

Programmer's Reference Series
6125 Magnetic Tape Subsystem

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Preface

This manual describes the 6125 magnetic tape subsystem architecture from a programming viewpoint. It presents the instruction set and discusses programming methods.

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6125 MAGNETIC TAPE SUBSYSTEM

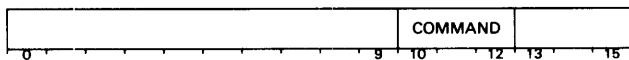
Programming Summary

Mnemonic (first controller)	MTA
Mnemonic (second controller)	MTA1
Device code	Jumper select; standard are: 22_8 (primary) 62_8 (secondary)
Priority mask bit	10
Record size	2 bytes (min) 65,536 bytes (max)
Reel size (max)	8.5 inches
Storage (max)	
(1200-ft standard tape)	20 Mbytes
(1600-ft DG 1-mil tape)	25 Mbytes
Data transfer rate (max)	48 Kbytes/second
Data channel latency (max)	160 μ s

Accumulator Formats

Specify Command

DOA

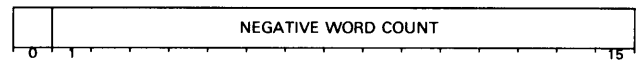


Commands:

000	Read
001	Rewind
010	Reserved
011	Space Forward
100	Space Reverse
101	Write
110	Write EOF
111	Erase

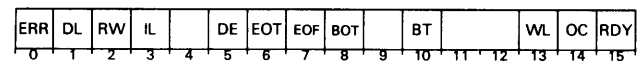
Load Word Count Register

DOC



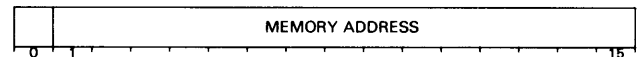
Read Status Register

DIA



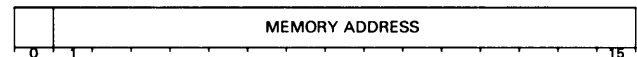
Load Memory Address Register

DOB



Read Memory Address Register

DIB



Device Flag Commands

- f=S** Sets Busy to 1 (except on Rewind), sets Done to 0, and starts the command.
- f=C** Sets command, status, and address registers to 0 and terminates execution of command in progress.
- f=P** No function.
- IORST** Same as Clear.

Introduction

The 6125 magnetic tape subsystem provides up to 20 megabytes of tape storage for NOVA- and ECLIPSE-line computers (25 megabytes if DG 1-mil tape is used). The subsystem uses a phase-encoded, 9-track recording method and a “streaming” tape drive for optimal performance. (Streaming means continuous tape motion.) The subsystem incorporates a modular design that facilitates maintenance and provides high reliability.

Located in the tape drive, the subsystem controller connects the tape drive to the CPU via the interface board which resides in the computer.

The tape drive contains a microprocessor-controlled servo system which moves the tape from the supply to the take-up reel while it maintains constant tape speed and tension. This servo system eliminates the need for vacuum columns or tension arms and further increases the maintainability.

The recording medium — the tape — is held on an interchangeable reel which is mounted on the supply hub of the tape drive. When the tape drive is recording or reading data, the tape is moved from the supply reel past the read/write heads to the take-up reel. As the tape moves, the read/write heads define nine parallel tracks along the surface of the tape.

Data are recorded on the tape using a method called phase encoding (PE). This recording method allows the drive to record data at a density of 1600 bits per inch.

The controller commands the drive to record data in a specific tape format. The data are recorded in records. Each record consists of a number of bytes (since there are nine tracks, this is an 8-bit data byte and one parity bit). The number of bytes in a record and the location of the records to be read/written are determined by issuing a particular instruction. For a more detailed explanation, see the Instruction Set.

The 6125 tape subsystem is a “streaming” tape drive. This means that it does not stop in the gap between records (i.e., inter-record gap) as a conventional tape drive does. The drive can maintain a constant 30-inch-per-second tape speed throughout a data transfer as long as consecutive records are transferred within 10 milliseconds of each other. If for some reason this timing constraint cannot be met, the drive will operate in a “repositioning” mode. In this mode, the drive overshoots the gap, then moves in the reverse direction past the gap it overshoot, and accelerates in the forward direction until it finds the gap.

Controller Registers

The tape controller contains the two 16-bit registers described below.

Command register specifies the operation to be performed.

Status register contains flags that permit software to determine the operating state of the drive.

Interface Registers

The interface contains the two 16-bit registers described below.

Memory address register holds the address of the next word in memory to be transferred to or from the controller. This register is incremented after each word is transferred.

Word count register holds the two’s complement of the number of words to be transferred to or from the tape. During spacing operations, holds the number of records to be skipped. Increments after each word is transferred or as each record is skipped.

Instruction Set

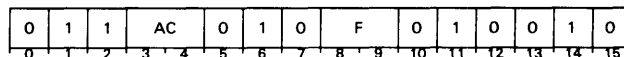
Five instructions program data channel transfers to and from the tape subsystem. Three specify data transfers; the other two examine subsystem status and analyze error conditions.

The device flag commands control the subsystem Busy and Done flags as follows:

- f*=**S** Sets Busy to 1 (except on a Rewind), sets Done to 0, and starts the current command.
- f*=**C** Terminates any command in progress; sets the command/unit, status, and memory address registers to 0; and initializes the controller logic.
- f*=**P** Reserved for future use.
- IORST** Performs same function as Clear.

Specify Command and Drive

DOA[*f*] *ac*,**MTA**



Loads the contents of the specified accumulator into the controller's command register. The bits specify a command as detailed below. The contents of the specified accumulator are unchanged. Some accumulator bits have more than one function depending on the particular command being specified.

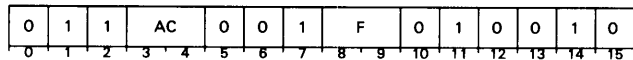
This instruction sends a command to the controller, but does not actually start execution of the command. To start execution, issue an I/O Start command, typically by appending an **S** to the instruction mnemonic.

The format of the specified accumulator for various commands is

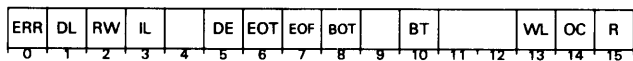


Bits	Name	Contents or Function
0-9	---	Reserved; must be 0.
10-12	Command	000 Read 001 Rewind 010 Reserved 011 Space Forward 100 Space Reverse 101 Write 110 Write EOF 111 Erase
13-15	---	Reserved; must be 0.

Read Status Register

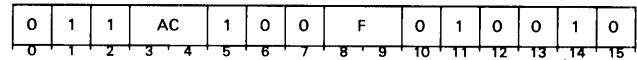
DIA[f] ac,MTA

Loads the contents of the controller's status register into the specified accumulator. The format of the specified accumulator is

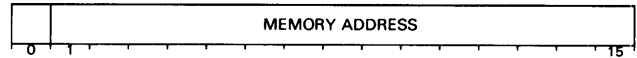


Bits	Name	Contents or Function
0	Error	At least one of these bits is 1: 1, 3, 5, 6, 7, 8, 10, 14.
1	Data late	Data channel did not respond in time.
2	Rewinding	Transport is rewinding to BOT.
3	Illegal	Command cannot be executed because of drive condition or because command is reserved.
4	---	Not used (always 1).
5	Data error	Parity error or other condition not correctable by controller.
6	EOT	End of tape marker detected.
7	EOF	End of file code detected on Read or successfully written by Write EOF command.
8	BOT	Tape is at the load point.
9	---	Not used (always 1).
10	Bad tape	Excessive signal loss, noisy gap, tape format error, or runaway tape.
11, 12	---	Not used (always 0).
13	Write lock	No write enable ring on tape.
14	Odd character	Record just read contained an odd number of bytes; ignore bits 8-15 of the last word read.
15	Unit ready	Transport is on line and is not performing a command.

Load Memory Address Register

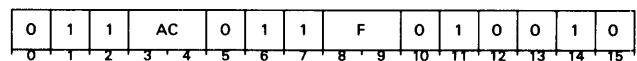
DOB[f] ac,MTA

Loads the contents of the specified accumulator into the interface's memory address register. The accumulator should contain the address of the first word to be transferred to/from main memory. The format of the specified accumulator is

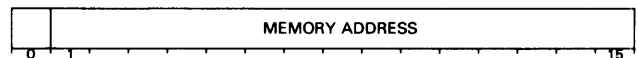


Bits	Name	Contents or Function
0	---	Reserved.
1-15	Address	Main memory address of first word to transfer.

Read Memory Address Register

DIB[f] ac,MTA

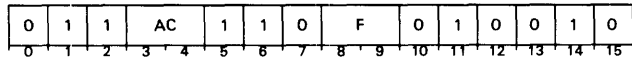
Loads the contents of the interface's memory address register into the specified accumulator. After the subsystem has completed a Read or Write operation, the contents of this register are one greater than the address of the last word transferred. The format of the specified accumulator is



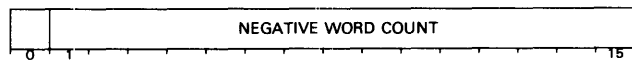
Bits	Name	Contents or Function
0	---	Reserved.
1-15	Address	Contents of the memory address register; after a transfer, this is 1 greater than the address of the last word moved to/from memory.

Load Word Count Register

DOC[f] ac,MTA



Loads the contents of the specified accumulator into the interface's word count register. When the controller executes a Read or Write command, this register should contain the two's complement (i.e., the negative) of the number of words to be transferred to or from memory. When the controller executes a Space Forward or Space Reverse command, the register should contain the two's complement of the number of records to be skipped. The format of the specified accumulator is



Bits	Name	Contents or Function
0	---	Reserved.
1-15	Count	The two's complement of either the number of words to transfer or the number of records to skip.

Programming

Programming the tape subsystem consists of initializing the drive, positioning the tape, and reading or writing the data. These procedures are detailed in the following sections. The flowcharts accompanying this section show typical routines for use with the subsystem.

Initialization

To initialize the interface and controller logic (Figure 1), issue an I/O Clear command to it. This terminates any command in progress and clears all error flags.

Check the drive's status with a *Read Status Register* instruction. Examine the status flags to be sure that the drive is on line and ready to accept a command. If the status word indicates that the tape is not positioned at BOT, rewind the tape by specifying a Rewind operation with the *Specify Command* instruction and issue an I/O Start command. You may repeatedly execute the *Read Status Register* instruction until the Rewinding flag becomes 0. Note that a Rewind may take over two minutes to complete.

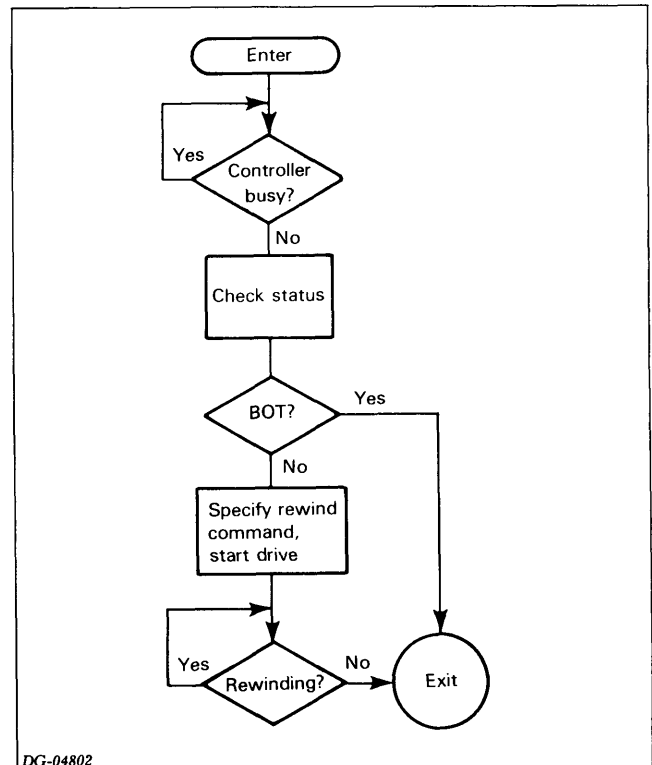
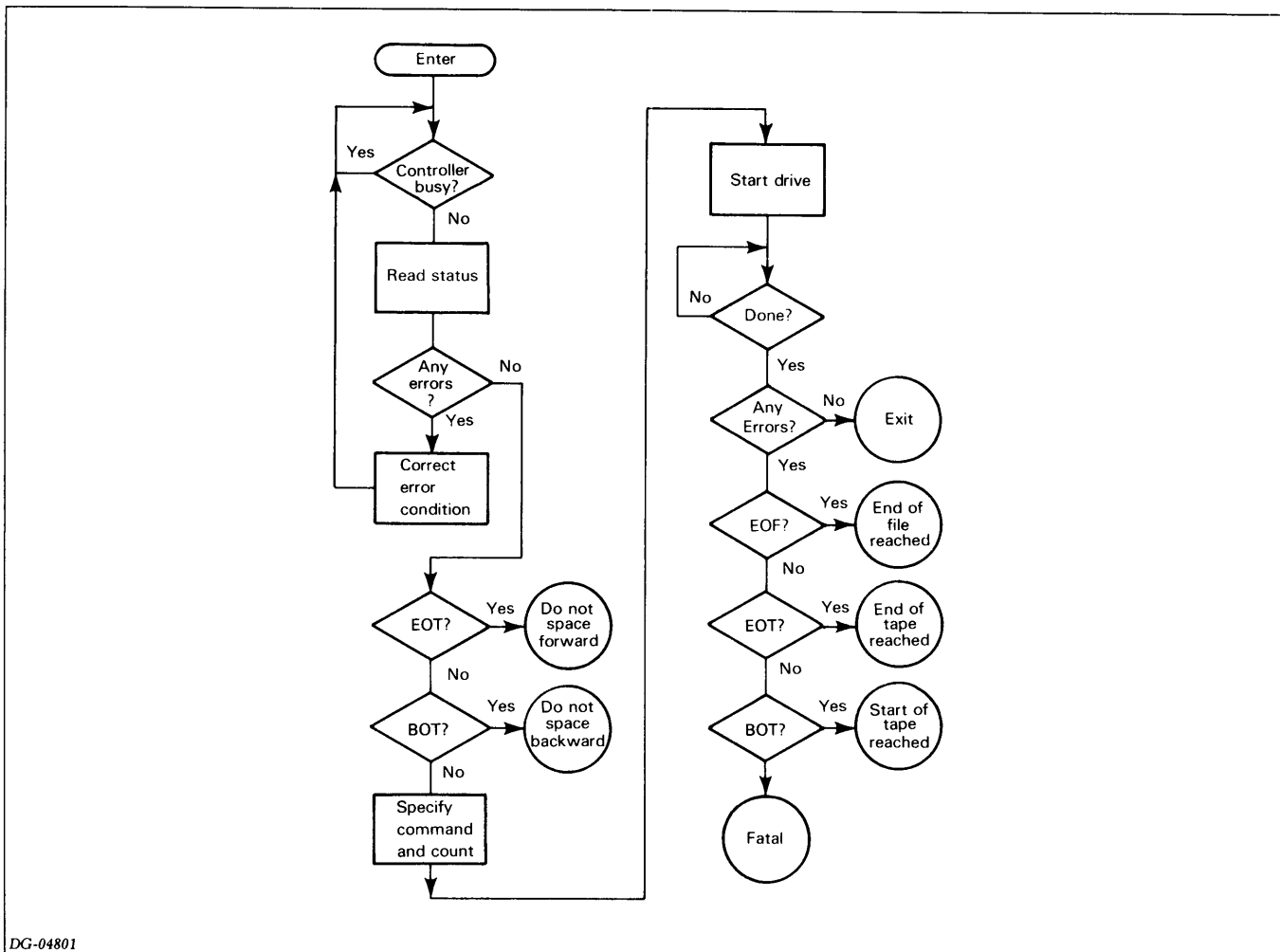


Figure 1 Initialization flowchart

Once the tape is rewound and no error conditions exist, the subsystem is ready for positioning operations and I/O operations.



DG-04801

Figure 2 Tape positioning flowchart: space forward/reverse

Tape Positioning

Tape positioning or spacing commands are used to access a particular record of a particular file on a tape. During spacing operations, the word count register is used to hold the number of records to be skipped.

To perform a spacing operation (Figure 2), specify either Space Forward or Space Reverse with the *Specify Command* instruction. Use the *Load Word Count Register* instruction to specify the number of records to be skipped. Start the drive by issuing an **S** flag command.

Positioning operations will not space past an end of file (EOF) mark. If an EOF mark is encountered during a spacing operation, the operation stops and the End of File and Error flags in the status word are set to 1. The Done flag is also set to 1, causing an interrupt.

In order to access a record in any file other than the current one, you must issue one spacing command for each intervening EOF mark. An easy way to skip over an entire file is to issue a spacing command with 0 in the word count register. The controller, using two's complement representation, interprets this as 32,768 (2^{15}), which is

greater than the maximum number of records that can fit on a tape. Thus, the drive will always space to the next EOF mark.

The physical EOT and BOT markers terminate a spacing operation in the same fashion as an EOF mark. They set their respective flags in the status word, instead of the End of File flag. When the EOT marker is reached, single record spacing is allowed to access data which may have been recorded beyond the marker.

Upon termination of the spacing operation, the controller sets its Done flag to 1, causing an interrupt. The program may issue a *Read Status Register* instruction to determine if any errors occurred.

Rewind

The Rewind command causes the tape to be wound at high speed back to the load point (BOT). The Rewinding flag in the status word is set to 1 while the operation is in progress, but the controller's Busy flag is not set to 1. No interrupt is generated when the operation finishes.

Read

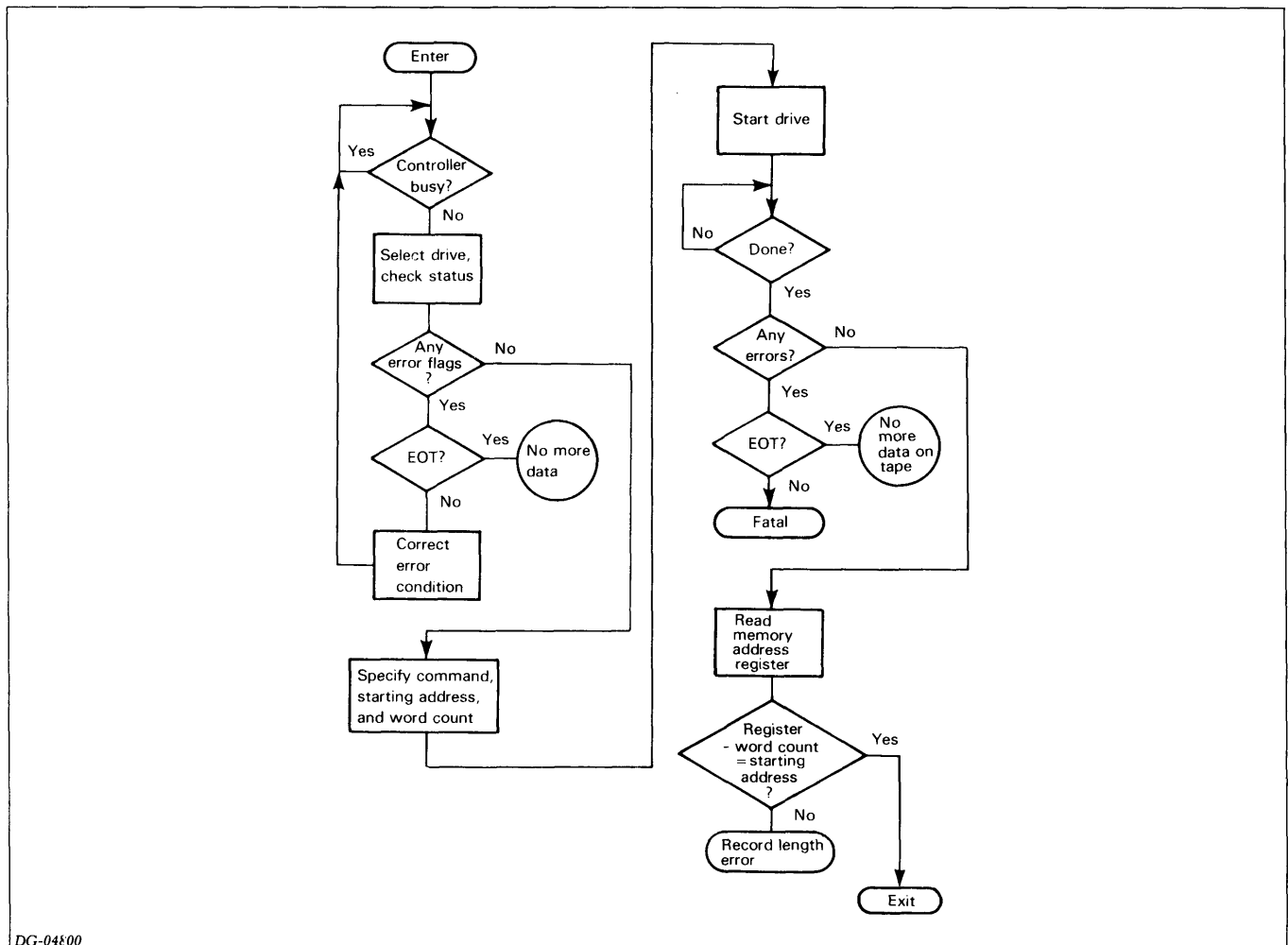
After the tape has been positioned so that the desired record is about to pass the heads, three instructions are required to read a record from a tape. Use the *Specify Command* instruction to select the operation, use *Load Word Count Register* to specify the length of the record, and use *Load Memory Address Register* to specify the address into which the first word of the record is to be read. The instructions may be executed in any order. The last instruction to be executed should specify an I/O Start command to begin the operation (see Figure 3).

The drive reads two bytes from the tape, assembles them into a 16-bit word, and transfers the word to memory via the data channel. After each transfer, the word count and memory address registers are incremented. Reading continues until either the word count register becomes 0 or an inter-record gap is detected on the tape.

All preambles, parity, and other format-dependent data are checked automatically by the controller.

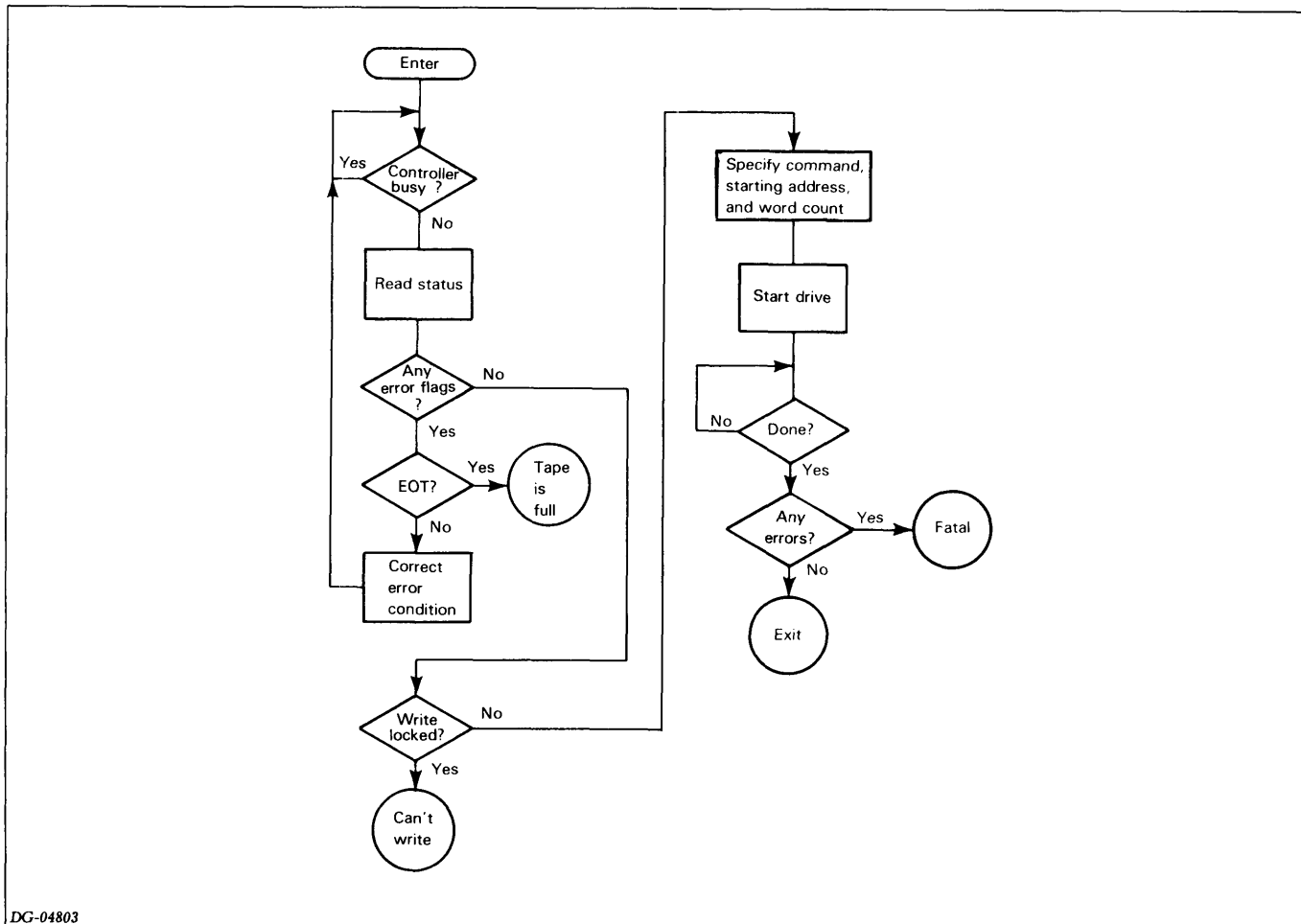
When the read is completed, the controller sets its Done flag to 1, causing an interrupt. Use the *Read Status Register* instruction to make sure that no errors occurred. Also check the Odd Byte flag; if it is 1, the record just read contained an odd number of bytes, and bits 8-15 of the last word read, therefore, are meaningless and should be ignored. Note that the model 6125 controller cannot write an odd number of bytes; this flag is included for compatibility with nonDGC tape subsystems.

If the record was shorter than the specified word count, no explicit error is indicated. The *Read Memory Address Register* instruction will return a number that is one greater than the address into which the last word was written. You may subtract the address you originally specified from this to obtain the number of words read.



DG-04800

Figure 3 Read flowchart



DG-04803

Figure 4 Write flowchart

Write

Writing a record on a tape (Figure 4) takes three instructions after the tape has been positioned. Use the *Specify Command* instruction to specify a Write operation, use *Load Memory Address Register* to specify the address of the first word in memory to be written, and use *Load Word Count Register* to specify the number of words to write. The instructions may be executed in any order. Append an **S** flag command to the last of the three instructions to begin the operation.

The interface fetches the first word from memory, increments the word count and memory address registers, and then transfers it to the controller which writes the first word as two bytes on the tape. The controller automatically writes preambles and other format-dependent data. Writing continues until the word count register becomes 0 or a write error occurs. The controller reads all data immediately after writing and checks for errors.

When the operation terminates, the interface sets its Done flag to 1, causing an interrupt. Use the *Read Status Register* instruction to determine if the operation was successful.

Write End of File

A single instruction writes an EOF mark on the tape. Use *Specify Command* with an **S** flag to select and perform the operation. When the operation is complete, the interface sets its Done flag to 1, causing an interrupt. The End of File flag in the status word is set to 1. This causes the Error flag to be 1 also, even though the operation was successful.

Erase

The Erase function is performed by a single instruction. Use *Specify Command* with an **S** flag to perform this function. The controller erases about three inches of tape. When the operation is complete, the controller sets its Done flag to 1, causing an interrupt. This command is used to erase old data and also to skip over bad sections of tape.

Record Size

In many programming applications, you will need to use a specific record size to insure compatibility with existing tapes. However, you should be aware of the tradeoffs involved in choosing a record size.

The contents of a tape consist primarily of records and gaps. Since the gaps contain no useful data, it is desirable to minimize the number of gaps on a tape. Using a large record size means that there will be a smaller number of gaps for a given amount of data. The model 6125 controller can read and write records of up to 32,768 words.

The use of very large records, however, introduces some problems. Almost any tape in other than brand new condition will have a certain number of bad spots where the magnetic coating is too worn to hold data reliably. The program must retry any Read or Write that produces an error. Each retry requires rewriting the entire record, and therefore the time spent on retries is considerably greater when long records are used.

The recommended maximum size for data records is about 8192 bytes. This amounts to less than six inches of tape. Thus, only two retries are performed to skip over a bad spot on the tape. A write retry operation would normally include a backspace, erase, and rewrite. With larger record sizes, several retries might be needed to skip over a single bad spot near the end of the record.

Timing

The timing specifications for the model 6125 magnetic tape subsystem are summarized in Table 1. As mentioned previously, the 6125 tape drive is a streaming tape drive. This means that the drive can execute consecutive commands without stopping the tape in the inter-record gaps as a conventional tape drive does. In order for the drive to operate in a streaming mode, a command must be received within 10 milliseconds of the end of the last record. This is halfway through the inter-record gap. This 10 milliseconds is called the re-instruct time. If a command is not received within 10 milliseconds, one of the following conditions will exist:

1. The drive will overshoot the mid-point of the gap for 70 milliseconds while decelerating. During this 70 milliseconds, a command is issued and stored in the controller. After this 70 milliseconds (i.e., the start/stop time), the drive stops. Once stopped, the drive moves in reverse to the end of the previous record, then moves forward into the gap, and the stored command is performed. The time spent backing up and moving forward into the gap is 200 milliseconds, which combines with the 70-millisecond start/stop time to produce the 270-millisecond repositioning time listed in Table 1.
2. The drive will overshoot the mid-point of the gap for 70 milliseconds while decelerating. After this 70-millisecond start/stop time, the drive stops. During the time, no command was issued; therefore, the drive will remain stopped until it receives a command. Upon receipt of a command, the drive moves in reverse to the end of the previous record, then moves forward into the gap, and the command is performed. Again, the time spent backing up and moving forward into the gap is 200 milliseconds. In this condition, however, the 200 milliseconds, the 70-millisecond start/stop time, and the time spent waiting for the command to be issued must be combined to give the total repositioning time plus the system overhead time.

Characteristics	Specifications
Tape speed	30 ips
Density	1600 bpi
Data transfer rate	48 Kbytes/s
Time per word	41.6 μ s
Maximum allowable data channel latency	320 μ s
Stop/Start time	70 ms
Re-instruct time (half gap)	10 ms
Reposition time (including stop)	270 ms

Table 1 Timing specifications

Power-Up Response

When the tape drive is powered up, a reset signal (PWRST) is generated once the +5-volt power supply reaches approximately +4 volts. This signal is asserted for approximately 120 milliseconds and resets all of the controller registers and the microprocessor circuits.

Error Conditions

If an I/O Start command is issued for any operation when the drive is not on line, the Illegal and Error flags are set to 1. They are also set to 1 if the program issues a reserved command.

The illegal flag can be set to 0 by an I/O Clear command or **IORST**. A Start command will clear Illegal if the condition which caused the error has been corrected.

Bad Tape

The controlling program should give special attention to any errors which set the Bad Tape flag in the status word. This flag indicates that the error which occurred was so severe that the controller has lost track of where the tape is positioned. The program should respond to a Bad Tape error by spacing back to a file mark or BOT to insure reliable operation.

Positioning Errors

The Illegal and Error flags are set to 1 if the program issues a Space Reverse command when the tape is at BOT. The Error and EOT flags are set to 1 when the drive passes the physical EOT mark; however, the drive is still able to perform I/O. This enables the program to take appropriate action, e.g., writing an end-of-volume label for a multiple-reel file.

Reading Errors

The Data Late and Error flags will be 1 if the data channel does not respond in time to a request from the controller. The Read operation will continue until the word count becomes 0 or the end of the record is reached; however, the Data Late flag indicates that at least one word is missing from the record in memory.

Writing Errors

If the controller attempts to write to a tape which is write-locked (no write enable ring on the tape reel), the Illegal and Error flags are set to 1. This will also result from a Write EOF Mark or Erase command.

The controller automatically reads back all data from the tape as it is written and checks for error conditions. If any condition that would cause read errors is detected, the Data Error flag will be asserted. The program should then issue a backspace followed by an erase command. This will cause the marginal section of tape to be skipped.

The Data Late and Error flags are set to 1 if the data channel does not respond in time to a request from the controller. The data transfer is terminated and the drive continues moving the tape into the inter-record gap.

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USSR: Espoo
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West Germany: Dusseldorf, Frankfurt, Hamburg, Hannover, Munich, Nuremberg, Stuttgart

Data General

Users Group

Installation Membership Form

Name _____ Position _____ Date _____

Company, Organization or School _____

Address _____ City _____ State _____ Zip _____

Telephone: Area Code _____ No. _____ Ext. _____

1. Account Category

- OEM
- End User
- System House
- Government
- Educational

5. Mode of Operation

- Batch (Central)
- Batch (Via RJE)
- On-Line Interactive

2. Hardware

Qty. Installed | Qty. On Order

M/600	_____	_____
COMMERCIAL ECLIPSE	_____	_____
SCIENTIFIC ECLIPSE	_____	_____
AP/130	_____	_____
CS Series	_____	_____
Mapped NOVA	_____	_____
Unmapped NOVA	_____	_____
microNOVA	_____	_____
Other (Specify) _____	_____	_____
_____	_____	_____
_____	_____	_____

6. Communications

- HASP
- RJE80
- RCX 70
- CAM
- XODIAC
- Other

Specify _____

7. Application Description

3. Software

- AOS
- DOS
- MP/OS
- RDOS
- Other

Specify _____

8. Purchase

From whom was your machine(s) purchased?

Data General Corp.

Other

Specify _____

4. Languages

- Algol
- DG/L
- Cobol
- PASCAL
- Business BASIC
- BASIC
- Assembler
- Fortran
- RPG II
- PL/1
- Other

Specify _____

9. Users Group

Are you interested in joining a special interest or regional Data General Users Group?

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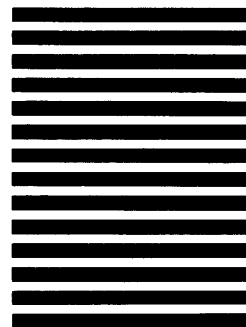
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