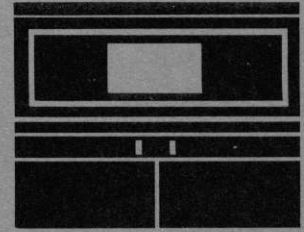


DS-20 Disc Storage



GENERAL  ELECTRIC

**DS-20
DISC STORAGE**

REFERENCE MANUAL

JANUARY 1964

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GENERAL  ELECTRIC

COMPUTER DEPARTMENT

PREFACE

This manual contains reference information on the General Electric DS-20 Disc Storage Unit (DSU) subsystem--a large capacity, random access storage device and its associated electronics and controller units.

Much of the discussion in this manual is aimed specifically at the performance characteristics of the DS-20 subsystem, and is applicable regardless of the General Electric computer system used. Chapter 4, however, assumes that the DS-20 is linked to any one of the General Electric 400 Series of information processing systems.

The compatibility feature of the General Electric 400 family permits a user to grow into a larger system without incurring the vast expense in time and money of a reprogramming effort. The systems range upward in size from the 415 to the 435. They are equally powerful for batch, random, and real-time processing. Special input/output channels give the Compatibles/400 access to remote stations via communication lines, or access to a communication network via a data communication channel.

Comments on this publication may be sent to General Electric Computer Department, P. O. Box 2961, Phoenix, Arizona, 85001.

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DS-20

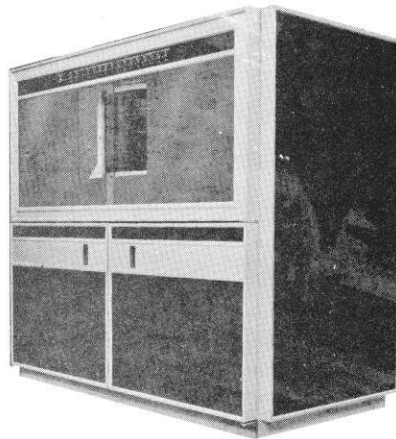
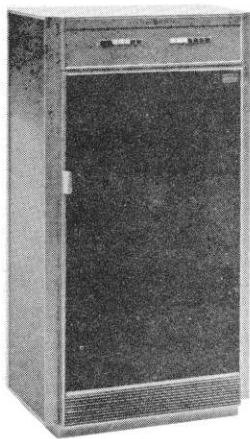
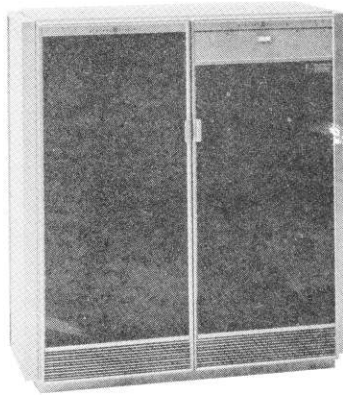
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General Electric DS-20 Disc Storage Unit (DSU) Subsystem Basic Configuration Showing the File Unit (foreground), Controller (left rear), and Electronics (right rear).

DS-20

1. GENERAL DESCRIPTION

INTRODUCTION

The DS-20 disc storage unit (DSU) subsystem greatly extends the usefulness of the General Electric families of compatible information processing systems. Today's information processing systems require rapid retrieval of randomly-stored data for processing. The DSU subsystem is an indispensable part of this type of system.

The distinctive feature of the DS-20 subsystem is its file unit, which contains a stack of revolving magnetic discs mounted on a vertical shaft similar to that of a record player. Electronically controlled positioning arms (actuators) move between the discs, recording data on them in the form of magnetized spots and retrieving the data when it is needed.

The random-access capability of the DS-20 subsystem permits a program to store or locate information on the discs immediately, without passing the previously-stored records in sequence. In a typical application, a manufacturer may obtain a specific order record quickly by employing a direct-referencing technique which operates as follows. The order number is processed mathematically and its exact location is determined. It is then retrieved and verified immediately. Cross-referencing enables the manufacturer to obtain all information about any aspect of a subject--for example, all purchase order records for a vendor.

A key element in General Electric's Integrated Data Store (I-D-S) system is the rapid information retrieval capabilities of the DS-20 subsystem. The DS-20 is used as an extension of the information processing system's main memory. I-D-S substitutes a single, consolidated, interrelated file for the individual files of the conventional business information system, which is organized to take advantage of the random-access capabilities of the DS-20 subsystem.

Application studies of present and proposed random-access installations indicate that many of the tasks usually performed by sequential storage equipment are more efficiently processed on random-access equipment. These include engineering parts explosions, manufacturing scheduling and loading, raw material and finished goods inventory control, statistical analysis, cost and general accounting, payroll and others.

Data communications equipment available with General Electric families of compatible systems enables inquiries from remote locations to be made of records stored on the DSU subsystem and current answers to be supplied in seconds. For example, a field sales office can check the current price and availability of a product or service via data communications and the DSU-equipped data processing system at the firm's headquarters. This information is supplied automatically within seconds and can help gain a profitable sales order that might otherwise be lost or unprofitable.

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The DS-20 subsystem provides up to 94 million characters of random-access storage to the General Electric families of compatible information processing systems. A minimum configuration of one file unit with four magnetically coated dual-surface storage discs can be expanded in four disc increments to 8, 12, or 16 discs as the user's storage requirements grow. Up to four 16-disc units, each with a capacity of 23.5 million characters, can be connected to one DSU controller-- a free-standing unit that controls the flow of information between the processing system and the subsystem.

The DSU controller communicates with the processing system through the Input/Output Controller (IOC) and performs a parity check on each character received. An odd-parity check is also made on each character transferred from the DSU buffer to a file unit or from the DSU buffer to the processing system.

Each disc is served by an independent positioning arm (actuator) with eight read/write heads (four per disc surface), so that the total distance the heads must move for each access is minimized. Each actuator can move from one read/write position to another in an average of 199 milliseconds. An automatic validity check is made on each actuator position.

As with all peripheral subsystems, status conditions reflecting the general state of the DS-20 subsystem, such as Busy and Ready, are automatically transmitted to the processing system when each instruction is completed. By issuing a Request Status command, the program can determine whether or not the subsystem is ready to accept an instruction and whether or not an instruction was accepted and executed successfully by the subsystem and, if not, why not.

Additional features of the DS-20 subsystem include: automatic address confirmation, clocking, and read-back and compare-after-write checks; operator alert indicators; a unit data protect switch; and 16 individual disc data protect switches.

PHYSICAL CHARACTERISTICS

The DS-20 subsystem consists of three physically separate units; the file unit (or rotating assembly); the electronics, which house the control electronics for the file unit; and the controller, which controls the flow of data between the file unit and the processing system. As many as four file units may be connected to one controller.

DSU Controller

The DSU controller (Figure 1) receives and interprets program instructions from the Input/Output Controller (IOC) of the processing system and transmits them to the electronics and file units. It also monitors the status of the electronics and file units and presents this status to the processing system at the required time and in the proper format.

The equipment configuration within the controller consists of:

- Interface to permit communication with the processing system
- Interface to permit communication with the electronics and file units
- Control and storage of logic for performing defined functions
- A random-access buffer of 1024 addressable 6-bit character locations
- Supporting electronics.

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DSU Electronics and File Units

The electronics and the file unit shown in Figure 2 are free standing but in operation depend upon each other. The electronics unit receives all information flowing in either direction between its related file unit and the DSU controller. It functions as a translator by controlling the positioning of the read/write heads, confirming the accuracy of the positioning, and telling the file unit when to start reading or writing.

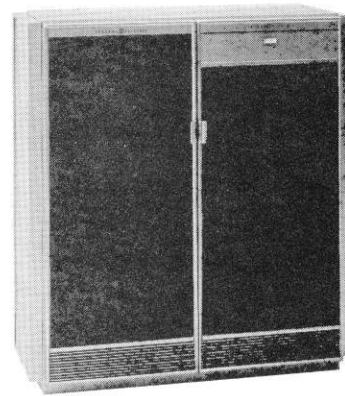


Figure 1. DS-20 Controller

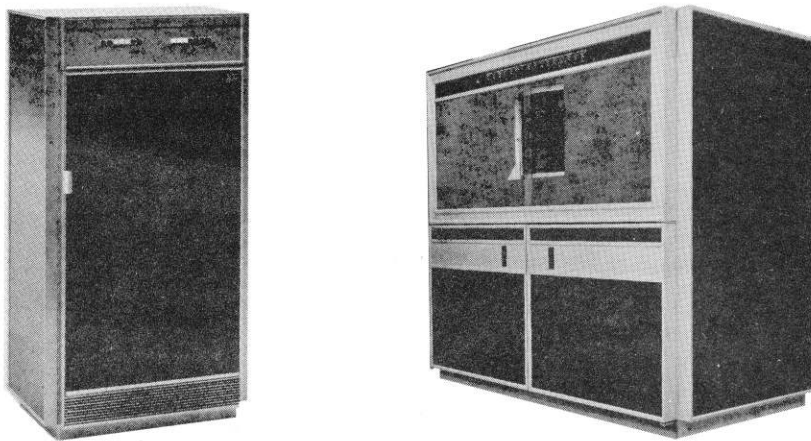


Figure 2. DS-20 Electronics and File Unit

Reading and writing are accomplished within the file unit. Each disc is serviced by a related positioning arm (actuator) on which are mounted eight read/write heads. The heads are numbered according to their servicing sequence. Figure 3 shows the relationship of the heads to the surface of the disc.

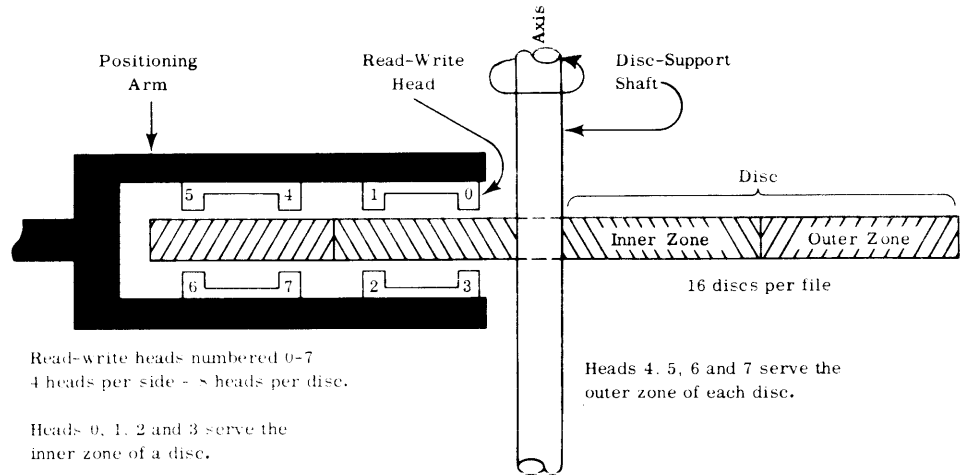


Figure 3. Read/Write Heads

STORAGE DISCS. Each file unit can accommodate from 4 to 16 circular storage discs mounted on a central vertical shaft. A basic file unit consisting of 4 discs can be expanded in 4-disc increments to 8, 12, or 16 discs as storage requirements increase.

The physical configuration of a single disc are illustrated in Figure 4. This disc is coated on both sides with a magnetic film layer upon which data is recorded as magnetized spots.

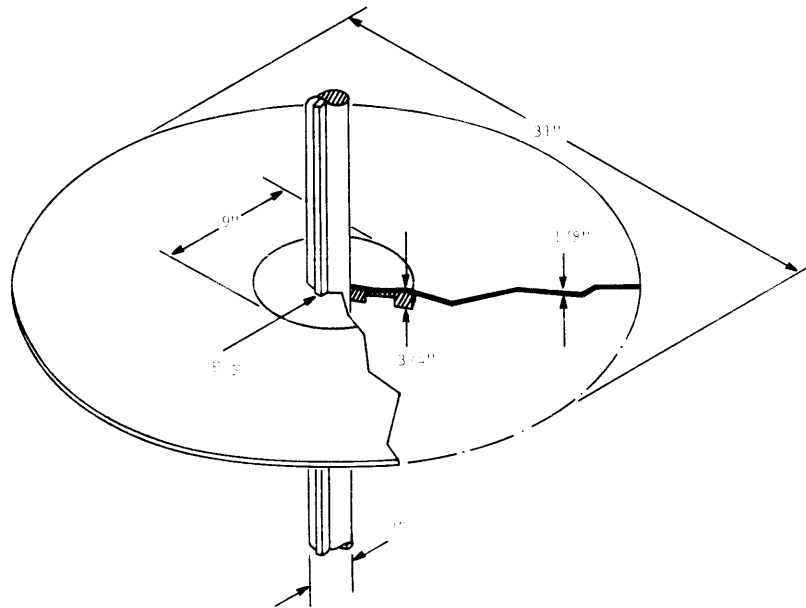


Figure 4. Storage Disc Configuration

DATA FORMAT. The magnetized spots representing data are recorded on 256 concentric tracks on each disc surface. The surface of each disc is divided into zones, an inner zone with 128 tracks nearest the center of the disc and an outer zone with 128 tracks nearest to the outer edge (see Figure 5). Each zone is divided into sectors and each track within each zone is divided into fixed segments. There are 8 sectors or 1024 segments in the inner zone and 16 sectors or 2048 segments in the outer zone. A total of 241 characters, including a 6-bit check character, can be stored on each segment (called data segment) in both the inner and outer zone sectors. The configuration of a single disc surface serviced by one arm position is illustrated in Figure 5.

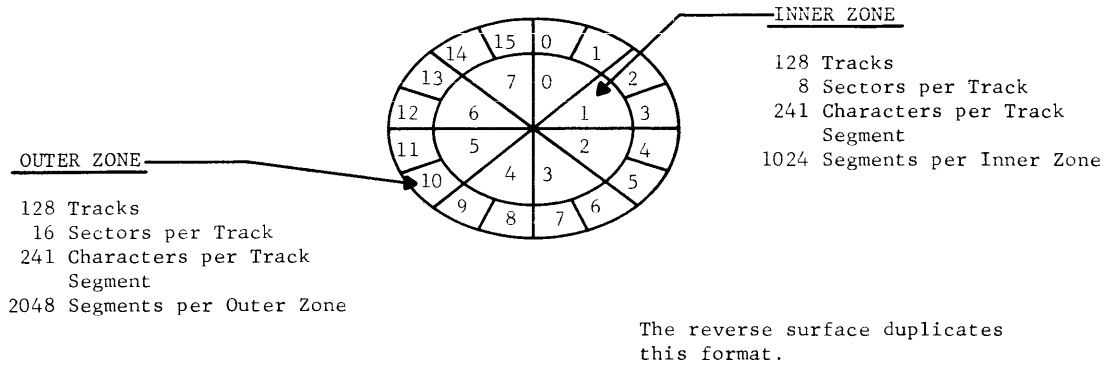


Figure 5. Disc Format for One Arm Position

Heads 0, 1, 2, and 3 (see Figure 3) serve the inner zone (8 segments per head) and heads 4, 5, 6, and 7 serve the outer zone (16 segments per head). It is possible to read or write 32 consecutive segments without moving the positioning arm. Input or output instructions can be issued to sequentially address the segments served by the eight read/write heads, since they switch automatically.

A head positioning motor moves the positioning arms parallel to the disc surface. An air cushion generated by the rotating discs enables the read/write heads to float over the discs. The read/write head positioning assembly is illustrated in Figure 6.

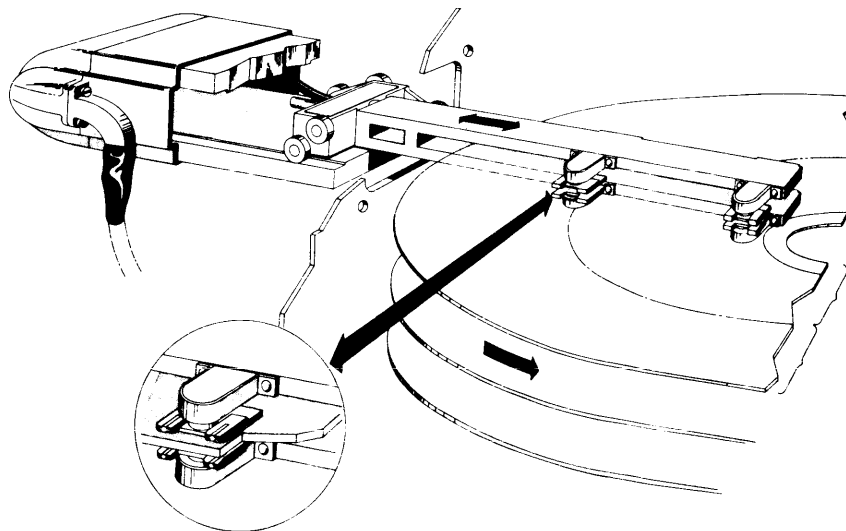


Figure 6. Read/Write Head Positioning Assembly

During a writing operation any one or all of the discs of a file unit can be protected from writing over existing data by optional switch settings provided for the operator. The switches are mounted on the front upper panel of the file unit cabinet, easily accessible to the operator.

Dimensions

The physical dimensions of each of the three units constituting the DS-20 subsystem are shown in Figure 7.

UNIT	HEIGHT (in.)	WIDTH (in.)	DEPTH (in.)	WEIGHT (lb)
File Unit	63	71	38	2500
Electronics	76	76	32	490
Controller	67	61	21	975

Figure 7. Physical Dimensions

FEATURES

Storage Capacity

Each disc surface is divided into 3072 fixed addressable positions called data segments. Each data segment has a fixed storage capacity of 240 six-bit characters plus a 6-bit check character. Data segments are consecutively addressable in each file unit. To ensure accuracy of recording and operation of the file unit, four consecutive data segments of each subsystem configuration are reserved for diagnostic program purposes.

The number of available data segments and the total number of 6-bit characters than can be stored in various file unit configurations are illustrated in Figure 8.

File Unit Configuration	Number of Addressable Segment Positions	Storage Capacity In 6-Bit Characters
4 Disc	24,572	5,897,280
8 Disc	49,148	11,795,520
12 Disc	73,724	17,693,760
16 Disc	98,300	23,592,000
A total of Four 16 Disc File Units	393,200	94,368,000

Figure 8. Storage Capacity Table

Speeds

The operating speeds of the DS-20 subsystem are indicated below:

Average transfer rate when reading from an inner-zone segment	41,700 characters/second
Average transfer rate when reading from an outer-zone segment	83,400 characters/second
Average positioning time to a specified track	225 milliseconds
Maximum positioning time to a specified track	305 milliseconds
File latency time (time for one disc revolution)	52 milliseconds
Average access time to a specified segment	199 milliseconds
Maximum access time to a specified segment	357 milliseconds
Maximum access time to a specified segment on an adjacent track	150 milliseconds
Speed of disc rotation	1170 rpm

Fast-Access Disc Options

Two fast-access disc options are available on the DS-20 subsystem to provide high access speeds to small segments of data stored on specific discs--such as subroutines, indexes, tables, etc. The system configuration will determine a user's requirement of either of these options. The actuators associated with these discs are permanently positioned and require no position verification sequence. Each fast-access disc has a total of 96 fixed data segment positions, or a total storage capacity of 23,040 characters. The average access time is 52 milliseconds. The processing system must transmit the segment address to the subsystem to indicate which data segments are to be accessed.

Status Information

When any DS-20 instruction is initiated by the program, information indicating the general condition of the DS-20 subsystem--such as Ready, Busy, or Attention--is reflected automatically to the processing system and stored in the form of a status word. This status word can be interrogated by the program to determine:

1. If a desired operation was initiated successfully
2. If the DS-20 subsystem is available for use
3. If a previously initiated operation was executed successfully
4. The specific reason for an abnormal status condition, if any.

With this status-reflection capability, certain error or inoperable conditions are indicated to the program, thus permitting programmed recovery procedures. Instructions can, in other cases, be given to the operator for correcting errors requiring his intervention.

Checking Features

The DS-20 subsystem automatically performs the following checks and, in the event of an error, reflects the corresponding status to the processing system:

Read-back and compare-after-write check	Check character alert
Odd-parity check on read/write transfers	Segment compare failure check
Address confirmation check	Buffer section committed check
Clocking check	Invalid operation code check
Transfer timing check	Invalid device code check
Transmission parity check	Illegal buffer address check
Invalid control character check	Over-temperature check
Internal error check	Power loss check

Buffering

A 1024-character magnetic core buffer in the DSU controller provides complete buffering. Each character is stored in the buffer in individually addressable locations. The buffer is divided functionally into four data areas. Each area can hold one data segment (240 six-bit characters plus a 6-bit check character) as well as the address and other control (instruction) characters.

Operations between one file unit and the DSU controller buffer can occur simultaneously with operations between the processing system and the DSU controller buffer. For example, since the DSU controller buffer is under control of the processing system, only those data segments requiring updating need to be moved to memory of the processing system, thus saving memory space and time. Up to 32 consecutive data segments can be transferred through the buffer to memory from a file unit or vice versa, using a scatter/gather technique, if desired.

2. DS-20 PROGRAMMING CHARACTERISTICS

Programming Input/Output (I/O) operations for the DS-20 subsystem need not be a laborious task for a programmer, since he has available proven routines and subroutines in the software packages for the processing system. Because of the availability of I/O routines and subroutines the programmer needs only to be acquainted with the basic characteristics of the subsystem as discussed in this chapter.

ADDRESSING A FILE UNIT

During the execution of an instruction from the processing system, the DS-20 subsystem receives a device code character indicating the specific file unit to which the instruction is directed. This device code character is defined as follows:

Bit Configuration	Meaning	
000000	Controller only	(for instructions whose execution does not involve a specific disc storage file, the device code character is ignored.)
000001	File Unit 1	
000010	File Unit 2	
000011	File Unit 3	
000100	File Unit 4	

ADDRESSING A DATA SEGMENT

Each data segment on a disc surface has its own unique address. The binary configurations for these unique addresses are shown in Figure 9.

ZONE	DISC	TRACK	SEGMENT
00	0000	000000	00000
to	to	to	to
00	1111	111111	11111
01	0000	000000	00000
to	to	to	to
01	1111	111111	11111
10	0000	000000	00000
to	to	to	to
10	1111	111111	11111
11	Invalid Zone Address		

Figure 9. Data Segment Address Configurations

The maximum number of sequentially addressed data segments which can be transferred by one instruction and before an actuator arm movement occurs is 32. Segments cannot be sequentially addressed from one disc to another; each disc must be addressed, since each is independent of the other.

As segments are being transferred, a count is maintained in the DSU controller, so that the read or write operation continues for the specified number of segments. The sequential incrementing of the segment address automatically results in the proper head switching. Because 32 is the highest valid segment address, incrementing the address beyond 32 causes the counter to be set to zero; and the instruction execution ends after the last segment is accessed.

For any one specified disc and actuator position, the zone code addresses 32 segments. Zone code 00 addresses the 32 segments under the four heads covering both the upper and lower surfaces of the disc in the inner zone. The zone code of 01 addresses the 32 segments under the two heads covering the upper surface of the disc in the outer zone, and code 10 addresses the 32 segments under the two heads covering the lower surface of the disc in the outer zone. Zone code 11 is not legal.

Last Consecutive Segment Addressable

Any data segment whose address has 1-bits in all five low-order bit positions is the last consecutive addressable segment available from a disc without requiring repositioning of the actuator. Instruction execution always ends after the last consecutive segment is accessed.

Reserved Segments

Four consecutive data segments on each file unit, starting at address zone 0, disc 0, track 0, segment 0, are reserved for diagnostic program purposes and should not be used by the programmer. Although there is nothing to prevent a reserved diagnostic segment from being accessed, the programmer should bear in mind that, in using these segments, there is considerable risk of having a diagnostic program overwrite the contents of the reserved segments.

Check Character

A check character generated by the DSU controller during a write operation is automatically written as the last character of the data segment. It is an odd-parity character. It is never transmitted to the processing system during a normal read operation; however, it is available for examination as a result of a read buffer command.

DATA TRANSFER

The DS-20 subsystem signals the processing system each time it is ready to receive a command or a character. All peripheral operations occur through the Input/Output Control (IOC), which is a part of the processing system. Data is transferred between the IOC and the DS-20 subsystem character by character. The IOC provides the communication between the processing system and the subsystem by:

1. Transmitting instructions from the processing system to the subsystem
2. Permitting status of the subsystem to be available to the processing system at all times

3. Transmitting data to and from the processing system
4. Transmitting signals to and from the processing system initiating and terminating operations of the subsystem.

I/O Commands

Before a read or write operation can be executed, a Seek File must be issued preceding the read or write command to ensure that the positioning arm (actuator) is properly positioned for the segment being addressed. A brief functional description of the basic read and write commands follows:

<u>Mnemonic Code</u>	<u>Command Code Character</u>	<u>Instruction</u>	<u>Functional Description</u>
SF	011100	Seek File	Transfers segment address from processing system to DSU controller.
RFCR	010101	Read File Continuous and Release Seek	Positions actuator, reads up to 32 consecutive segments, and releases actuator. Assumes segment address and other control characters are already in the buffer.
WFCR	011001	Write File Continuous and Release Seek	Positions actuator, writes up to 32 consecutive segments, and releases actuator. Assumes segment address and other control characters are already in the buffer.
WFCV	011011	Write File Continuous, Verify, and Release Seek	Positions actuator, writes up to 32 consecutive segments, compares check characters of each written segment against a new check character generated by rereading each segment, and releases actuator. Assumes segment address and other control characters are already in the buffer.
RQS	000000	Request Status	Notifies the processing system of the existing status of the addressed file unit or the DSU controller.
RSS	100000	Reset Status	Resets existing data alert or end-of-file status within the addressed device and then reflects the prevailing status to the processing system.

End Data Transfer

When all characters for the command currently being executed have been transferred by the processing system, the subsystem receives a signal; and the current command is terminated with the existing status set.

When the subsystem completes the execution of a command operation it sends a terminate signal to the processing system; and the existing status of the subsystem is set and available to the program.

Special Interrupt

The special interrupt signal is transmitted from the DS-20 subsystem to the processing system to indicate completion of an off-line operation which required that a file unit revert to the Device Busy status to complete the operation.

If, at the time the special interrupt signal is to be sent, the DS-20 subsystem is in a Channel Busy status, the transmission of the signal is delayed and sent simultaneously with the terminate signal which ends the Busy status. If, while the subsystem is in the Channel Busy status, more than one special interrupt requirement develops, only one such signal is sent when the Busy status ends.

If, at the time the special interrupt signal is to be sent, the DS-20 subsystem is in the process of receiving an instruction from the processing system, the special interrupt signal is delayed and it is then sent at the end of the instruction sequence or at the end of the resulting Channel Busy status if reception of the instruction caused the DS-20 to revert to this Channel Busy status. Again, if more than one special interrupt signal requirement develops during the time the signal transmission is delayed, only one special interrupt signal is sent.

STATUS INFORMATION

The information furnished by the DS-20 subsystem relative to its status (operating condition) and its substatus (more specific operating conditions) is always available to the processing system. This information changes only at the termination of a command or when a command is initiated. The principal uses of the status information are:

1. To permit the program to determine if the subsystem is ready to accept a command or is busy
2. To permit detection of and recovery from certain error conditions under program control
3. To enable the program to give specific instructions to the operator for correcting errors requiring his intervention.

Channel Ready

Reflection of the Channel Ready status by the DS-20 in response to any instruction, except a Request Status instruction, indicates that the instruction was accepted and properly executed.

When reflected in response to a Request Status instruction at the end of instruction execution, the Channel Ready status indicates that the last operation on the addressed device (file unit or controller) was completed successfully and that no error was detected. If the operation involved a file unit, the Channel Ready status also indicates that the power of the actuator used in the executing operation is now off.

Reflection of the Channel Ready status in response to a Reset Status instruction addressed to a file unit indicates that any existing malfunction has been cleared and that no actuator has power on.

Device Busy

Reflection of the Device Busy status in response to an instruction indicates that the addressed disc storage unit is already in the process of executing an off-line instruction. The attempted instruction is therefore rejected unless it is a Request Status or a Reset Status instruction.

At the time this major status condition is reflected to the processing system, one of the following two substatus conditions associated with the Device Busy major status will also be indicated.

OVERRIDABLE. The Overridable substatus indicates that a Seek File instruction is being executed by the addressed file unit. Execution of the Seek File instruction in process can be overridden by the reception of any other Seek instruction addressed to the same file unit.

NOT OVERRIDABLE. The Not Overridable substatus indicates that some off-line instruction other than a Seek File instruction is being executed by the addressed file unit. These instructions cannot be overridden by any other instruction.

Attention

Reflection of the Attention status indicates any one of the following conditions (all of which require manual intervention):

1. The addressed file unit or controller is not usable because of an inoperable condition, such as overheating or electrical power loss.
2. The controller is in a test mode.
3. A write instruction was addressed to a protected disc.

Data Alert

Reflection of the Data Alert major status indicates that the last instruction executed on the addressed device (file unit or controller) resulted in the detection of one of several possible errors. The type error detected is indicated to the processing system by one of the following Data Alert substatus conditions:

Transfer Timing Alert
Transmission Parity Alert
Invalid Control Character
Internal Alert
Check Character Alert

The Data Alert status may be reflected to the requesting program in response to a Request Status instruction.

TRANSFER TIMING ALERT. The Transfer Timing Alert substatus indicates that the IOC failed to respond to a data transfer request from the DS-20 subsystem within 30 milliseconds after the request was sent. The operation in process ends immediately upon detection of this condition.

TRANSMISSION PARITY ALERT. The Transmission Parity Alert indicates that an incorrect parity bit was detected in a character being transmitted from the IOC to the DS-20 subsystem, during which time the DS-20 is in a Channel Busy status. The operation in process ends as soon as this condition is detected.

INVALID CONTROL CHARACTER. The Invalid Control Character indicates that the processing system did not transmit all of the required control (address definition) characters to the DS-20 subsystem. That is, the end-data-transfer signal was received from the processing system before all six control characters were received.

INTERNAL ALERT. Reflection of the Internal Alert substatus indicates any one of the following occurrences:

1. An incorrect parity bit was detected in a character being transferred out of the DSU controller.
2. There was a seek failure. A seek failure indicates a parity error on segment address bits received by the electronics unit from the DSU controller or the failure of an actuator arm to position correctly.
3. An error was detected during the transfer of data between the electronics and a file unit. An example is a programming error specifying illegal zone bits (11) in the segment address used with the instruction.

CHECK CHARACTER ALERT. The DS-20 controller generates a check character for each segment while reading data from a file unit. If the check character generated by the controller does not correspond with the check character recorded on the disc at the end of the segment, the Check Character Alert substatus is reflected.

End of File

The End of File major status indicates that execution of the last instruction on the addressed file unit ended after the operation specified in the instruction was performed on the last consecutive segment.

For continuous-type instructions, the size of the buffer is considered to be infinite (a closed loop). Hence, in executing a Read Continuous instruction, the last consecutive segment always sets the End of File status (providing no error is detected) because there will always be more segments of the buffer to be filled. However, the last consecutive segment may or may not have been transferred to the processing system.

Command Rejected

The Command Rejected major status indicates that the instruction just received is not acceptable to the DS-20 subsystem and therefore was not initiated. At the time this major status is reflected, one of the following Command Rejected substatuses is also indicated.

INVALID OPERATION CODE. The Invalid Operation Code substatus indicates that the operation code just received by the DS-20 is either not recognizable or has incorrect parity.

INVALID DEVICE CODE. The Invalid Device Code substatus indicates that the device code just received by the DS-20 is either not recognizable or has incorrect parity.

Intermediate

The Intermediate status indicates that the DS-20 subsystem is not presently busy, but may be waiting for another instruction to continue a sequence that was started by a prior instruction.

When reflected in response to a Request Status or a Reset Status instruction, the Intermediate status indicates that the addressed file unit is holding power on an actuator. In the case of a Request Status instruction, it also indicates that no error or alert condition exists within the addressed file unit as a result of executing the last instruction.

Channel Busy

The Channel Busy status indicates that the DS-20 controller is already in the process of executing an instruction involving direct communication between the subsystem and the processing system. No further instructions can be received by the DS-20 subsystem for the duration of this status.

Absent/Off-Line

The Absent/Off-Line status is reflected to the processing system by the IOC when an instruction is addressed to a peripheral that is disconnected or without power.

STATUS PRIORITY

If there are two or more major status conditions existent within a subsystem at the same time, the status reflected to the processing system is the one with the highest priority. Status priority of the status is listed below from the highest to the lowest.

1. Command Rejected
2. Data Alert
3. End of File
4. Attention
5. Intermediate
6. Device Busy

3. OPERATING CONTROLS

The DS-20 subsystem is equipped with two operator control and indicator panels. One panel is on the controller and the other on the electronics unit. Sixteen individual disc data protect switches and one unit data protect switch are conveniently located in a switch panel at the top of the file unit cabinet.

The function of the panel control pushbuttons and indicators and the write protect switches is given below.

CONTROLLER PANEL

The control and indicator panel on the controller contains the following:

POWER ON (Pushbutton and Indicator)

This pushbutton, when depressed, applies power to the controller. When the power comes on, the indicator glows yellow; and the DS-20 subsystem assumes a Channel Ready status.

POWER OFF (Pushbutton)

Depressing this pushbutton turns the controller power off and puts the DS-20 subsystem in the Absent/Off-Line status.

ELECTRONICS UNIT PANEL

The electronics unit control and indicator panel, shown in Figure 10, is a convenient arrangement of control buttons and indicator lights. They enable the operator to maintain a degree of control over operation of the file unit and also provides a visual check on whether or not all the required functions are being carried out.

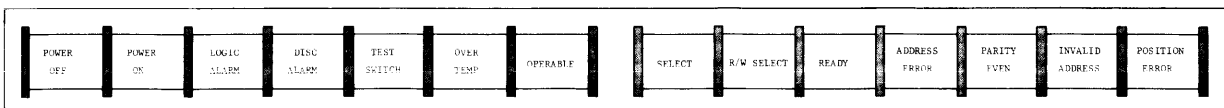


Figure 10. Electronics Unit Panel

POWER ON (Pushbutton and Indicator)

This pushbutton, when depressed, applies d-c power to both the electronics and the file unit. When the power comes on, the indicator portion glows yellow, the discs begin rotating, and the file unit assumes a Channel Ready status.

POWER OFF (Pushbutton)

Depressing this pushbutton turns the d-c power off for both the electronics and the file unit. When the power goes off, the Attention status is reflected to the processing system.

LOGIC ALARM (Indicator)

This indicator glows red when the electronics unit is approaching a critically high temperature. This condition will not halt the unit, and further operations may be executed. As soon as this indicator lights, the General Electric service engineer should be notified.

DISC ALARM (Indicator)

This indicator glows red when the file unit is approaching a critically high temperature. This condition will not halt the unit, and operations may continue until the critical temperature is reached. As soon as this indicator lights, the General Electric service engineer should be notified.

TEST SWITCH (Indicator)

This indicator glows blue when any one of the maintenance test switches on the electronics unit is in the ON position. The Attention status is reflected to the processing system in response to any instruction while this indicator is lit.

OVER TEMPERATURE (Indicator)

This indicator glows red when the electronics unit reaches a sufficiently high temperature to prohibit further operations. When this critically high temperature is reached, the power goes off automatically; and the Attention status is reflected to the processing system in response to any instruction.

OPERABLE (Indicator)

This indicator glows green when the file and electronics units are both in an operable state. The indicator will not light if any alarm condition is present or if the power is off.

SELECT (Indicator)

This indicator glows white when the file unit is in the process of executing a seek operation.

R/W SELECT (Indicator)

This indicator glows white when a read or write instruction is being transmitted from the the controller to the electronics unit. The indicator remains lit until execution of the instruction is completed by the electronics unit.

READY (Indicator)

This indicator glows white when the file unit has completed a seek operation and is ready to perform a read or write operation on the addressed segment. The indicator light goes off when the portion of the instruction to read or write the addressed segment is received.

ADDRESS ALARM (Pushbutton and Indicator)

This indicator glows red when an error is detected on a segment address transmitted from the controller to the electronics unit. Depressing the pushbutton clears and resets the error circuitry.

NOTE: This indicator always glows red when the PARITY EVEN, INVALID ADDRESS, or POSITION ALARM indicators are lit.

PARITY EVEN (Indicator)

This indicator glows red when a parity error is detected in a segment address transmitted from the controller to the electronics unit. The electronics unit always checks for odd parity before an address is accepted from the controller.

INVALID ADDRESS (Indicator)

This indicator glows red when an invalid seek address is received from the controller. When this occurs, the operation ends immediately; and the Data Alert status, Internal Error sub-status, is reflected to the processing system, indicating a seek failure.

POSITION ALARM (Indicator)

This indicator glows red when the positioning arm is not positioned on the segment address specified in the instruction. If this occurs, the operation ends; and the Data Alert status, Internal Error substatus, is reflected to the processing system, indicating a seek failure.

WRITE PROTECT SWITCHES

The Write Protect switches are located at the top of the front panel on the file unit and are illustrated in Figure 11.

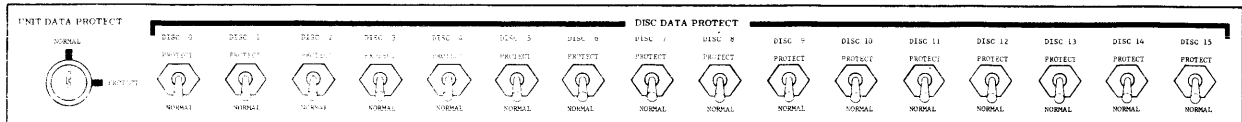


Figure 11. Write Protect Switches

Unit Data Protect Key

The Unit Data Protect Key is a two-position key. When set, it prevents data from being written on all discs associated with a particular file unit. When in the normal position, the switch has no effect on instruction execution. When a Write instruction is directed to a file unit with this switch in the Protect position, the operation ends automatically when the Write instruction is received from the controller; and, the Attention status is set. The Attention status can be reset by directing any new instruction, except a Request Status instruction, to the same file unit.

Disc Data Protect Switches

The 16 two-position Disc Data Protect toggle switches enable the operator to prevent data from being written on one or more of the discs associated with a particular file unit. When in the normal position, these switches have no effect on instruction execution. When a Write instruction is addressed to a disc whose corresponding switch is in the Protect position, the operation ends automatically when the Write instruction is received from the controller; and the Attention status is set. The Attention status can be reset by issuing any new instruction, except a Request Status instruction, to the file unit involved.

4. PROGRAMMING CONSIDERATIONS

The programming characteristics of the DS-20 subsystem as they relate to the Compatibles/400 information processing systems are summarized in this chapter. There are several methods of programming input/output operations for the subsystem. These methods range from the situation in which the programmer codes every operation himself to the situation in which the programmer need hardly be concerned with any details of the subsystem. By using the basic input/output supervisor and the extended input/output system available to users, the programmer is provided with proven routines and subroutines. (See Macro Assembly Program Reference Manual, CPB-351A.)

INPUT/OUTPUT CONTROL

The input/output (I/O) control section, a major part of the Compatibles/400 central processors, provides for orderly data transfers between the central processor's memory and the DS-20 subsystem. The subsystem, like other peripheral subsystems, is assigned one of eight I/O channels connected to the control section. Channels are assigned according to priority. Each channel has a specific number, program interrupt priority, and data transfer priority.

The assigned channel receives instructions from the central processor and transmits them to the subsystem. Information indicating the status of the subsystem and the channel is also transmitted from the subsystem to the central processor via the assigned channel. The transfer of data between the subsystem and the assigned channel is always serial--one character at a time.

Initiating an Operation

Each DS-20 subsystem operation is initiated by the execution of a General instruction which designates:

1. The channel assigned to the DS-20 subsystem
2. The device
3. The operation to be performed (Write File, Seek Read File, etc.)

Once an operation is initiated, it proceeds under control of both the I/O channel and the DSU controller; the central processor is free to continue processing instructions.

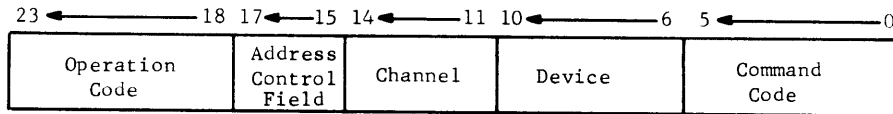
General Instruction Word Format

The General instruction can perform any one of the following functions:

1. Initiate a peripheral operation and obtain the status of the addressed peripheral to determine whether or not the operation was initiated.

2. Request the status of the addressed peripheral subsystem (usually at the time of a program interrupt).
3. Reset all resettable conditions (status) in the addressed peripheral subsystem and obtain the remaining status.

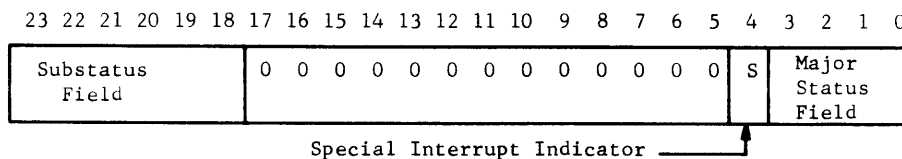
The word format is illustrated below.



The General instruction is a two-address instruction.

Status Word Format

Execution of a General instruction causes the status of the subsystem to be stored in a memory word for subsequent program examination. The status of the addressed subsystem is stored in a status word whose location is specified by a Second Address Sequence (SAS) word. The information placed in the status word reflects one of the eight possible general conditions (major status) associated with the DS-20 subsystem, and may also include substatus information that reflects more specific information about the major status word stored in memory as illustrated below.



The status word can be interrogated by the program to determine:

1. If a desired operation was initiated successfully
2. If the DS-20 subsystem is available for use
3. If a previously initiated operation was completed successfully
4. The specific reason for an abnormal status condition, if any.

Input/Output Control Words

Four control words for the channel are stored in fixed memory locations. The words are used by the I/O logic during program interrupt operations. The List Pointer Word (LPW) and the Data Control Word (DCW) determine the memory locations to or from which successive characters

are to be transferred. The Program Interrupt Word (PIW) and the Program Interrupt Second Word (PSW) provide an automatic branch to an interrupt subroutine to service the condition that caused the interrupt.

Data Transfer Sequence

During Data Transfer Sequences (DTS), memory access for data is controlled automatically by two of the channel control words for the selected channel--the LPW and the DCW words. These control words are effective only during operations involving data transfers. They control memory addressing and character counting during each memory access.

The primary purpose of a DTS is to effect data transfer between the requesting I/O channel and memory with minimum delay in program execution. The amount of data transferred during a single DTS is a function of the channel type. As soon as the transfer of data is completed, program execution is resumed. When the channel is ready for the next data transfer, another request for a DTS is initiated. A DTS is required for each memory access involved in a DS-20 subsystem operation. Between Data Transfer Sequences, and while data is being processed within the channel and DS-20 subsystem, program execution continues.

Execution of a General Instruction

After the status word is stored, the List Pointer Word (LPW) for the selected channel is accessed from memory. The LPW count field is incremented by one to indicate that processing of the first word in the Data Control List (DCL) has been initiated and the LPW is restored to memory. Each word in a DCL specifies the number of characters in the field and the starting address in memory to or from which the field is to be transferred. The first word in the DCL, as determined by the LPW address field, is read from memory and placed in the DCW for the channel.

At this point, execution of the General instruction is complete, and the next instruction in the program is accessed. The General instruction has served to store the status of the subsystem and initiate the desired operation. A simplified flowchart of a Data Transfer Sequence is illustrated in Figure 12.

The device and command codes for the subsystem are now held in the selected control logic of the subsystem to be used to direct the balance of the data transfer operation. Whenever the subsystem becomes ready to transfer data subsequent to receiving a data transfer command code, the selected channel issues to the central processor a request for a DTS.

When a General instruction involving data transfer has been executed and the subsystem is ready for data movement to begin, the I/O channel issues a request for a Data Transfer Sequence. When a DTS is granted to the requesting channel, sequential processing of instructions stops momentarily and the central processor enters a Data Transfer Sequence.

The events shown in the flowchart in Figure 12 occur during a DTS. The level of detail parallels that of the following discussion:

When a DTS is granted to the requesting channel, instruction processing momentarily halts at the first convenient point during the execution of an instruction or upon completion of instruction

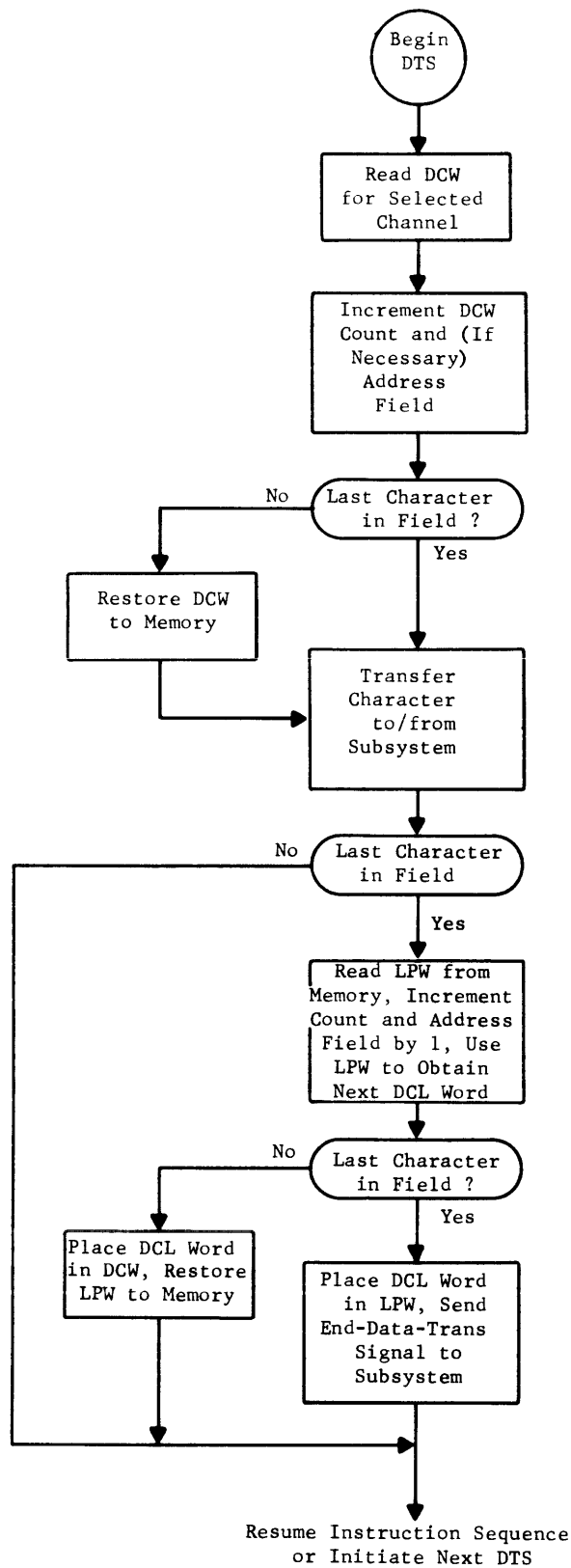


Figure 12. Data Transfer Sequence

execution. The DCW for the channel is automatically read from memory. Initially, the DCW contains the first word of the DCL as it was loaded from the DCL into the DCW by the General instruction that initiated the I/O operation.

The DCW count field is automatically incremented by one in order to count the number of characters moved by this DTS. Each time that the count field is incremented, the DCW address field is also incremented by one to form the address of the next sequential word in memory to be used in the data transfer operation.

If the DCW count field reaches the end of its count (overflow) as a result of adding, this indicates that the last of the data field represented by the DCW is not being transferred during the current DTS, and the DCW is not restored to memory. If the DCW does not overflow, then at least one more DTS is to be made using this DCW, and the updated DCW is restored to memory.

The DCW address field--as read from memory and before updating--is used to determine the memory location to be used in the transfer of one character. If the DCW count field indicated that this DTS is not transferring the last character in the field defined by the DCW, the DTS is complete at this point, and instruction processing is resumed at the point where it was momentarily halted when the DTS was initiated--or, alternatively, another DTS for another requesting channel is granted. Each time the subsystem is again ready to transfer data, the channel will initiate another request for a DTS.

When the DCW count field indicates that the last character of the field is being transferred during the DTS, the LPW for the selected channel is read from memory. The LPW count and address fields are both incremented by one to indicate that the next word in the DCL is to be accessed, and to show the address of the memory location containing that DCL word.

The LPW address field is used to obtain the next DCL word. This word will either define another data field to be transferred or will be the last word in the DCL and not define another data field.

If the word obtained is the last word in the DCL--as indicated if the LPW count field reaches its maximum count, or overflows--that word is the LPW Restore word and is read into the LPW memory location in order to re-initialize the LPW for the next data transfer operation involving this channel. The I/O control logic sends an end-data-transfer signal to the subsystem, the DTS is terminated, and instruction processing is resumed.

If, however, the DCL word obtained is not the last word in the DCL--the LPW count field does not overflow--the DCL word is placed in the DCW to control subsequent data transfers in subsequent Data Transfer Sequences, the DTS is terminated, and instruction processing is resumed.

Termination of Data Transfer

A normal data transfer operation--such as that previously described, is not considered complete until the subsystem sends a termination signal to the I/O indicating that the subsystem has completed its operation, and the I/O channel has issued a request for Program Interrupt (PI) to the central processor.

Program Interrupt

One of the major purposes of a Program Interrupt (PI) is to provide a means of notifying the program that the subsystem causing the PI has completed a previously initiated operation.

When a PI request is recognized and granted, instruction processing is interrupted--usually upon completion of the current instruction execution--and control is transferred directly to the Program Interrupt Word (PIW) for the channel.

Special Program Interrupt

The PIW and its associated Program Interrupt Second Word (PSW) will contain either a Store Program Counter and Branch (SPB) instruction causing storage of the contents of the program counter and a branch to a PI subroutine, or a Request Status instruction that stores the status of the channel and subsystem that requested the PI. If the PIW contains a Request Status instruction, no PI is actually granted because the contents of the program counter is not changed and--as soon as status is stored--the next instruction in the program sequence is accessed.

Upon conclusion of a PI subroutine, the program counter is loaded with the address that it held at the time the PI was granted and control returns to the main program.

BUFFERING

The buffering capability of the DS-20 controller enables the subsystem to move to memory of the central processor only those data segments requiring updating, thus saving space and time within the processing system. Data (1 to 240 characters) can be moved from one area of the subsystem's buffer to another without involving the central processor's memory. Up to 32 consecutive data segments can be transferred through the buffer to memory from a file unit or vice versa, using a scatter/gather technique, if desired.

This buffering capability allows the subsystem to operate in three different modes: On-line only, Off-line only, or a combined On-line/Off-line.

The buffer is organized as illustrated in Figure 13. It is divided functionally into four data areas: W, X, Y, and Z. Each area is composed of a data block and a control block.

Data Block

One data segment, consisting of 240 characters and a 6-bit check character can be stored in each data block. There is no fixed format limitation on the 240 characters since the characters are generated by the processing system. The check character is generated by the DS-20 controller during a write operation and is automatically written as the last character of the data segment as an odd parity check. The check character is never transmitted to the processing system during a normal read operation; however, it is available for examination as a result of a read buffer command.

The four data blocks of the buffer can be considered a cyclic memory in that data read in or out of the buffer from a data block is immediately followed by the next sequential data block. For example, a data transfer of two segments from a file unit to the buffer starting with data

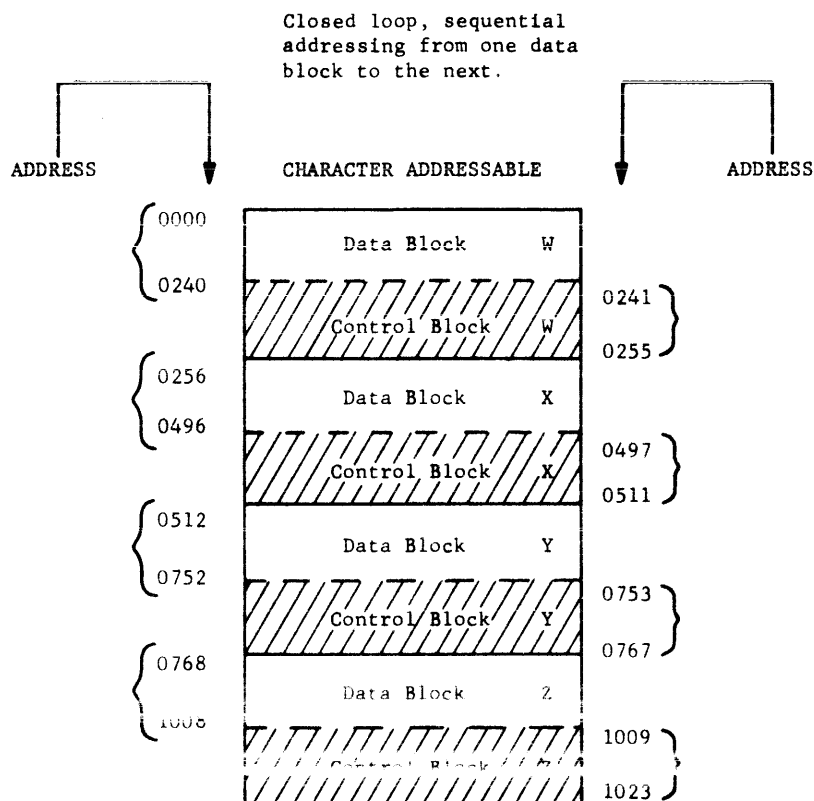


Figure 13. Buffer Data Area Configuration

block Z would result in the first segment being stored in data block Z and the second segment in data block W. Another example would be a read command of 8 characters starting in buffer address 1005. The characters would be transferred to the processing system in the following order: 1005, 1006, 1007, 0000, 0001, 0002, 0003, and 0004. Note that the check character 1008 is not transferred.

Control Block

There are fifteen character positions in the control block assigned to each data area. The first nine positions are reserved for internal use with the DS-20 subsystem and are not available to the programmer. The last six positions store the control characters which are used to define the operation to be executed. The processing system can effect the writing of control characters into the last six positions by issuing certain commands but cannot effect writing into any other part of the control block. A read buffer command, however, can cause any part of the control block to be read.

For any one specified disc and actuator position, the zone code will address 32 segments. Zone code 00 addresses the 32 segments under the four heads covering both the upper and lower surfaces of the disc in the inner zone. The zone code of 01 will address the 32 segments under the two

heads covering the upper surface of the disc in the outer zone and code 10 addresses the 32 segments under the two heads covering the lower surface of the disc in the outer zone. Zone code 11 is not legal.

Four consecutive data segments on each file unit, starting at address Zone 0, Disc 0, Track 0, Segment 0, are reserved for diagnostic program purposes, and should not be used by the programmer. Although there is no hardware to prevent a reserved diagnostic segment from being accessed, the programmer should bear in mind that in using these segments, there is considerable risk of having a diagnostic program overwrite the contents of the reserved segments.

Fast-Access Options

When the DS-20 subsystem includes either of the fast-access options, each disc used in one of these options is addressed by expressing its number, in binary form, in the four disc bits of the segment address:

OPTION 1. Discs 12 through 15 are used for fast access and the six track position bits of the segment address must be zero.

OPTION 2. Discs 8 through 15 are used for fast access and the six track position bits of the segment address must be zero.

Each option contains three groups of data, one group for each of the three legal combinations of zone codes in the segment address. Each of the three groups contains 32 segments of data.

The central processor must transmit the segment address to the DS-20 subsystem to indicate which data segments are to be accessed.

In a system configuration consisting of four file units, each control block is assigned to a specific file unit as indicated:

Control Block W - Assigned to file unit 1
Control Block X - Assigned to file unit 2
Control Block Y - Assigned to file unit 3
Control Block Z - Assigned to file unit 4

The functional assignment of a control block to a specific file means that if a command is addressed to the file, the controller will access the control characters assigned to that file for a definition of the operation to be executed.

The six control characters received by the subsystem define the data segment address and the operation to be executed. The six control characters are encoded according to the configuration shown in Figure 14.

Character 0		Character 1		Character 2		Character 3		Character 4		Character 5																										
5	4	3	2	1	0	5	4	3	2	1	0	5	4	3	2	1	0	5	4	3	2	1	0	5	4	3	2	1	0	5	4	3	2	1	0	Bits
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	Fields
0	Zone	Disc	Track		Data Segment	Operation Code																														
Address						Operation																														

Figure 14. Control Block Characters

MODES OF OPERATION

The 6-bit operation code (bits 18-23) included with each General instruction specifies the type of operation to be performed in one of the following modes:

- On-line only - the transfer of information between the I/O channel and the DSU controller is under control of the central processor for the entire duration of the execution of the instruction.
- Off-line only - implies that the pertinent address of the file unit to perform the operation is already stored in the control block of the controller buffer for the addressed device. Execution of the instruction is accomplished entirely off-line between the specified file unit and the controller buffer.
- Combined On-line/Off-line - the transfer of information between the I/O channel and the DSU controller is under control of the central processor for only a short period of time while control characters are being transferred to the controller buffer. The remainder of the execution time is accomplished off-line between the specified file unit and the controller buffer.

DS-20 INSTRUCTIONS

Instructions for operating the DS-20 subsystem in each of the operating modes are described in detail in this section. The writing of DS-20 instructions is simplified by the use of mnemonic codes that are interpreted by the Macro Assembly Program (MAP) furnished by the General Electric Company. MAP automatically converts the programmer-generated decimal or symbolic addresses into binary notation. Memory addressing is binary rather than decimal to provide efficient use of the bits in the instruction word.

Status, error, and exception conditions effecting each instruction are included in the description of the instruction. The possible status returns in response to initiation and termination of each instruction are summarized in Appendices A and B.

Format of Instruction Descriptions

Each DS-20 instruction is introduced by a standardized heading shown in the following example. An explanatory key follows the example.

1
/

SEEK/READ FILE

SRF 07 X YYY 14

\ / / / \

 2 3 4 5 6

1. Command name, a brief description of the operation to be performed.
2. The mnemonic code for the Operation field of the coding sheet.
3. The octal representation of the operation code (bits 18-23) of the General instruction word.
4. Address control field (bits 15-17) of the General instruction word. This code can be any digit, 0 through 7, depending upon the type of address control required.
5. Channel and Device control fields (bits 6-14) of the General instruction word.
6. A representation of the octal format of the command code (bits 0-5) of the General instruction word.

Universal Select Instruction

SEEK FILE

SF 07 X YYY 34

FUNCTION. Transfers segment address from memory to controller buffer and moves positioning arm (actuator) to location of segment address. The Seek File instruction does not commit the involved buffer areas.

INSTRUCTION INITIATION. The device code character included with this instruction indicates the specific file unit to which the seek is directed. Device code 0 is not legal for this instruction and will result in a Command Rejected status.

The possible status returns upon initiation of a Seek File instruction are as follows:

Status Condition

Indication to Central Processor

Channel Ready

The instruction is accepted.

Device Busy
Not Overridable

Addressed file unit is engaged in an off-line operation and cannot be interrupted. The instruction is rejected.

Attention

Addressed file unit is not usable because of an existing inoperable state.

Status Condition

Indication to Central Processor

Command Rejected
Invalid Operation Code
Invalid Device Code

The instruction is rejected.

Channel Busy

The subsystem is busy with an on-line operation and cannot be interrupted. The instruction is rejected.

NOTE: The DS-20 subsystem actually reverts to a Channel Busy status at the time an instruction is received and accepted. However, this Busy status is changed to Channel Ready by the channel, and the Ready status is stored in memory. Thus, the program is informed that the instruction is accepted.

INSTRUCTION EXECUTION. If the Seek File command is accepted, the subsystem immediately reverts to a Channel Busy status and initiates a request for six address-definition (control) characters from the central processor.

NOTE: The central processor uses the Data Control List (DCL) to define the six address-definition or control characters. The six control characters define the specific seek operation to be performed and are stored in the control block of the buffer area assigned to the addressed file unit.

Characters 0, 1, and 2 Define the address of the specific segment to be located on the addressed file unit.

Characters 3, 4, and 5 - These three characters are not pertinent to the Seek File operation, but may be significant in executing a subsequent instruction.

Upon reception of the six control characters, the DS-20 sends a Terminate signal to the central processor and reverts from the Channel Busy status to one of the status conditions as follows:

Status Condition

Indication to Central Processor

Channel Ready

Seek operation will be initiated.

Data Alert
Transfer Timing Alert
Transfer Parity Alert
Invalid Control Character

Seek operation will not be initiated because an error condition was detected.

OFF-LINE EXECUTION. If the six control characters were received successfully and accepted (as indicated by the Channel Ready status at the end of the Busy state), the DS-20 subsystem executes the specified seek operation.

While the seek operation is being executed, the involved file unit will be in the Device Busy status. If a Request Status or a Reset Status instruction is addressed to the specific file unit during this period, the Device Busy major status condition is transmitted to the central processor along with the overridable substatus, indicating that the Device Busy condition can be overridden

by another instruction. Hence, during execution of the off-line portion of the seek operation, the DS-20 subsystem may accept another seek instruction for the same file unit. This new seek instruction will override the seek operation currently in process. When the seek operation ends, the DS-20 subsystem sends a Special Interrupt signal to the central processor. If, after this signal has been sent, a Request Status instruction is addressed to the same file unit, any one of the following status conditions could be reflected by the DS-20 subsystem.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Attention	Seek operation aborted because an inoperable condition was detected in the addressed file unit.
Data Alert Internal Error	Seek operation was not successful, or the seek address was illegal.
Intermediate	Seek operation was completed successfully.

On-Line Only Instructions

The on-line only mode of operation involves the transfer of information between memory and the DS-20 controller for the entire duration of instruction execution.

Upon reception of any one of the following on-line instructions the DS-20 subsystem reverts to the Channel Busy status and remains in this status for the entire duration of the instruction execution. Upon completion of instruction execution, the subsystem reverts to the status which defines the outcome of instruction execution, and then sends a Terminate signal to the central processor.

The instructions resulting in on-line only operation are as follows:

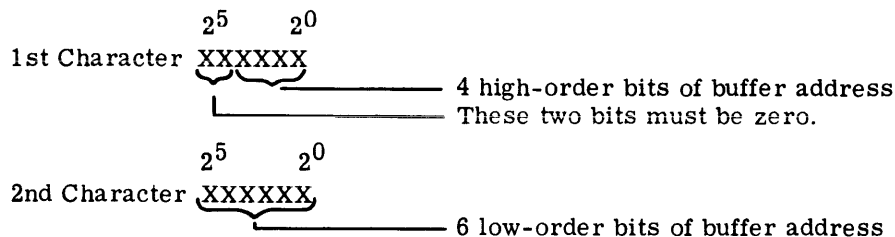
ACCEPT BUFFER ADDRESS

ABA 07 X YYY 32

FUNCTION. Transfers a buffer address to the controller. Since this instruction does not involve a file unit, the device code portion of the General instruction is ignored but checked for correct parity by the subsystem. Possible status returns for this instruction are indicated below:

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Command Rejected Invalid Operation Code Invalid Device Code	The instruction is rejected.
Channel Busy	The subsystem is engaged in an on-line operation and cannot be interrupted. The instruction is rejected.

Upon receipt of this instruction, the subsystem reverts to the Channel Busy status and initiates a request for six control characters from the central processor. The first two control characters received are interpreted as a ten-bit buffer address as indicated below.



After reception of the first two control characters, the subsystem requests four additional control characters from the central processor; however, these four characters are ignored by the subsystem.

When all six control characters are received from the central processor, the subsystem reverts from the Channel Busy status to one of the status conditions indicated below, and sends a Terminate signal to the central processor.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	Buffer address received error-free from channel processor and accepted.
Data Alert	The buffer address is not accepted.
Transfer Timing Alert	
Transfer Parity Alert	
Invalid Control Character	

The buffer address received during execution of this instruction is stored in the subsystem and is used as the starting buffer location for subsequent execution of a Read Buffer, Write Buffer, or Load Buffer for Compare instruction.

If, after completion of the Accept Buffer Address instruction, any instruction other than a Request Status, Reset Status, Write Buffer, Read Buffer, or Load Buffer for Compare instruction is received by the subsystem, the buffer address is reset.

All six control characters must be received from the central processor or the Data Alert, Invalid Control Character status will be reflected to the central processor at the end of the busy state.

READ BUFFER

RB 07 X YYY 24

FUNCTION. Transfers successive characters from controller buffer to memory of the central processor.

Since this instruction does not involve a file unit, the device code portion of the General instruction is ignored but checked for correct parity by the subsystem. Possible status returns for this instruction are indicated below.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Command Rejected Invalid Operation Code Invalid Device Code Buffer Committed	The instruction is rejected.
Channel Busy	The subsystem is engaged in an on-line operation and cannot be interrupted. Instruction is rejected.

Upon receipt of this instruction, the subsystem reverts to the Channel Busy status and starts sending the buffer contents to the central processor. If the Read Buffer instruction was directly preceded by an Accept Buffer Address instruction, the subsystem will use the buffer address received during execution of the latter instruction as the starting address for executing the Read Buffer instruction.

If the Read Buffer instruction was not directly preceded by an Accept Buffer Address instruction, buffer location 0000 (Data Block W) will be used as the starting address for executing the Read Buffer instruction.

NOTE: If, in this case, buffer area W is committed to an off-line operation, the Command Rejected, Buffer Committed status is reflected to the central processor in response to the Read Buffer instruction.

If the starting address to be used in executing this instruction has been set by a preceding Accept Buffer Address, the subsystem will read and transmit to the central processor the contents of the data block from the starting address. When this data block is completely read, the subsystem will continue reading from the data block of the next consecutive buffer area. Consecutive data blocks will be read until either an error is detected, or the End Data Transfer signal is received from the central processor.

NOTE: Neither the control blocks nor the check character of the buffer sections are read and transmitted to the central processor if the starting location is in a data block of one of the buffer areas.

In order to read the check character of a buffer area, the Read Buffer instruction must be preceded by an Accept Buffer Address instruction whose control characters address the required check character's location. The Read Buffer instruction will then cause that check character to be transmitted to the central processor. Only the one check character will be transmitted.

If the starting buffer location to be used in executing the Read Buffer instruction is in a control block of one of the buffer areas, the subsystem will read and transmit to the central processor only that one control block of the buffer, from the starting address within the control block to

the end of that control block. When this block has been completely read and transmitted, instruction execution ends.

Execution of this instruction will terminate upon receipt of the End Data Transfer signal from the central processor, or upon detection of an error condition. If an End Data Transfer signal is received, the operation ends and the Terminate signal is sent. If an error is detected during instruction execution, the operation ends after the current buffer block is read. The appropriate error status is set, and the Terminate signal is sent.

If, upon receipt of this instruction, the subsystem is holding a buffer address as a result of an Accept Buffer Address instruction, and if this address is for a data block of a buffer area committed to an off-line operation, the Read Buffer instruction is rejected with the Command Rejected, Buffer Committed status.

If one or more areas of the buffer is committed to an off-line operation, the subsystem will allow reading of the buffer until a block of a committed buffer area is to be read. At this point, the operation ends, and the Terminate signal is sent. This is not considered an error.

The following status conditions may be reflected to the central processor by the subsystem upon termination of the Read Buffer instruction.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	Read operation completed successfully with no error conditions.
Data Alert Transfer Timing Alert Internal Error	An error was detected during the read operation.

WRITE BUFFER

WB 07 X YYY 30

FUNCTION. Transfers successive characters from central processor memory to the controller buffer.

This instruction is similar to the Read Buffer instruction except that:

1. Data is received from the central processor instead of being sent to it.
2. If the starting address specifies a character within the 15 positions of a control block of any buffer area or check character location, the instruction is rejected with the Command Rejected, Illegal Address status.
3. The Data Alert, Transmission Parity Error status may be reflected at the end of the execution of this instruction, in addition to those status conditions indicated for the Read Buffer instruction.
4. The reflection of the Data Alert, Internal Error status is not possible.

LOAD BUFFER FOR COMPARE

LBFC 07 X YYY 36

FUNCTION. Transfers successive characters from central processor memory to controller buffer and always completes a buffer area with data characters received from memory or with generated octal 17's.

This instruction is similar to the Write Buffer instruction with the following exceptions: As soon as the End Data Transfer signal is received from the central processor, indicating that all characters to be written have been sent, the subsystem fills the remainder of the buffer area being written with Ignore characters (octal 17). The subsystem remains in the Channel Busy status until the write operation on the buffer area is completed.

If the buffer data block is filled before the End Data Transfer signal is received from the central processor, the operation ends automatically, and the Terminate signal is sent to the central processor. Only one buffer data block can be filled with this instruction.

READ FILE CONTINUOUS and RELEASE SEEK

RFCR 07 X YYY 25

FUNCTION. Positions actuator, reads up to 32 consecutive segments into memory by way of the controller buffer, and releases actuator. Assumes segment address and other control characters are already in the buffer.

INSTRUCTION INITIATION. The device code character specifies the file unit to which the Read File Continuous and Release Seek instruction is directed. Device code 0 is not legal for this instruction, and will result in the Command Rejected status.

The possible status returns for this instruction are indicated below:

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Command Rejected Invalid Operation Code Invalid Device Code Buffer Committed	The instruction is rejected.
Attention	Addressed file unit is not usable because of an existing inoperable state.
Channel Busy	The subsystem is busy with an on-line operation and cannot be interrupted. The instruction is rejected.

NOTE: If any off-line instruction other than a Seek File instruction is being executed at the time this instruction is received, the Read File Continuous and Release Seek instruction will be rejected with a Command Rejected, Buffer Committed status.

INSTRUCTION EXECUTION. If the instruction is accepted, the subsystem reverts to the Channel Busy status. Execution of this instruction is governed by the control characters previously stored in the buffer control block associated with the addressed file unit.

Characters 0, 1, and 2 - Indicate the segment address

Characters 3, 4, and 5 - Are not pertinent to the execution of the Read File Continuous and Release Seek instruction.

At the time the Read File Continuous and Release Seek instruction is received and accepted, any one of the following states may exist within the DS-20 subsystem.

1. The state of the addressed file unit may be such that it must perform a seek operation before data transfer can occur. This will be the case if the previous instruction executed by the addressed file unit was any instruction other than a seek instruction.
2. The addressed file unit may have completed a previous seek operation and be waiting for an instruction to act on the accessed data segment.
3. The addressed file unit may be in the process of executing a seek operation.

If, following the reception and acceptance of this instruction, the state of the addressed file unit is as defined in 1, the subsystem initiates a seek operation on the addressed file unit using control characters 1, 2, and 3 from the appropriate buffer control block to define the segment to be accessed.

If case 2 or 3 exists at the time the instruction is accepted, the control characters will not be accessed, since the file unit is already executing or holding on to a previously received seek.

NOTE: If at the time the Read File Continuous and Release Seek instruction is received, the addressed file unit is in the process of executing a seek operation and the seek operation subsequently fails, the Read File Continuous and Release Seek instruction will not be executed, and the Channel Busy status ends. In this case, the Data Alert, Internal Error status is set, and the operation ends with the transmission of the Terminate signal.

As soon as the subsystem is ready to start the read operation, the first data segment will be read from the disc and written into buffer area W. When the first data segment is completely transferred to the buffer, the subsystem also initiates the transfer of the second data segment from the disc to the next consecutive buffer area. This operation continues in serial fashion. The transfer of a data segment from the buffer to the central processor will not be initiated until the complete segment is in the buffer. The transfer of a data segment from the disc to the buffer will not be initiated until a complete buffer area is free. If no buffer area is free, the file unit will incur a latency while waiting for a buffer area to become available.

The read operation continues until one of the following occurs:

1. An error is detected
2. The last consecutive segment is read
3. The End Data Transfer signal is received from the central processor.

If an error condition is detected during the seek portion of the operation, instruction execution ends immediately, the appropriate error status condition is set, and a Terminate signal is sent. In this case, no data is transferred to the central processor.

If an error is detected while data is being read from the file unit, the subsystem will complete the transfer of all valid segments currently in the buffer to the central processor, set the appropriate error status, and send a Terminate signal. The transmission of the Terminate signal will be delayed until any data segment transfer in process between the file unit and the buffer is completed.

NOTE: No data segment for which an error has been detected will be transmitted to the central processor (except in the case of a transfer timing error).

Detection of the last consecutive segment will end the read operation, since this is the last segment available to the instruction. The file unit is always at least one segment ahead of the central processor, so that this last segment may or may not reach the central processor. When this segment is completely transmitted, appropriate status is set, and instruction execution ends with the Terminate signal.

Upon completion of instruction execution, the following status conditions may be reflected to the central processor in response to a Request Status instruction.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	Instruction executed with no errors detected. Last consecutive segment was not detected.
Data Alert Transfer Timing Alert Internal Error Check Character Error	An error was detected during instruction execution.
End of File	Operation error free, but may or may not have been completed due to the transfer of the last consecutive segment.
Attention	An inoperable condition was detected within the file unit during execution of this instruction.

When execution of this instruction ends, the power of the actuator used in executing the instruction is turned off.

WRITE FILE CONTINUOUS and RELEASE SEEK

WFCR 07 X YYY 31

FUNCTION. Positions actuator, writes up to 32 consecutive segments from memory by way of the controller buffer and releases actuator. Assumes segment address and other control characters are already in the buffer.

This instruction is similar to the Read File Continuous and Release Seek instruction except that data segments are first transferred from the central processor into the buffer and then written on the addressed disc. Since data is being transferred from the central processor to the buffer, it is possible that a Data Alert, Transmission Parity Error status condition may be reflected at the end of instruction execution.

If an error is detected on a data segment while it is being transferred from the central processor to the subsystem, the writing of all data segments previously received for the addressed file unit will be completed. However, the writing of the segment containing the error is inhibited, although this full segment will be requested from the central processor and placed in the buffer.

If an internal error is detected while a data segment is being written on a file unit, the writing of the segment in progress is completed, but further writing on the disc is inhibited, and instruction execution ends. Any segment transfer in progress between the central processor and the subsystem will be completed before instruction execution ends.

If a partial segment is received from the central processor as a result of an End Data Transfer signal, the subsystem will store the partial segment in the appropriate buffer area. When the segment is written on the disc, the entire area of the buffer will be written, including the partial segment received from the central processor plus whatever was left in the remainder of the buffer area. This is true of all write operations.

Reflection of the Attention status during execution of this instruction may indicate that the specific disc upon which data is to be written has its corresponding write inhibit switch in the inhibit position. If so, the switch must be set to the normal position and the instruction initiated again in order to complete the instruction.

WRITE FILE CONTINUOUS, VERIFY, and RELEASE SEEK

WFCV

07 X YYY 33

FUNCTION. Positions actuator, writes up to 32 consecutive segments from memory by way of the controller buffer, compares check character of each written segment against a new check character generated by rereading each segment, and releases actuator. Assumes segment address and other control characters are already in the buffer.

This instruction is similar to the Write File Continuous and Release Seek instruction except that after completion of the write operation, all segments that were written are read, and the check character for each segment is verified.

In addition to the status conditions listed for the Write File Continuous and Release Seek instruction, the Data Alert, Check Character Error status may be reflected at the end of instruction execution, indicating detection of an error on one of the segments written.

MOVE DATA

MVDT 07 X YYY 37

The Move Data instruction is included in the On-Line Only category of instructions because the subsystem remains in the Channel Busy status during the entire time that data is being move. There is however, no transfer of data to or from the central processor during the Move Data operation, except for the six control characters. The movement of data characters is entirely within the buffer; that is, data is moved from one buffer location to another as specified by the control characters.

FUNCTION. Transfers starting addresses for source and destination fields to buffer memory of the central processor and moves up to 240 characters from source to destination within the controller buffer.

INSTRUCTION INITIATION. Upon receipt of this instruction, one of the following status conditions is reflected to the central processor.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Command Rejected Invalid Operation Code Invalid Device Code Buffer Committed	The instruction is rejected.
Channel Busy	The subsystem is already engaged in an on-line operation and cannot be interrupted. Instruction is rejected.

The device code received with the Move Data instruction is ignored but checked for correct parity.

If any instruction other than a seek instruction is being executed at the time the move instruction is received, the Move Data instruction will be rejected with a Command Rejected, Buffer Committed status.

INSTRUCTION EXECUTION. If the instruction is accepted, the subsystem reverts to the Channel Busy status and initiates a request for six control characters from the central processor. These six characters define the specific move operation to be accomplished as follows:

Characters 0 and 1 - Define the starting address of the buffer location to which data is to be moved. The six low-order bits of this starting address are contained in character 1. The four high-order bits are contained in the four low-order bits of character 01. The two high-order bits of character 0 must be zero.

Characters 2 and 3 - Define how many characters are to be moved. The six low-order bits of this binary number are contained in character 3. The two high-order bits are contained in the two low-order bits of character 2. The four high-order bits of character 2 must be zero.

Characters 4 and 5 - Define the starting address of the buffer location from which data is to be moved. The six low-order bits of this starting address are contained in character 5. The four high-order bits are contained in the four low-order bits of character 4. The two high-order bits of character 4 must be zero.

If an error is detected during the transfer of the control characters, instruction execution ends after all six control characters are received by the subsystem, one of the following status conditions is set, and a Terminate signal is sent to the central processor: Data Alert, Transfer Timing, Transmission Parity, or Invalid Control Character.

If an End Data Transfer signal is received by the subsystem before all six control characters are received, the Data Alert, Invalid Control Character status is set, and the Terminate signal is sent to the central processor.

If no error is detected, the subsystem remains in the Channel Busy status and initiates the move operation. The number of characters specified by control characters 2 and 3 are moved from the buffer location indicated by control characters 4 and 5 to the buffer location indicated by control characters 0 and 1.

If upon initiation of the move operation, it is determined that the starting address which designates the buffer location from or to which data is to be moved falls into a control block of the buffer or coincides with the check character position of the buffer area, instruction execution ends immediately with the Data Alert, Invalid Control Character status, and a Terminate signal is sent to the central processor.

Upon completion of the move operation, one of the following status conditions is set, and a Terminate signal is sent to the central processor.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction was executed error free.
Data Alert	An error was detected during instruction execution.
Internal Error	
Invalid Control Character	

If the move operation, as specified by the control characters, is such that when data is moved to or from the last character position of a buffer area and there is still more data movement implied, the operation ends, the Data Alert, Invalid Control Character status is set, and the Terminate signal is sent to the central processor.

Combined On-Line/Off-Line Instructions

Combined on-line/off-line instruction execution involves a short period of time while the subsystem is under control of the central processor and control characters are being transferred to the DS-20 controller. The remainder of execution time is off-line, between the addressed file unit and the controller buffer area assigned.

Upon receipt of any one of the combined on-line/off-line instructions, the DS-20 controller reverts to a Channel Busy status, and initiates a request for the six control characters to be stored in the control block. If the subsystem receives an End Data Transfer signal before all six control characters are received, instruction execution ends, and the Data Alert, Invalid Control Character status condition is set in the DS-20 controller. If all six control characters are received and stored in the assigned buffer area and no errors are detected, the controller reverts to a Channel Ready status, and transmits a Terminate signal to the central processor to indicate that the on-line portion of the instruction execution is completed.

The off-line portion of the instruction begins as soon as the Terminate signal is sent to the central processor. While the off-line portion of the instruction is being executed, the controller is free to accept and execute other instructions, provided the execution of these other instructions does not require the use of a file unit or buffer area previously committed to an off-line operation.

Combined on-line/off-line instructions cause the buffer areas involved to be committed. The involved buffer areas remain committed until the off-line portion of instruction execution ends. As soon as off-line execution ends, the buffer becomes uncommitted, even if transmission of the program interrupt signal is delayed.

If an instruction requiring the use of a buffer area already committed is received, it will not be accepted. In this case, the Data Alert, Buffer Committed status condition is set in the controller.

Once the off-line portion of the instruction on a file unit has begun, subsequent instructions addressed to that same file unit will be rejected with the Device Busy status until execution of the instruction in process ends. However, if a Seek File instruction is being executed on a file unit and any other instruction is addressed to that same file, the new instruction will be accepted. If the new instruction requires a Seek operation other than the one being executed, the Seek operation in process ends, and the new seek is initiated.

As soon as the off-line portion of an instruction is executed, the DS-20 subsystem sends a Program Interrupt (PI) signal to the central processor. When the PI signal is received by the central processor, the outcome of execution of the off-line portion of the instruction can be determined by addressing a Request Status instruction to the file unit involved.

The instructions resulting in a combined on-line/off-line type of operation are as follows:

SEEK/READ FILE

SRF 07 X YYY 14

FUNCTION. Transfers segment address and other control characters from memory to controller buffer, positions actuator, and reads 1 to 4 consecutive segments into buffer from file unit.

INSTRUCTION INITIATION. The device code character defines the specific file unit to which the Seek/Read File command is directed. Device code 0 is not legal for this instruction and will result in the Command Rejected status.

The possible status returns upon initiation of a Seek/Read File instruction are as follows:

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Device Busy Not Overridable	Addressed file unit is engaged in off-line operation and cannot be interrupted. The instruction is rejected.
Attention	Addressed file unit is not usable because of an existing inoperable state.
Command Rejected Invalid Operation Code Invalid Device Code	The instruction is rejected.
Channel Busy	The subsystem is busy with on-line operation and cannot be interrupted. The instruction is rejected.

INSTRUCTION EXECUTION. If the Seek/Read File instruction is acceptable, the subsystem reverts to the Channel Busy status and initiates a request for six control characters from the central processor. The control characters define the specific operation to be performed and are stored in the control block of the buffer area assigned to the addressed file unit.

Characters 0, 1, and 2 - Define the address of the specific segment to be located on the addressed file unit.

Character 3 - Not pertinent to the Seek/Read File instruction.

Character 4 - Indicates the area of the buffer into which the segments are to be read. The four low-order bits of this character are functionally encoded as follows:

- 1 indicates buffer area Z
- 2 indicates buffer area Y
- 3 indicates buffer area X
- 4 indicates buffer area W

The two high-order bits of this character must be zero.

Character 5 - Indicates the buffer area (W, X, Y, or Z) into which the first data segment read from the file unit is to be placed. The encoding of this character is indicated below:

<u>Code</u>	<u>Applicable Buffer Area</u>
1	Z
2	Y
3	X
4	W

The two high-order bits of this character must be zero.

The buffer areas specified by control character 4 become committed, and remain committed throughout instruction execution.

Upon reception of the six control characters, the subsystem sends a Terminate signal to the central processor, and then reverts from the Channel Busy status to one of the status conditions below:

<u>Status Conditions</u>	<u>Indication to Central Processor</u>
Channel Ready	Seek/Read operation will be initiated.
Data Alert	Seek/Read operation will not be initiated because an error was detected.
Transfer Timing Alert	
Transfer Parity Alert	
Invalid Control Character	
Buffer Committed	

OFF-LINE EXECUTION. If the six control characters were received successfully and accepted (as indicated by the Channel Ready status upon termination of the Busy state), the subsystem performs the specified Seek/Read operation.

Upon completion of the seek operation on the addressed file unit, the transfer of data from the file unit to the buffer is initiated. Sequential segments are read into the buffer, starting at the area of the buffer specified in control character 5. Subsequent file segments will be read into subsequent buffer areas until all segments specified by control character 4 have been filled. If, for example, control character 4 indicated buffer area W, X, and Z and control character 5 indicated buffer area Z, successive data segments would be read into buffer areas Z, W, X.

The following possible inconsistencies between control characters 4 and 5 will be detected during off-line instruction execution:

1. The combination of control characters 4 and 5 implies reading nonsequential buffer areas.
2. Control character 5 specifies a buffer area which is not included in control character 4.
3. Control character 5 does not specify a buffer area or specifies more than one buffer area.

In case 1, instruction execution will proceed until, in order to continue, a nonsequential buffer area would have to be accessed. When this occurs, instruction execution ends, and the Data Alert, Internal Error status is set.

In cases 2 and 3, the required seek operation is performed, instruction execution ends, and Data Alert, Internal Error status is set. No data is read into the buffer.

When the operation ends, the DS-20 subsystem transmits the Special Interrupt signal to the central processor. The six original control characters will remain stored in the control block of the applicable buffer area.

Before the Special Interrupt signal is transmitted, an instruction addressed to the file unit involved in the off-line portion of the Seek/Read operation will receive a Device Busy status response from the subsystem.

Following transmission of the Special Interrupt signal, any one of the following status conditions will be reflected by the DS-20 in response to a Request Status instruction addressed to the file unit.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Attention	An inoperable condition was detected during instruction execution.
Data Alert Internal Error Check Character Error	An error condition was detected during operation.
End of File	Operation completed successfully.

NOTE: Detection of a Data Alert condition will end instruction execution. If a Data Alert condition is detected when a data segment is being transferred from file unit to the buffer, the operation ends when the complete segment is transferred.

SEEK/READ FILE and RELEASE SEEK

SRFR 07 X YYY 15

FUNCTION. Transfers segment address and other control characters from memory to controller buffer, positions actuator, reads 1 to 4 consecutive segments into the buffer from addressed file unit and releases actuator.

This instruction is similar to the Seek/Read File instruction except that when instruction execution ends with no errors detected, the power of the actuator used in executing the instruction is turned off.

A Special Interrupt signal is transmitted to the central processor at the end of instruction execution. If the Seek/Read File and Release Seek instruction is executed successfully with no errors detected, the Channel Ready status is reflected in response to a subsequent Request Status command addressed to the same file unit. If an error is detected during instruction execution, the actuator power remains on, and the appropriate error status is reflected.

NOTE: In the case of the Seek/Read File instruction, the Intermediate status is reflected after the instruction has been completed successfully. All other status returns are identical to those indicated for the Seek/Read File instruction.

SEEK/READ FILE and INCREMENT ADDRESS

SRFI 07 X YYY 16

FUNCTION. Transfers segment address and other control characters from memory to controller buffer, positions actuator, reads 1 to 4 consecutive segments into the buffer from the addressed file unit and increments by one the address stored in the buffer for each segment read.

This instruction is identical to the Seek/Read File instruction except that at the end of instruction execution, the subsystem changes the existing file segment address stored in control character 2 of the control block associated with the file unit being accessed. The segment address placed in the control characters will be the next sequential address following the last segment address used in executing the Seek/Read File and Increment Address instruction.

Incrementing of segment address 11111 results in address 00000 being stored. A carry is not propagated from the segment number field to the actuator field.

NOTE: If execution of this instruction results in a Data Alert status (that is, an error is detected during instruction execution), the segment address stored in control character 2 will not be incremented, and will contain the address of the segment in which the error was detected.

SEEK/WRITE FILE

SWF 07 X YYY 10

FUNCTION. Transfers segment address and other control characters from memory to controller buffer, positions actuator, and writes 1 to 4 consecutive segments from the buffer onto the addressed disc.

This command is similar to the Seek/Read File command except that the flow of data between the file unit and the controller buffer is reversed; that is, data is read from the buffer and written on the disc. At the time this instruction is received, the data to be written on the disc must have been previously stored in the applicable buffer area.

The possible status returns upon initiation of a Seek/Write File instruction are as follows:

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Device Busy Not Overridable	Addressed file unit is engaged in off-line operation and cannot be interrupted. The instruction is rejected.
Attention	Addressed file unit is not usable because of an existing inoperable state.
Command Rejected Invalid Operation Code Invalid Device Code	The instruction is rejected.

Status Condition

Indication to Central Processor

Channel Busy

The subsystem is busy with an on-line operation and cannot be interrupted. The instruction is rejected.

NOTE: If an Attention status is reflected at the beginning of the on-line portion of instruction execution, one possible reason is that the corresponding write inhibit switch at the top of the disc storage cabinet is in the inhibit position. If so, the switch must be placed in the normal position before writing can occur, and the instruction must be initiated again.

If an error is detected during execution of this instruction, the writing of the data segment in progress when the error was detected will be completed, after which the instruction execution ends.

If a partial segment is received from the central processor as a result of an End Data Transfer signal, the subsystem will store the partial segment in the appropriate buffer area. When the segment is written on the disc, the entire buffer area will be written, including the partial segment received from the central processor plus whatever was left in the remainder of the buffer area.

The status returns of this instruction at the termination of an instruction execution are identical to those indicated for the Seek/Read instruction except that the Data Alert, Check Character Error status will never be detected during the execution of the instruction.

The possible status returns in response to a Request Status instruction are as follows:

Status Condition

Indication to Central Processor

Attention

An inoperable condition was detected during instruction execution.

Data Alert
Internal Error

An error condition was detected during operation.

End of File

Operation was error free but not completed due to the transfer of the last consecutive segment.

Intermediate

Operation completed successfully.

SEEK/WRITE FILE and RELEASE SEEK

SWFR 07 X YYY 11

FUNCTION. Transfers segment address and other control characters from memory to the controller buffer, positions actuator, writes 1 to 4 consecutive segments from the buffer onto the addressed disc and releases actuator.

This command is identical to the Seek/Write File command except that when execution ends with no errors detected, the power of the actuator used in executing the command goes off. As in the case of the Seek/Write File command, a Special Interrupt signal is transmitted to the central processor at the end of command execution.

If the Seek/Write File and Release Seek instruction is executed successfully with no errors detected, the Channel Ready status will be reflected in response to a subsequent Request Status command addressed to the same file unit. If an error is detected, the actuator power remains on, and the appropriate error status is reflected.

NOTE: In the case of the Seek/Write File instruction, the Intermediate status is reflected after successful completion. All other status returns are identical to those defined for the Seek/Write File instruction.

SEEK/WRITE FILE and INCREMENT ADDRESS

SWFI 07 X YYY 12

FUNCTION. Transfers segment address and other control characters from memory to controller buffer, positions actuator, writes 1 to 4 segments from the buffer onto the addressed disc, and increments by one the address stored in the buffer.

This instruction is similar to the Seek/Write File instruction except that at the end of instruction execution, the DS-20 changes the segment address stored in control character 2 of the control block associated with the file unit being accessed. The segment address to be placed in the control characters will be the next sequential segment following the last segment address used in executing the Seek/Write File and Increment Address instruction.

Incrementing of segment address 1111 results in segment address 0000 being stored. A carry is not propagated from the segment number field to the actuator field.

NOTE: If execution of this instruction results in a Data Alert status (that is, if an error is detected during instruction execution), the segment address stored in control character 2 will not be incremented and will contain the address of the segment in which the error was detected.

SEEK/WRITE FILE and VERIFY

SWFV 07 X YYY 13

FUNCTION. Transfers segment address and other control characters to the controller buffer, positions actuator, writes 1 to 4 consecutive segments from the buffer onto the addressed disc and compares data written with buffer contents.

This instruction is similar to the Seek/Write File instruction except that after completion of the buffer-to-disc write operation, a latency is incurred, and the segment written on the disc is read and compared, bit for bit, with the original information stored in the corresponding data block of the buffer.

The possible status responses for this instruction are identical to those resulting from execution of the Seek/Write File instruction except that, following the transmission of the Special Interrupt signal (indicating the end of instruction execution), the Data Alert, Block Compare Failure or the Data Alert, Check Character Error status may be reflected, in addition to the Data Alert conditions listed under the Seek/Write File instruction.

The Block Compare Failure substatus indicates that verification of the segments written was not successful. The Check Character Error substatus indicates that an erroneous check character was detected in a segment read from the file unit during the verification process.

SEEK/COMPARE

DSCP 07 X YYY 17

FUNCTION. Transfers segment address and other control characters to buffer, positions actuator, reads and compares up to 32 consecutive segments with buffer contents, places address of matching segment in the buffer, and fills buffer with contents of up to 4 segments.

INSTRUCTION INITIATION. The device code character of the General instruction specifies the file unit to which the Seek/Compare instruction is directed. Device code 0 is not legal under the Seek/Compare instruction and will result in a Command Rejected status.

Possible status reflections in response to this instruction are indicated below.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	The instruction is accepted.
Device Busy Not Overridable	Addressed file unit is engaged in an off-line operation and cannot be interrupted. Instruction is rejected.
Command Rejected Invalid Operation Code Invalid Device Code	The instruction is rejected.
Attention	Addressed file unit is not usable because of an existing inoperable state.
Channel Busy	The subsystem is executing an on-line operation and cannot be interrupted. The instruction is rejected.

INSTRUCTION EXECUTION. If the instruction is acceptable, the subsystem reverts to the Channel Busy status and initiates a request for the six control characters from the central processor. These six control characters define the specific operation to be accomplished.

Characters 0, 1, and 2 - Define the specific segment address to be located on the addressed file unit.

Character 3 - Not pertinent to execution of the Seek/Compare instruction.

Character 4 - Indicates the areas of the buffer into which segments from the file unit are to be written in the event a comparison is made. This character is encoded as follows:

- 1 indicates buffer area Z
- 2 indicates buffer area Y
- 4 indicates buffer area X
- 8 indicates buffer area W

The two high-order bits of this character must be zero.

Character 5 - Indicates the area of the buffer (W, X, Y, or Z) against which the addressed data segment is to be compared and where the first segment is to be stored after a successful compare. This character will be encoded as follows:

- 1 indicates buffer area Z
- 2 indicates buffer area Y
- 4 indicates buffer area X
- 8 indicates buffer area W

The two high-order bits of this character must be zero.

Buffer areas specified by control character 4 are set to "committed." The six control characters are stored in the buffer control block assigned to the addressed file unit. Upon reception of the six control characters, the subsystem reverts from Channel Busy status to one of the status conditions defined below, and sends a Terminate signal to the central processor.

Status Condition

Indication to Central Processor

Channel Ready

Seek/Compare operation will be initiated.

Data Alert

Transfer Timing Alert
Transfer Parity Alert
Invalid Control Character
Buffer Committed

Seek/Compare operation will not be initiated either because an error was detected or because the buffer area required to accomplish the operation is already committed to a previous operation.

OFF-LINE EXECUTION. If the six control characters are received successfully and accepted (as indicated by the Channel Ready status at the end of the busy state), the subsystem initiates execution of the specified Seek/Compare operation.

Upon completion of the seek operation on the addressed disc file, the first data segment from the file unit is compared with the buffer area (specified by control character 5). The comparison of data segments and buffer areas is made on the basis of "fields." A field is a group of sequential characters bounded by Ignore characters (octal 17); or bounded by an Ignore character and the beginning of the segment; or bounded by an Ignore character and the end of the segment. A field may contain any number of characters from 1 to 240. A segment may contain as many fields as desired within the limits defined above.

If, during the compare operation, any one field of the buffer data block compares exactly with the corresponding field of the segment, the compare operation is successful.

If, during the compare operation on the first data segment, the compare is not successful, the next sequential data segment is read from the file unit and compared, in like manner, with the buffer area. This operation continues until either a successful compare is made or the last consecutive segment is accessed. When all data segments to be compared have been accessed, the operation ends as described below.

If, upon completion of the compare operation for a segment, it is determined that a successful compare was made for that segment, the compare operation ends, and reading is initiated. The segment upon which the compare was effected is read into the buffer area indicated by control character 5. When the number of data segments indicated in control character 4 are completely written into the buffer, off-line operation ends. If a successful compare was effected, the address of the data segment for which the compare was made will be stored in the control block of the buffer area assigned to the file unit being used, replacing the segment address originally put there by the Seek/Compare instruction.

The following possible inconsistencies between control characters 4 and 5 will be detected during off-line instruction execution:

1. The combination of the two characters implies writing into nonsequential buffer areas.
2. Control character 5 specifies a buffer area which is not included in control character 4, or control character 4 does not specify any area.
3. Control character 5 does not specify a buffer area, or specifies more than one buffer area.

If case 3 exists, the seek operation is completed, instruction execution ends, and the Data Alert, Internal Error status is set. In this case, the compare operation will not be carried out.

If either case 1 or case 2 exists, the compare operation, if successful, will be carried out to its completion. If case 1 exists and the compare is successful, the writing of file segments into the buffer area will progress up to the point where, in order to continue, a nonsequential buffer area would have to be accessed. At this point, instruction execution ends and the Data Alert, Internal Error status is set. If the compare operation is successful and case 2 above exists, the operation ends immediately, and the Data Alert, Internal error status is set.

At the end of the Seek/Compare operation, regardless of outcome, the subsystem sends a Special Interrupt signal to the central processor. Before this Special Interrupt signal is sent, any instruction addressed to the file unit involved in the off-line portion of the Seek/Compare operation will receive a Device Busy status response from the subsystem.

If, after transmission of the Special Interrupt signal, a Request Status instruction is addressed to the file unit, any one of the following status signals may be reflected by the subsystem:

Status Condition

Indication to Central Processor

Attention

Compare operation aborted because an inoperable condition was detected in the addressed file unit.

Status Condition

Indication to Central Processor

Data Alert
 Check Character Error
 Internal Error
 Block Compare Failure

The compare operation was successful unless the Block Compare Failure substatus is reflected under Data Alert status.

End of File

Compare operation was successful, but the read operation was not completed due to the transfer of the last consecutive segment.

Intermediate

Entire operation was completed successfully.

The Seek/Compare operation will end upon detection of any error condition. If, at the end of the Seek/Compare operation, a successful compare has not been effected, the Data Alert status is reflected to the central processor.

SEEK/LINK

SLNK 07 X YYY 35

FUNCTION. Transfers segment address and other control characters to controller buffer, positions actuator, reads one segment, locates (in buffer) the address of the next segment in chain, and transfers that address to the buffer address control for the next instruction.

INSTRUCTION INITIATION. The device code of the General instruction specifies the file unit to which the Seek/Link instruction is directed. Device code 0 is not legal under this instruction and will result in the Command Rejected status.

The possible status conditions reflected in response to this instruction are indicated as follows:

Status Condition

Indication to Central Processor

Channel Ready

The instruction is accepted.

Device Busy
 Not Overridable

Addressed file unit is engaged in an off-line operation and cannot be interrupted. The instruction is rejected.

Command Rejected
 Invalid Operation Code
 Invalid Device Code

The instruction is rejected.

Attention

Addressed file unit is not usable because of an existing inoperable status.

Channel Busy

The subsystem is already engaged in an on-line operation and cannot be interrupted. Instruction is rejected.

INSTRUCTION EXECUTION. If the instruction is acceptable, the subsystem reverts to the Channel Busy status, and initiates a request for six control characters from the central processor. These six control characters define the Seek/Link operation to be accomplished.

Characters 0, 1, and 2 - Define the specific address of the segment to be located on the addressed file unit.

Characters 3 and 4 - Define the address of a buffer location at which the three-character link address will be found. The six low-order bits of the buffer address are contained in control character 4; the four high-order bits are contained in the four low-order bits of character 3. The two high-order bits of character 3 must be zero.

NOTE: The buffer address specified by characters 3 and 4 must have a decimal value of 0 - 1007 and must specify a starting location within the buffer area specified by control character 5. In addition, the buffer address must specify a location such that the three characters, starting at that location, fall within the data block of the specified buffer area.

Character 5 - This character defines the buffer area to be used during execution of the Seek/Link instruction. The character is encoded as follows:

- 1 indicates buffer area Z
- 2 indicates buffer area X
- 4 indicates buffer area Y
- 1 indicates buffer area W

The two high-order bits of this character must be zero.

The six control characters will be stored in the control block of the buffer area assigned to the addressed file unit.

The buffer area called for by control character 5 is set to committed. Upon reception of the six control characters, the subsystem reverts from the Channel Busy status to one of the status conditions defined in the following, and sends a Terminate signal to the central processor.

Status Condition

Indication to Central Processor

Channel Ready

Seek/Link operation will be initiated.

Data Alert

Seek/Link operation will not be initiated because an error was detected.

Transfer Timing Alert

Transfer Parity Alert

Invalid Control Character

Buffer Committed

OFF-LINE EXECUTION. If the six control characters are received successfully and accepted (as indicated by the reflection of the Channel Ready status to the central processor at the end of the busy state), the subsystem initiates execution of the seek operation for the data segment indicated by control characters 0, 1, and 2.

Upon completion of the seek operation, the designated data segment is read and written into the data block of the buffer area indicated by control character 5.

When the segment is completely transferred from the file unit to the buffer, the subsystem examines the three "link address" characters in the buffer, starting at the buffer location specified in control characters 3 and 4. The high-order bit of the first link address character, herein referred to as the "link fence bit," is interrogated. If this bit is zero, the three link address characters will be stored in the control block of the buffer area assigned to the file unit being used, replacing control characters 0, 1, and 2 of the segment address. If, however, the high-order bit is a one, the link address characters will not be stored in the control block of the buffer. The major status reflects the link fence bit condition.

If, after completion of the off-line seek operation, it is determined that control character 6 does not specify a buffer area to be read into, or specifies more than one buffer area, the operation ends, and the Data Alert, Internal Error status is set.

At the end of instruction execution, the subsystem transmits a Special Interrupt signal to the central processor. During the off-line portion of instruction execution, before the transmission of the Special Interrupt signal, the subsystem will respond with the Device Busy status to any instruction addressed to the file unit being used in the Seek/Link operation. After the Special Interrupt signal is transmitted, the subsystem will respond with the Device Busy status to any instruction addressed to the file unit being used in the Seek/Link operation. After the Special Interrupt signal is transmitted, the subsystem will respond with one of the following status returns in response to a Request Status instruction addressed to the file unit used in the Seek/Link operation.

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Attention	An inoperable condition was detected during instruction execution.
Data Alert Internal Error Check Character Error	An error condition was detected during instruction execution.
End of File	Instruction execution completed with no errors detected. The "fence" bit was set, indicating the segment read into the buffer is the last segment of the linked chain.
Intermediate	Instruction execution completed with no errors detected. The "fence" bit was not set, indicating the segment read into the buffer is not the last segment of the linked chain.

Off-Line Only Instructions

The off-line only mode of operation implies that the address characters are already stored in the control block of the buffer area addressed by the device code of the General instruction. Instruction execution is accomplished entirely off-line between the specified file unit and the controller buffer.

Caution should be exercised in using the off-line instructions because buffer areas do not become committed for execution of off-line only instructions. That is, the hardware does not restrict the simultaneous use of a buffer area by both the central processor and a file unit or the same buffer area by more than one file unit (one immediately after the other).

Execution of any one of the off-line only instructions is identical to execution of the corresponding on-line/off-line instruction except that no control characters are transferred from the central processor, and the buffer areas involved are not committed. In executing off-line only instruction, the subsystem uses the address control characters that are already stored in the buffer control block as a result of some previous on-line/off-line instruction.

As soon as one of the off-line only instructions is received, the subsystem reflects the Channel Ready status to indicate acceptance of the instruction. The subsystem is free to accept and execute other instructions, provided they do not require the use of the same file unit.

In executing an off-line only instruction, the subsystem accesses the last six character positions in the control block of the buffer area assigned to the addressed file unit. The control characters stored in these six positions are interpreted in the same way as for combined on-line/off-line instruction execution. It is, therefore, necessary that the appropriate control characters be transferred to the subsystem prior to transmission of any one of the off-line only type of instructions. This can be accomplished by issuing any one of the combined on-line/off-line type of instructions.

When execution of an off-line only instruction is completed, the subsystem transmits a Special interrupt signal to the central processor. As soon as the Special Interrupt signal is sent, the outcome of the off-line portion of the operation can be determined by addressing a Request Status instruction to the file unit involved.

READ FILE

RF 07 X YYY 54

FUNCTION. Positions actuator, reads 1 to 4 consecutive segments into controller buffer from file unit. Assumes segment address and other control characters are already in the controller buffer.

This instruction is similar to the Seek/Read File except that no control characters are transferred from the central processor, and the involved buffer areas do not become committed. Upon receipt of the Read File instruction, the subsystem initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction.

The Channel Ready status is reflected in response to the reception of the Read File instruction, provided the instruction is accepted. If it is not accepted, the status reflected will be the same as for the rejection of the Seek/Read File command.

READ FILE and RELEASE SEEK

RFR 07 X YYY 55

FUNCTION. Positions actuator, reads 1 to 4 consecutive segments into controller buffer from file unit. Assumes segment address and other control characters are already in the controller buffer.

This instruction is similar to the Seek/Read File and Release Seek instruction except that no control characters are transferred from the central processor, and the buffer areas involved do not become committed. Upon receipt of this instruction, the subsystem initiates off-line execution using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction.

The Channel Ready status is reflected in response to this instruction provided the instruction is accepted. If the instruction is not accepted, the status reflected will be the same as for the rejection of the Seek/Read File and Release Seek instruction.

READ FILE and INCREMENT ADDRESS

RFI 07 X YYY 56

FUNCTION. Positions actuator, reads 1 to 4 segments into the controller buffer, and increments by one the segment address stored in the buffer for each segment read. Assumes segment address and other control characters are already in the buffer.

This instruction is similar to the Seek/Read File and Increment Address instruction except that no control characters are transferred from the central processor, and the involved buffer areas do not become committed. Upon receipt of this instruction, the subsystem initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the command.

The Channel Ready status is reflected in response to this instruction, provided it is accepted. If the instruction is not accepted, the status reflected will be the same as for the rejection of the Seek/Read File and Increment Address instruction.

WRITE FILE

WF 07 X YYY 50

FUNCTION. Positions actuator, and writes 1 to 4 consecutive segments from the controller buffer. Assumes segment address and other control characters are already in the buffer.

This instruction is similar to the Seek/Write File instruction except that no control characters are transferred from the central processor, and the involved buffer areas do not become committed. Upon receipt of this instruction, the subsystem initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction. At the time this instruction is received, the data to be written on the disc must have been previously stored in the applicable buffer area.

The Channel Ready status is reflected in response to this instruction, provided it is accepted. If the instruction is not accepted, the status reflected will be the same as for the rejection of the Seek/Write File instruction.

WRITE FILE and RELEASE SEEK

WFR 07 X YYY 51

FUNCTION. Positions actuator, writes 1 to 4 consecutive segments from the controller buffer, and releases actuator. Assumes segment address and other control characters are already in the controller buffer.

This instruction is similar to the Seek/Write File and Release Seek instruction except that no control characters are transferred from the central processor, and the involved buffer areas do not become committed. Upon receipt of this instruction, the subsystem initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction.

The Channel Ready status is reflected in response to this instruction, provided it is accepted. If the instruction is not accepted, the status reflected will be the same as for the rejection of the Seek/Write File and Release Seek instruction.

WRITE FILE and INCREMENT ADDRESS

WFI 07 X YYY 52

FUNCTION. Positions actuator, writes 1 to 4 consecutive segments from the controller buffer onto the addressed disc, and increments by one the segment address stored in the buffer. Assumes segment address and other control characters are already in the controller buffer.

This instruction is identical to the Seek/Write File and Increment Address instruction except that no control characters are transferred from the central processor, and the buffer areas involved do not become committed. Upon receipt of this instruction, the subsystem initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction.

The Channel Ready status is reflected in response to this instruction, provided it is accepted. If the instruction is not accepted, the status reflected will be the same as for the rejection of the Seek/Write File and Increment Address instruction.

WRITE FILE and VERIFY

WFV 07 X YYY 53

FUNCTION. Positions actuator, writes 1 to 4 consecutive segments from the controller buffer onto the addressed disc, and compares data written with buffer contents. Assumes segment address and other control characters are already in the buffer.

This instruction is similar to the Seek/Write File and Verify instruction except that no control characters are transferred from the central processor, and the involved buffer areas do not become committed. Upon receipt of this instruction, the subsystem initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction.

The Channel Ready status is reflected in response to this instruction, provided it is accepted. If the instruction is not accepted, the status reflected will be the same as for the rejection of the Seek/Write File and Verify instruction.

COMPARE

DCP 07 X YYY 57

FUNCTION. Same as Seek/Compare instruction, except sector address and other control characters are assumed to be already in the buffer.

This instruction is similar to the Seek/Compare instruction except that no control characters are transferred from the central processor, and the involved buffer sections are not committed. Upon reception of this instruction, the DS-20 initiates off-line execution, using the control characters previously stored in the buffer control block reserved for the file unit addressed by the instruction.

The Channel Ready status will be reflected to the central processor in response to the Compare instruction, provided it is accepted. If it is not accepted, the status reflected will be the same as for the rejection of the Seek/Compare instruction.

LINK

LNK 07 X YYY 75

FUNCTION. Positions actuator, reads one segment, locates (in buffer) the address of the next segment in chain, and transfers that address to the buffer address control for the next instruction. Assumes segment address and other control characters are already in the buffer.

This instruction is similar to the Seek/Link instruction except that there is no transfer of control characters from the central processor to the subsystem, and the buffer areas involved do not become committed. The possible status returns for this instruction follow:

<u>Status Condition</u>	<u>Indication to Central Processor</u>
Channel Ready	Instruction is accepted, and off-line execution is initiated.
Device Busy Not Overridable	Addressed file unit is engaged in an off-line operation and cannot be interrupted. The instruction is rejected.

Command Rejected
Invalid Operation Code
Invalid Device Code

Instruction is rejected.

Attention

Instruction cannot be accepted because the addressed file unit is inoperable.

Channel Busy

The subsystem is engaged in an on-line operation and cannot be interrupted. Instruction is rejected.

If the instruction is accepted, the subsystem will access the buffer control block associated with the addressed file unit. A seek operation will be initiated on the addressed file unit, using control characters 0, 1, and 2 as the address of the segments to be accessed. Execution of the Link instruction from this point is identical to execution of the Seek/Link instruction.

No-Op Instruction

The No-Op mode results from the issuance of an instruction requiring no operation other than to determine or to reset the existing status of the subsystem. Issuance of a No-Op instruction results in the reflection of the status of the addressed device to the central processor.

REQUEST STATUS

RQS 07 X YYY 00

FUNCTION. Stores the highest priority status existing in the addressed device or channel at the time the instruction is issued in memory of the central processor at the address specified by the Second Address Sequence (SAS) word.

If the Request Status instruction is addressed to the controller (that is, device code 00g), the existing status of the controller is reflected to the central processor. If the instruction is addressed to a file unit (device code 01g, 02g, 03g, or 04g), the status of that file unit is transmitted to the central processor, providing no Data Alert condition exists in the controller.

Detection of any error involving the transfer of data or control characters between the central processor and the controller causes the Data Alert status to be set in the controller. If this is the case, a Request Status instruction addressed to any file unit will obtain the controller's Data Alert status. The controller's Data Alert status must be reset before the status of any file unit can be obtained. This can be accomplished by issuing any instruction except a Request Status instruction. If file unit responds with a Data Alert status to a Request Status instruction, that Data Alert must also be reset before the status of any other file unit can be obtained.

RESET STATUS

RSS 07 X YYY 40

FUNCTION. Clears any existing Data Alert or End of File status within the addressed file unit and stores the remaining highest priority status of that file unit in the central processor's memory at the address specified by the Second Address Sequence (SAS) word.

A Reset Status instruction addressed to a file unit will also clear any existing Data Alert or End of File status in the controller.

APPENDIX A

STATUS & SUBSTATUS CONDITIONS	Seek File	Seek/Read File	Read File	Seek/Read File & Release Seek	Read File And Release Seek	Seek/Read File And Increment Address	Read File And Increment Address	Seek/Write File	Write File	Seek/Write File & Release Seek	Write File & Release Seek	Seek/Write File & Increment Address	Write File & Increment Address	Seek/Write File And Verify	Write File & Verify	Read File Continuous & Release Seek	Write File Continuous & Release Seek	Write File Continuous, Verify & Release Seek	Seek/Compare	Compare	Seek/Link	Link	Accept Buffer Address	Read Buffer	Write Buffer	Load Buffer For Compare	Move Data	Request Status	Reset Status
READY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
DEVICE BUSY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X						X	X
Overridable																			X	X	X	X						X	X
Not Overridable	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X						X	X
ATTENTION	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X
DATA ALERT																													X
Transfer Timing Alert																													X
Transmission Parity Alert																													X
Invalid Control Character																													X
Internal Error																													X
Check Character Error																													X
Buffer Committed																													X
Block Compare Failure																													X
END OF FILE																													X
COMMAND REJECTED	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Invalid Operation Code	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Invalid Device Code	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Illegal Buffer Address																													
Buffer Committed																X	X	X											
INTERMEDIATE																													X
BUSY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

1. Device Code will be ignored unless a parity error is detected on the code.
2. Indicates instruction was not interpreted as sent.

POSSIBLE STATUS RETURNS TO INSTRUCTION INITIATIONS

APPENDIX B

STATUS & SUBSTATUS CONDITIONS	Seek File	Seek/Read File	Read File	Seek/Read File & Release Seek	Read File & Release Seek	Seek/Read File & Increment Address	Read File & Increment Address	Seek/Write File	Write File	Seek/Write File & Release Seek	Write File & Release Seek	Seek/Write File & Increment Address	Write File & Increment Address	Seek/Write File & Verify	Write File & Verify	Read File Continuous	Write File Continuous	Write File Continuous & Verify	Seek/Compare	Compare	Seek/Link	Link	Accept Buffer Address	Read Buffer	Write Buffer	Load Buffer for Compare	Move Data	Request Status	Reset Status
CHANNEL READY	X	X		X		X		X		X		X		X		X		X		X		X		X		X		X	
DEVICE BUSY																													
Overridable																													
Not Overridable																													
ATTENTION															X	X	X												
ALERT																													
Transfer Timing Alert	X	X		X		X		X		X		X		X		X		X		X		X		X		X		X	
Buffer Error	X	X		X		X		X		X		X		X		X		X		X		X		X		X		X	
Internal Error															X	X	X							X				X	
Check Character Error															X	X	X							X				X	
Block Compare Failure																													
Buffer Committed	X		X	X		X		X		X		X		X				X		X									
END OF FILE															X	X	X												
COMMAND REJECTED																													
Invalid Operation Code																													
Invalid Device Code																													
Illegal Buffer Address																													
Buffer Committed																													
INTERMEDIATE																													
CHANNEL BUSY																													

POSSIBLE STATUS RETURNS UPON INSTRUCTION TERMINATION OF BUSY STATE

APPENDIX C

STATUS & SUBSTATUS CONDITIONS	Seek File	Seek/Read File	Read File	Seek/Read File & Release Seek	Read File & Release Seek	Seek/Read File & Increment Address	Read File & Increment Address	Seek/Write File	Write File	Seek/Write File & Release Seek	Write File & Release Seek	Seek/Write File & Increment Address	Write File & Increment Address	Seek/Write File & Verify	Write File & Verify	Read File Continuous	Write File Continuous	Write File & Verify	Seek/Compare Continuous	Compare	Seek/Link	Link	Accept Buffer Address	Read Buffer	Write Buffer	Load Buffer For Compare	Move Data	Request Status	Reset Status
CHANNEL READY				X	X					X	X																		
DEVICE BUSY Overridable Not Overridable																													
ATTENTION	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X						
DATA ALERT Transmission Parity Alert Invalid Control Character	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X						
Check Character Error Block Compare Failure Buffer Committed		X	X	X	X	X	X							X	X				X	X	X	X							
END OF FILE		X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X						
COMMAND REJECTED Invalid Operation Code Invalid Device Code Illegal Buffer Address Buffer Committed																													
INTERMEDIATE	X	X	X			X	X	X	X			X	X	X	X				X	X	X	X							
CHANNEL BUSY																													

POSSIBLE STATUS RETURNS UPON COMPLETION OF OFF-LINE INSTRUCTION EXECUTION

APPENDIX D

LIST OF DS-20 INSTRUCTIONS

MNEMONICS	OCTAL COMMAND CODE	DESCRIPTION	OPER. MODE	PAGE
ABA	32	Accept Buffer Address	On-line	32
DCP	57	Compare	Off-line	58
DSCP	17	Seek/Compare	Combined	49
LBFC	36	Load Buffer For Compare	On-line	36
LNK	75	Link	Off-line	58
MVDT	37	Move Data	On-line	40
RB	24	Read Buffer	On-line	33
RF	54	Read File	Off-line	55
RFCR	25	Read File Continuous and Release Seek	On-line	36
RFI	56	Read File and Increment Address	Off-line	56
RFR	55	Read File and Release Seek	Off-line	56
RQS	00	Request Status	No-op	59
RSS	40	Reset Status	No-op	60
SF	34	Seek File	Univ.	30
SLNK	25	Seek/Link	Combined	52
SRF	14	Seek/Read File	Combined	42
SRFI	16	Seek/Read File and Increment Address	Combined	46
SRFR	15	Seek/Read File and Release Seek	Combined	45
SWF	10	Seek/Write File	Combined	46
SWFI	12	Seek/Write File and Increment Address	Combined	48
SWFR	11	Seek/Write File and Release Seek	Combined	47
SWFV	13	Seek/Write File and Verify	Combined	48
WB	30	Write Buffer	On-line	35
WF	50	Write File	Off-line	56
WFCR	31	Write File Continuous and Release Seek	On-line	38
WFCV	33	Write File Continuous, Verify and Release Seek	On-line	39
WFI	52	Write File and Increment Address	Off-line	57
WFR	51	Write File and Release Seek	Off-line	57
WFV	53	Write File and Verify	Off-line	57

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