(International)

GA26-1617-3

IBM®