

IX. MAGNETIC TAPE SUBSYSTEM

GENERAL DESCRIPTION

The magnetic tape subsystem (Figure IX-1) serves as both an input and an output device, and reels of tape provide permanent storage. Theoretically, as many as eight magnetic tape subsystems may be included in a GE 225 System, each subsystem consisting of a controller and from one to eight handlers. However, the most common arrangement is one or two controllers to a system. An advantage in having more than one controller is that read and write operations can then be conducted simultaneously.

Magnetic Tape Controller

The controller contains the circuits for the selection and control of the tape units and for data transfer between tape and memory. It also contains its own power unit. Each controller operates through the controller selector and is addressed through its controller selector plug number. It is customary to use a low numbered plug, and the most frequently used number is 1. The central processor is interrupted whenever the tape controller either has data for memory or is requesting data from memory. What actually happens is that the program requests access to the controller for reading or writing and the controller then determines the exact time of interrupt. Aside from these interruptions, the central processor is released to continue with its calculations while the controller executes the instruction.

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 in the controller selector. Hardware design does not permit simultaneous read and write operations. The tape controller also contains error-checking circuitry to insure reliability of the reading and writing. The following five types of checks are made. 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.

Errors showing up as a result of these checks are visible to the operator as lights on the controller control and indicator panel, illustrated in the upper portion of Figure IX-1.

Lateral Parity. The parity bit which is written on tape in parallel with each six-bit character is checked, when read, to see if the sum of all seven bits is odd in binary modes or even in BCD mode of operation. The error indicator is a LATERAL PARITY ALERT.

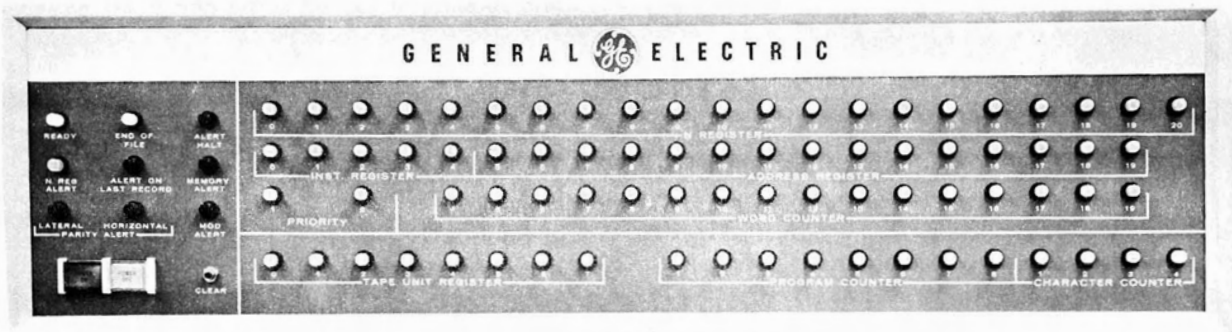
Horizontal Parity. The parity bit which is written at the end of a record on each of the seven tape recording tracks is checked, when read, to see if the total number of ones in any track, including the check digit, is even. The error indicator is a HORIZONTAL PARITY ALERT.

Module 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 the number of characters must be a multiple of four. The error indicator is MOD ALERT. (The operator should check this indicator each time he begins to read a new tape, for it is a way for him to check whether he has selected the correct tape.)

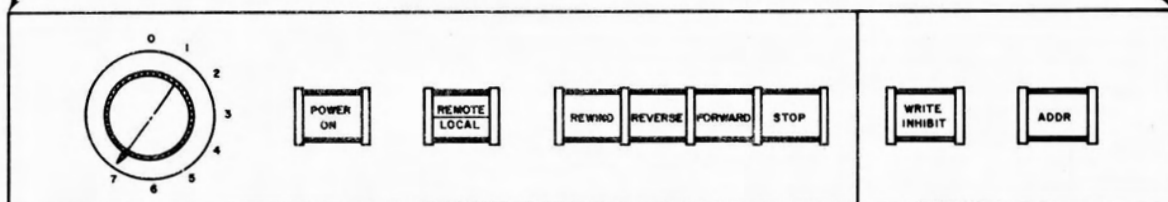
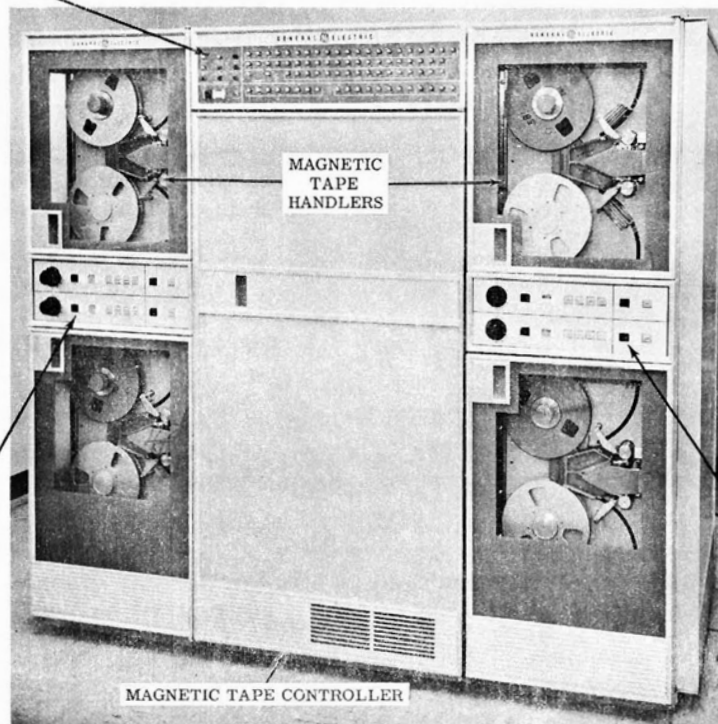
Controller Input/Output Register Overflow. The tape controller has an input/output register capacity to store two complete memory words. An error indicator is set whenever a read or write command could result in an overflow or exhaust of this register. The error indicator is MEMORY ALERT.

Parity Error in Input/Output Register. During reading operations, a parity bit is generated for the whole word and then checked in the controller after it is transferred to the controller from the central processor. The error indicator is N REG ALERT.

GE-225



MAGNETIC TAPE CONTROLLER CONTROL AND INDICATOR PANEL



MAGNETIC TAPE HANDLER CONTROL AND INDICATOR PANEL

Figure IX-1. Magnetic Tape Subsystem

Four other indicators on the same control and indicator panel are:

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

READY. This light is illuminated if controller power is on. (It doesn't actually mean that the controller is ready for the central processor to address it, e.g., tapes may not be threaded).

ALERT HALT. This light is illuminated under the following error conditions. In every case the computer halts and operator intervention is required to correct the condition by going back to the nearest rerun point.

1. A parity error on instruction words 2 and 3 during the transfer of these words from memory to the tape controller.
2. Addressing a tape transport while it is rewinding.
3. Attempting to address a tape which has not been manually selected.
4. Any detectable malfunction of the tape handler.
5. Specifying a tape handler logical address for which there is more than one unit selected.
6. Attempting to write on a tape which has been protected by the removal of the write-permit ring from the tape reel.
7. Attempting to perform a read backward instruction (RBB, RBD, or RBS) when the tape is in the rewound condition and initially positioned at the beginning-of-tape marker.

END OF FILE. This light 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 error indicators just described are summarized in Table X, and the descriptions of the use of these indicators under error conditions are summarized in Table XI.

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 for the operator to use these indicators in routine operations, the information is most helpful in understanding what is causing the program to hang up under certain error conditions. All 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 databits and a parity bit.

INST. REGISTER. Indicates the type of instruction to be executed. (The operator should be thoroughly familiar with the magnetic tape programming instructions and know the octal and binary representations of their operation codes.) The following is a list of these instructions:

<u>Instruction</u>	<u>Mnemonic Code</u>	<u>Octal Code</u>
Write Tape Decimal	WTD	02*
Write Tape Binary	WTB	03
Read Tape Decimal	RTD	04
Read Tape Binary	RTB	05
Read Tape Special Binary Mode	RTS	25
Write Tape Special Binary Mode	WTS	23
Read Backward Binary	RBB	15
Read Backward Decimal	RBD	14
Read Backward Special Binary	RBS	35
Rewind	RWD	20
Write End of File	WEF	02*
Backspace and Position Write Head	BKW	16

*WTD and WEF may be differentiated by noticing that WTD has a memory address and a specific number of words to write, but WEF has neither.

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 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, so the visible count 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 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 the operator, but it is used by the service engineer.

There are three controls on the controller control and indicator panel:

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

POWER OFF switch. When depressed, this pushbutton 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.

Magnetic Tape Handler

Each tape handler contains two reels, one for tape feeding called the supply reel, and the other for tape takeup, illustrated in Figure IX-2.

The supply reels are held in place by an expandable rubber ring in the mount assembly (Figure IX-3). 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.

The tape handler mechanism (Figure IX-4) drives the tape past separate read and write heads. Tape is threaded around tape guides, and between the capstans and their respective pinch rollers. In earlier models of tape handlers, pressure pads held the tape even and smooth as it passed the read and write heads; in the newer models, vacuum pockets perform that function. When the handler power is on, the tape-drive capstans rotate continuously in opposite directions (top one rotates clockwise), and are always ready to drive the tape when a pinch roller forces the tape against one of them. Tape moves forward

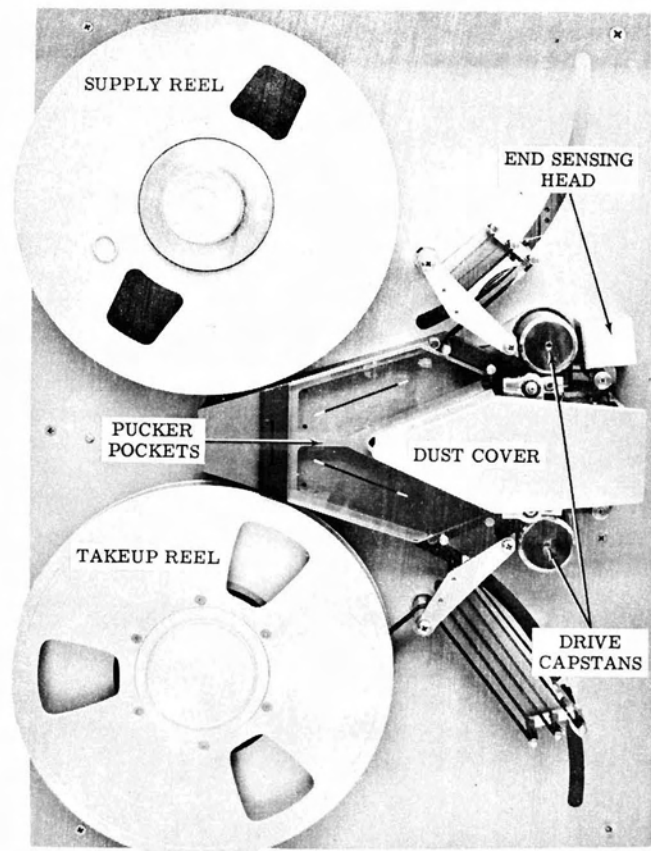


Figure IX-2. Tape Handler Mechanism
(Vacuum Feed Type)

when the pinch roller is against the forward capstan and backward when the pinch roller is against the reverse capstan. Two sensing cells in the photo-sensor are positioned to detect the beginning and end of tape markers.

Each tape handler has a power supply to move tape forward at a rate of 75 inches per second or backward (rewind) at 150 inches per second. The information transfer rate is 15,000 characters per second. The dust cover acts on a thread switch such that when the dust cover is opened, the tape takeup arms are pulled open and a brake holding the mount hubs is released to allow the reels to turn freely. When the dust cover is closed, the thread switch is released to the normal position, and the tape sensing arms will return to a null position.

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

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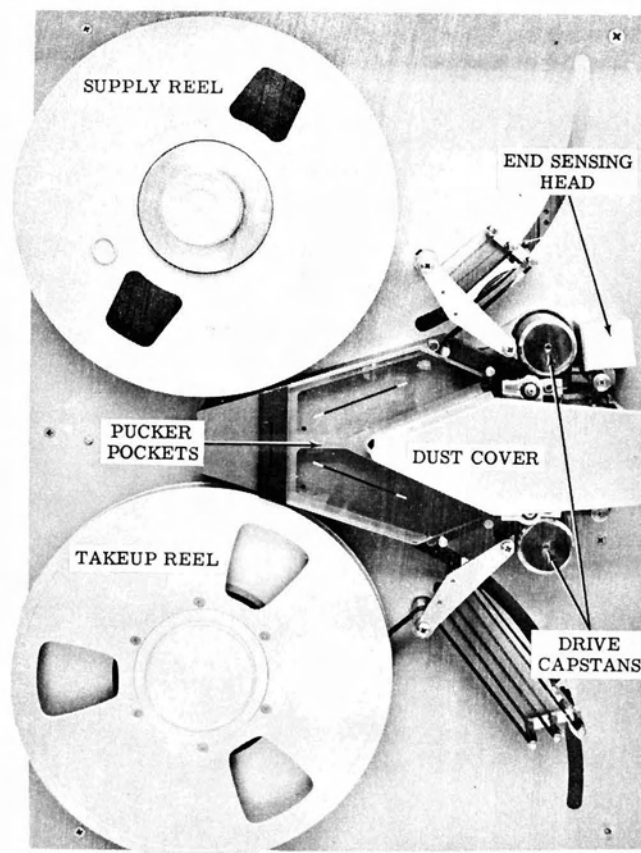


Figure IX-2. Tape Handler Mechanism
(Vacuum Feed Type)

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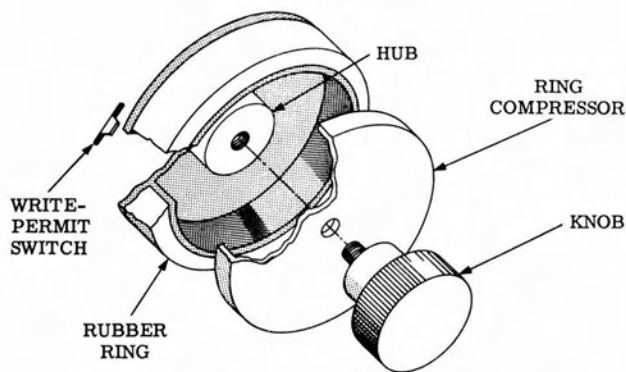


Figure IX-3. Tape Handler Mounting and Hub Assembly

tape movement, the operator must first depress STOP, and then depress the pushbutton for the desired change of direction.

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. This panel is illustrated in the lower portion of Figure IX-1; 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 that 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

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

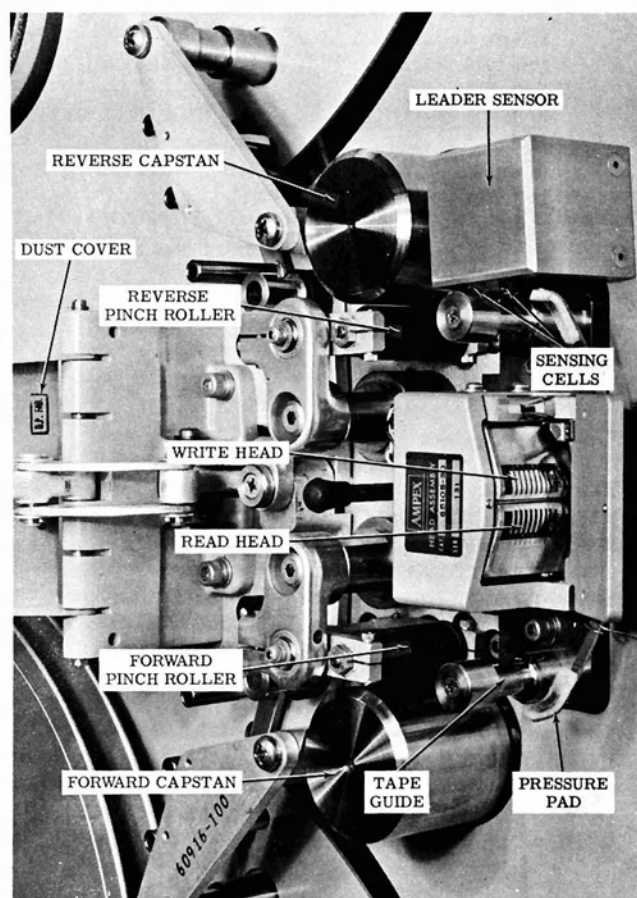


Figure IX-4. Tape Handler Mechanism (Nonvacuum Feed Type)

second until it is stopped by the sensing of the leader foil. 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.

FORWARD switch and indicator. This pushbutton, when depressed, energizes the forward pinch 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, the REMOTE/LOCAL switch is placed in the REMOTE position, or the REVERSE switch is depressed. The pushbutton is illuminated during forward movement.

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; it is not an indicator.

WRITE INHIBIT indicator. This is an indicator which is illuminated when the tape supply reel does not have a write-permit ring. (Only reading can be done on the tape.)

ADDR indicator. This indicator is illuminated under program control whenever the magnetic tape controller is addressed by the central processor for a read or write operation.

File Protection

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 (Figure IX-5), 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 IX-3). 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.

Magnetic Tape.

The GE 225 System uses heavy duty, hard-binder tape.

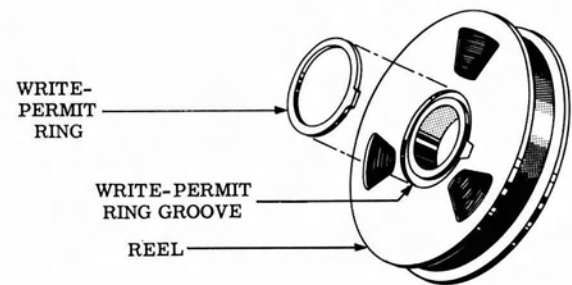
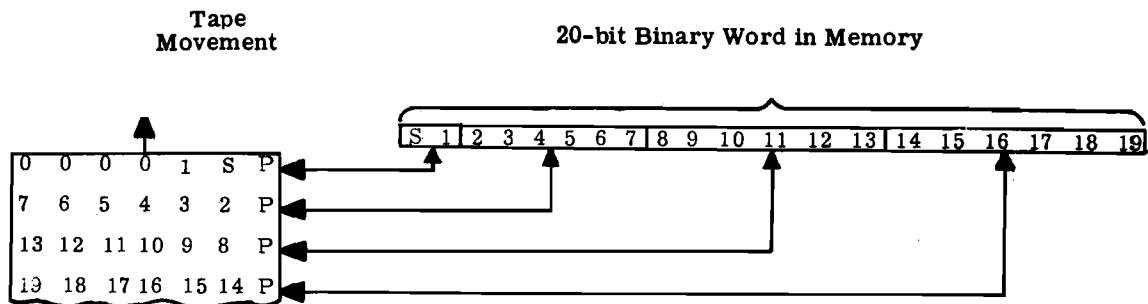


Figure IX-5. Installation or Removal of Write-Permit Ring.

The functional characteristics of this tape are fully compatible with those of the system itself, so this tape and only this tape is recommended for use with the GE 225. The tape is 1/2 inch wide and 0.0015 inch thick. It is wound on plastic reels which are 10-1/2 inches in diameter and hold up to 2400 feet of tape. The tape has a mylar base (the shiny side) and an oxide coating on the other side which is wound on the reel facing the center. A characteristic of the mylar base is that it doesn't break easily, but it can stretch if it is subjected to pressures. All kinds of tapes show evidence of wear by friction; this is seen in the shedding of the oxide coating. Hard-binder tape sheds this coating gradually and evenly in the form of a fine powder which does not adhere to the tape, so a slow and even wear is assured. On soft-binder tapes, the shed is in the form of a sticky, gummy substance that collects on the tape in such a way that it causes migratory errors. It is the rise in temperature caused by friction on the handler which demands the use of hard-binder rather than soft-binder tape. The soft-binder tape heats up excessively and accelerates the oxide shedding which causes read and write errors.

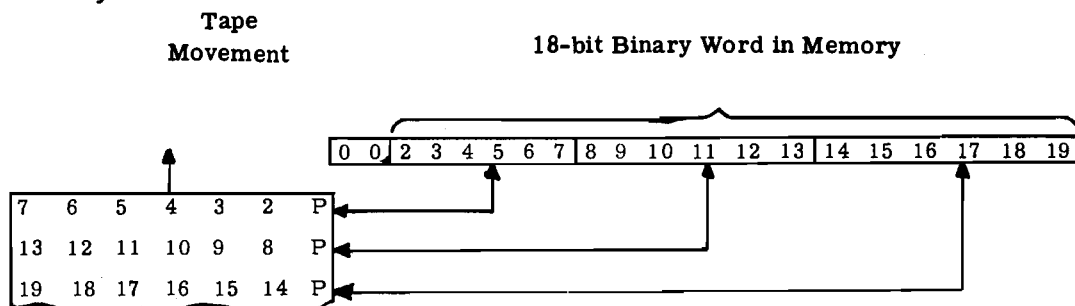
Information is stored on magnetic tape in the form of magnetized spots arranged in seven tracks. Six tracks are for data and one is for the parity bit used as a checking feature. The magnetic tape system communicates with the computer in three different modes: binary, special binary, and binary coded decimal, illustrated as follows:

Binary



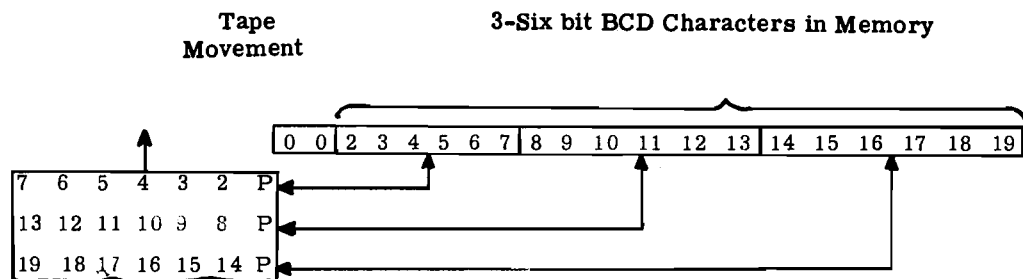
P is generated odd parity bit for each line of binary information.

Special Binary



P is generated odd parity bit for each line of binary information.

Binary Coded Decimal



P is generated even parity bit for each character.

The two most significant bits of each BCD character in memory are altered during transfer of information between the memory and the tape system. This alteration is performed automatically by the tape controller.

Data are spaced on tape at a density of 200 bits to an inch, in groups of words called records. Records may be of variable length, that is, any single record may contain a different number of words from any other record. The minimum record length may be one word and maximum record length may be 32,767 words.

Magnetic tape records are physically separated from each other by three-fourths of an inch of erased tape designated as an inter-record gap. This gap is used for starting and stopping magnetic tape between records. Similarly, a 3-3/4 inch long erased section followed by the tape character 0001111 identifies the end of file. The information on tape cannot normally be read by eye; however, it is possible to develop the tape so that the recorded bits can be read. The development procedure is a maintenance function and is not normally of interest to the operator. Developing the tape consists of immersing the recorded tape in a solution containing fine-grain iron filings. The iron filings are attracted and held by the magnetized spots. **CAUTION:** Magnetic tape cannot be used after it has been developed.

SETUP PROCEDURE

The steps in preparing the magnetic tape subsystem for on-line operation are as follows. Unless specified otherwise, controls and indicators referred to are on the tape handler control and indicator panel. See Figure IX-1 and Table IX.

Loading Tape

1. Check to make sure the service engineer has connected the correct controller-selector plug in the magnetic tape controller. **CAUTION:** The identification number on the plug 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 located on each magnetic tape handler control and indicator panel of the handlers 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. **CAUTION:** Never tighten the reel mount knob more than necessary to secure the reel; over-tightening will result in stripping the threads of the knob screw.
- d. Pull the dust cover open slowly. This causes the tape take-up 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 IX-6. Wind the end of the tape leader around the hub of the take-up reel and manually turn the reel approximately six revolutions (clockwise) to secure the tape. **CAUTION:** The tape end must lay 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

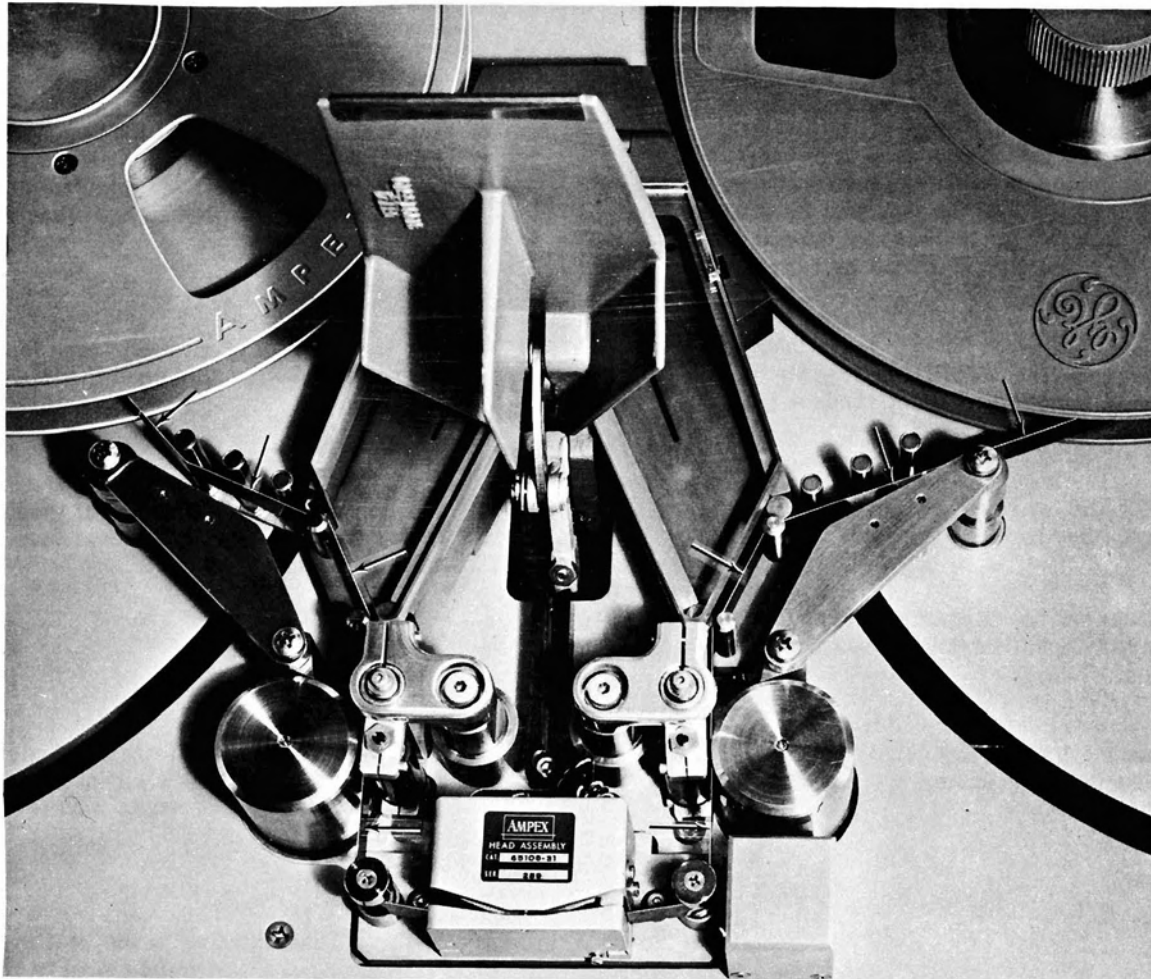


Figure IX-6. Threading Tape Through Magnetic Tape Handler

- lightly over the vacuum pocket opening until the tape is drawn into the opening. (Vacuum pockets are often called 'pucker' pockets.)
- h. Depress the FORWARD switch.
 - (1) If the tape is threaded properly, the leader foil has not yet passed the sensing cells, and the tape will stop on or a little beyond the foil.
 - (2) If the tape happened to be threaded with the leader foil 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 (leader foil).
 - 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.
 1. Set the REMOTE/LOCAL switch to the REMOTE position.
 - c. If a considerable amount of tape is on the takeup reel, depress REWIND to bring the tape to the leader foil.
 - d. Open the dust cover slightly so the vacuum decreases slowly; otherwise, tape is sucked into the pockets, causing damage.
 - e. On both models, 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 is not to be saved, place it in a clean container and store it with 'non-save' tapes.

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 leader foil, depress REVERSE to make sure it is on the foil.
- (2) If the information on the reel is 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
 Destination of tape (name of program or programmer which 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. CAUTION: Power to the handlers must be turned off before it is turned off to the controller(s).

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

TABLE X
SUMMARY OF CONTROLS AND INDICATORS
FOR THE MAGNETIC TAPE SUBSYSTEM

Location	Control or Indicator	Function
Magnetic tape handler control and indicator panel (See Figure IX-1.	Rotary selector switch and indicator.	Establishes and indicates address of the magnetic tape handler.
	POWER ON switch and indicator.	Turns power on to the magnetic tape handler when depressed once; turns power off when depressed again. Is illuminated to indicate when power is on.
	REMOTE/LOCAL switch and indicator.	Determines and indicates 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.	Rewinds magnetic tape at double speed (150 inches/second) under manual control when REMOTE/LOCAL switch is in LOCAL position. Stops on the leader foil. Is illuminated during rewind.
	REVERSE switch and indicator.	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 foil. Is illuminated during reverse movement.
	FORWARD switch and indicator.	Moves tape in the forward direction under manual control when REMOTE/LOCAL switch is in LOCAL position. Is illuminated during forward motion.
	STOP switch.	Halts tape movement under manual control when REMOTE/LOCAL switch is in LOCAL position.
	WRITE INHIBIT light.	Indicates when tape supply reel does not have write-permit ring installed.

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TABLE X (CONT.)

Location	Control or Indicator	Function
Magnetic tape handler control and indicator panel (continued)	ADDR light.	Indicates when magnetic tape handler is being addressed for either a read or write operation.
Magnetic tape controller control and indicator panel (See Figure IX-1).	READY light.	Indicates when magnetic tape controller is available to be selected by central processor through controller selector.
	END OF FILE light.	Indicates when end of file has been reached.
	ALERT HALT light.	Indicates when an error condition requiring operator action has halted the computer. See Section on restart for the list of conditions.
	N REG ALERT light.	Indicates that a parity error resulted in the transfer from memory to the controller.
	ALERT ON LAST RECORD light.	Indicates when error occurs on last record of tape being read or written.
	MEMORY ALERT light.	Indicates that a delay results because a read or write instruction reaches the controller before its input/output register is empty.
	LATERAL PARITY ALERT light.	Indicates when an error is detected by lateral parity check.
	HORIZONTAL PARITY ALERT light.	Indicates when an error is detected by horizontal parity check.
	MOD ALERT light.	Indicates in record word check as record is read from tape, that the record does not consist of whole words.
	POWER ON switch and indicator.	Turns power on to magnetic tape subsystem. (Is illuminated when power is on).

TABLE X (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 after alert halt condition has occurred.
	N REGISTER display lights.	Display contents of N register which serves as input/output buffer between magnetic tape subsystem and central processor.
	INST. REGISTER display lights.	Display operation code portion of current instruction.
	ADDRESS REGISTER display lights.	Display address (location in memory) portion of current instruction.
	PRIORITY display lights.	Indicate phases of controller access to central processor.
	WORD COUNTER display lights.	Display quantity of words to be written on or read from tape.
	TAPE UNIT REGISTER display lights.	Indicate which magnetic tape handler is currently engaged.
	PROGRAM COUNTER display lights.	Indicate sequencing in the controller.
	CHARACTER COUNTER display lights.	Indicate the character count as words are read from or written on tape.

SPECIAL PROCEDURES

Replacing Leader and Trailer Foils

New tape has reflective photo sensing markers approximately 15 feet from either end of the tape. The marker at the leader end of the tape (called leader foil) provides a 'leader interlock' so that depressing the REVERSE button (after tape is beyond the leader foil) causes tape to move back only as far as the leader foil, so the tape will not move off the takeup reel. Another function of the leader foil is to position the tape after a high speed REWIND. The tape runs at high speed past the leader foil, stops, then moves forward at a normal rate and stops on the foil. The marker near the end of the reel (trailer foil) provides a 'trailer interlock' so that depressing the FORWARD button causes tape to move only as far as the trailer foil, so the tape will not run 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, if it does happen, the foil must be replaced. It is also possible that the new foil must be placed farther from the end of the tape when the end of the tape becomes worn. The worn part may be cut off.

The photo sensing markers themselves are of reflective foil with an adhesive base. Each marker should be one inch long and 3/16 of an inch wide. Markers are often supplied in rolls of the proper width and marked in one-inch strips, but it is possible that the strips may have to 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 shall extend beyond the edge of the tape and the adhesive material shall 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 leader and trailer foils can be understood when one looks at the sensing cells in the leader sensor (Figure IX-4). 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).

Leader Foil. Locate it 15 to 25 feet from the beginning end of the tape, on the Mylar (shiny) side, and 1/32 inch from the edge farthest from the handler deck and closest to the operator.

Trailer Foil. Locate it 14 to 19 feet from the end of the reel of tape, on the Mylar (shiny) side, and 1/32 inch from the edge nearest the handler deck and farthest from the operator.

Cleaning and Care of Tape Handlers

The following should be done at least after every eight hours of computer use and under heavy use of tape, should be done between each reel change. As has been stated before, this can be done cooperatively with the service engineer and under his direction.

1. Clean the read-write heads with a Kim Wipe or lint-free cloth dampened with denatured alcohol or Ampex 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 area where the tape travels. When this occurs, call the service engineer.
3. Wipe all areas where the tape travels (except the pressure pads) with a Kim Wipe 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 openings to the lamp and photo diodes on the photosense head. Insert the Q-tip into each opening and rotate it to remove dust particles from the opening.

Inspection and Replacement of Damaged Tape

It is very unlikely that mylar-based tape would 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 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 a 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. CAUTION: do not 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

Magnetic tape is one of the most critical factors affecting the operational reliability of a tape system. 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:

A. 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 to never 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; and the flakes which come off the tape stay on the area of the read head where they 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.

B. STORING MAGNETIC TAPE

1. Always put 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 might be damaged.
2. Never place an uncased reel of tape on a dusty surface.
3. Keep the insides of tape containers clean.
4. Store tapes where conditions are as follows:
 - a. Free from dust and dirt.
 - b. Temperature range between 60 degrees and 80 degrees Fahrenheit.
 - c. Relative humidity between 40% and 60%.
 - 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 length of time of improper exposure, not exceeding 48 hours.

6. Store the tape in its container in a rack vertically (the container stands on edge). Avoid stacking them 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.

ERRORS AND OPERATOR CORRECTIVE ACTION

Operator Errors

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. Select correct controller plug.

7. Make sure that no two handlers are set to the same number.

Program Errors

Although program errors are the responsibility of the programmer and not the operator, it is important that the operator recognize the type of error when it occurs. For this reason, the following program information is reviewed. As in all operations involving use of the controller-selector number, the peripheral must first be selected by controller-selector plug number before it can respond to a command. The service engineer must install the correct plug in the cabinet of the tape controller. Instructions RTD, RTB, RTS, RBD, RBB, RBS, RWD, WTD, WTB, WTS, WEF, and BKW must be preceded by the SEL P (P being the plug number) instruction or the program will hang up. 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 and I registers where the program hung up. Routines are usually programmed to instruct the tape controller to try to reread or rewrite several times when an error occurs. If this fails, the controller 'gives up,' the program halts, and the operator must take over.

It is advisable to restart a program after a tape error has occurred. However, in some cases it is possible to recover after the cause of the error has been corrected. The decision to restart or recover a program should be based on direct knowledge of the program in question.

Table XI summarizes error conditions, their possible causes, and operator corrective action.

TABLE XI
MAGNETIC TAPE SUBSYSTEM ERROR CONDITIONS

Error Condition	Possible Cause	Corrective Action
CONTROL CONSOLE INDICATORS ECHO ALARM light comes on	Nonexistent controller is addressed	Check controller-selector plug number, have service engineer install correct plug; return program to originator if condition cannot be corrected
	Busy controller is addressed	Return program to originator for programmer correction
CONTROLLER INDICATORS ALERT HALT light comes on	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; return to nearest rerun point
	Tape is broken or stretched	If leader is broken, put new reflector leader foil 15 to 25 feet from beginning of tape; if break is in record sections, data may require rewriting on new tape
	Tape not loaded	Load tape on addressed handler that is loaded
	Dust cover on tape handler is open (in latched position)	Release latch and close dust cover
	Attempting to write with write-permit ring removed from reel	Install write-permit ring on tape supply reel
	Addressing nonexistent tape handler (rotary address selector switch, 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 (delay loops not programmed)	Return program to originator for programmer correction
	Attempting to read reverse or to backspace while on leader	Return program to programmer with note on required revision; if inadvertently rewound by operator, correct and rerun

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TABLE XI (CONT.)

Error Condition	Possible Cause	Corrective Action
ALERT HALT (continued)	Parity error on instruction words 2 or 3 on transfer from memory to tape controller (N REG ALERT comes on);	Try to rerun program; if error recurs, notify service
MEMORY ALERT light comes on	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 light comes on while writing (no alert light)	Parity error on a data word transferred between the controller and memory	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 light comes on	Parity error while reading or writing a tape character (resets next time controller is selected)	
HORIZONTAL PARITY ALERT light comes on	Parity error on reading or writing a tape record (resets next time controller is selected)	
MOD ALERT light comes on 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.
	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 leader foil	Leader foil 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.

TABLE XI (CONT.)

Error Condition	Possible Cause	Corrective Action
After threading tape: Tape starts then quickly stops and refuses to start reading or writing	Leader foil not positioned past read head	Press FORWARD , then STOP , then REWIND 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 14 to 19 feet from trailing end of tape, 1/32 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.

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