GENERAL ELECTRIC
COMPUTERS

GE-200 Series Magnetic Tape Subsystem

GENERAL ELECTRIC

CPB-339B

GE-200 SERIES
MAGNETIC TAPE SUBSYSTEM

REFERENCE MANUAL

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GENERAL ELECTRIC
INFORMATION SYSTEMS DIVISION

PREFACE

This manual describes Model 680 and Model 690 Magnetic Tape Subsystems which operate with transfer rates of 15 kc and 15/41.6 kc, respectively. Chapter 2 of the manual is of special interest to programmers and Chapter 3 is of special interest to operators. The magnetic tape subsystems operate in the GE-200, 215, 225 and 235 Information Processing Systems. A more complete understanding of the use of the subsystem requires reference to the manual for the central processor with which it will be used. The GE-225 Programming Reference Manual, CPB-252A contains information which applies to the GE-215 and -225. The GE-235 Central Processor Reference Manual, CPB-374, applies to the GE-235. The GE-200 Bank Transit System Manual CPB-342, applies to the GE-200.

In this revised edition, changes in technical content from the previous edition are identified with a bar in the margin opposite the change.

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ILLUSTRATIONS

1. GENERAL DESCRIPTION

Magnetic tape is one of the most widely used computer input/output media. It provides a fast method of transmitting data between the central processor and bulk storage. Millions of characters of data can be recorded on a single reel of tape, thus providing a compact and economical storage medium. Magnetic tape can provide in-process (on-line) or static (off-line) storage for immediate or subsequent use, yet can be erased and be reused repeatedly.

Each magnetic tape controller can have as many as eight tape handlers connected to it. The combination of a tape controller and its associated tape handlers constitutes a magnetic tape subsystem, as illustrated in Figure 1. A subsystem of one tape controller and multiple tape handlers permits reading or writing concurrently with other operations. A subsystem containing two or more tape controllers permits reading and writing simultaneously with other operations. Data can be read or written in either binary, special binary, or in binary-coded decimal (BCD) modes.

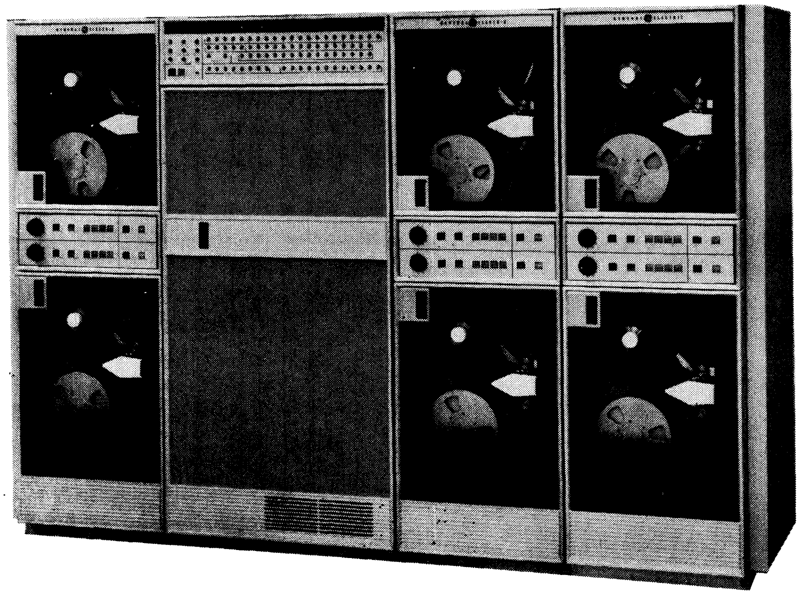


Figure 1. Magnetic Tape Subsystem

The maximum number of magnetic tape controllers which can be used in any one system varies with the type of central processor. The GE-200 Bank Transit System can have one model 680 or one model 690 subsystem. The GE-215 can have one model 680 or 690. The GE-225 can have eight subsystems of either model. This means that a maximum of 64 tape handlers can be used with one central processor. The GE-235 can have a maximum of seven magnetic tape subsystems of either model, a maximum of 56 tape handlers.

Programs written for one of the compatible General Electric information processing systems--the GE-200, 215, 225, and 235--can be readily used with any other of the systems using the same input/output equipment.

SUBSYSTEM MODELS

Magnetic tape models 680 and 690 appear to be identical, their operation is identical (with the exception of the use of one switch), and their programming is identical. The subsystems differ in their internal electronic circuitry which results in a considerable difference in the reading and writing speeds.

Model 680 (15 kc)

Model 680 reads tape and writes on tape with a density of 200 bits or characters per inch. The tape moves forward at the rate of 75 inches per second. Therefore, the transfer rate is:

200 x 75 = 15,000 characters per second

Model 690 (15/41.6 kc)

Model 690 permits the user to choose between two tape densities and tape transfer rates. Tape moves forward at the rate of 75 inches per second. Therefore, the transfer rate with the 200 bits per inch density is the same as that with model 680, or 15,000 characters per second. The transfer rate with the tape of 555.5 bits per inch is:

555.5 x 75 = 41,660 characters per second

MAGNETIC TAPE CONTROLLER

The controller is the link between the central processor and magnetic tape handlers. It contains the circuits for the selection and control of the tape handler and for data transfer between tape handlers and memory. It also contains its own power unit. Each controller operates through a controller selector channel and is addressed by its channel number. It is customary to use a low numbered (high priority) channel. The most frequently used number is 1. Memory access is requested whenever the tape controller either has data for memory or is requesting data from memory. Aside from these interruptions, the central processor memory is released.

The tape controller selects and controls the starting and stopping of the tape handlers, forms and/or detects the end-of-record or end-of-file gaps, and sets memory interrupt circuits. Hardware design does not permit simultaneous read and write operations with only one controller.

Error-Checking Circuitry

The tape controller contains error-checking circuitry to ensure reliability of reading and writing. The following five types of checks are made. Errors showing up as a result of these checks are visible as lights on the controller control and indicator panel illustrated in Figure 2 and are available to the program as error indicators which can be tested:

1. Lateral Parity. A parity bit is written on tape in parallel with each six-bit character. It is checked, when read, to see if the sum of all seven bits is odd in binary mode or even in BCD mode of operation. The error indicator is a LATERAL PARITY ALERT.
2. Horizontal Parity. A parity bit is written at the end of a record on each of the seven tape recording tracks. It is checked, when read, to see if the total number of 1's in any track, including the check digit track, is even. (Horizontal parity is sometimes referred to as longitudinal parity.) The error indicator is a HORIZONTAL PARITY ALERT.
3. Modulo Three or Four. A check is made when a record is read to see if the data consists of whole words. In BCD and 18-bit binary modes of operation the number of characters must be a multiple of three. In 20-bit binary mode the number of characters must be a multiple of four. The error indicator is MOD ALERT. The error can be overridden by program control when reading different length records.

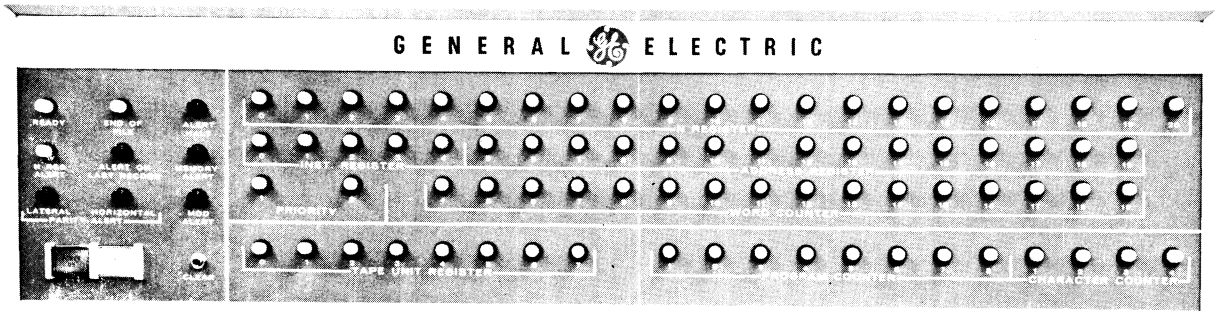


Figure 2. Control and Indicator Panel, Magnetic Tape Controller

4. Controller Input/Output Register Exhaust or Overflow. The tape controller has the capacity to store two complete memory words. If at any time during read or write operations the controller requests a memory cycle and is not granted access to memory before its input/output register is either exhausted or overflowed, an error results. Either of these conditions turns on the MEMORY ALERT indicator on the controller display panel.

5. Controller Input/Output Register Parity Error. Before information is transferred to the controller from memory, a parity bit is generated on the whole word. This parity bit is checked in the controller input/output register before each word of data is written on tape. Conversely, a parity bit is generated for the word to be transferred to memory from the controller input/output register. This parity bit is used to check the transmission of information between the controller and memory. A parity error turns on the N REG ALERT light on the controller display panel.

These errors are recoverable, meaning that the program does not stop, for the programmer can cause the program to repeat the whole read or write cycle until the error is corrected. Whenever the controller is reselected, the error lights go out.

Control and Indicator Panel

Five of the indicators on this panel have just been described under the heading of error checking circuitry. Four other indicators are:

1. ALERT ON LAST RECORD. This indicator is illuminated when any of the above five types of recoverable errors occurred in the last record read or written.

2. READY. This indicator is illuminated if controller power is on. (It does not actually mean that the controller is ready for the central processor to address it; for example, tapes may not be threaded.)

3. ALERT HALT. This indicator is illuminated under the following error conditions (in every case the computer halts and operator intervention is required to correct the condition):

    a. A parity error on instruction words 2 and 3 during the transfer of these words.

    b. Addressing a tape transport while it is rewinding.

    c. Attempting to address a tape which has not been manually selected.

    d. Any detectable malfunction of the tape handler such as handler power not on, REMOTE/LOCAL switch set to LOCAL, or no tape threaded.

    e. Specifying a tape handler logical address for which there is more than one unit selected.

f. Attempting to write on a tape which does not have a write-permit ring.

g. Attempting to perform a read backward instruction (RBB, RBD, or RBS) when the tape is in the rewound condition and initially positioned at the load point marker.

4. END OF FILE. This indicator is illuminated after an end-of-file has been reached on tape while reading. It remains lit until cleared manually by the CLEAR button or until the next SEL instruction is given.

The functions of the indicators just described are summarized in Figure 20, and the descriptions of the use of these indicators under error conditions are summarized in Figure 28.

The controller contains registers and counters for use in storage and timing of information as it passes in either direction between tape and memory. Information in some of these registers and counters can be seen on the control and indicator panel, where it is displayed mainly for use by service engineers. Although it is not necessary to use these indicators in routine operations, the information they display is helpful in understanding what causes processing to stop under certain error conditions. All of these indicators are white lights.

N REGISTER. Indicates the data stored temporarily while in transit (in either direction) between a tape handler and the central processor. Shown are the 20 data bits and a parity bit.

INST. REGISTER. The five bits of this register indicate the type of instruction to be executed. The operator should be familiar with the magnetic tape programming instructions and know the octal and binary representations of their operation codes.

ADDRESS REGISTER. Indicates the starting address in memory for reading or writing.

PRIORITY 1 and 2. Indicates two phases of a time cycle, the first of which is the time during which the controller is requesting access and the second is the time when it is actually granted access to the central processor.

WORD COUNTER. Indicates the counting of words written or read from magnetic tape. Initially, the counter is preset to the 2's complement of the number of words to be written or read as a result of a single instruction. The visible count, therefore, increases rather than decreases as the instruction is executed.

CHARACTER COUNTER. Indicates the character count in a word as it is read or written on magnetic tape. Each new instruction transferred to the controller from the central processor resets the counter to zero. The count goes to three if in BCD or 18-bit (special) binary mode and to four if in 20-bit binary mode of operation. The function of the character counter is to control the number of characters transferred to and from tape and to step the word counter after the proper number of characters has been transferred.

TAPE UNIT REGISTER. Indicates the rotary selector switch setting of the tape unit in use.

PROGRAM COUNTER. Indicates the place in a sequence of events in the controller's internal control mechanism as it controls the sequence of operation of the tape controller. This will probably never be meaningful to an operator, but it is used by the service engineer.

There are three switches of the pushbutton type on the controller control and indicator panel:

POWER ON switch and indicator. When depressed, this turns on power to the magnetic tape subsystem, and indicates that it is on.

POWER OFF switch. When depressed, this turns off power to the magnetic tape subsystem.

CLEAR switch. When depressed, this clears the circuitry of all error conditions, and turns off all the error condition indicators on the control and indicator panel.

Optional Buffer

Model 690 can have an optional additional buffer in its controller. This buffer is known as the "magnetic tape buffer" and holds an additional word while information is in transit in either direction between the tape unit and the central processor. The buffer doubles the length of time the tape controller can wait for priority, permitting the magnetic tape subsystem to be assigned a lower order of priority.

When a system has two 41.6 kc magnetic tape controllers, each controller should have the optional buffer to take full advantage of the ability of the system to read and write simultaneously with other controller selector input/output devices. Fully buffered equipment facilitates expansion of system operations.

MAGNETIC TAPE HANDLER

General Description

The tape handler can read tapes backward or forward in three formats. Each tape handler contains two reels, one for tape feeding called the "supply reel," and the other for tape takeup. See Figure 3.

The supply reel is held in place by an expandable rubber ring in the mount assembly, shown in Figure 4. When the reel mount knob is tightened (turned clockwise), the ring compressor is forced against the rubber ring and expands it to hold the reel in place. The takeup reel is solidly and permanently attached in place by screws.

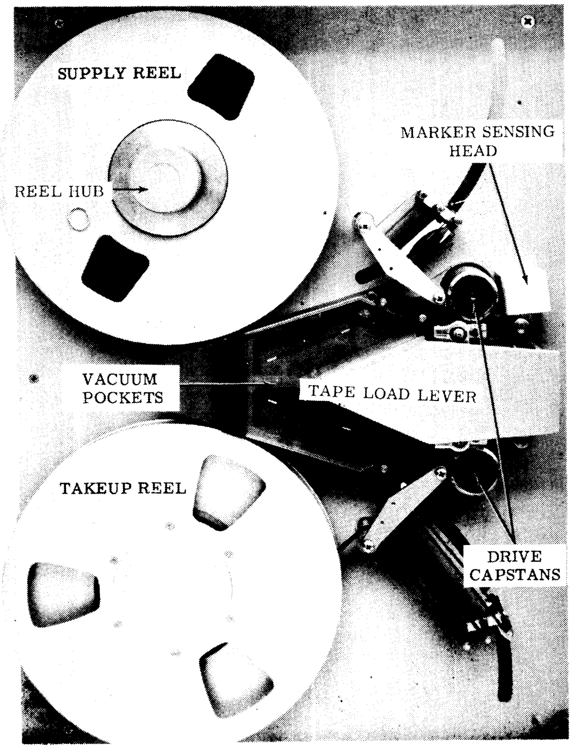


Figure 3. Tape Handler Mechanism

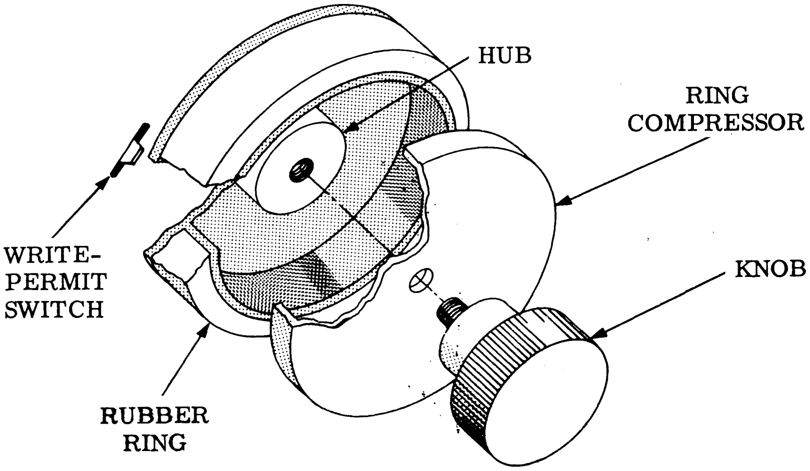


Figure 4. Tape Reel Hub Assembly

The tape handler mechanism drives the tape past separate read and write heads. See Figure 5. Tape is threaded around tape guides, and between the capstans and their respective drive rollers. Vacuum pockets perform that function of holding the tape even and smooth as it passes the read and write heads. When the handler power is on, the capstans rotate continuously in opposite directions (the top one rotates clockwise) and are always ready to drive the tape when a drive roller forces the tape against one of them. Tape moves forward when the drive roller is against the forward capstand and backward when the drive roller is against the reverse capstan. Two sensing cells in the photosensor are positioned to detect the beginning-of-tape and end-of-tape markers.

Each tape handler has a provision to move tape forward at a rate of 75 inches per second or to rewind at 150 inches per second. When tape moves backward as a result of a read backward instruction, its speed is 75 inches per second. The tape load lever acts on a thread switch so that when the lever is opened, the tape tension arms are pulled open and a brake holding the reel hubs is released to allow the reels to turn freely. When the load lever is closed, the thread switch is released to the normal position, and the tape tension arms return to a null position.

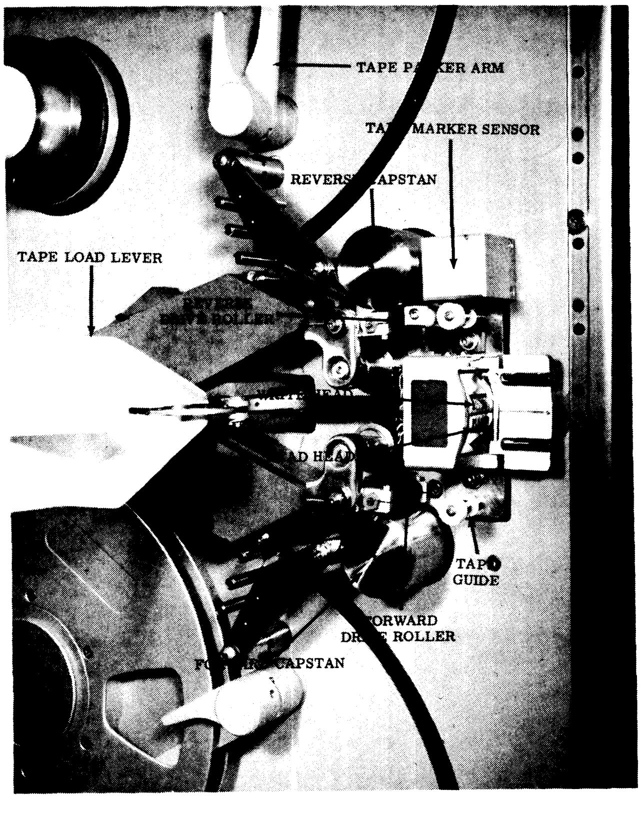


Figure 5. Tape Handler Mechanism Parts

The handler has a protective feature which prevents damaging tape by sudden changes in direction of motion on the handler system. When tape is moving forward, the REVERSE and REWIND switches are inoperative; and when moving backward, the FORWARD switch is inoperative. To change direction of tape movement, the operator must first depress STOP, and then depress the pushbutton for the desired change of direction.

Switches and Indicators

Each magnetic tape handler has a control and indicator panel which permits the operator to see various conditions of tape operation and permits him to perform necessary off-line operations. Figure 6 illustrates this panel. All switches and indicators are labeled except the rotary address selector switch which is on the extreme left of the panel. On the panel are the following:

Address Selector switch. This eight-position switch selects the channel from the controller (0-7) for on-line operations. The switch is completely disabled when the handler is set for local operation. Since each handler can be set to any one of eight channels, any tape reel can be mounted on any transport, and the handler can be selected by the computer program. This selected number is referred to as the "logical tape number."

POWER ON switch and indicator. This pushbutton turns on power to the handler when depressed. It turns power off again when depressed a second time. When on, it is illuminated.

REMOTE/LOCAL switch and indicator. This pushbutton determines whether the handler will operate under local control from the handler's control and indicator panel or whether it will operate under remote control from program instructions relayed to the handler through the tape controller. The pushbutton is horizontally divided and changes from one condition to the other when depressed. The effective condition is indicated by illumination.

REWIND switch and indicator. This pushbutton operates only when the handler is set for local operation. When depressed, it causes tape to move in a reverse direction at a speed of 150 inches per second. This movement is caused by energizing the reverse drive roller and changing the speed of the capstan drive. The REWIND switch is normally used to return the tape to its load point, for the tape stops on the load point marker. The rewind motion is stopped by depressing STOP or by placing the REMOTE/LOCAL switch in the REMOTE position. The pushbutton is illuminated during rewind.

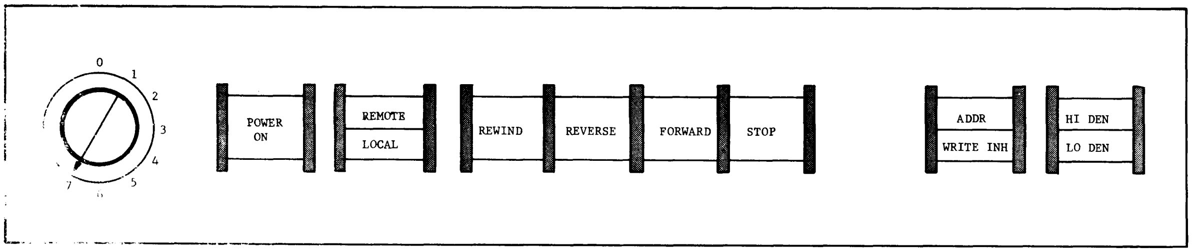


Figure 6. Magnetic Tape Handler Control and Indicator Panel

REVERSE switch and indicator. This pushbutton operates only when the handler is set for local operation. When depressed, it energizes the reverse drive roller and causes tape to move in a reverse direction at a speed of 75 inches per second until it is stopped by the sensing of the load-point marker. The motion is also stopped by depressing STOP or by placing the REMOTE/LOCAL switch in the REMOTE position. The pushbutton is illuminated during reverse movement of tape.

FORWARD switch and indicator. This pushbutton, when depressed, energizes the forward drive roller and therefore causes forward movement of tape when the handler is in the local state. Tape will continue moving until the STOP pushbutton is depressed, the trailer foil is detected, or the REMOTE/LOCAL switch is placed in the REMOTE position. The pushbutton is illuminated during forward movement of tape.

STOP switch. This pushbutton operates only when the handler is set for local operation. When depressed, it stops all local movement of the tape handler. The switch must be used every time direction of tape movement is changed. It is not an indicator.

ADDR/WRITE INH indicator. This indicator is split horizontally through the center. The top half (ADDR) is illuminated under program control whenever the magnetic tape controller is addressed by the central processor for a read or write operation. The bottom half (WRITE INH) is illuminated when writing is inhibited and only reading is possible, meaning that the write-permit ring is not on the supply reel.

HI DEN/LO DEN switch and indicator. On model 690, this switch determines the selection of density for reading or writing tape. The density is either 555.5 bits per inch (HI DEN 41.6 kc) or 200 bits per inch (LO DEN, 15 kc). The pushbutton changes density from one to another when depressed, and is horizontally divided so that the density selected is illuminated. On model 680, the switch is disabled because the handler operates on low density only.

MAGNETIC TAPE

Magnetic tape may be used as on-line storage during a computer run and may also be used as off-line storage to retain information as a file for subsequent related computer runs.

Physical Characteristics

The General Electric information processing systems use heavy-duty, hard-binder tape. (See Figure 7.) The functional characteristics of this tape are compatible with those of the system itself, so this tape and only this tape must be used with the GE-200, 215, 225, and 235 information processing systems. The tape is 0.5 inch wide and 0.0019 inch thick. It has a polyester base (the shiny side) and an oxide coating (the dull side).

Another feature of the tape for the GE-200, 215, 225, and 235 computer systems is its high conductivity. This minimizes the static charge commonly experienced with magnetic tape, and consequently reduces the collection of dust and other foreign matter on the tape.

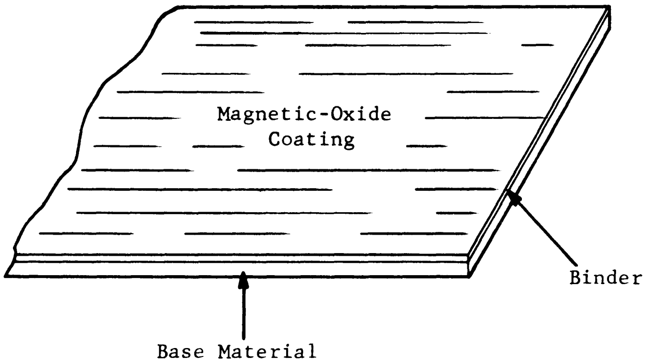


Figure 7. Composition of Magnetic Tape

Tape is wound on plastic reels in either of two sizes: 8 1/2-inch reels which hold 1200 feet of tape and 10 1/2-inch reels which hold up to 2400 feet of tape. Reels may be used, of course, with lesser amounts of tape, with a practical minimum length of about 50 feet. The tape is wound with the dull side facing the center of the reel.

Photosense Markers

Tape has photosense markers near the beginning and the end of a reel to indicate the beginning or end of the portion of tape used for reading and writing. The markers are of reflective foil with an adhesive base. Photosensing cells in the handler (see Figure 5) detect the presence of the markers on tape. The marker near the beginning of tape is designated a leader marker. It is used to position tape for starting to read or write. It also prevents tape from coming off the takeup reel after a rewind operation. The marker near the end of the tape is designated a "trailer marker." This marker prevents the tape from coming off the supply reel after depression of the FORWARD button on the tape handler control and indicator panel. If the end-of-tape is detected when the trailer marker is sensed, an indicator in the tape controller is set, and the condition of the indicator can be tested by programmed instructions after reading or writing each record. If the indicator is not set, normal processing continues. If it is set, a branch can be made to a subroutine to rewind the current reel and continue the program on an alternate reel. When it is desired that the markers be positioned differently from the way they are on the reel of tape, they can be removed and replaced with new markers at a specified distance from either end of the tape. Some routines use a memory dump which places the contents of memory on the end of tape beyond the trailer marker.

To ensure that sufficient tape exists beyond the trailer marker to permit memory dumps, the tape reels should be visually checked and measured. The following table shows tape lengths required for binary memory dumps on different tape densities and memory sizes:

Density	8 k Dump	16 k Dump
15 kc/200 bpi	14 feet	28 feet
41.6kc/555.5 bpi	5 feet	10 feet

Both 1200 foot and 2400 foot reels of tape initially have the load point marker positioned 10 to 15 feet from the beginning of tape. The trailer marker is initially positioned 14 to 19 feet from the end of tape on 1200 foot reels and 100 feet from the end on 2400 foot reels.

Tape Formats

Information is stored on magnetic tape in the form of magnetized spots arranged in seven longitudinal tracks. Six bits of data are recorded simultaneously in six tracks laterally across the tape to form a tape character. The seventh track contains a parity bit for each tape character, generated at the time of recording. The six-bit magnetic tape characters are recorded serially in groups of three or four, depending upon the mode of operation, to form a memory word. The magnetic tape subsystem communicates with the central processor in three different modes: binary, special binary, and binary coded decimal (BCD). The mode for reading or writing tape is specified in the instruction word.

BINARY MODE (20 BITS). In the binary mode, the 20 bits of a memory word are written on magnetic tape as four 6-bit magnetic tape characters. This is referred to as a modulo of four. Three of the magnetic characters contain six bits of data and the fourth character contains only two bits of useful data. The four remaining bits in this character are written as zeros. The four zeros are automatically inserted by the hardware during recording, and are ignored when read back from tape. The parity of each tape character is odd. Figure 8 illustrates the orientation (by bit position) of information transferred between a memory word and magnetic tape.

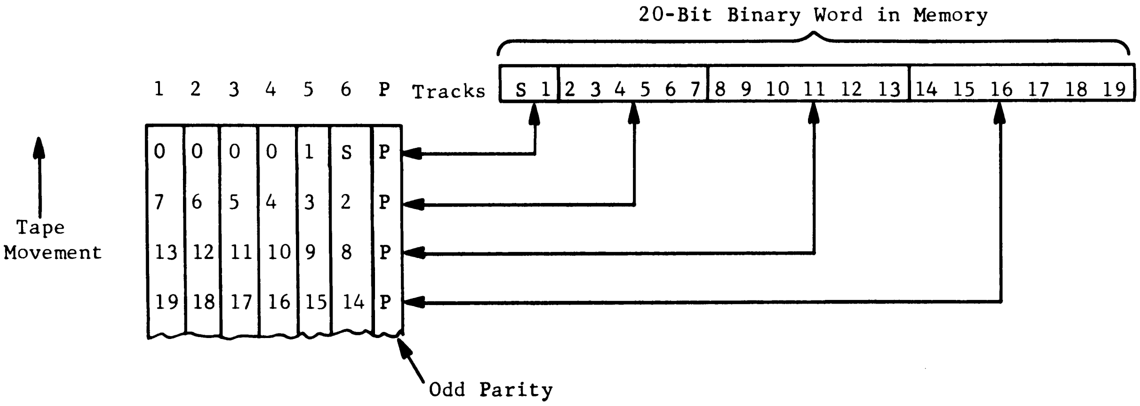


Figure 8. Binary Mode of Data Transfer

SPECIAL BINARY MODE (18 BITS). In the special binary mode, bit positions 2-19 of a memory word are written on tape as three 6-bit tape characters. Parity of each tape character is odd. Bit positions 0 and 1 of the memory word are automatically set to zero when reading from tape and are not transferred to tape when writing. Figure 9 illustrates the orientation (by bit position) of information transfer between a memory word and magnetic tape.

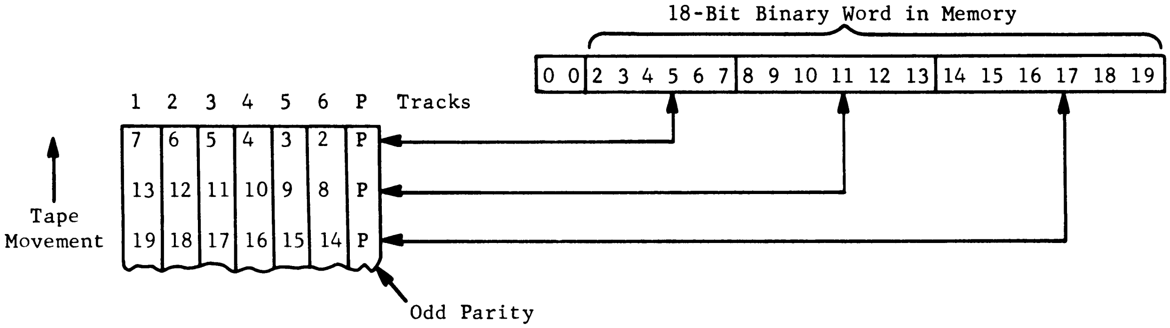


Figure 9. Special Binary Mode of Data Transfer

BINARY-CODED DECIMAL MODE (BCD). In the BCD mode, bit positions 2-19 of a memory word are written on tape as three 6-bit tape characters. Bit positions 0 and 1 of the memory word are automatically set to zero when reading from tape and are not transferred to tape when writing. (So far, transfer is identical to that in the special binary mode.) Parity on each tape character is even. Figure 10 illustrates the orientation (by bit position) of information transfer between a memory word and magnetic tape.

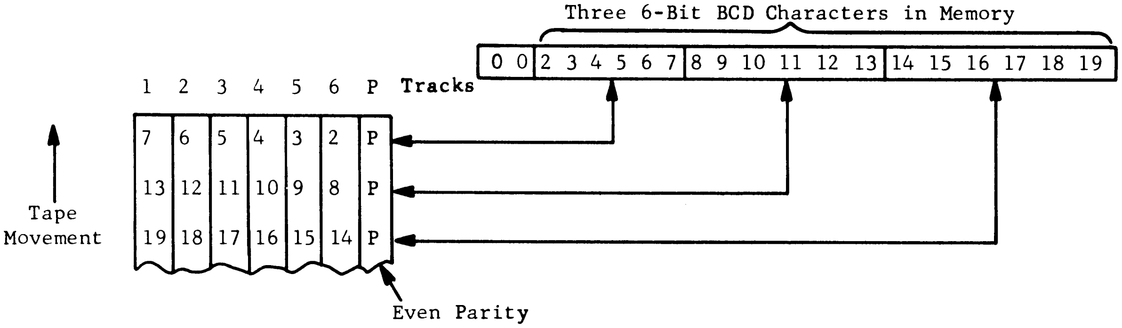


Figure 10. Binary-Coded Decimal Mode of Data Transfer

In reading and writing in the decimal (BCD) mode, an alteration is made to zone bits (two high-order bits) of magnetic tape characters as data is transferred to and from memory through the tape controller. This is done to make magnetic tapes compatible with decimal mode tapes produced by other information processing systems. The change is made automatically by the hardware and is not controlled by the program. The changes made by the controller are the following:

1. Zone bits of BCD characters are changed:

   01 in memory becomes 11 on tape
   11 in memory becomes 01 on tape
   11 on tape becomes 01 in memory
   01 on tape becomes 11 in memory

2. BCD zero is changed

000000 in memory becomes 001010 on tape
001010 on tape becomes 000000 in memory

It should be noted that a BCD memory octal 12 is written on tape as a 12; but, because of the "zero" change, it is read back into memory as a zero.

BCD MEMORY (OCTAL) →	BCD MAGNETIC TAPE (OCTAL) →	BCD MEMORY (OCTAL)
00	12	00
12	12	00

Figure 11 is an example of an actual BCD character transfer from memory to magnetic tape. Notice that the zone bits of the percent character were altered from 11 to 01 in the transfer and that a parity bit was added where necessary.

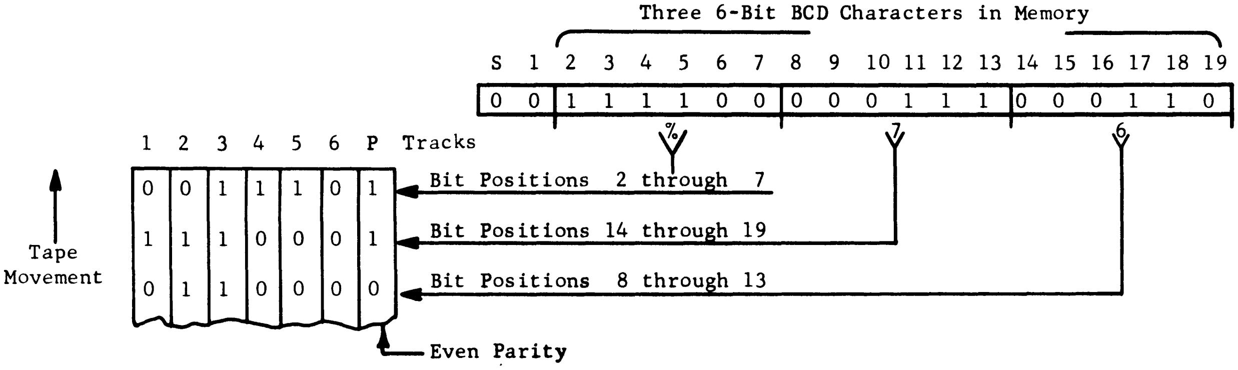


Figure 11. Binary-Coded Decimal Character Transfer to Magnetic Tape

The octal equivalent of the BCD character **set** as it appears in memory and on tape is shown in Figure 12.

Figure 13 illustrates the recording of BCD characters on tape. The configuration is that of the "Tape" column of Figure 12, to which parity bits have been added to result in even parity.

CHARACTER	CHARACTERS - OCTAL	
	MEMORY	TAPE
0	00	12
1	01	01
2	02	02
3	03	03
4	04	04
5	05	05
6	06	06
7	07	07
8	10	10
9	11	11
A	21	61
B	22	62
C	23	63
D	24	64
E	25	65
F	26	66
G	27	67
H	30	70
I	31	71
J	41	41
K	42	42
L	43	43
M	44	44
N	45	45
O	46	46
P	47	47
Q	50	50
R	51	51
S	62	22
T	63	23
U	64	24
V	65	25
W	66	26
X	67	27
Y	70	30
Z	71	31
	12	12
#	13	13
@	14	14
_(undrscr)	15	15
=	16	16
EOF*	17	17
+	20	60
0	32	72
.	33	73
⌑	34	74
	35	75
	36	76
	37	77
-	40	40
0	52	52
$	53	53
*	54	54
	55	55
	56	56
	57	57
△	60	20
/	61	21
	72	32
,	73	33
%	74	34
⌈	75	35
⌉	76	36
	77	37

* The octal 17 produces an EOF only in a single character record.

Figure 12. BCD Character Set in Memory and on Tape

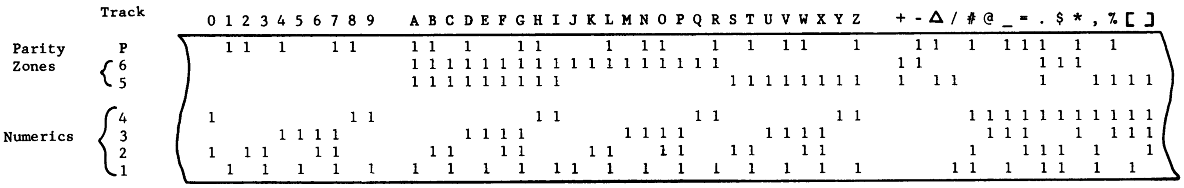


Figure 13. BCD Characters on Magnetic Tape

MIXED DATA MODES. When core storage contains information in both decimal and binary form, writing and reading of this data to and from magnetic tape must be done in the binary mode so that all twenty bits of each memory word are transferred. This means, however, that each BCD memory word is placed on tape as four 6-bit characters instead of 3 characters. This fourth character on tape contains meaningless information which is of no significant value.

Figure 14 shows a BCD memory word written on tape in the binary mode. It is written as four 6-bit tape characters with odd parity.

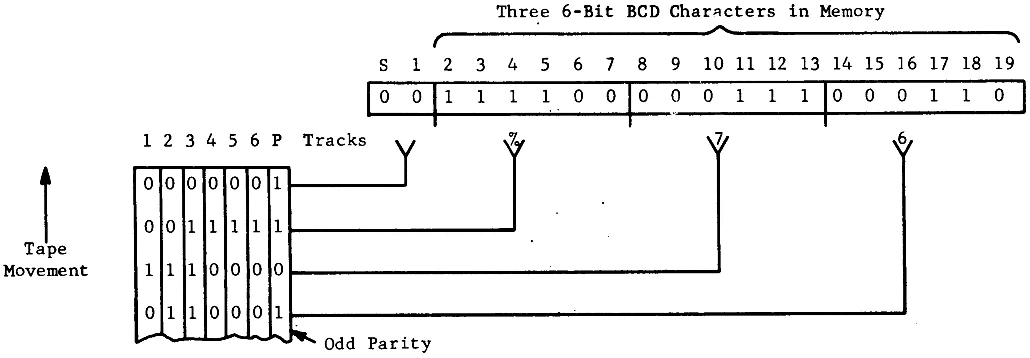


Figure 14. BCD Memory-to-Tape Transfer in Binary Mode

TAPE RECORDS AND FILES. Data is recorded on magnetic tape in groups of words called physical records (sometimes called blocks). It must be noted that a physical record is not the same as a data record. A data record is an item of a given length, such as a logical record (for example, pay number). A physical record is the physical section of tape between two gaps of erased portions of tape. The length of the physical record may be predetermined by the programmer, and usually includes several data (logical) records. The minimum limit for a logical record length is one word and the maximum limit is equal to the size of the memory. A larger grouping of data on tape is designated a file. The file is an accumulation of related records, and may be even longer than one reel of tape.

Inter-Record Gap. The inter-record gap is the 3/4 inch section of erased magnetic tape which separates one physical record from another. The gap permits starting and stopping of tape between records. Following each record is a longitudinal parity check character.

End-of-File Gap. The end-of-file gap is the 3-3/4 inch section of erased magnetic tape which separates one file from another. The gap follows the longitudinal parity check character of the last record of the file. Following the gap is an end-of-file character (0001111). Another longitudinal check character follows the end-of-file character (the character is treated as a one-word record).

Figure 15 illustrates the positioning of an inter-record gap and an end-of-file gap. Indicated also is the 0.02-inch space which always precedes a longitudinal check character on tapes used with subsystem model 680.

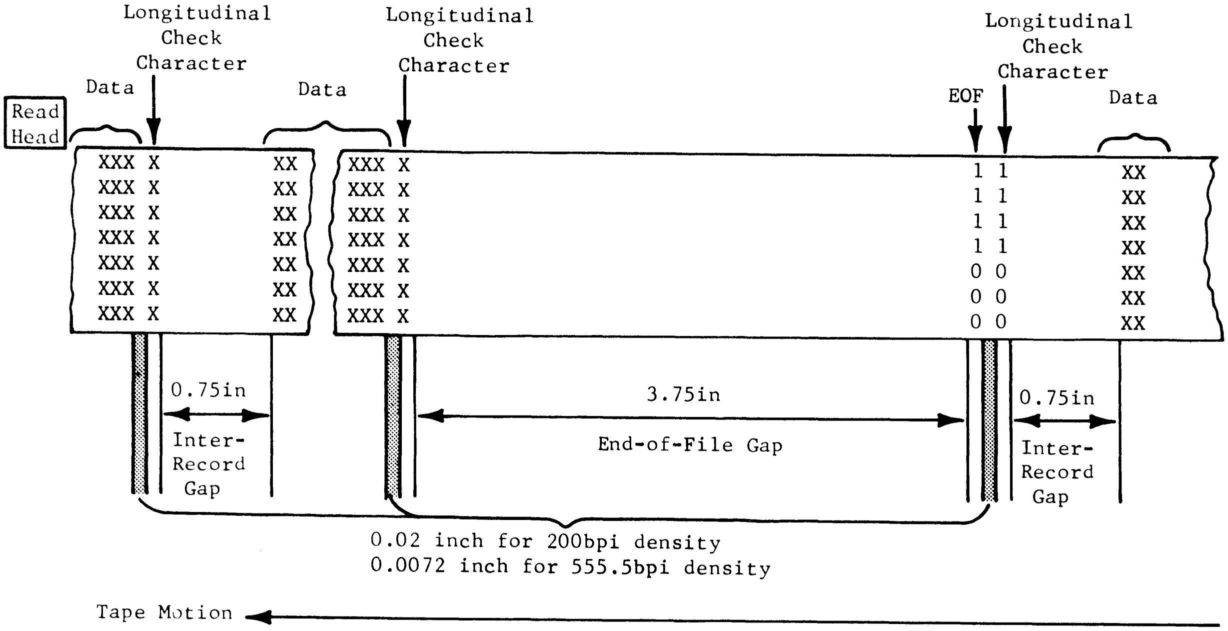


Figure 15. Magnetic Tape Records and Files

CHECKING FEATURES

The magnetic tape subsystem automatically performs various checks to ensure the accuracy of data transfer between memory and tape. Word parity is checked in transfers (in both directions) between memory and the tape controller. Parity of magnetic tape characters is checked in transfers (in both directions) between the tape and the tape controller. The checking circuits are also designed to prevent the execution of an illegal operation such as addressing a magnetic tape handler that is in process of rewinding. The program can test for errors by use of test-and-branch instructions.

Write Check

Each tape handler has two sets of magnetic heads: a read head and a write head. During a read operation only the read head is used. During a write operation (except at end-of-file character) both sets of heads are used. After each tape character is written on tape by the write head, it is read back by the read head and checked for parity. Errors detected in this way can be corrected under program control.

Write-Permit Ring

Reading may be done at any time from a magnetic tape reel, but writing may be done only when a write-permit ring is present on the reel. This is to guard information from accidental destruction by writing. The write-permit ring (see Figure 16), fits into a groove in the back of a tape reel. The ring activates a write-permit switch beneath the mount assembly (visible in Figure 4). After the switch senses the presence of the ring, it retracts into the panel next to the hub assembly to prevent damage by friction. The WRITE INHIBIT indicator on the handler's control and indicator panel is illuminated when the write-permit ring is not present on the supply reel, indicating that writing cannot be performed.

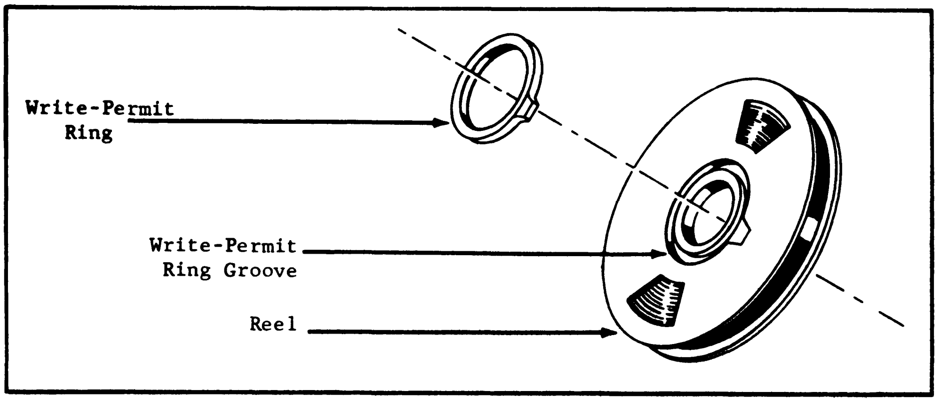


Figure 16. Installation or Removal of the Write-Permit Ring

Controller and Program Checks

The tape controller checks the following types of errors. When an error is encountered, the error is indicated visually on the tape controller by the ALERT ON LAST RECORD light plus the specific error light. The program can test for these error conditions by using test and branch instructions, and then take corrective action. Refer to the following error conditions described earlier in the manual under the heading of "Magnetic Tape Controller":

1. Lateral parity check
2. Horizontal parity check (also called longitudinal parity check)
3. Modulo three or four
4. Controller input/output register exhaust or overflow
5. Input/output register parity error

Figure 17 illustrates an example of lateral and horizontal parity checks.

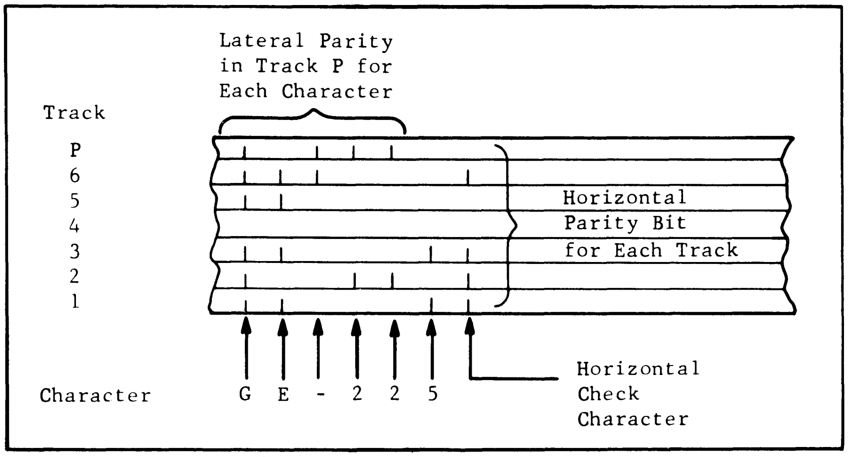


Figure 17. Lateral and Horizontal Magnetic Tape Parity (Decimal Mode)

The magnetic tape test-and-branch instructions BCS BIO (Branch on Input/Output Buffer Error) and BCS BIC (Branch on Input/Output Buffer Correct) test for two conditions of the tape controller input/output register. The first condition concerns the granting or not granting of memory requests; a memory request error is indicated by a MEMORY ALERT light on the controller display panel. The other condition concerns a parity error on a data word from memory; a parity error on a data word is indicated by the N REG ALERT light.

Alert Halt Conditions

Certain error conditions and malfunctions which can occur during magnetic tape operations cause the faulty or affected tape handler and its associated controller to halt. These are known as alert halt conditions and cause the ALERT HALT indicator on the controller's control and indicator panel to glow blue. Manual intervention is required to return the controller and tape handler to operation. The alert halt condition may or may not cause the central processor to halt. If the alert condition occurs during the transfer of words 1, 2, or 3 to the controller, the central processor also halts. If the condition occurs after the tape handler becomes busy, the central processor continues processing. However, a subsequent attempt to address the halted controller and tape handler (or other handler on that controller) will then halt the central processor. An ALERT HALT condition occurs as a result of:

1. A parity error on instruction words 2 or 3 as these words are transferred from memory to the tape controller.
2. Addressing a tape handler that is rewinding.
3. Addressing a nonexistent tape handler.
4. Addressing a tape handler which is one of two units on a controller having the same address.

5. A detectable malfunction of a tape handler.
6. Giving a write instruction to a tape handler without the write-permit ring on the tape reel.
7. Giving a read backward instruction when the tape is positioned on the leader.

2. PROGRAMMING
FOR MAGNETIC TAPE OPERATIONS

INSTRUCTION FORMAT

All instructions executed by the magnetic tape controller require three memory words. The format for writing these instructions in the General Assembly Program language uses the following conventions:

P = controller assigned (controller selector channel number)
M = memory location (starting)
TC = code for the specific tape command
T = tape handler assignment (number 0-7)
TT = binary configuration of the code for tape handler number
N = number of words (length of record)
Index = address modification locations (0-3)

Each of the two **models** of magnetic tape subsystems requires the same formats for instruction words.

Instruction Word 1

Instruction word 1 is the general Select instruction (SEL) which is the same for all input/output instructions. The octal representation of the instruction (when not indexed) is 2500P20 in which P is the controller selector channel on the central processor. The format is:

Machine Coding

S - 4	5 - 6	7 - 8	9 - 10	11 - 13	14	15	16 - 19
1 0 1 0 1	Index	0 0	Not Used	Channel No.	Not Used	1	Not Used

Bit positions 5 and 6 contain the address of the indexing register when indexing is used. The SEL instruction clears any error conditions from a previous operation (except an ALERT HALT which requires manual intervention) and selects the specified tape controller. The General Assembly Program coding with the tape controller on channel 2 and no indexing is shown on the following page.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	

Instruction Words 2 and 3

Instruction word 2 specifies the tape operation to be performed (TC) and, when the operation is a read or a write, specifies the starting memory address (MMMMM). The memory address is right-justified in the word. The word cannot be indexed.

Instruction word 3 specifies the coded number of the tape handler to be used (TT) and the maximum number of words to be read or written in one record (NNNNN). The number is right-justified in the word. The word cannot be indexed. The following is the code for the tape handler number:

Handler Number	Bits 0-4	Octal Code
0	00001	01
1	00010	02
2	00100	04
3	01000	10
4	10001	21
5	10010	22
6	10100	24
7	11000	30

The assembler generates words 2 and 3 in the following formats:

Instruction Word 2

Machine Coding

0-4	5 ——— 19
TC	M M M M M

Instruction Word 3

Machine Coding

0-4	5 ——— 19
TT	N N N N N

The General Assembly Program coding format for these two words differs from the machine language coding in that the tape handler number is specified in word 2 on the coding sheet. During assembly, the handler number is made part of word 3. The coding is illustrated in the following example in which:

Word 1 selects the controller on channel 2.

Word 2 specifies a write tape decimal operation on tape handler number 4, starting from memory location 1000 (decimal).

Word 3 specifies that 200 words are to be written.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	
	WTD	1000	4
		200	

Summary of Words 1, 2, and 3

In summation, the three basic instructions that the programmer must provide for each magnetic tape read or write operation will assume the following form:

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	P	
	CCC	M	T
		N	

The SEL P instruction clears previous error conditions (except ALERT HALT) and selects the desired magnetic tape controller P.

The CCC (line 2) represents the three-letter mnemonic code for specifying the desired operation.

The M (line 2, operand field) indicates the starting address for reading and writing operations. For non-read and non-write instructions, such as Backspace and Position Write Head and Write End-of-File, the operand field is blank.

The T (line 2, column 20) specifies the number of the desired tape handler.

The N (line 3) specifies the number of words to be read or written. In cases where N must be zero, the third word may be left off the coding sheet (as in Rewind Tape). It is not necessary to leave a blank line on the coding sheet. The assembler then generates the third word with N as zero.

MAGNETIC TAPE INSTRUCTIONS

Programming for 15 kc tape is identical to that for 41.6 kc tape. There is no difference in instructions or in their execution on magnetic tape subsystem models 680 and 690. Tape density selection on model 690 is a physical operation performed by the operator. Programmers' instructions to the operator specify the tape density to be used. Programming is also identical for each of the compatible General Electric Information Processing Systems--the GE-200, 215, 225, and 235. If a program needs to know on which system it is being run, the instruction WAI (Who Am I, octal code 2504010, see CPB-374, GE-235 Central Processor Reference Manual) can be used to test for GE-200, 215, 225, or 235. The knowledge may be required for selection of timing loops in programs which are to be used on all of the systems.

Each instruction for magnetic tape operation is explained in paragraphs which follow by use of a specific format. Following the name of the instruction is a heading. Following the heading is a functional description of the execution of the instruction and the results of its execution. For most instructions, an example is then given of its use and its General Assembly Program coding.

Tape Movement Instructions

The heading of a tape movement instruction contains:

1. Symbols for assembly program coding for the second and third words of the instruction.
2. The octal representation of the machine coding for those two words.

The single letter T in the heading stands for the tape handler number (the same as the switch setting on the handler). Each of the tape movement instructions must have SEL P as the first word. For convenience, the first word has been assumed and is not shown with the individual instruction descriptions.

Word times, of course, differ depending upon which central processor is used. The actual time in microseconds varies as follows:

System	Word Time
GE-200	18 microseconds
GE-215	36 microseconds
GE-225	18 microseconds
GE-235	6 microseconds

FORWARD TAPE MOVEMENT. During forward tape movement, the tape subsystems can read or write information in the BCD, binary, or special binary modes. However, a write instruction must never be used immediately after a read instruction on the same tape. Every write instruction must follow either another write instruction, a Rewind instruction, or a Backspace and Position Write Head instruction. This is necessary to correctly position tape records under the read and write heads.

WRITE TAPE DECIMAL

WTD	M	T	02MMMMM
(Blank)	N		TTNNNNN

The number of decimal words specified by N, starting from memory location M, are written by magnetic tape handler T. Bits 2-19 of each word are written on tape. Zone bits of BCD characters are altered in transfer to tape. The last word written is M + N - 1.

Example: Write on magnetic tape, in BCD mode, 100 BCD words starting at location 1000. Use tape handler 1 on the tape controller connected to controller selector channel 2:

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	
	WTD	1000	1
		100	

Resulting Assembly:

Notice that the third word has the coded handler number.

Location in Octal	Contents in Octal	Coding	
02757	2500220	SEL 2	
02760	0201750	WTD 1000	1
02761	0200144	100	

WRITE TAPE BINARY

WTB	M	T	03MMMMM
(Blank)	N		TTNNNNN

The number of binary words specified by N, starting from memory location M, are written by magnetic tape handler T. Bits 0-19 of each word are written on tape exactly as they appear in memory.

WRITE TAPE SPECIAL BINARY

WTS	M	T	23MMMMM
(Blank)			TTNNNNN

The number of words specified by N, starting from memory location M, are written by magnetic tape handler T. Bits 2-19 of each word are written on tape exactly as they appear in memory.

READ TAPE DECIMAL

RTD	M	T	04MMMMM
(Blank)	N		TTNNNNN

A maximum of N decimal words is read by magnetic tape handler T and placed in memory, starting at location M. Bits 2-19 of each word are stored in memory. Zone bits of BCD characters are altered in transfer to memory.

Example: Read in the BCD mode from magnetic tape 100 BCD words into memory starting at location 2000. Use tape handler 1, channel 2.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	
	RTD	2000	1
		100	

Resulting Assembly:

Location in Octal	Contents in Octal	Coding
03000	2500220	SEL 2
03001	0403720	RTD 2000 1
03002	0200144	100

READ TAPE BINARY

RTB	M	T	05MMMMM
(Blank)	N		TTNNNNN

A maximum of N binary words is read by magnetic tape handler T and placed in memory, starting at location M. Bits 0-19 of each word are stored at in memory exactly as they appear on tape.

READ TAPE SPECIAL BINARY

RTS	M	T	25MMMMM
(Blank)	N		TTNNNNN

A maximum of N words is read by magnetic tape handler T and placed in memory, starting at location M. A data word from tape is stored in bit positions 2-19 of a memory location just as it appears on tape.

WRITE END OF FILE

WEF		T	0200000
			TT00000

The end-of-file character (0001111) and end-of-file gap are written on tape by magnetic tape handler T.

Example: Write an end-of-file record on tape using tape handler 4, channel 2.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	
	WEF		4

Resulting Assembly:

Location in Octal	Contents in Octal	Coding	
02000	2500220	SEL 2	
02001	0200000	WEF	4
02002	2100000		

Notice that the assembler has generated the third instruction word. Tape handler 4 is coded in binary as 10001, and in octal as 21.

ERASE TAPE

EKT		T	1300000
		N	TTONNNN

The controller attempts to erase N words on tape handler T. If information is detected which cannot be erased, a horizontal parity error is set.

BACKWARD TAPE MOVEMENT. During backward tape movement, data may be read in BCD, binary, or special binary. Data cannot be written backwards. The read tape backward instructions must not be used after a write instruction on the same handler. Care must be used in selection of the proper backspace instruction prior to rereading or rewriting.

READ BACKWARD DECIMAL

RBD	M	T	14MMMMM
(Blank)	N		TTNNNNN

Decimal information is read from tape moving backward. A maximum of N words is read into memory, the first word being placed in memory location M. The second word is placed in M minus 1 and so on until N words are read. The tape controller alters the zone bits of characters read so that they conform to the General Electric Character Set code for internal BCD characters. The last operation on this handler must not have been a write operation.

READ BACKWARD BINARY

RBB	M	T	15MMMMM
(Blank)	N		TTNNNNN

Binary information is read from tape moving backward. A maximum of N words is read into memory, the first word being placed in memory location M. The second word is placed in M minus 1 and so on until N words are read. The last operation on this handler must not have been a write operation.

READ BACKWARD SPECIAL BINARY

RBS	M	T	35MMMMM
(Blank)	N		TTNNNNN

Information is read from tape moving backwards. Bit positions 2-19 of each word read are placed in memory exactly as on tape. A maximum of N words is read into memory, the first word being placed in memory location M. The second word read is placed in M minus 1 and so forth until N words are read. The last operation on this handler must not have been a write operation.

REWIND

RWD	T	2000000 TT00000

Tape on magnetic tape handler T is rewound to the load point marker. N must be zero.

Example: Rewind the tape on tape handler 6 on controller selector channel 2.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	
	RWD		6

BACKSPACE AND POSITION WRITE HEAD

BKW	T	1600000 TT00000

The tape on magnetic tape handler T is backspaced one record and the write head is positioned to write. This instruction must not be followed by a read instruction on the same tape handler. N must be zero.

The write operation following a BKW instruction adds approximately 0.20 inch to the length of the inter-record gap when used with magnetic tape subsystem model 680.

Although there is not a specific instruction to backspace and position the read head, this may be done by using a read backward instruction with N set to zero.

Example: Backspace one record to position the read head. (Channel 2, tape handler 3)

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	2	
	BKW	1000	3
		0	

Tape Reading Residue Word

During tape reading, the General Assembly Program generates a word called "residue word." The residue word contains information about the number of words in the record previously read. Information contained in the residue word varies according to whether the record length (number of words read) is equal to, greater than, or less than the number of words (N) specified on the coding sheet. The residue word contains information as follows:

1. Reading Tape Forward (any mode)

   The residue word is always placed in memory in location M + N where M is the location in memory into which the first word of the record is read and N is the number of words specified on the coding sheet. In memory layout, this extra word location must be allowed for. N + 1 word locations are always required to read N words of tape into memory. In reading tape forward, residue words are as follows:

   a. Record length exactly N words--The residue word consists of all zeros.

   b. Record length is less than N words--The residue word consists of the 2's complement of the difference between N and the record length (N - record length) and 1 in the sign position.

      Example:

      M = location 0500

      N = 50 words

      Record length = 30 words

      Information is stored in locations 0500 - 0529 (0530 - 0549 remain unchanged)

      Residue word is in location 0550

      Residue word consists of the 2's complement of 24_8 (which is 50 - 30) and 1 in the sign position

   c. Record length is greater than N words--Only N words are read. The residue word consists of the number of excess words (record - N) and 0 in the sign position. The controller remains busy until the entire record has passed the read heads and the inter-record gap is reached.

      Example:

      M = location 0500

      N = 50 words

      Record length = 75 words

      Information is stored in locations 0500 - 0549

Residue word is in location 0550

Residue word consists of 31_8 (which is 75 - 50) and 0 in the sign position

The controller remains busy until 75 words have passed the read head

Example: Two hundred words of a decimal tape record are read into memory starting at location 2000. Tape handler 3 on tape controller 1 is used.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	1	
	RTD	2000	3
		200	

The residue word is in memory location (M + N) which equals 2000 + 0200, or 2200. Three conditions can exist as shown by the chart below.

Condition	Record Length (R)	Octal Contents of 2200 (M + N)
R = N	200	0000000
R > N	250	0000062
R < N	100	3777634

If the programmer neglects to allow for the residue word, he runs the risk of destroying the contents of a memory location vital to the successful operation of his program.

2. Reading Tape Backward (any mode)

   The residue word is always placed in memory location M - N. The first word is read into location M, the second is read into M - 1, and so forth. In reading tape backward, residue words are as follows:

   a. Record length is exactly N words--The residue word consists of all zeros.

      Example:

      M = location 0500

      N = 50 words

      Record length = 50 words

Information is stored in locations 0451 - 0500

Residue word is in location 0450

Residue word consists of all zeros

b. Record length is less than N words--The residue word consists of the 2's complement of the difference between N and the record length (N - record length) and <u>1</u> in the sign position.

Example:

M = location 0500

N = 50 words

Record length = 30 words

Information is stored in locations 0471 - 0500 (0451 - 0471 remains unchanged)

Residue word is in location 0450

Residue word consists of the 2's complement of 20 (which is 50 - 30) and <u>1</u> in the sign position

c. Record length is greater than N words--Only N words are read. The residue word consists of the number of excess words (record - N) and <u>0</u> in the sign position. The controller remains busy until the entire record has passed the read heads and the inter-record gap is reached.

Example:

M = location 0500

N = 50 words

Record length = 75 words

Information is sorted in locations 0451 - 0500

Residue word location is 0450

Residue word consists of 25 (which is 75 - 50) and <u>0</u> in the sign position

The controller is busy until 75 words have passed the read head

The residue word resulting from a tape read operation indicates to the programmer the actual number of words read into memory and provides a way of determining the actual record length.

Example: Two hundred words of a decimal tape record are read into memory starting at location 2000 by a read backward instruction. Tape handler 3 on controller selector channel 1 is used.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	SEL	1	
	RBD	2000	3
		200	

The residue word is in memory location (M - N) which is 2000 - 200, or 1800. Three conditions can be indicated by the contents of the residue word as follows:

Condition	Record Length (R)	Octal Contents of 1800 (M - N)
R = N	200	0000000
R >N	250	0000062
R<N	150	3777716

Tape Interrogation Instructions

Normally, the SEL instruction selects the particular controller desired, and the second and third coding lines of the instruction group tell what is to be done by the peripheral unit connected to the controller. However, before these instructions can be programmed, the tape controller should be interrogated to determine its status: whether it is busy or whether a particular condition occurred during its previous operation. When the controller is interrogated for conditions such as end-of-file (EOF), end of tape, parity errors, or input/output buffer errors, the interrogation must be made before the next SEL instruction is executed. This is because the SEL instruction automatically resets all of the indicators.

Test-and-branch instructions are used to interrogate the controller. These instructions are performed by executing a BCS instruction specifying the particular test condition desired. BCS is the common operation code for all test instructions pertaining to the status of the controller. The instructions test to determine whether a specified magnetic tape controller condition is true or false. If the condition tested is true, the computer executes the next sequential instruction. If it is false, the computer executes the second sequential instruction (skipping the first). The following are the test-and-branch instructions for magnetic tape operations. The heading for the instruction contains first the common code, BCS. Next is the assembly program operation code for the specific instruction. The P stands for the controller selector channel number. This is followed by the octal representation of the machine coding for the instruction in which P is again the channel number. The number at the right of the heading indicates the number of word times required to bring the instruction from memory and execute it.

BRANCH ON TAPE CONTROLLER READY

BCS	BTR	P	2514P20

The tape controller is tested for the ready status.

BRANCH ON TAPE CONTROLLER NOT READY

BCS	BTN	P	2516P20

The tape controller P is tested for the not-ready status.

BRANCH ON END OF FILE

BCS	BEF	P	2514P21

The tape controller P is tested for end-of-file condition detected. (If true, the previous read command detected the end-of-file character 0001111).

BRANCH ON NO END OF FILE

BCS	BNF	P	2516P21

The tape controller P is tested for end-of-file condition not detected. (If true, the previous read command did not detect the end-of-file character 0001111.)

BRANCH ON END OF TAPE

BCS	BET	P	2514P22

The tape controller P is tested for end-of-tape condition detected. (If true, the direction of tape motion of the last instruction indicates which end of tape was detected. For example, if the previous instruction was a read backward, it was not executed and the tape handler is positioned on the load point marker. A second read backward instruction produces an error halt.)

BRANCH ON NO END OF TAPE

BCS	BNT	P	2516P22

The tape controller P is tested for end-of-tape condition not detected. (If true, the last instruction was executed and neither end of the tape was detected.)

BRANCH ON TAPE PARITY ERROR

BCS BPE P 2514P24

The tape controller P is tested for parity error detected. (If true, either a lateral or longitudinal parity error was detected during the execution of the previous instruction, or an unsuccessful erase was attempted.)

BRANCH ON TAPE PARITY CORRECT

BCS BPC P 2516P24

The tape controller P is tested for <u>no</u> parity error detected. (If true, no parity error was detected during the execution of the previous instruction or an attempted erase was successful.)

BRANCH ON INPUT/OUTPUT BUFFER ERROR

BCS BIO P 2514P25

The tape controller P is tested for detection of an input/output buffer error. (If true, either a memory exhaust, overflow, or a parity error on data transfer from the controller selector was detected.)

BRANCH ON INPUT/OUTPUT BUFFER CORRECT

BCS BIC P 2516P25

The tape controller P is tested for an input/output buffer error not detected. (If true, no memory exhaust, overflow, or parity error on data transfer from the controller selector was detected.)

BRANCH ON MOD 3 OR 4 ERROR

BCS BME P 2514P26

The tape controller P is tested for occurrence of a modulo 3 or 4 error. (If true, a partial word was accumulated at the time the inter-record gap was detected during a Read instruction, indicating that reading was in the wrong mode.)

BRANCH ON NO MOD 3 OR 4 ERROR

BCS BNM P 2516P26

The tape controller P is tested for no occurrence of a modulo 3 or 4 error. (If true, no partial word was accumulated at the time the inter-record gap was detected during a read instruction. It indicates that reading was in the correct mode.)

BRANCH ON ERROR

BCS BER P 2514P27

The tape controller P is tested for detection of an error. (If true, either a tape parity error, input/output buffer error, or MOD 3 or 4 error was detected during execution of the last instruction. Further testing is required to identify the specific type of error.)

BRANCH ON NO ERROR

BCS BNE P 2516P27

The tape controller P is tested for detection of no error. (If true, no tape parity error, input/output buffer error, or MOD 3 or 4 error was detected during execution of the last instruction.)

Notice that neither BCS BER nor BCS BNE detects end of file, end of tape, or tape rewinding.

BRANCH ON TAPE REWINDING

BCS BRW P 2514P23

The tape controller P is tested for rewinding of tape on any or all handlers. (If true, one or more tapes is rewinding on controller P.)

BRANCH ON NO TAPE REWINDING

BCS BNR P 2516P23

The tape controller P is tested for tape not rewinding. (If true, no tapes are rewinding on controller P.)

The programmer must be aware that a rewind instruction for any tape handler on a controller puts that controller in the not-ready status for 250 microseconds, after which the controller returns to the ready status even though the tape handler is still rewinding. A read or write instruction can then be given to any tape unit that is not rewinding. The controller indicates when one or more tape units are rewinding at any time during the entire rewind operation. Addressing a rewinding tape unit to read or write causes an alert halt condition.

Thus, a rewind interrogation of a tape controller will indicate that a tape is rewinding without specifying which particular tape handler.

The assembly language coding for test-and-branch instructions places the controller selector channel number in column 20 of the coding sheet as is illustrated in the following example which checks for controller 2 being ready.

Example: Test tape controller on channel 2 for ready status.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	BCS	BTN	2
	BRU	* - 1	
	SEL	2	

The BCS command in the example interrogates the controller on channel 2. If the controller is not ready, the central processor executes the next sequential instruction which is a branch back to the BCS command. Thus, a delay is effected until the controller becomes ready at which time the SEL command is executed and a tape operation can be performed.

When a magnetic tape controller is tested and found to be ready (not busy), any tape handler connected to it can be addressed by a read, write, read backwards, or rewind instruction, unless the tape handler already is rewinding. Tape handlers that are rewinding should not be addressed until the completion of the rewind operation.

A read, write, or read backward instruction puts the controller in the not-ready (busy) status until the completion of the operation. A rewind instruction puts the controller in a not-ready status for 250 microseconds, after which the controller returns to the ready status.

Example: Test tape controller on channel 1 for any error condition and branch to an error subroutine to determine the type of error, if any exists from the previous tape operation.

Assembly Language Coding

Symbol	Opr	Operand	X
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20
	BCS	BER	1
	BRU	ERROR	

TECHNIQUES OF PROGRAMMING MAGNETIC TAPE

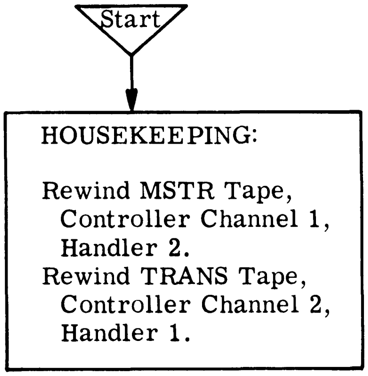
General Considerations

In processing information from magnetic tape, it is necessary that each tape be identified. Exterior labels on the tape container are required as well as interior labels on the tape itself. The interior labels are tested by the program. They must be placed in the first record of the tape, and must contain the date, identification, and reel number.

Before processing data from magnetic tape, it is good programming practice to rewind the tapes that are to be used. This makes sure that tape is at the load point when processing begins. The programmer also should program a tape rewind upon completion of processing and provide appropriate messages to the operator specifying what is to be done with the rewound tape. It is necessary to test the magnetic tape controller or controllers for ready status before attempting any tape operation.

Example 1.

Flow Chart 1



Assembly Language Coding

Symbol	Opr	Operand	X	REMARKS	
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20	31 75	
START	BCS	BTN	1	CHECK FOR CONTROLLER BUSY	
	BRU	*-1		DELAY FOR CONTROLLER BUSY	
	SEL	1		SELECT CONTROLLER 1	
	RWD		2	REWIND TAPE HANDLER 2	
	BCS	BTN	2	CHECK CONTROLLER 2 READY	
	BRU	*-1		DELAY FOR CONTROLLER READY	
	SEL	2		SELECT CONTROLLER 2	
	RWD		1	REWIND TAPE HANDLER 1	

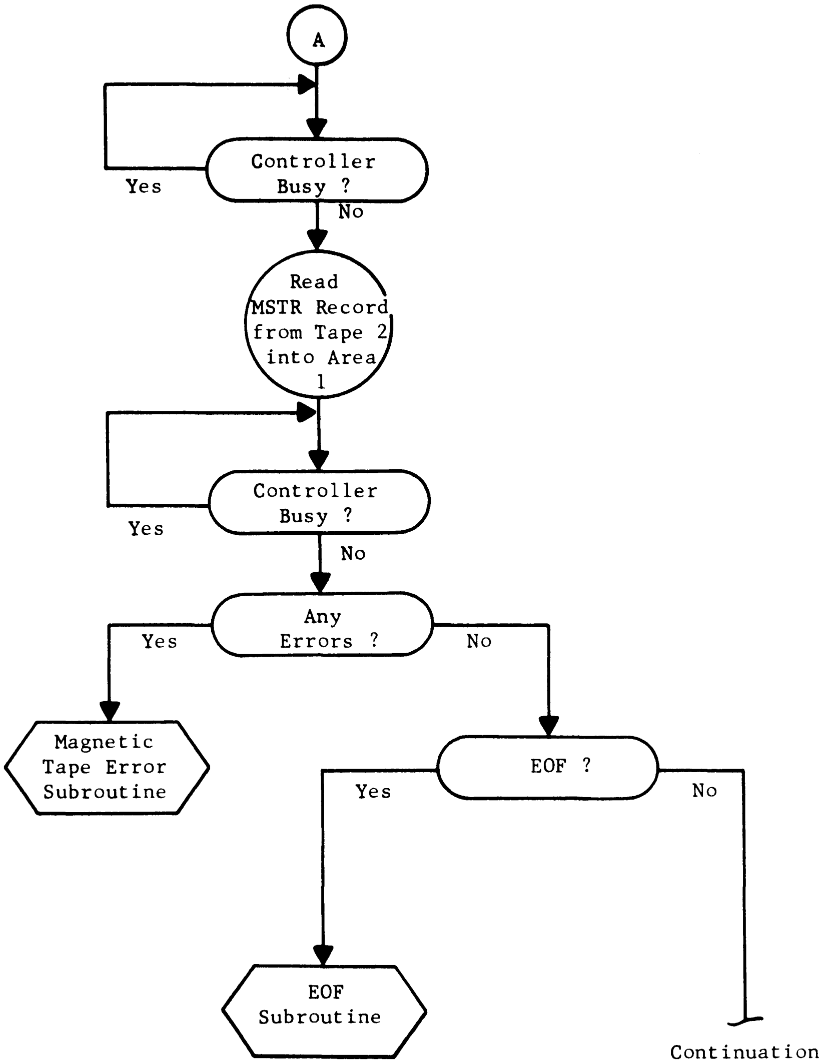
After performing a tape operation on a controller and before using the controller for another operation, tests must be made to determine if the operation was successful or if any condition such as end of file, end of tape, etc., occurred. It is essential that these tests be made before another SEL command is executed since the SEL instruction clears the controller.

Example 2. Assume that tape handlers 2 and 3 of controller on channel 1 are being used, as is indicated in the assembly language coding. The flow chart for this example is on the next page.

Assembly Language Coding

Symbol	Opr	Operand	X	REMARKS	Sequence
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20	31 75	76 77 78 79 80
A	BCS	BTN	1	CHECK FOR CONTROLLER BUSY	200
	BRU	*-1		DELAY FOR CONTROLLER BUSY	210
	SEL	1		SELECT CONTROLLER #1	220
	RTD	AREA.1	2	READ MSTR RECORD	230
		250		NO. WORDS IN RECORD	240
	BCS	BTN	1	CHECK FOR READ COMPLETED	250
	BRU	*-1		DELAY FOR READ COMPLETED	260
	BCS	BER	1	CHECK FOR READ ERROR	270
	BRU	ERROR		GO TO ERROR SUBROUTINE	280
	BCS	BEF	1	CHECK FOR END-OF-FILE	290
	BRU	EOF		GO TO END-OF-FILE SUBROUTINE	300

Flow Chart 2

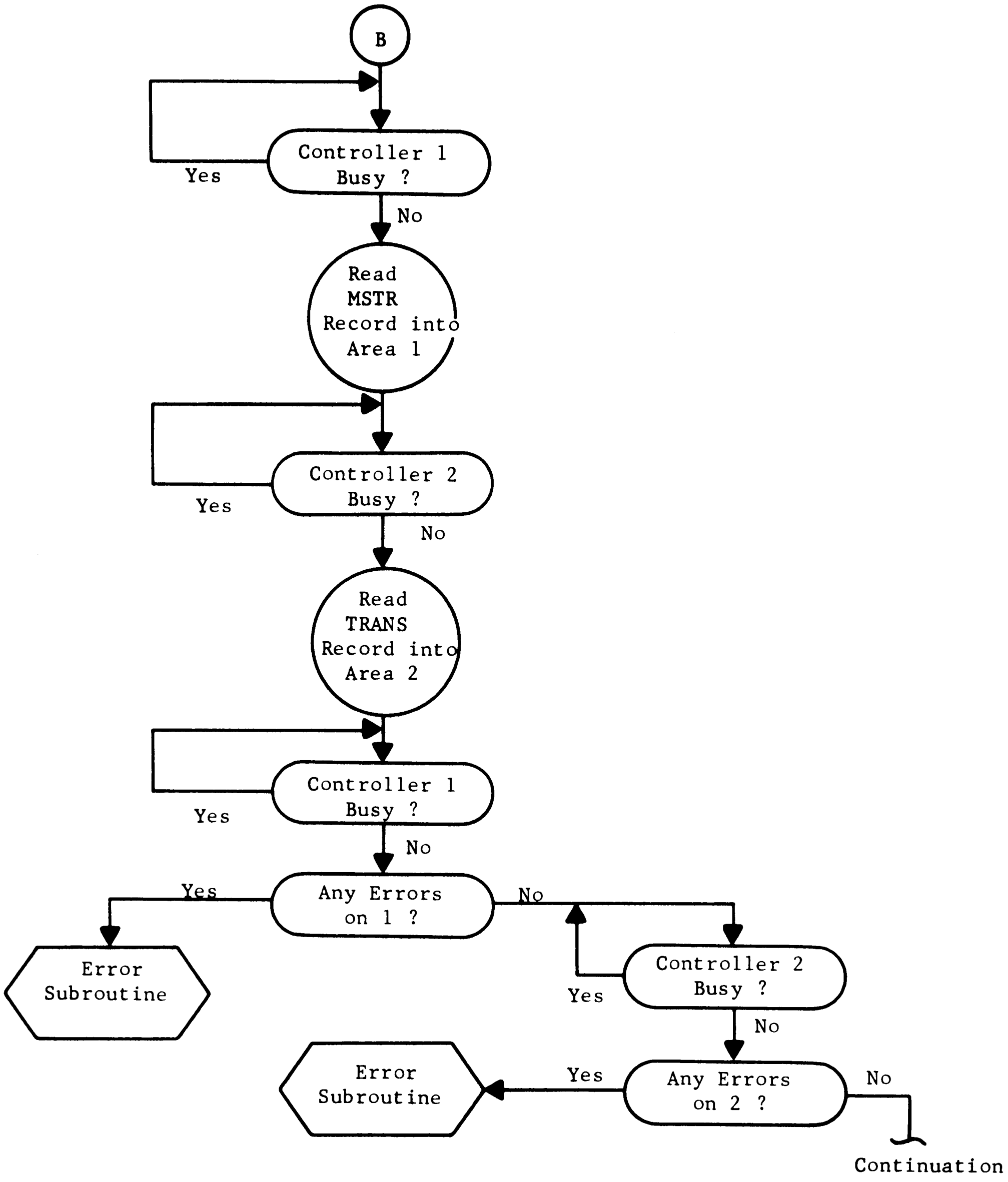


Any error occurring during the read operation in the example would cause a branch to a subroutine to determine the type of error and the corrective action necessary.

Reading and writing operations can be performed simultaneously only when two or more tape controllers are available. Again, each operation must be tested by the programmer for any errors or other conditions.

Example 3. Assume that MSTR tape is on the controller on channel 1, tape handler 1 and that TRANS tape is on the controller on channel 2, tape handler 2.

Flow Chart 3



Assembly Language Coding

Symbol	Opr	Operand	X	REMARKS	Sequence
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20	31 75	76 77 78 79 80
B	BCS	BTN	1	CHECK CONTROLLER #1 BUSY	300
	BRU	*-1			310
	SEL	1		SELECT CONTROLLER #1	320
	RTD	AREA#1	1	READ MSTR RECORD	330
		200		NO. WORDS	340
	BCS	BTN	2	CHECK CONTROLLER #2 BUSY	350
	BRU	*-1		DELAY FOR CONTROLLER BUSY	360
	SEL	2		SELECT CONTROLLER #2	370
	RTD	AREA#2	2	READ TRANS RECORD	380
		200		NO. WORDS	390
	BCS	BTN	1	CHECK CONTROLLER #1 BUSY	400
	BRU	*-1		DELAY FOR CONTROLLER BUSY	410
	BCS	BER	1	CHECK FOR ANY ERROR	420
	BRU	ERROR		GO TO ERROR SUBROUTINE	430
	BCS	BTN	2	CHECK CONTROLLER #2 BUSY	440
	BRU	*-1		DELAY FOR CONTROLLER BUSY	450
	BCS	BER	2	CHECK FOR ANY ERROR	460
	BRU	ERROR		GO TO ERROR SUBROUTINE	470
	PROCESS				

Example 4. At the conclusion of processing an old master file on controller on channel 1, **handler 1 and** creating a new master file on controller on channel 2, handler 2, write an end-of-file record on the new master and rewind both tapes.

Assembly Language Coding

Symbol	Opr	Operand	X	REMARKS	Sequence
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20	31 75	76 77 78 79 80
	BCS	BTN	1	CHECK CONTROLLER #1 BUSY	520
	BRU	*-1		DELAY FOR CONTROLLER BUSY	530
	SEL	1		SELECT CONTROLLER #1	540
	RWD		1	REWIND TU #1	550
	BCS	BTN	2	CHECK CONTROLLER #2 BUSY	560
	BRU	*-1		DELAY FOR CONTROLLER BUSY	570
	SEL	2		SELECT CONTROLLER #2	580
	WEF		2	WRITE EOF ON TU #2	590
	BCS	BTN	2	CHECK FOR EOF COMPLETION	600
	BRU	*-1		DELAY FOR COMPLETION	610
	SEL	2		SELECT CONTROLLER #2	620
	RWD		2	REWIND TU #2	630

Assembly Language Coding

Symbol	Opr	Operand	X	REMARKS	Sequence
1 2 3 4 5 6	8 9 10	12 13 14 15 16 17 18 19	20	31 75	76 77 78 79 80
START	BCS	BTN	4	CHECK FOR CONTROLLER 4 BUSY	200
	BRU	* - 1		DELAY FOR CONTROLLER BUSY	210
LOOP	SEL	4		SELECT CONTROLLER 4	220
	RTD	1000	1	READ A RECORD FROM INPUT TAPE	230
		50		NO WORDS IN RECORD	240
	BCS	BTN	4	CHECK FOR CONTROLLER BUSY	250
	BRU	* - 1		DELAY FOR CONTROLLER BUSY	260
	BCS	BER	4	CHECK FOR READ ERROR	270
	SPB	ERROR	1	GO TO ERROR SUBROUTINE	280
	BCS	BET	4	CHECK FOR END OF TAPE	290
	SPB	TAPE	1	GO TO END OF TAPE SUBROUTINE	300
	BCS	BEF	4	CHECK FOR END OF INPUT FILE	310
	BRU	END4		GO TO REWIND TAPE 4	320
	BCS	BTN	5	CHECK FOR CONTROLLER BUSY	330
	BRU	* - 1		DELAY FOR CONTROLLER BUSY	340
	SEL	5		SELECT CONTROLLER 5	350
	WTD	1000	2	WRITE RECORD ON TAPE	360
		50		NO WORDS IN RECORD	370
	BCS	BTN	5	CHECK FOR CONTROLLER BUSY	380
	BRU	* - 1		DELAY FOR CONTROLLER BUSY	390
	BCS	BER	5	CHECK FOR ERROR	400
	SPB	ERROR	1	GO TO ERROR SUBROUTINE	410
	BCS	BET	5	CHECK FOR END OF TAPE	420
	SPB	TAPE	1	GO TO END-OF-TAPE SUBROUTINE	430
	BRU	LOOP		GO TO LOOP	440
END4	SEL	4		SELECT CONTROLLER 4	450
	RWD		1	REWIND INPUT TAPE	460
	SEL	5		SELECT CONTROLLER 5	470
	WEF		2	WRITE END OF FILE ON OUTPUT TAPE	480
	BCS	BTN	5	CHECK FOR CONTROLLER BUSY	490
	BRU	* - 1		DELAY FOR CONTROLLER BUSY	500
	BCS	BER	5	CHECK FOR ERROR	510
	SPB	ERROR	1	GO TO ERROR SUBROUTINE	520
	SEL	5		SELECT CONTROLLER 5	530
	RWD		2	REWIND OUTPUT TAPE	540
	BRU	*		HALT	550

Example 5. The following example demonstrates reading, writing, testing for end of file and end of tape, and rewinding tapes. This example transfers information from tape handler 1 on controller on channel 4 to tape handler 2 on controller on channel 5. In the example, only one area in memory is used for both reading and writing. This is the 51-word area starting at location 1000. Both the error routines and tape routines use index register 1.

It should be remembered that the General Assembly Program generates a line of coding for the third word of the WEF and RWD instructions. It is important to consider the necessity for writing the delay instructions when initiating action on the individual tape handlers. When information is transferred from or to a tape handler, the controller is busy during the transfer. All operations affecting any tape handler on the same controller must be delayed until the transfer is completed (by use of the appropriate BCS and BRU commands). When rewinding tapes on the same controller, the rewind controller is busy for 250 microseconds; therefore rewind instructions in a series should be preceded by appropriate BCS and BRU commands. It is desirable to precede all operations which affect magnetic tape with appropriate BCS and BRU commands.

Multireel Flip-Flopping

The use of magnetic tapes implies files of great size, and in many applications a file consists of more than one reel of tape. Thus, whenever the end of a tape or the end of a file is reached, the tape reel must be rewound, removed, and replaced with the next tape to be processed. To maintain the continuity of the running program, it is worthwhile to program an immediate switch, or alteration, from the just-completed tape to a succeeding tape (already mounted on another tape handler). This is accomplished by a technique called flip-flopping of multireel tape files.

This technique permits the mechanical rewind and manual removal of the completed tape to proceed entirely independent of further processing. If sufficient tape handlers are not available to permit such convenient switching of all files, then the most extensive files should be given priority in the allotment of tape handlers.

As explained earlier, the actual number of the tape handler (T) to perform a specified operation appears in bit positions 0-4 of the third coding line (word 3). The tape handler is selected according to the following formats:

Handler Number	Bits 0-4
0	00001
1	00010
2	00100
3	01000
4	10001
5	10010
6	10100
7	11000

These configurations make flip-flopping of multireel tape files relatively easy. If the proper combinations of tape handlers are used, one need only load the third instruction word of a magnetic tape instruction into the A-register, change the sign, and store the word back into memory.

For example, assume a multireel file is placed on tape handler 1 and the second reel on tape handler 5. When the end-of-file indication is reached on the tape on tape handler 1, the third word of the instruction is loaded into the A-register, the sign changed, and then stored in memory as the third word of the tape instruction. Notice that the only difference in bit positions 0 thru 4 of the codes for the two handlers is a difference in bit position 0, the sign bit position. The same technique can be used for the following tape handler combinations which are identical except for the bit in the sign position:

0 ↔ 4

1 ↔ 5

2 ↔ 6

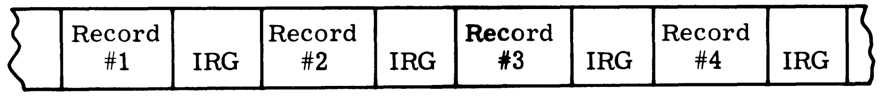
3 ↔ 7

Thus, if a spare tape handler is available during a given program run, the flip-flopping of handler numbers of all tape instructions related to a given multireel file, after an end-of-file condition, allows the program to continue uninterrupted while the used up reel is rewinding.

Processing Magnetic Tape Records

The central processor is capable of performing simultaneous peripheral operations. This is of particular importance in processing magnetic tape data in that reading and writing can be done simultaneously with two tape controllers. However, the time consumed processing tape data is directly affected by the arrangement of the data records on the tape. For example:

Tape A. 24-Word BCD Records, 15 kc Tapes



The tape time involved in reading these records is calculated by the following timing formula.

$$\frac{3RW}{K} + (R)\,S = \text{time in seconds}$$

R = Number of records

W = Words per record

K = Tape transfer rate in characters per sec

S = Start-stop time in IRG

This equation is only for tapes with BCD data. For binary tapes the expression (3 RW) should be replaced by (4 RW).

For tape A, the tape time for reading the data is:

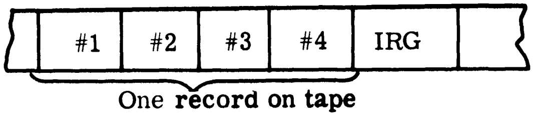
$$\frac{3 \times 4 \times 24}{15000} + 4(0.018) = \underline{0.0912 \text{ sec}}$$

This time is based on a start-stop time in the IRG of 18 milliseconds for both the high-density and the low-density magnetic tape subsystems.

If the data on tape A were written on tape B as only one blocked record of 96 words, as shown below, the time to read the data is:

$$\frac{3 \times 1 \times 96}{15000} + (1)(0.018) = 0.0372 \text{ sec}$$

Tape B



The time saved in reading the data from tape B as compared to tape A is due to elimination of three inter-record gaps and to the blocking of four records into one. Blocking of records can result in considerable reduction in tape processing time.

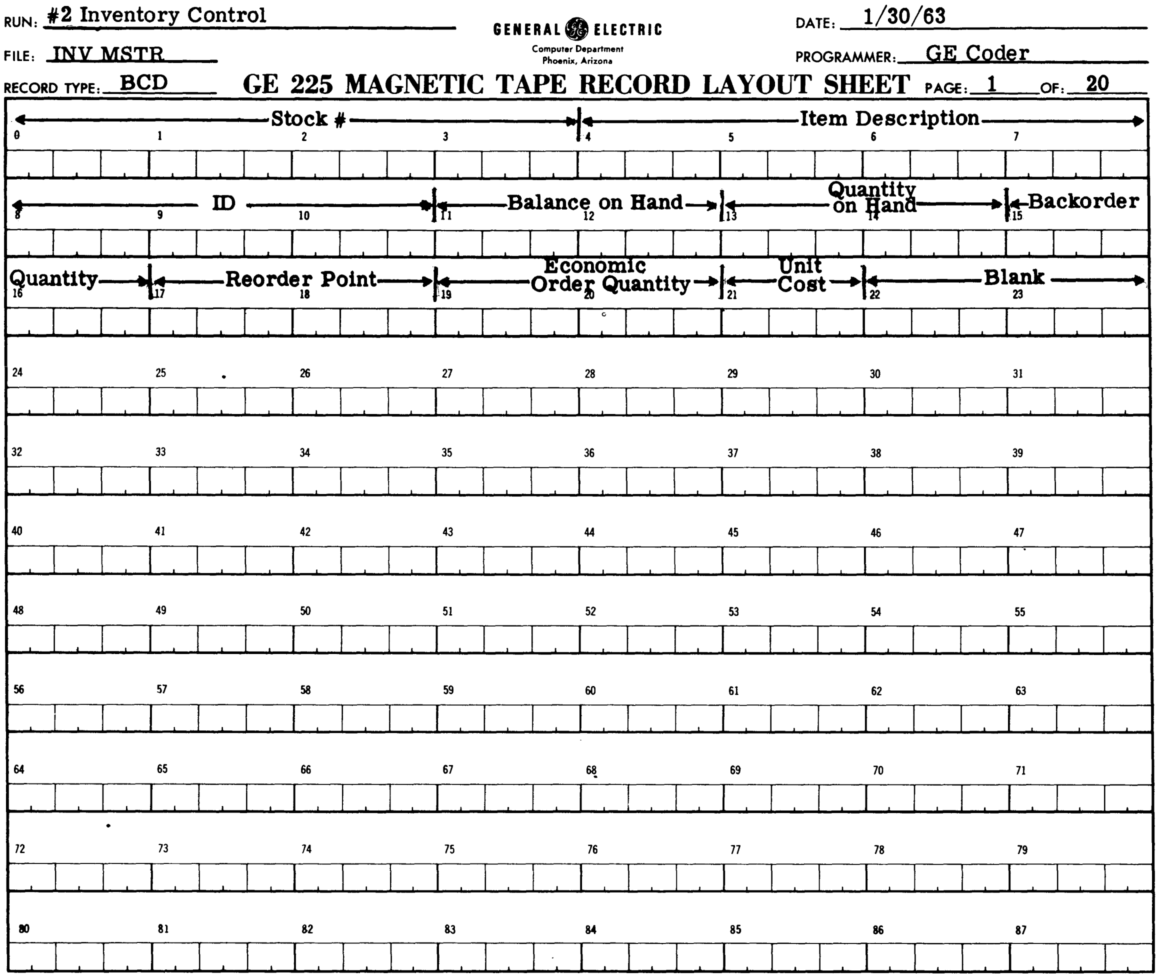
Record Documentation

Adequate record documentation on the part of the systems designer or the programmer helps reduce programming costs, machine time needed for debugging, and file maintenance costs. Figure II-1 illustrates a record layout sheet for systems designer or programmer use. Documentation of this type provides a clear description of the contents of a record, the size of each individual data field, and the size of the record itself.

MAGNETIC TAPE INPUT/OUTPUT SOFTWARE

Although it is important for the programmer to understand input/output programming for magnetic tape operations, he will most often use the software designed to perform the input and output for him. The functions which it performs are:

1. Blocking or unblocking (if desired).



RUN: #2 Inventory Control

GENERAL ELECTRIC
Computer Department
Phoenix, Arizona

DATE: 1/30/63

FILE: INV MSTR

PROGRAMMER: GE Coder

RECORD TYPE: BCD

GE 225 MAGNETIC TAPE RECORD LAYOUT SHEET

PAGE: 1 OF: 20

← Stock # → | ← Item Description →
0 1 2 3 4 5 6 7

← ID → | ← Balance on Hand → | ← Quantity on Hand → | ← Backorder
8 9 10 11 12 13 14 15

Quantity → | ← Reorder Point → | ← Economic Order Quantity → | ← Unit Cost → | ← Blank →
16 17 18 19 20 21 22 23

24 25 26 27 28 29 30 31

32 33 34 35 36 37 38 39

40 41 42 43 44 45 46 47

48 49 50 51 52 53 54 55

56 57 58 59 60 61 62 63

64 65 66 67 68 69 70 71

72 73 74 75 76 77 78 79

80 81 82 83 84 85 86 87

Figure 18. Sample Magnetic Tape Record Layout Sheet

2. Reading and writing in 20-bit binary, BCD, or 18-bit binary format.
3. Buffering (if desired).
4. Detecting read/write errors and attempted reread/rewrite errors.
5. Rewinding.
6. Swapping magnetic tape.
7. Counting blocks and logical record.
8. Checking and writing labels.

9. End-of-file functions.
10. End-of-tape functions.
11. Rerun functions.
12. Producing typewriter messages concerning magnetic tape files.
13. Executing user's coding sections at beginning and ending of magnetic tapes, end of file, and rerun point.

For a more complete description of what the system does and of how it is used, refer to the publication CPB-265, GE-225 Symbolic Tape Input/Output System, SIOS.

3. OPERATING PROCEDURES

MAGNETIC TAPE CONTROLS AND INDICATORS

Before explaining actual operations, individual switches and indicators will be reviewed. These have already been described in Chapter 1 of this manual.

Tape Handlers

The control and indicator panel for tape handler models 680 and 690 is shown on Figure 19. The panels for both models appear to be identical. There is, however, one difference. On model 680, the HI DEN/LO DEN switch is locked at the LO DEN position of 200 bits per inch. Since only one density of tape can be used with model 680, there is no need to use a density switch. Figure 20 summarizes the descriptions of tape handler switches and indicators. All switches except the rotary selector switch are of the pushbutton type.

Tape Controllers

Magnetic tape controllers for subsystem models 680 and 690 have control and indicator panels like the one shown at the top of Figure 19. Functions of these switches and indicators and their use are the same for both models. All switches are of the pushbutton type. They are summarized in Figure 20.

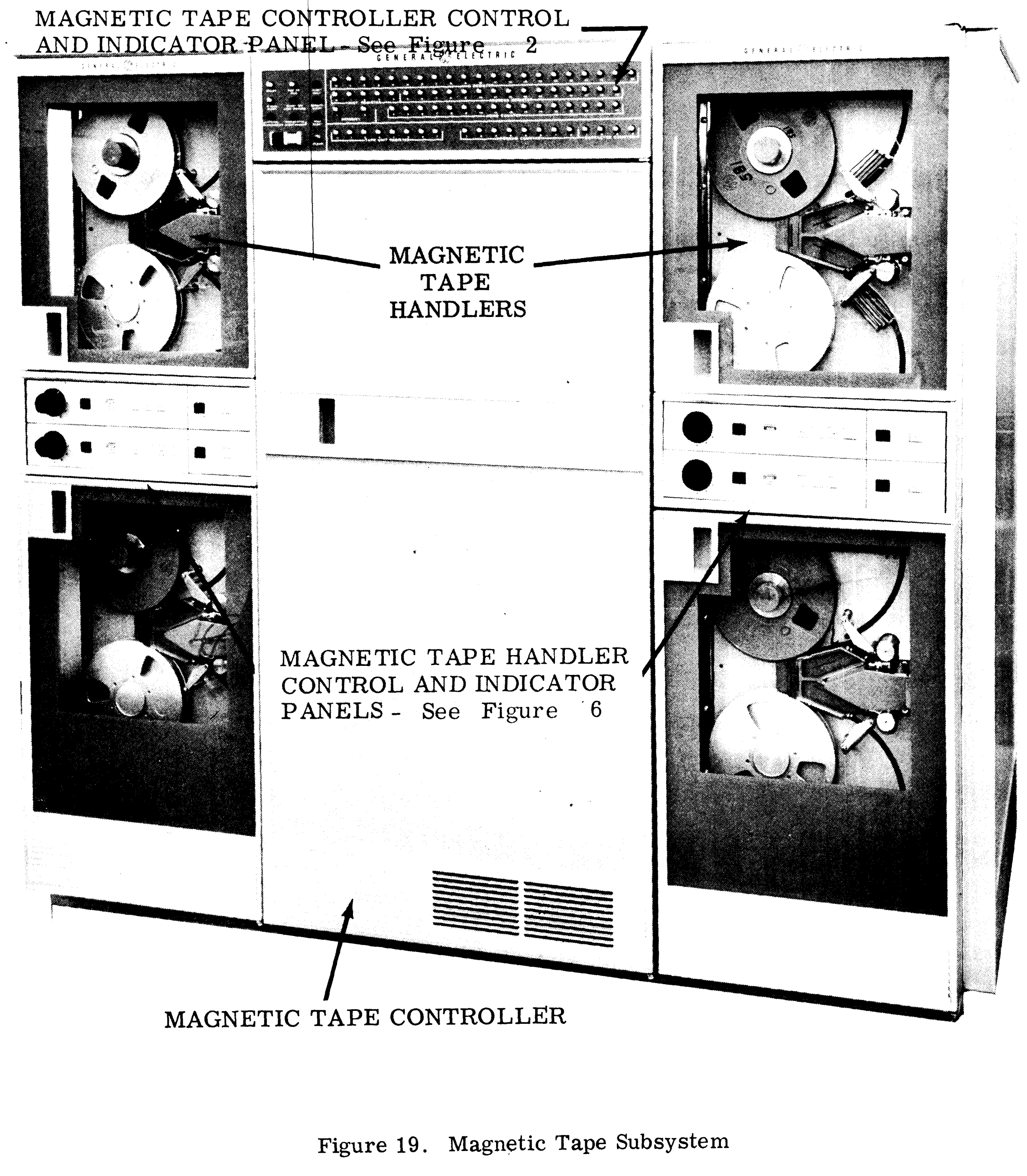


Figure 19. Magnetic Tape Subsystem

Location	Control or Indicator	Function
Magnetic tape handler control and indicator panel, (See Figure 6).	Rotary selector switch and indicator.	Establishes and indicates address on the controller of the magnetic tape handler.
	POWER ON switch and indicator (red).	Turns on power to the magnetic tape handler when depressed once; turns power off when depressed again. Glows red to indicate when power is on.
	REMOTE/LOCAL switch and indicator (REMOTE is blue, LOCAL is white).	Determines and indicates by illumination whether operation is to be REMOTE (on-line) by the central processor or LOCAL (off-line at the handler's control panel).
	REWIND switch and indicator (white).	Rewinds magnetic tape at double speed (150 inches/second) under manual control when REMOTE/LOCAL switch is in LOCAL position. Stops on the leader marker. Glows white during rewind.
	REVERSE switch and indicator (white).	Moves tape in the rewind direction at normal speed (75 inches/second) under manual control when REMOTE/LOCAL switch is in LOCAL position. Stops on the leader marker. Glows white during reverse movement.
	FORWARD switch and indicator (white).	Moves tape in the forward direction at normal speed under manual control when REMOTE/LOCAL switch is in LOCAL position. Glows white during forward motion.
	STOP switch.	Halts tape movement under manual control when REMOTE/LOCAL switch is in LOCAL position.
	ADDR/WRITE INH indicator (white).	ADDR half of indicator glows white when the tape handler is being addressed for either a read or write operation. WRITE INH half of indicator glows white when tape supply reel does not have a write-permit ring installed (only reading is possible).

Figure 20. Summary of Controls and Indicators

Location	Control or Indicator	Function
Magnetic tape handler control and indicator panel (continued).	HI DEN/LO DEN switch and indicator, (white).	Selects density as HI (555.5 bpi) or LO (200 bpi). The selected density indicator glows white.
Magnetic tape controller control and indicator panel (See Figure 2).	READY indicator (white).	Glows white when magnetic tape controller is available to be selected by central processor through controller selector.
	END OF FILE indicator (white).	Glows white when an end of file has been reached.
	ALERT HALT indicator (blue).	Glows blue when an error condition requiring operator action has halted the controller. See Chapter 1 on error conditions.
	N REG ALERT indicator (white).	Glows white when a parity error resulted in the transfer from memory to the controller.
	ALERT ON LAST RECORD indicator (red).	Glows red when error occurs on last record of tape being read or written.
	MEMORY ALERT indicator (red).	Glows red when a delay results because a read or write instruction reaches the controller before its input/output register is empty.
	LATERAL PARITY ALERT indicator (red).	Glows red when an error is detected by lateral parity check.
	HORIZONTAL PARITY ALERT indicator (red).	Glows red when an error is detected by horizontal parity check.
	MOD ALERT indicator (red).	Glows red when a record word check on record read from tape shows that the record does not consist of whole words.
	POWER ON switch and indicator (red).	Turns on power to the magnetic tape subsystem. Glows red when power is on.

Figure 20. (Cont.)

Location	Control or Indicator	Function
Magnetic tape controller control and indicator panel (continued).	POWER OFF switch.	Turns power off to magnetic tape subsystem.
	CLEAR switch.	Clears circuitry of error indications after alert halt condition has occurred.
	N REGISTER display indicators (white).	Glow white to display contents of N register which serves as input/output buffer between magnetic tape subsystem and central processor.
	INST REGISTER display indicators (white).	Glow white to display operation code portion of current instruction.
	ADDRESS REGISTER display indicators (white).	Glow white to display address (location in memory) portion of current instruction.
	PRIORITY display indicators (white).	Glow white to indicate phases of controller access to central processor.
	WORD COUNTER display indicators (white).	Glow white to display quantity of words to be written on or read from tape.
	TAPE UNIT REGISTER display indicators (white).	Glow white to indicate which magnetic tape handler is currently engaged.
	PROGRAM COUNTER display indicators (white).	Glow white to indicate sequencing in the controller.
	CHARACTER COUNTER display indicators (white).	Glow white to indicate the character count as words are read from or written on tape.

Figure 20. (Cont.)

STARTING PROGRAM OPERATION

After the central processor is readied for operation, the following steps initiate magnetic tape operations:

1. Depress the POWER ON switch on the magnetic tape controller (it will glow red).
2. Depress the POWER ON switch on the tape handler to be used (it will glow red).
3. Mount tapes on the handlers (instructions for this follow).
4. By use of the console of the central processor, start tape operations as follows:

   a. If the system has a card reader--use a call card to initiate tape reading. Almost any combination of the use of cards and magnetic tape is possible. For example, both the program and the data can be on tape; the program can be on cards and the data on tape or vice versa; or, the master file of data can be on tape and the program and transaction file of data can be on cards. See the Compatibles/200 Punched Card Subsystem Reference Manual CPB-302 for card reading instructions.

   b. If the system is without a card reader--tape reading is initiated by a bootstrap program which is entered manually by means of console switches. When the bootstrap program is executed, it reads in the first tape record, which is a loader. The loader in turn reads in the program, any necessary data, and starts program execution. The example which follows demonstrates entering a bootstrap program to read binary tape. The bootstrap program consists of six instructions stored in memory locations $(00144 - 00151)_8$ and tape is read into memory beginning at location zero. All switches referred to in the example below are on the console of the central processor. Refer to the GE-225 or GE-235 Reference Manuals CPB-252A and CPB-374 for console switch descriptions.

Use tape controller on channel 1 and tape handler 2 and initiate reading the binary tape. Enter the bootstrap program as follows:

1. Set the INSTR/WORD switch to the INSTR position.

2. Set the AUTO/MANUAL switch to the MANUAL position.

3. Toggle the RESET A switch to clear the A-register.

4. Load an STA instruction into the A-register using the A-register input switches. This instruction is an octal 0300144, in which $(00144)_8$ is the memory address where the information in the A-register is to be stored.

5. Depress the A→I switch.

6. Toggle the RESET A switch.

7. Load a SEL instruction into the A-register using the A-register input switches. This instruction is an octal 2500P20 in which P is to be controller on channel 1.

8. Depress the START switch to store the SEL instruction in memory location $(00144)_8$.

9. Toggle RESET A.

10. Load an STA instruction into the A-register designating memory location $(00145)_8$ as the address for storage. The instruction is an octal 0300145.

11. Depress A→I.

12. Toggle RESET A.

13. Load the octal equivalent of the word 2 of the tape instruction including an operation code and the memory location into which tape reading is to commence. In this case, load an octal 0500000 to read tape binary starting at location 00000.

14. Depress START to store word 2 of the tape instruction in location $(00145)_8$.

15. Toggle RESET A.

16. Load an STA instruction into the A-register, designating memory location $(00146)_8$. The instruction is an octal 0300146.

17. Depress A→I.

18. Toggle RESET A.

19. Load the octal equivalent of word 3 of the tape instruction including the number of the tape handler to be used and the number of binary words to be written from the first tape record. In this case, load an octal 0400060 to designate tape handler 2 and a record of $(50)_{10}$ words.

20. Depress START to store word 3 of the tape instruction in location $(00146)_8$.

21. Toggle RESET A.

22. Load an STA instruction into the A-register, designating memory location $(00147)_8$. The instruction is 0300147.

23. Depress A→I.

24. Toggle RESET A.

25. Load the octal equivalent of the Branch, Tape Controller Not Ready instruction to test controller on channel 1 for completion of reading the first tape record. This instruction is octal 2516120.

26. Depress START to store the BCS BTN instruction in location $(00147)_8$.

27. Toggle RESET A.
28. Load an STA instruction into the A-register, designating memory location $(00150)_8$. The instruction is 0300150.
29. Depress A→I.
30. Toggle RESET A.
31. Load the octal equivalent of the BRU instruction to complete the branch test. This instruction is an octal 2600147, in which 00147 is the location of the BCS BTN instruction.
32. Depress START to store the BRU instruction in location $(00150)_8$.
33. Toggle RESET A.
34. Load an STA instruction into the A-register, designating memory location $(00151)_8$. The instruction is an octal 0300151.
35. Depress A→I.
36. Toggle RESET A.
36. Toggle RESET A.
37. Load the octal equivalent of the BRU instruction to branch to the first location into which tape has just been read. This starts execution of the instructions of the loader. The BRU instruction is octal 2600000 with zero as the location of the branch.
38. Depress START to store the BRU instruction in location $(00151)_8$.
39. Toggle RESET A.
40. Load the octal equivalent of the BRU instruction to branch to the first instruction of the bootstrap program. This is the SEL instruction in location $(00144)_8$. The BRU instruction is an octal 2600144.
41. Depress A→I.
42. Set the AUTO/MANUAL switch to the AUTO position.
43. Depress START.

MOUNTING TAPE

The steps in mounting tapes are as follows. Unless specified otherwise, controls and indicators referred to are on the tape handler control and indicator panel. See Figure 21.

1. Check to make sure the service engineer has connected the magnetic tape controller to the correct controller selector channel. The identification number on the channel

must correspond to the address specified by the program for this magnetic tape controller. This number is included in the operating instructions for the program.

2. Depress the POWER ON switch located on the magnetic tape controller control and indicator panel.

3. Depress the POWER ON switch on the magnetic tape handler control and indicator panel of each handler to be used.

4. Ready each magnetic tape handler to be used for reading or writing as follows:

   a. Set the REMOTE/LOCAL switch to the LOCAL position.

   b. Select a reel of tape.

      (1) If the tape is to be used for writing, select a scratch reel of tape (one with no information to be saved) and install a write-permit ring in the groove on the back of the reel to permit writing.

      (2) If the tape is to be used for reading, check the label to see that it is the correct tape and make sure that the write-permit ring is removed.

   c. Place the tape reel (grooved side first) onto the upper reel mounting hub. The reel must be fully seated on the mount; hold the reel in place with one hand (be sure to press only on the reel hub) and tighten the knob by turning it clockwise. Never tighten the reel mount knob more than necessary to secure the reel; overtightening will result in damaging the threads of the knob screw.

   d. Pull the dust cover open slowly. This causes the tape takeup arms to be pulled into the open position. There must be an audible click as the mechanism goes into the cocked position. If the click is not heard, close the dust cover and reopen it slowly to cause the click. This procedure also releases brakes holding the mount hubs and allows the reels to turn freely.

   e. Thread the tape leader through the guides as shown in Figure 21. Wind the end of the tape leader around the hub of the takeup reel and manually turn the reel approximately six revolutions (clockwise) to secure the tape. The tape end must lie straight and flat on the lower reel. If the tape is folded, bunched, or protrudes from the reel, it could cause damage to the working portion of the tape.

   f. Prior to closing the dust cover, pull it back slightly to release the thread switch. Do not let it slam; it could cause damage to the handler assembly.

   g. If tape is not drawn into the vacuum pocket by the vacuum, tap the tape lightly over the vacuum pocket opening until the tape is drawn into the opening.

   h. Depress the FORWARD switch.

      (1) If the tape is threaded properly, the load point marker has not yet passed the sensing cells, and the tape will stop on or a little beyond the foil.

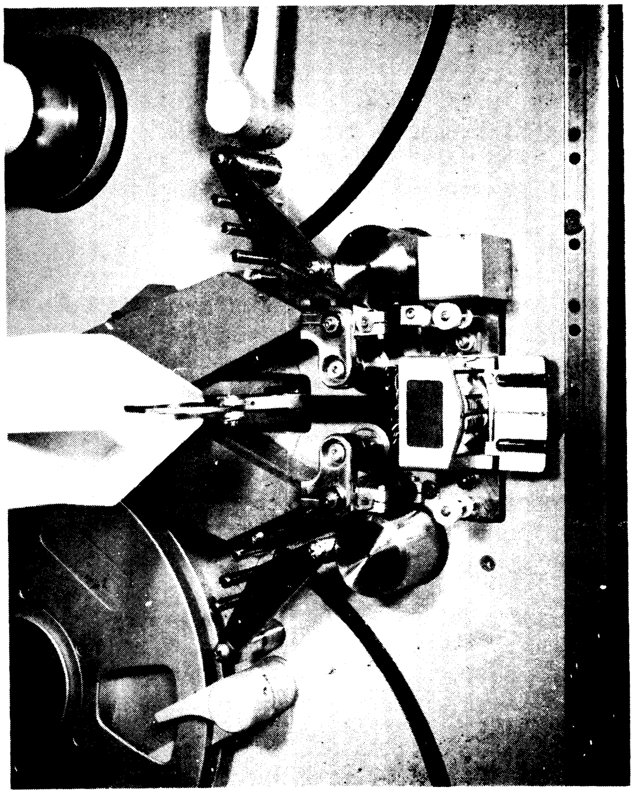


Figure 21. Threading Tape Through Magnetic Tape Handler

(2) If the tape happened to be threaded with the load point marker beyond the sensing cells, the tape will keep right on going. In this case, the operator must stop the tape by depressing STOP.

i. Depress the REWIND switch to bring the tape to the load point marker.

j. Set the selector switch to the number required by the program.

k. Depress the CLEAR switch on the magnetic tape controller control and indicator panel.

l. Set the REMOTE/LOCAL switch to the REMOTE position.

UNLOADING TAPE

After a program has been run, remove tapes as follows (included are the shutdown procedures for the magnetic tape subsystem, which apply only at the time of system shutdown at the end of the day):

1. Rewind any magnetic tapes not rewound by program control as follows:
    a. Set the REMOTE/LOCAL switch to the LOCAL position.
    b. If tape appears to be rewound to approximately the load point marker, depress REVERSE to make sure it is on the foil.
    c. If a considerable amount of tape is on the takeup reel, depress REWIND to bring the tape more quickly to the leader foil.
    d. Open the dust cover slightly so the vacuum decreases slowly; otherwise, tape can be sucked into the pockets and cause damage.
    e. Rewind the upper reel by turning it by hand until all the tape is rewound. The hand winding prevents causing damage to both tape and equipment.
2. Remove the top reel of magnetic tape from each magnetic tape handler used in the program as follows:
    a. Turn the knob in the center of the top reel mounting hub counterclockwise to release the reel.
    b. Remove the reel.
        (1) If the information on the reel <u>is not</u> to be saved, place it in a clean container and store it with "non-save" tapes.
        (2) If the information on the reel <u>is</u> to be saved, make doubly sure to remove the write-permit ring, and fasten an adhesive-backed label with the following or similar information (as specified locally) onto the reel:

            Date

            Particular tape handler used

            Programmer or project name and the destination of tape (name of program or programmer that will use it).

            Place the reel in a clean container and file it in an area specified for tapes to be saved.
3. If it is the end of the day's operation, or normal shutdown for some other reason, the following additional steps should be taken:
    a. Release the spring tension on the dust covers to avoid damage to the covers' springs.

b. Depress each lighted POWER ON switch on the magnetic tape handlers to turn off power to these units. Power to the handlers must be turned off before it is turned off to their controllers.

c. Depress the POWER OFF switch on each magnetic tape controller.

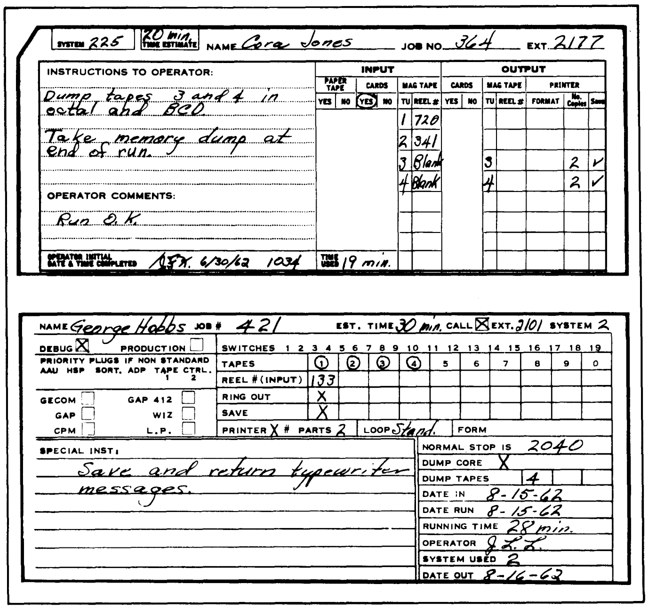
SPECIAL PROCEDURES

Using Operator Instruction Forms

Various types of forms are used at individual computer sites, and the operator needs to become familiar with these. The forms illustrated in this section are samples of types of forms used in connection with magnetic tape operations.

Operator Instruction Cards. Cards are used to provide a compact form of instructions to the operator, as illustrated in Figure 22. Here, all necessary information is written on a card the size of a tab card. It should be noted that on each of these cards there is a space for the operator to write his initials, the date, the running time of the program, as well as any special remarks about the operation of the run.

Operator Instruction Sheet. This form, illustrated in Figure 23, was developed for use in run books, but is also found useful in giving instructions for nonproductive types of runs and during debugging stages of runs which would later have their own run books.



SYSTEM 225 | 20 min. TIME ESTIMATE | NAME Cora Jones JOB NO. 364 EXT. 2177

INSTRUCTIONS TO OPERATOR:

Dump tapes 3 and 4 in octal and BCD.

Take memory dump at end of run.

OPERATOR COMMENTS:

Run O.K.

OPERATOR INITIAL DATE & TIME COMPLETED A.F.K. 6/30/62 1034

TIME USED 19 min.

INPUT						OUTPUT						
PAPER TAPE		CARDS		MAG TAPE		CARDS		MAG TAPE		PRINTER		
YES	NO	[✓ YES]	NO	TU	REEL #	YES	NO	TU	REEL #	FORMAT	No. Copies	Save
				1	720							
				2	341							
				3	Blank			3			2	✓
				4	Blank			4			2	✓

NAME George Hobbs JOB # 421 EST. TIME 30 min. CALL ☒ EXT. 2101 SYSTEM 2

DEBUG ☒ PRODUCTION ☐

PRIORITY PLUGS IF NON STANDARD
AAU HSP SORT. ADP TAPE CTRL. 1 2

GECOM ☐ GAP 412 ☐
GAP ☐ WIZ ☐
CPM ☐ L.P. ☐

SWITCHES 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

TAPES	①	②	③	④	5	6	7	8	9	0
REEL # (INPUT)	133									
RING OUT	X									
SAVE	X									

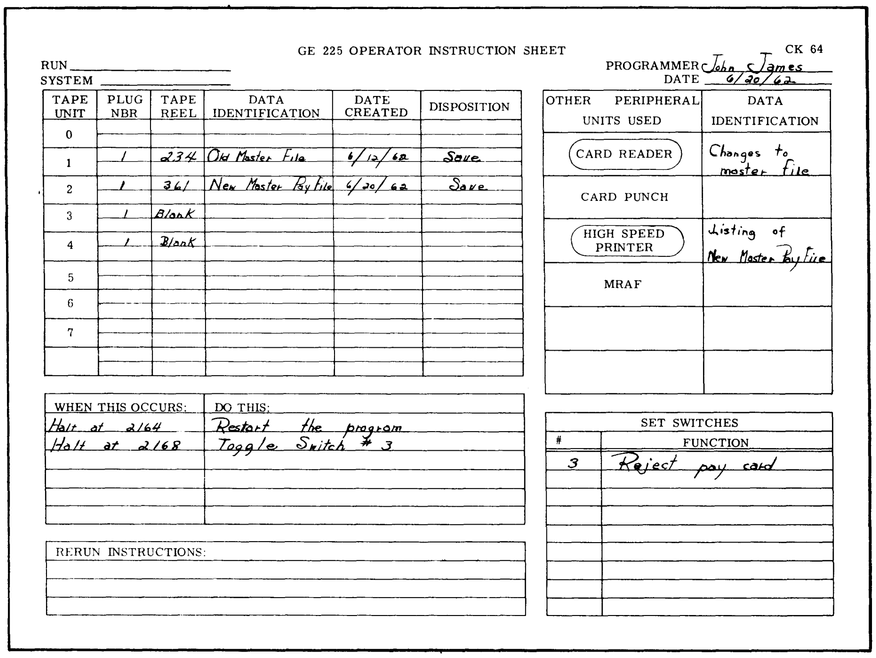
PRINTER X # PARTS 2 LOOP Stand. FORM

SPECIAL INST:

Save and return typewriter messages.

NORMAL STOP IS 2040
DUMP CORE X
DUMP TAPES 4
DATE IN 8-15-62
DATE RUN 8-15-62
RUNNING TIME 28 min.
OPERATOR J.L.L.
SYSTEM USED 2
DATE OUT 8-16-62

Figure 22. Two Types of Operator Instruction Cards



GE 225 OPERATOR INSTRUCTION SHEET

CK 64

RUN
SYSTEM

PROGRAMMER John James
DATE 6/20/62

TAPE UNIT	PLUG NBR	TAPE REEL	DATA IDENTIFICATION	DATE CREATED	DISPOSITION
0					
1	1	234	Old Master File	6/12/62	Save
2	1	361	New Master Pay File	6/20/62	Save
3	1	Blank			
4	1	Blank			
5					
6					
7					

OTHER PERIPHERAL UNITS USED	DATA IDENTIFICATION
[✓ CARD READER]	Changes to master file
CARD PUNCH	
[✓ HIGH SPEED PRINTER]	Listing of New Master Pay File
MRAF	

WHEN THIS OCCURS:	DO THIS:
Halt at 2164	Restart the program
Halt at 2168	Toggle Switch # 3

SET SWITCHES	
#	FUNCTION
3	Reject pay card

RERUN INSTRUCTIONS:

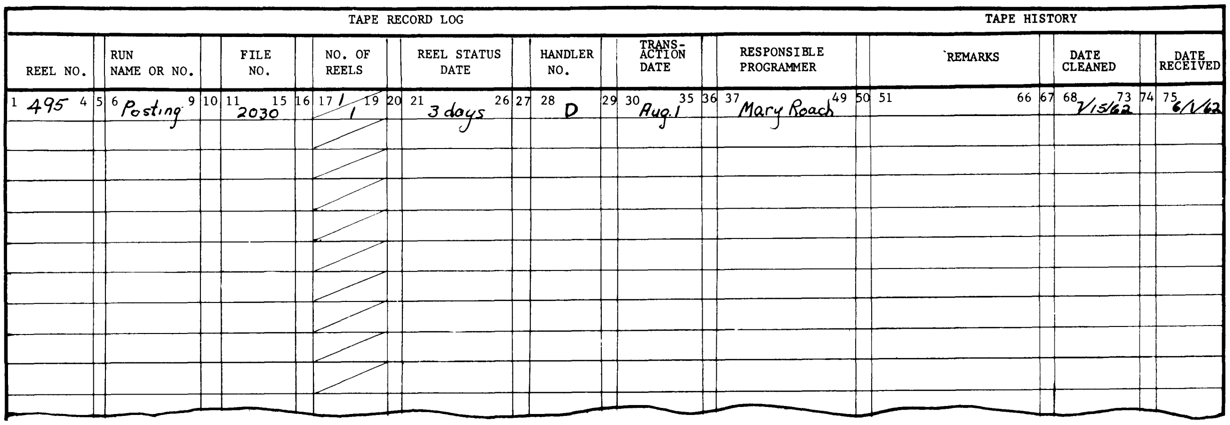
Figure 23. Sample Instruction Sheet for Operators

Establishing Library Storage and Reference Files

A regular library storage and handling procedure should be established for magnetic tapes. Some sites may be large enough to have a librarian to control the storage and use, while at other locations, the operators have this responsibility.

Either a librarian or the senior operator should establish procedures for storage, checkout, and use of master tapes, save tapes, and scratch tapes. Master tapes are those which contain a master file of permanent or semi-permanent information. The information on the tapes is updated rather than replaced. Save tapes are those which contain information which must be saved for a short period of time. Scratch tapes are those which have information which is of no further use and may be destroyed.

Tapes should be identified by numbers painted on their reels. A tape control form such as the one illustrated in Figure 24 can be used for record purposes.

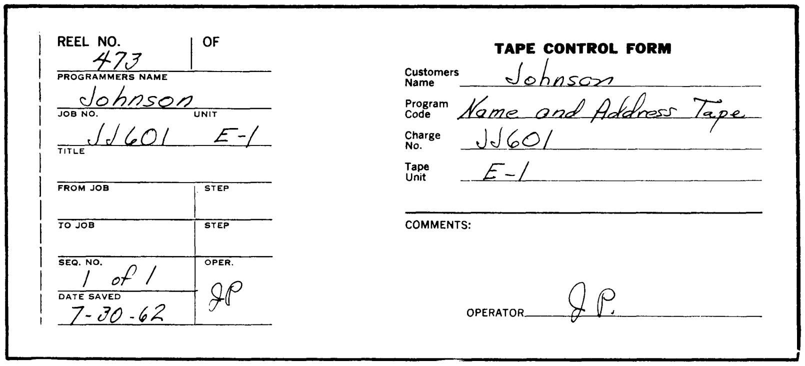


TAPE RECORD LOG																TAPE HISTORY				
REEL NO.		RUN NAME OR NO.		FILE NO.		NO. OF REELS		REEL STATUS DATE		HANDLER NO.		TRANS-ACTION DATE		RESPONSIBLE PROGRAMMER		REMARKS		DATE CLEANED		DATE RECEIVED
1 495 4	5	6 Posting 9	10	11 2030 15	16	17 1/1 19	20	21 3 days 26	27	28 D	29	30 Aug. 1 35	36	37 Mary Roach 49	50	51 66	67	68 1/15/62 73	74	75 6/1/62

Figure 24. Sample Tape Control Form

The left portion of this form is in triplicate, and the first copy has an adhesive back. The right portion of the form is in duplicate. When a programmer checks out a tape for use, he fills out the form and fastens the adhesive backed portion to the reel itself. He keeps one copy of the form, and gives one copy to the librarian (or operator). Activities which have a sizable and active tape library use the information from these forms to punch tabulator cards which can be sorted and used to give various printouts of tape library information. A log of tape use may be kept on a form like the one in Figure 25.

Because of the importance of master program tapes, special precautions are taken with these. A duplicate of a master tape is usually kept for use in case some of the information is destroyed and needs to be retrieved. As an added safety precaution, duplicates of master tapes are stored in a different location and often in a different building to eliminate loss of information, for example, in case of a fire. Duplicates can easily be made by use of the tape copy routine. At most locations, no change may be made in a master program tape without special authorization. Figure 26 is an example of a form used by an activity which requires the signature of the assigned programmer, the data processing manager, and the manager of the computer center before a change may be made.



REEL NO. 473
OF
PROGRAMMERS NAME Johnson
JOB NO. JJ601
UNIT E-1
TITLE
FROM JOB
STEP
TO JOB
STEP
SEQ. NO. 1 of 1
DATE SAVED 7-30-62
OPER. JP

TAPE CONTROL FORM

Customers Name Johnson
Program Code Name and Address Tape
Charge No. JJ601
Tape Unit E-1

COMMENTS:

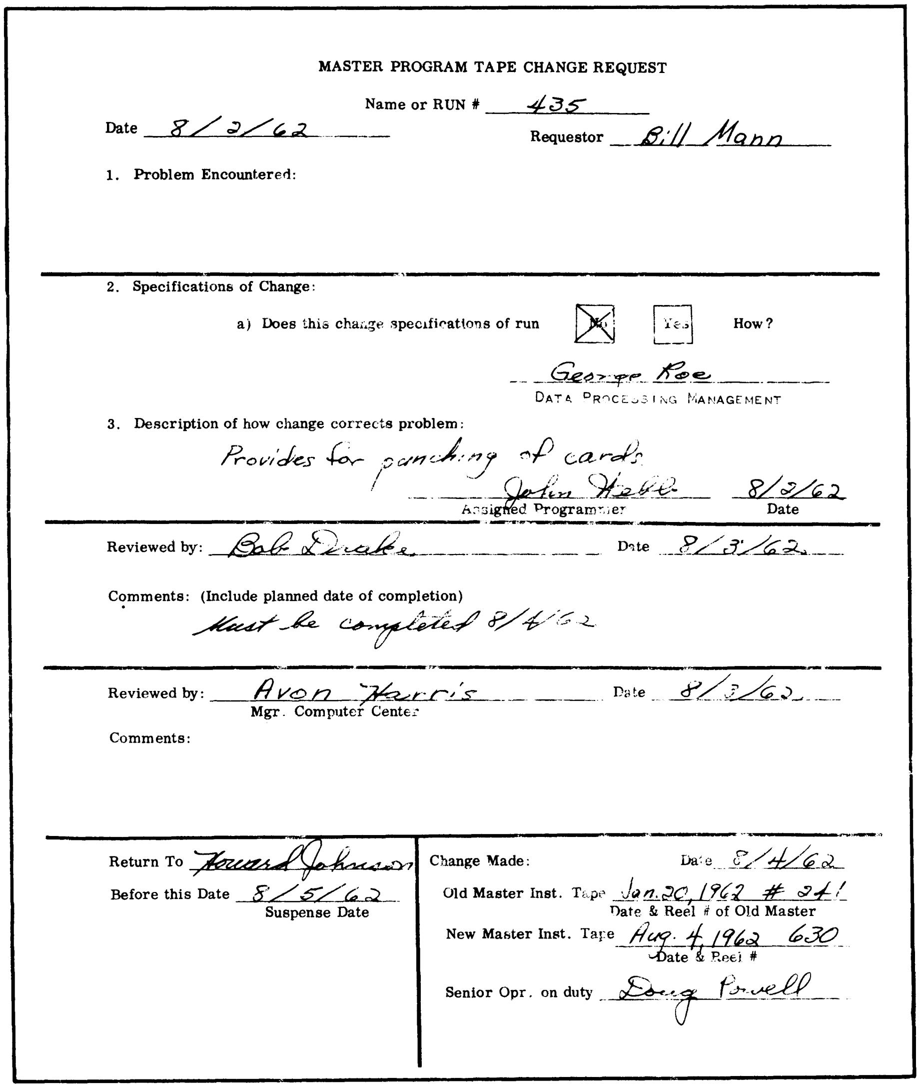
OPERATOR J.P.

Figure 25. Sample Log of Tape Use

Another precautionary method of preserving information for master tape is known as the "grandfather" concept. This requires that two levels of change tapes always be kept so that the master tape can be reconstructed, if need be, from tapes of two change levels back.

An example of tape library procedure is described in the following paragraphs. This example explains the procedure used by an activity which has a librarian and keeps a tabulator card record of the use and storage of every tape in its library. Like the other examples in this manual, it may either be copied or used as a basis for designing procedures to more aptly fit a particular situation.

1. Two source logs of tapes are kept for each 24-hour period. One log is at the console where the tape reels to be saved are listed. The other is in the tape library and lists save tapes released for use.
2. The release of save tapes (to become scratch tapes) is the responsibility of the programmer. Release may be made either by a retention schedule or by an initialed entry in the library's tape log.
3. The librarian makes a tabulator card for each save tape and each scratch tape. He maintains a save tape file and a scratch tape file and each file has an "in use" section for tapes in use on that day. At the beginning of each day, the librarian updates these files and provides for tape rotation as follows:
    a. Updates the save tape file according to retention schedules or entries from the logs.
        (1) Makes a new save tape card for each scratch tape changed to a save tape.



MASTER PROGRAM TAPE CHANGE REQUEST

Name or RUN # 435

Date 8/2/62

Requestor Bill Mann

1. Problem Encountered:

2. Specifications of Change:

a) Does this change specifications of run ☒ No ☐ Yes How?

George Roe

DATA PROCESSING MANAGEMENT

3. Description of how change corrects problem:

Provides for punching of cards

John Hebb — Assigned Programmer

8/2/62 — Date

Reviewed by: Bob Drake Date 8/3/62

Comments: (Include planned date of completion)

Must be completed 8/4/62

Reviewed by: Avon Harris Date 8/3/62

Mgr. Computer Center

Comments:

Return To Howard Johnson

Before this Date 8/5/62

Suspense Date

Change Made: Date 8/4/62

Old Master Inst. Tape Jan. 20, 1962 # 241

Date & Reel # of Old Master

New Master Inst. Tape Aug. 4, 1962 630

Date & Reel #

Senior Opr. on duty Doug Powell

Figure 26. Sample Master Program Change Request

(2) Files newly made cards for save tapes by file number and date, with the latest date in the front of the file.

(3) Removes from the save tape file cards for tapes which have been changed to scratch tapes.

b. Updates the scratch tape file as follows:

(1) Makes a new scratch tape card for tapes released in step 3a (3) above.

(2) Files updated scratch tape cards behind the remainder of the cards in the file so as to provide for rotation.

(3) Places cards corresponding to the scratch tapes used the previous day in the back of the scratch tape file.

c. Preselects all tapes for the console operation for the day's shifts and places these cards in the in-use section of the file. Scratch tapes are taken to correspond to the first cards in the scratch tape file.

d. After the card files are completely updated for the day, makes a complete tabulated listing of the cards including the in-use file.

The retention schedule mentioned in step 3a above is a schedule used with production-run tapes. The schedule lists data numbers which identify a reel as containing a certain kind of data. Depending on the kind of data, the reel must be kept a specified number of days after the save tape was originated.

If the librarian is absent, the senior operator selects scratch-tape reels corresponding to the cards in the front of the scratch-tape card file and places the cards in the in-use section of the file.

Replacing Photosense Markers

New tape has reflective photosensing markers at specified distances from either end of the tape. The marker at the leader end of the tape, called a "load point marker," provides a "leader interlock," so that depressing the REVERSE or REWIND button (after tape is beyond the leader foil) causes tape to move back only as far as the load point marker. This prevents the tape from moving off the takeup reel. Another function of the leader foil is to position the tape after a high-speed rewind. The tape runs backward at high speed, slows down before it reaches the marker, and stops on the marker. The marker near the end of the reel is called the trailer marker. It provides a "trailer interlock," so that depressing the FORWARD button causes tape to move only as far as the marker. This prevents the tape from running off the supply reel. (The programmer can program around the trailer foil if he chooses.) These leader and trailer foils do not normally come off or even get loose at the corners. However, it can happen that a marker needs to be moved or replaced. For example, the marker must be placed farther from the end of the tape when an end of tape becomes worn. The worn part may be cut off when this happens.

The photosensing markers themselves are of reflective foil with an adhesive base. Each marker should be one inch long and 0.2 inches wide. Markers are available in rolls of 250 markers each. Markers can also be cut from a large flat piece of the reflective material. The markers should be placed parallel to the edge of the tape and not more than 1/32 inch from the edge. No portion should extend beyond the edge of the tape, and the adhesive material should not extend beyond the edges of the marker. Markers can best be added to tape when the reels are mounted on the tape handlers. The importance of the positioning of the markers can be understood when one looks at the sensing cells in the leader sensor (see Figure 24). Each leader and trailer foil must pass under its respective sensing cell. Markers are to be placed as follows (tapes are assumed to be mounted on a tape handler):

1. Load Point Marker. Place marker 15 to 25 feet from the beginning end of the tape, on the shiny side, and 1/32 inch from the edge farthest from the handler deck and closest to the operator.

2. Trailer Marker. Place 32 to 35 feet from the end of tape, on the shiny side, and 1/32 inch from the edge nearest the handler deck and farthest from the operator.

Cleaning and Care of Tape Handlers

It is important that tape handlers be kept clean and free of dust and other extraneous particles. The service engineers for each site specify the exact procedures to be followed in the care of tape handlers and specify how much of the cleaning process must be done by the operators. The frequency of required routine cleaning depends, of course, upon the amount of tape use. The following list suggests the procedures necessary in the cleaning process, but it is not intended to replace instructions by the service engineer.

1. Clean the read-write heads with disposable tissue wiper or lint-free cloth dampened with an approved head cleaner. Wipe the head area until all of the dust particles are removed.

2. Look for bits or slices of tape or an excessive collection of caked oxide in any of the handler area. This could mean that flaws or burrs are developing on some of the surfaces where the tape travels. When this occurs, call the service engineer.

3. Wipe all surfaces over which where the tape travels (except the pressure pads on models which have pressure pads) with a disposable tissue wiper or lint-free cloth dampened with denatured alcohol. Remove all oxide and dust particles, making sure no caked oxide is left in corners of tape guides.

4. Use a Q-Tip to clean the glass cover over the lamp and photodiodes on the photosense head.

Inspection and Replacement of Damaged Tape

It is very unlikely that tape with a polyester base could ever break, but it can stretch. During unusual circumstances, tensions developed by the handler may be enough to damage a section of the tape beyond repair. Some more common forms of damage are scratched surface of the oxide; creased tape, where the plastic itself shows damage; and minor stretching of the tape which may be visible as oxide coming loose or flaking. Usually, the wear occurs first on the leading end of the tape. When this happens, the end may be cut off and new leader foil placed on the tape. Before the end of the tape is cut, the operator should, of course, make sure that there is no needed data on the portion of tape to be discarded. Never attempt to splice a tape. If a stretched or otherwise damaged portion of tape is found in the center portion of a reel, the tape may be split onto two reels.

As tape is used, its repeated passing over the read and write heads will gradually wear tracks in the oxide. These tracks are to be expected and are of no real concern until the wear becomes severe enough to cause parity errors. Eventually, there will come a time when the tape is either too short or is worn sufficiently to cause frequent read or write errors, and must be discarded altogether. At this time, all needed data must be moved to a new tape, and the old tape can be thrown away.

If a tape becomes creased, stretched, or broken such that needed data cannot be read, it may be necessary that the missing data be obtained by reconstructing the tape from the original tapes or other input media. The run book or the programmer should specify whether the operator should bypass the portion of the tape and reconstruct the data later or whether the run should be stopped at the point where the tape cannot be read.

Care of Magnetic Tape

Condition of tape has a critical effect on the operational reliability of a magnetic tape system. The operating environment in which tape is used should be within the temperature limits of 65 F to 90 F and relative humidity limits of 40 percent to 60 percent. The useful life of the tape depends greatly on its handling and storage. Negligence can cause tape to deteriorate relatively fast, while careful handling and storage can do much toward achieving its maximum useful life. Naturally, there is a right way and a wrong way for handling tape. Cigarette ashes and poor housekeeping practices can cause more tape trouble than does equipment failure. The following tape handling and storing procedures should be learned and practiced.

HANDLING MAGNETIC TAPE.

1. Handle reels of tape carefully. Do not press reel edges together; this could cause damage both to the reel and to the tape on the reel. Do not drop the reels. Do not touch the sides of the tape pack on the reel.

2. Do not touch the oxide (dull-finished) side of the tape where information may be written, for oil from one's fingers can damage the surface.

3. Do not handle the tape such that it can be creased in any way.

4. Do not allow any part of the tape, including the leader, to unravel and touch any surface,--not even a table top, and especially not the floor. Electrostatic charges on the tape attract dust particles.

5. Do not put the tape on a handler unless all tape travel areas (guides, heads, capstans) are clean and completely dry.

6. Make sure that the write-permit ring, when used, is pressed all the way into the slot on the reel. An improperly seated ring may rub the write-permit switch and produce plastic powder which falls onto the handler and tape.

7. On nonvacuum feed models, be careful never to touch the pressure pads. If these become soiled or out of tolerance, they allow the tape to creep and cause parity errors.

8. Never spin the tape off the leader under power, for it cracks the tape; the flakes which come off the tape stay on the area of the read head where they may later cause damage.

9. Occasionally inspect tape for wear and for damage. This should be done with the reel mounted so that, as the tape is inspected, it can be wound onto another reel.

10. When leaders become tightly curled, trim them off to make loading easier.

STORING MAGNETIC TAPE

1. Always have reels of tape in containers when they are removed from the tape handler mounts. Do not press the sides of the reel so that they make contact with the tape, since the tape may not be evenly wound and the edges could be damaged.

2. Never place uncased reels of tape on a dusty surface.

3. Keep the inside of tape containers clean.

4. Store tapes where conditions are as follows:

   a. Free from dust and dirt.

   b. Temperature range between 40 and 90 degrees Fahrenheit.

   c. Relative humidity between 20 and 80 percent.

   d. Free from magnetic fields such as those caused by motors, heavy power lines, and magnets.

5. When tape has been subjected to temperature and humidity conditions outside the prescribed limits, it must be reconditioned before use. This is done by removing the top of its case, but protecting the reel from dust, while exposing it to machine room conditions of proper temperature and humidity. It must be reconditioned in this way for double the length of time of improper exposure, not exceeding 24 hours.

6. Store tapes in their container in a rack vertically (the containers stand on edge). Avoid stacking tapes horizontally, for this could cause reel warpage.

7. Store tapes which contain information to be saved in a separate place from those which have no usable information on them. Be sure that all tapes to be saved are stored with the write-permit ring removed.

OPERATOR CORRECTIVE ACTION

During magnetic tape operations, it is important that any difficulty in running the program be quickly diagnosed. Operational difficulties can be caused by errors made by the operator or by errors in the program. The following information is presented to assist the operator in classifying errors. Figure 28, at the end of this section, summarizes alert conditions and their possible causes; it also suggests operator corrective action for each type of alert.

OPERATOR CHECKPOINTS

The magnetic tape system can fail to operate properly or a program can fail to run when the operator neglects to:

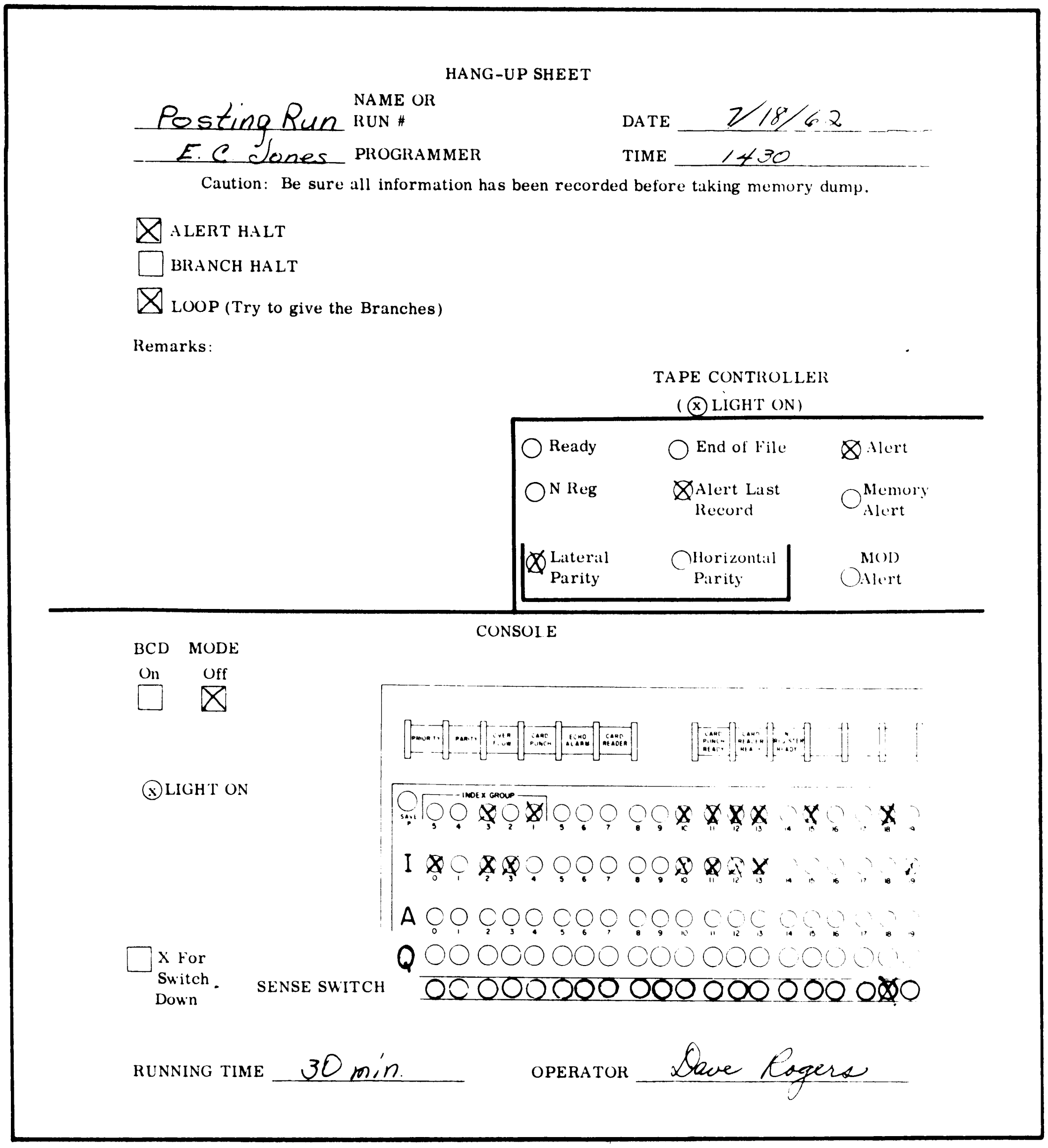
1. Load tape correctly.
2. Rewind tape when required.
3. Install write-permit ring when trying to write tape.
4. Set the rotary address selector switch on tape handler to the correct number.
5. Put tape handler on remote control.
6. Connect correct controller selector channel.
7. Make sure that no two handlers are set to the same number.

PROGRAM CHECKPOINTS

Although the program is the responsibility of the programmer and not the operator, it is important that the operator recognize program alerts when they occur. For this reason, the following program information is reviewed. As in all operations involving use of the controller-selector, the peripheral must first be selected by controller selector channel number before it can respond to an instruction. The service engineer must connect the tape controller to the correct channel. Instructions RTD, RTB, ERT, RTS, RBD, RBB, RBS, RWD, WTD, WTB, WTS, WEF, and BKW must be preceded by the SEL P (P being the channel number) instruction. The specific instruction must be accompanied by the tape handler number (switch setting on the tape handler control panel).

If the programmer has not put in needed instructions--for example, to rewind the tape, write end-of-file characters, backspace, or branch--the program will not run correctly. If extra instructions must be inserted, it is necessary to return the program to its originator with a notation of the contents of the P-counter and the I-register where the program stalled. Routines are usually programmed to instruct the tape controller to try to reread or rewrite several times when an alert occurs. If this fails, the controller "gives up," the program halts, and the operator must take over. In some cases it is possible to recover after the cause of the alert has been corrected. The decision to restart or recover a program should be based on restart procedure in the run book or other programmer instructions.

When the operator cannot proceed with the running of the program because of an error condition, he should make note of the status of various indicators and registers. He should give this information along with explanatory information to the programmer if he thinks there was a program error and to the service engineer if he thinks the equipment caused the error. Figure 27 shows a form which has been found useful in recording information from the magnetic tape controller and the console of the central processor.



HANG-UP SHEET

Posting Run NAME OR RUN #

DATE 7/18/62

E. C Jones PROGRAMMER

TIME 1430

Caution: Be sure all information has been recorded before taking memory dump.

☒ ALERT HALT

☐ BRANCH HALT

☒ LOOP (Try to give the Branches)

Remarks:

TAPE CONTROLLER

(ⓧ LIGHT ON)

○ Ready	○ End of File	⊗ Alert
○ N Reg	⊗ Alert Last Record	○ Memory Alert
⊗ Lateral Parity	○ Horizontal Parity	MOD ○ Alert

CONSOLE

BCD MODE

On ☐ Off ☒

ⓧ LIGHT ON

☐ X For Switch Down

SENSE SWITCH

RUNNING TIME 30 min.

OPERATOR Dave Rogers

Figure 27. Sample Indicator Sheet

Alert Condition	Possible Cause	Operator Corrective Action
CONTROL CONSOLE INDICATORS ECHO ALARM on the GE-200/215/225 or the CONT SEL alarm on the GE-235 glows red.	Nonexistent controller is addressed.	Check controller-selector channel number, have service engineer install correct channel connection; return program to originator if condition cannot be corrected.
	Busy controller is addressed.	Return program to originator for program correction.
TAPE CONTROLLER INDICATORS ALERT HALT indicator glows blue.	Tape handler is addressed while in local control or power is off.	Set REMOTE/LOCAL switch to REMOTE and turn on power; press controller CLEAR button and return to nearest rerun point.
	Tape is broken or stretched.	If leader is broken, put new reflector load point marker 15 to 25 feet from beginning of tape; if break is in record sections, data may require rewriting on new tape.
	Tape not loaded on handler.	Load tape on addressed handler or switch to handler that is loaded.
	Dust cover on tape handler is open (in latched position).	Release latch and close dust cover.
	Writing was attempted with write-permit ring removed from reel.	Install write-permit ring on tape supply reel.
	Nonexistent tape handler rotary address selector switch was addressed or switches not set correctly.	Set rotary address selector switches to correct numbers; if programmer error, return program to originator.
	Tape handler addressed while rewinding because delay loops not programmed.	Return program to originator for programmer correction.
	Reading in reverse or rewind was attempted while on the leader.	Return program to programmer with note on required revision; if inadvertently rewound by operator, correct and rerun.

Figure 28. Magnetic Tape Subsystem Alert Conditions

Alert Condition	Possible Cause	Operator Corrective Action
ALERT HALT glows blue and N REG ALERT glows white.	Parity error on instruction words 2 or 3 on transfer from memory to tape controller.	Try to rerun program; if error recurs, notify service engineer.
MEMORY ALERT glows red.	Memory access not granted in time to prevent loss of data in read or write operation.	If error routine does not correct error, go to nearest rerun point; if this fails, return program to originator.
N REGISTER ALERT glows white while writing and there is no alert light.	Parity error on a data word transferred between the controller and memory.	For recoverable condition, try changing handler or changing work tape; inspect input tape for bad spots; go to nearest restart point and try again. If errors persist, call service engineer; if none of these correct situation, return program to originator.
ALERT ON LAST RECORD light comes on.	When program halts, the error occurred on the last record read or written.	
LATERAL PARITY ALERT glows red.	Parity error while reading or writing a tape character (resets next time controller is selected).	
HORIZONTAL PARITY ALERT glows red.	Parity error on reading, writing, or erasing record (resets next time controller is selected).	
MOD ALERT glows red while reading.	Incorrect number of characters per word was read (Mod 3 error in BCD or special binary; Mod 4 error in binary). Alert is reset next time controller is selected.	
HANDLER INDICATIONS Handler is addressed but does not read or write.	Power to handler not on.	Turn on power (handler control panel); check for controller power on; call service engineer if power does not come on.

Figure 28. (Cont.)

Alert Condition	Possible Cause	Operator Corrective Action
HANDLER INDICATIONS (cont.) Handler is addressed but does not read or write.	Tape handler on local control.	Set REMOTE/LOCAL switch to REMOTE (REMOTE will glow.)
After tape is threaded, tape moves forward but does not stop at load point marker.	Load point marker missing, too near beginning of tape, or not positioned correctly.	Put leader foil 15 to 25 feet from beginning of tape, 1/32 inch from edge closest to the operator.
After threading tape, tape starts then quickly stops and refuses to start reading or writing.	Load point marker not positioned past read head.	Press FORWARD, then STOP, then REVERSE switches to position leader foil correctly.
No action on pressing FORWARD, REVERSE, REWIND, or STOP switches.	Handler is in remote control.	Set REMOTE/LOCAL switch to LOCAL (LOCAL lights up).
Tape does not stop when moving forward, comes off supply reel.	Trailer foil missing, too near end of tape, or not positioned correctly.	Put trailer foil from trailing end of tape, 1/32 inch from edge farthest from the operator.
A detectable malfunction of tape transport.	Faulty equipment.	Return to nearest rerun point; if this fails, call service engineer.

Figure 28. (Cont.)

APPENDIX A.
INSTRUCTION TIMES

OPERAND M = Memory Location - starting address
N = Length of record (number of words)
P = Channel Number (Priority Control)

General Assembly Program Symbol X T = Tape Handler Number
P = Channel Number (Priority Control)

				Times in µsec.			
Opr	Operand	X	Octal	200	215	225	235
BCS	BEF	P	2514P21	36	72	36	24/36
BCS	BER	P	2514P27	36	72	36	24/36
BCS	BET	P	2514P22	36	72	36	24/36
BCS	BIC	P	2516P25	36	72	36	24/36
BCS	BIO	P	2514P25	36	72	36	24/36
BCS	BME	P	2514P26	36	72	36	24/36
BCS	BNE	P	2516P27	36	72	36	24/36
BCS	BNF	P	2516P21	36	72	36	24/36
BCS	BNM	P	2516P26	36	72	36	24/36
BCS	BNR	P	2516P23	36	72	36	24/36
BCS	BNT	P	2516P22	36	72	36	24/36
BCS	BPE	P	2514P24	36	72	36	24/36
BCS	BPC	P	2516P24	36	72	36	24/36
BCS	BRW	P	2514P23	36	72	36	24/36
BCS	BTN	P	2516P20	36	72	36	24/36
BCS	BTR	P	2514P20	36	72	36	24/36
BKW		T	1600000	36	72	36	36
ERT		T	1300000	36	72	36	36
RBB	M	T	15MMMMM	36	72	36	36
RBD	M	T	14MMMMM	36	72	36	36
RBS	M	T	35MMMMM	36	72	36	36
RTB	M	T	05MMMMM	36	72	36	36
RTD	M	T	04MMMMM	36	72	36	36
RTS	M	T	25MMMMM	36	72	36	36
RWD		T	2000000	36	72	36	36
SEL	P		2500P20	36	72	36	24/36
WEF		T	0200000	36	72	36	36
WTB	M	T	03MMMMM	36	72	36	36
WTD	M	T	02MMMMM	36	72	36	36
WTS	M	T	23MMMMM	36	72	36	36

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