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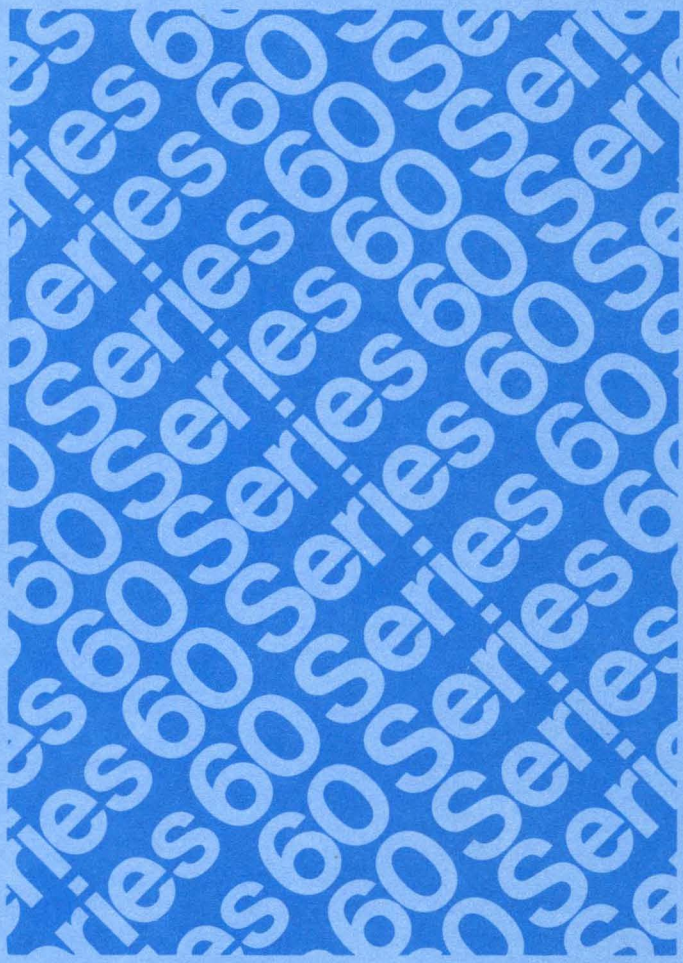

LEVEL 6

HARDWARE

MTU9104/9105/ 9112/9113 NRZI 7-/9-TRACK MAGNETIC TAPE UNIT OPERATION

SERIES 60 (LEVEL 6)

MTU9104/9105/9112/9113 NRZI 7-/9-TRACK MAGNETIC TAPE UNIT OPERATION

SUBJECT

General Description, Programming, Operation, and Maintenance Procedures for the MTU9104/9105/9112/9113 Magnetic Tape Units

SPECIAL INSTRUCTIONS

This manual supersedes Section 14 of the *System and Peripherals Operation* manual, AT04, Rev. 1, dated April 1977, and pertinent parts of Section 6 of the *Level 6 Minicomputer Handbook*, AS22, Rev. 2, dated September 1977.

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Preface

This reference document provides hardware-oriented descriptive and instructive material for the user of the MTU9104/9105/9112/9113 Magnetic Tape Units, and for others concerned with their technical aspects.

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Section 1
General Description

The MTU9104/9105/9112/9113 Magnetic Tape Units are compact, self-contained rackmountable units for use on Model 33 and larger systems. A choice from among four different tape units enables users to select tape units best suited to their tape processing requirements. Table 1-1 lists the specifications for the various magnetic tape units.

The MTU9104 and MTU9105 are 9-track, 800-bits-per-inch (bpi) units with transport speeds of 45 and 75 inches per second (ips), respectively. The MTU9112 and MTU9113 are 7-track, dual-density, 556-/800-bpi units with transports speeds of 45 and 75 ips, respectively. The recording technique used for all units is NRZI (Nonreturn-to-Zero-Inverted).

The magnetic tape units interface with the Level 6 Megabus by means of a Magnetic Tape Controller (MTC9101). All input/output transfers are in Direct Memory Access (DMA) mode, to or from main memory via the Megabus. Tape units can be mounted in freestanding expansion cabinets capable of housing up to two units, as shown in Figure 1-1, or mounted in the central processor cabinet.

Figure 1-1. Level 6 System with Tape Units Mounted in Freestanding Cabinet

NRZI MAGNETIC TAPE CONTROLLER (MTC9101)

The MTC9101 provides the capability of attaching magnetic tape units as well as unit record devices to a system with a single controller. Incorporating sophisticated hardware and firmware, the MTC9101 microprogrammed control supports the connection of up to four 7-track magnetic tape units (MTU9112/9113), or up to four 9-track magnetic tape units (MTU9104/9105), or a combination of tape units and unit record devices (serial/line printers and card readers), with a maximum of two tape units and two unit record devices.

Seven- and nine-track magnetic tape units cannot be mixed on the same MTC9101; however, they can be mixed on the same Level 6 system if a second MTC9101 is configured. Multiple MTC9101s can also be configured if users require extra functionality such as read-write simultaneity, additional tape drives, and additional unit record devices. Tape speeds of 45 ips and 75 ips can be mixed on the same MTC.

The tape units interface to the MTC9101 via a single 9-track NRZI Magnetic Tape Device-Pac (MTM9102) or single 7-track NRZI Magnetic Tape Device-Pac (MTM9101). Up to four 7-/9-track tape units are supported by either Device-Pac. An alternate configuration of two 7-/9-track tape units and two unit record devices is also permitted. The unit record devices require their own Device-Pac.

DATA INTEGRITY AND PROTECTION

The tape units offer built-in protection against destruction caused by an accidental write operation; before recording is permitted a write-enable ring must be in place. All information written on tape is immediately read and checked.

In the 7-track NRZI mode at 556 or 800 bpi, Longitudinal Redundancy Check (LRC) characters are generated during writing and checked during reading to detect errors.

In the 9-track NRZI mode at 800 bpi, Longitudinal Redundancy Check (LRC) and Cyclic Redundancy Check (CRC) characters are generated during writing and checked during reading to detect errors.

Tape deskewing in the write mode is electronically adjustable. In addition, an automatic vacuum tape cleaner reduces the incidence of data errors caused by foreign matter on the tape.

SYSTEM AVAILABILITY

Tape unit, Device-Pac, data recovery unit, or controller malfunctions are easily and quickly isolated to their Optimum Replaceable Unit (ORU). Boards within the central subsystem that have microprogramming (firmware) like the MTC9101 have built-in self-checking capabilities called QLTs (Quality Logic Tests) and LEDs (Light-Emitting Diodes) for problem indication. The QLTs are initiated in the MTC and elsewhere in response to a Master Clear or

an Initialize command. The LEDs on the associated boards are lit and, after internal checking is finished, the lights are extinguished one after another. Any LEDs remaining lit indicate a malfunction on a board(s) via an LED matrix. The CHECK light on the central processor control panel is lit to inform the operator.

More comprehensive testing is available to the operator via the test and verification (T&V) programs. The T&Vs are loaded and run when it is necessary to verify all operational aspects of the MTC and isolate failures to the MTC, device adapter, data recovery unit, or tape unit. Reference the Level 6 Model 3X, 4X, 5X System Checkout T&V Operator's Guide, Order No. AW94.

SPECIFICATIONS

Table 1-1 lists the specifications and characteristics for the magnetic tape units.

TABLE 1-1. MAGNETIC TAPE UNIT SPECIFICATIONS

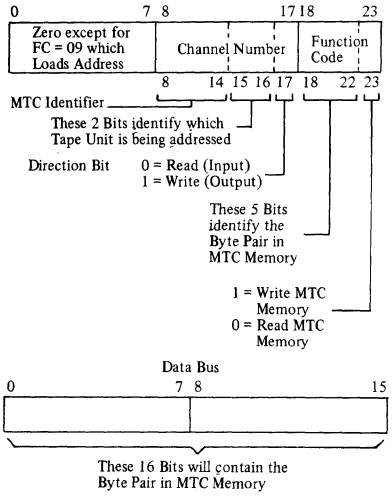
	MTU9104	MTU9105	MTU9112	MTU9113
No. of Tracks:	9	9	7	7
Tape Density (bpi):	800	800	556/800	556/800
Read/Write Speed (ips):	45	75	45	75
Rewind Speed (ips):	200	250	200	250
Transfer Rate:				
Bytes/s —	36K	60K	—	—
Chars/s —	—	—	25K/36K	41.7K/60K
Interblock Gap (in.):	0.60	0.60	0.75	0.75
Block Length (chars):	2048	2048	2048	2048
Vacuum Column:	single	dual	single	dual
Device-Pac:	1-MTM9102	1-MTM9102	1-MTM9101	1-MTM9101
Controller:	MTC9101	MTC9101	MTC9101	MTC9101
Units per Controller:	4	4	4	4
Electrical Characteristics:				
Power —	120 Vac +10%, −15%; single phase			
Power Consumption (kVA) —	0.78	0.82	0.78	0.82
Heat Dissipation (Btu/hr) —	2000	2360	2000	2360
Frequency —	60 Hz ± 0.5 Hz			
Environmental Characteristics:				
Operating Temperature —	50° F to 100° F (10° C to 38° C)			
Operating Relative Humidity —	10% to 90% (noncondensing)			
Physical Characteristics:				
Height (in) —	24.0	24.0	24.0	24.0
Width (in) —	19.0	19.0	19.0	19.0
Depth (in) —	15.4	15.4	15.4	15.4
Weight (lb) —	110	120	110	120
Cables:				
ac (ft) —	7.5	7.5	7.5	7.5
dc (ft) —	25	25	25	25
Tape:				
2400-foot reels of ½-inch Mylar base certified for either 800 or 1600 bpi; reel diameter of 10½ inches; IBM-compatible reel hubs				
Recording Format:				
Compatible with American National Standards Institute standards for recorded magnetic tape information interchange				

Section 2
Programming

MTC MEMORY AND COMMAND INTERPRETATION

The MTC9101 has a 128-word Read/Write memory that is divided into 32 registers (16 bits per register) for each of the four MTC channels (or ports). The address of each of the various registers in the MTC is a combination of two bits of the channel number and the five high-order bits of the function code used to write into or read from a particular register.

The CP can read or write any register as long as the specific channel is not busy. To write into a register, an I/O *output* command is used; reading is done with an I/O *input* command. Addressing of the various registers relates to the I/O command as follows:



The format shown is for a Write cycle on the bus. For a Read cycle, the memory data will be returned from the MTC on a second bus transfer.

To perform a specific operation, software first loads the address, range, and configuration registers. The task register is loaded last and specifies the operation to be performed. The MTC begins command execution when it receives the task word.

CHANNEL NUMBER

Units attached to the MTC9101 are software-addressable via channel numbers. Each tape unit has two such channel numbers assigned, differing only in their low-order bit position called the direction bit.

The channel number for the MTC is separated into three fields:

- MTC Identifier (bits 8-14) — switch-selectable and assigned at system installation time.
- MTC Port (bits 15-16) — identifies which of the four tape units is being addressed.
- Direction Bit (bit 17) — specifies in the IOLD command whether it is an input or output data transfer. For all other commands, the direction bit is ignored by the hardware.

SIMULTANEITY

The MTC9101 provides a single level of simultaneity (only one data transfer can be active in the subsystem). However, the MTC will accept a data transfer command to unit B while unit A is performing a data transfer, but will not start the data transfer on B until A's data transfer is completed.

INTERRUPTS

An interrupt will be attempted whenever a channel interrupt level is not zero, and an operation initiated by an Output Task Word or Output Control Word instruction is completed or the Attention bit is set in Status Word 1. If a negative response is received during an interrupt cycle, the MTC will store the interrupt until it can be retried. In the meantime, the MTC can receive commands and/or conduct data transfers on any of the other channels. The channel with the pending interrupt will remain busy and the MTC will not accept any commands issued to that channel except an Output Control Word.

If an interrupt level of a channel is zero (either via initialization or loaded to zero) no interrupts will be attempted for that channel. If a condition or event occurs that would normally cause an interrupt, the appropriate bits in the Status Words will be set, but no interrupt will be attempted or accepted.

If the interrupt level is set to zero when an interrupt is pending via an Output Control Word (Initialize) or a Master Clear, the pending interrupt will be discarded.

MEDIA INTERCHANGEABILITY

Tapes generated by these units are compatible with tapes generated by other units if the other tape units comply with American National Standards Institute recording standards.

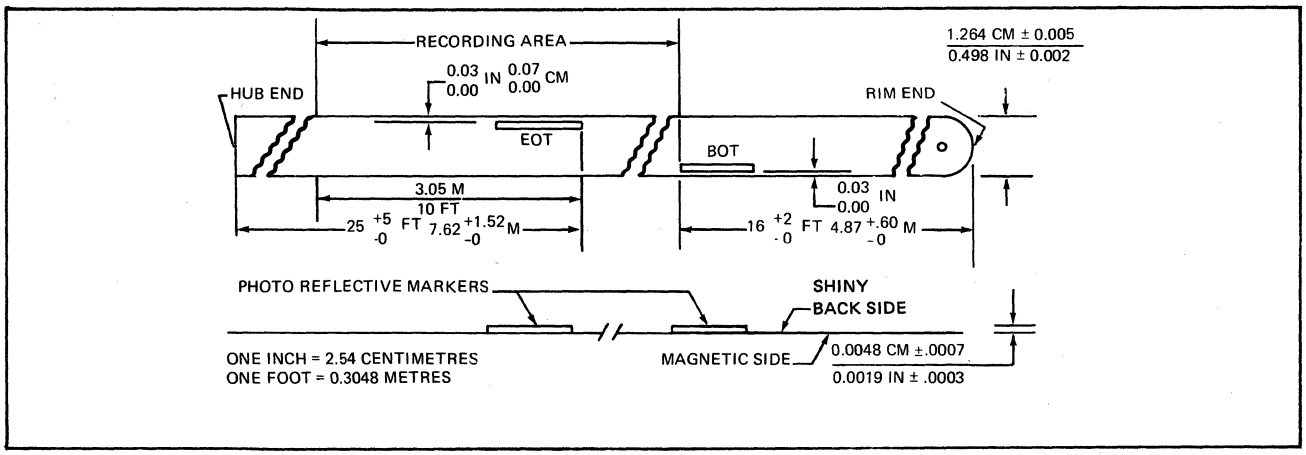


Figure 2-1. Magnetic Tape Layout

MAGNETIC TAPE

The physical layout of half-inch magnetic tape is illustrated in Figure 2-1. A full reel of tape has a nominal recording length of 2400 feet (732 m). The entire length of the tape is oxide-coated. Beginning- and end-of-tape sensing is controlled by reflective markers affixed to the Mylar-base side of the tape. The beginning-of-tape (BOT) spot is attached approximately 16 feet (4.88 m) from the physical beginning of the tape, and the end-of-tape (EOT) spot is attached approximately 25 feet (7.62 m) from the physical end of the tape.

BEGINNING AND END OF TAPE

In order to ensure maximum reliability in the storage of data, an erased area must be recorded in the vicinity of the beginning-of-tape (BOT) marker that is affixed near the reference edge at the start of every tape, and an unrecorded area must be left in the vicinity of the end-of-tape (EOT) marker affixed on the opposite edge of tape at the trailing end of a tape reel.

BEGINNING-OF-TAPE GAP

An erased section of tape is required surrounding the BOT marker. This serves as a defined area within which reading can start. This section begins a minimum of 1.3 in. (3.3 cm) before the hub end of the BOT marker and extends a minimum of 3.0 in. (7.6 cm) past the hub end of the BOT marker. This erased section totals about 4.3 in. (10.9 cm).

DATA BLOCKS

The data is formatted and recorded on the tape in blocks. The exact configuration of a block depends on whether the tape is in 7-track or 9-track format. On 9-track tape, each block consists of the data, a Cyclic Redundancy Check (CRC) character, and a Longitudinal Redundancy Check (LRC) character. The CRC character is positioned four character times after the final data character, and the LRC character must occur four character times after the CRC. A nominal spacing of 0.6 in. (1.5 cm) is required between blocks.

On 7-track tape, each block consists of data, followed by an LRC character four character times after the final data character. Nominal spacing between blocks is 0.75 in. (1.9 cm).

Standard block formats used for NRZI recording are shown in Figures 2-2 and 2-3 (data block and tape mark block formats respectively).

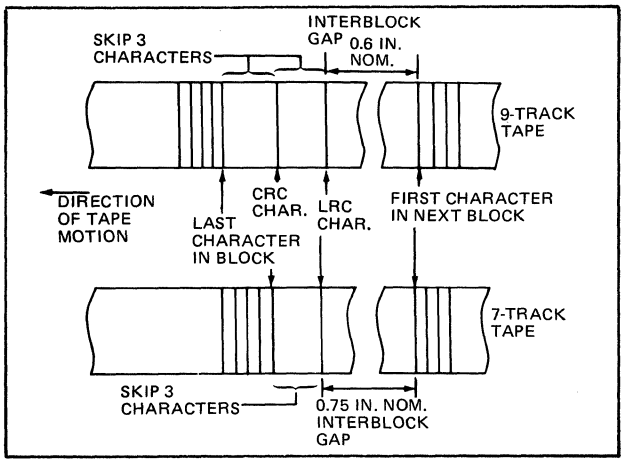


Figure 2-2. Data Block Formats

INTERBLOCK GAPS

Interblock gaps are areas without data (i.e., all tracks restored to the dc-erased polarity) placed between data blocks or records. The length of the gap is 0.75 in. (1.9 cm) nominal (0.6 in./1.5 cm minimum) for 7-track subsystems and 0.60 in. (1.5 cm) nominal (0.5 in./1.3 cm minimum) for 9-track subsystems. The maximum length should not exceed 25 feet (7.6 m).

TAPE MARKS

Figure 2-3 shows the format of the Tape Mark for 7-track and 9-track tapes. The distinguishing feature of the block is that it is a single, specific character block with a check character.

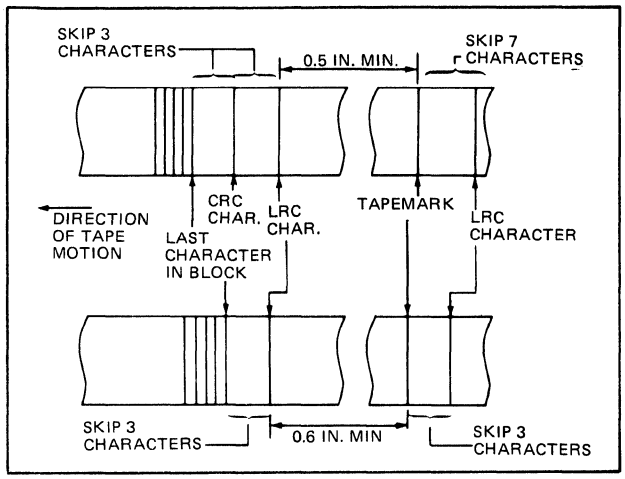


Figure 2-3. Tape Mark Block Formats

NRZI DATA RECORDING FORMAT

In NRZI coding, a logic One bit appears on the interface lines as a low voltage level and a logic Zero as a high voltage level. However, on the tape, a logic One bit is recorded as a flux change and a logic Zero bit as no change. The direction of the change is immaterial; however, the initial flux change direction after BOT conforms to ANSI standards.

CHECK CHARACTERS

The NRZI format provides for both vertical and longitudinal parity checks. In the 9-track system an additional check called the cyclic redundancy check character is used. Refer to Figures 2-2 and 2-3 for the location of the check characters.

- *Vertical Parity* — 7-track and 9-track tape subsystems use 6 and 8 tracks, respectively, for recording data. The remaining track carries parity information. When performing a Write operation, one parity bit is generated, either odd parity or even parity based on a previously stored Configuration Word, to accompany each character written on tape. The 9-track subsystems read and write odd parity only while 7-track subsystems allow the selection of odd or even parity to be recorded or read.

  When performing a Read (including Read-After-Write) operation, the parity read is checked against the parity created from the data portion of the character read. A mismatch causes a Vertical Redundancy Check (VRC) error condition to be set in Status. Note, however, if an even number of bits in the data character are "dropped" or "picked," a VRC error will not be detected; thus additional checking facilities are necessary.

- *Longitudinal Parity* — A Longitudinal Redundancy Check (LRC) character is written following the data portion of each block. It is separated from the end of the data or CRC in each block. This character is made up on a per-track basis. The LRC character written is one calculated so that an even number of "one" bits, including those of the data and LRC character, is recorded in each track of the block. On reading, this is checked and an error is detected if the count is odd in any track. This possibility of detecting an erroneous block still exists if an even number of bits in a given track of a block is dropped or picked. However, when this test is combined with the vertical parity test, the probability of not detecting an error is reduced.

- *Cyclic Redundancy Character Check (CRC)* — In the 9-track system another check character is written. This character is derived with relatively complex logic and, along with the LRC character and vertical parity, minimizes the possibility of undetected errors. The CRC character bits of a Tape Mark Block are all zeros. This check character follows the last data byte of the block by four cell positions.

DATA FORMATS

7-TRACK

Information can be written or read in two modes:

- *Byte Mode* — Transfers 12 bits (of 16) of a data word to or from the tape as shown in Figure 2-4 (the four nonsignificant bits — bits 0, 1, 8, and 9 of the memory word — are ignored on writes and zero-filled on reads from tape).

- *Pack Mode* — Transfers three characters between memory and the tape. On writing tape, the controller generates two bits (zeros) to complete the six bits of the third character. On reading tape, the controller strips off these two bits (Figure 2-4).

Even parity is used in the BCD (byte) mode and odd parity is used in the binary modes. In either mode, longitudinal even parity is indicated for each track at the end of a record. Since the file mark (17_8) is a single-frame record, the file mark longitudinal parity frame is identical to the file mark itself.

To accomplish IBM tape code compatibility in the BCD mode, the octal value 00 is converted to the octal value 12 when writing. Conversely, when reading, the octal value 12 is converted to the octal value 00.

9-TRACK

Data being written on or read from tape is handled on a byte basis. All 16 bits of a data word are transferred to or from the tape as shown in Figure 2-4. Odd parity (vertical redundancy check) is written on tape and is checked when read.

INSTRUCTIONS

Table 2-1 lists the I/O commands to which the MTC/Magnetic Tape Device-Pac/tape units respond. A detailed description of each command follows this table.

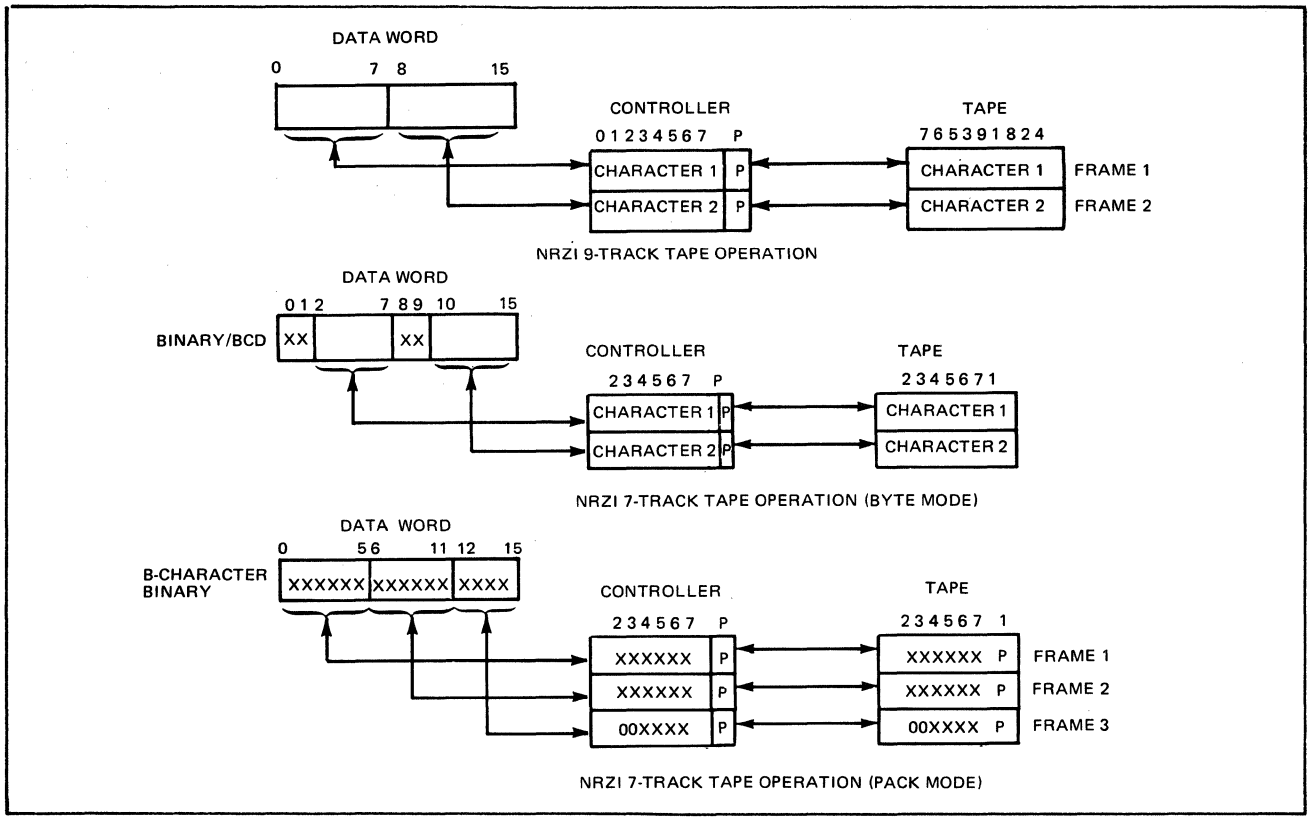


Figure 2-4. Data Formats

TABLE 2-1. MAGNETIC TAPE COMMANDS

Type	Function Code	Command
Output	09[a]	Output Address
	0D	Output Range
	11	Output Configuration Word
	03	Output Interrupt Control
	07	Output Task Word
	01	Output Control Word
Input	0C	Input Range
	10	Input Configuration Word
	02	Input Interrupt Control
	26	Input Device ID
	06	Input Task Word
	18	Input Status Word 1
	1A	Input Status Word 2

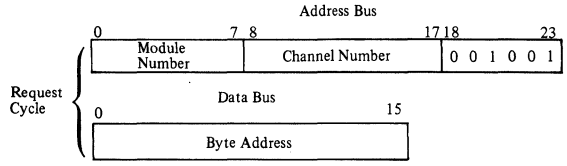
[a]Function Code 09 as executed by the CP will result in execution of functions 09 and 0D.

OUTPUT COMMANDS

Command Output Address

Function Code 09

Format



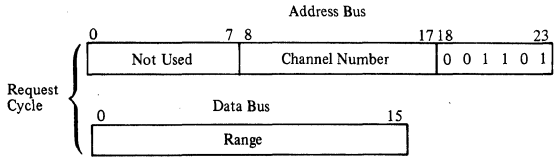
Function

Loads a 24-bit address into the address register associated with the referenced channel (device). The address refers to the starting (byte) location in main memory where the MTC will commence input or output data transfers. Bits 0-7 of the Address Bus (Module Number) are the most significant bits of the Address. The Data Bus contains the 16 least significant bits. Data transfers to or from memory will normally be on a word basis but byte mode transfers can occur associated with the first and/or last memory cycle of a particular data transfer if the main memory buffer (identified by this instruction) begins or ends on an odd byte boundary.

Command Output Range

Function Code 0D

Format



Function

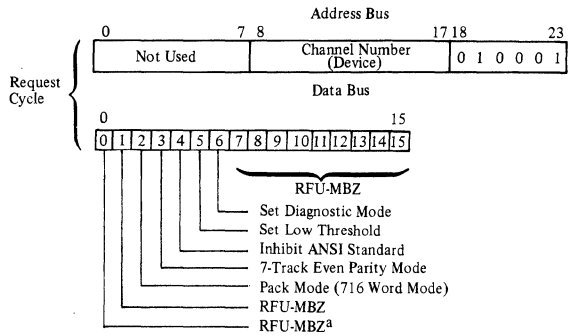
Loads the Range register associated with the referenced channel. The (16-bit) quantity loaded (data bus) is the number of bytes to be transferred during

the data transfer that is being set up. The number is a positive binary quantity (bit 0 must be zero) and is decremented by the MTC after each memory transfer. A range of zero results in a subsequently issued Read Forward order to perform the equivalent of a Forward Space Block order transferring no data to memory. A range of zero results in a subsequently issued Write order setting the Operation Check bit of Status Word 1, no data transfer, no tape motion initiated, and termination of the order. Any address and range register residue is applied to the next command unless reset by another Output Range instruction.

Command Output Configuration Word

Function Code 11

Format



[a]Reserved for future use, must be zero.

Function

Loads the Configuration Word for the device corresponding to the referenced channel.

- *Pack Mode* — This bit set to one puts the NRZI 7-track subsystem in Pack Mode. In this mode, data transfers to and from memory start and end on byte boundaries and the range is specified in bytes. However, if the range contents specify an odd number of bytes, the Operation Check bit in Status Word 1 is set, no tape motion is initiated, and the read or write order is terminated. For a write command, the 7-track subsystem generates three characters with odd parity on tape for each word obtained from memory. The high-order twelve bits of the word are written on tape as characters 1 and 2. The remaining four bits of the word are recorded in the low-order locations of character 3 with the remaining two bit locations zero-filled. For a read command, a data word is transferred to memory for each three characters read from tape or until the range register has been depleted to zero.

  Note:

  The NRZI 9-track subsystem ignores this bit.

- *7-Track Even Parity Mode* — This bit set to one puts the NRZI 7-track subsystem, if not in Pack mode, into even (vertical) parity mode. Even parity accompanies each data character written on tape and VRC logic checks for incorrect even parity during read and Read-After-Write operations. Status Word 2 bit 5 is set if errors are detected. This bit set to zero puts the subsystem into the normal odd parity mode.

  Note:

  The NRZI 9-track subsystem ignores this bit.

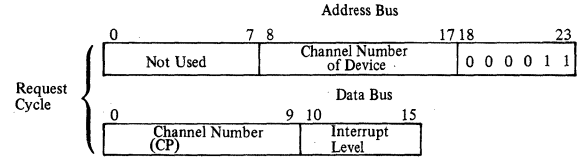
- *Inhibit ANSI Standard* – This bit set to zero requires that the ANSI Standard, write data blocks of no fewer than 18 bytes from memory, be adhered to; otherwise an Operation Check occurs. Also, if during reading, 11 or fewer characters from tape are detected, they are interpreted as noise, Status Word 1 bit 4 is set, and the search continues for the next block on tape. This bit set to a one inhibits the ANSI Standard and writing a minimum data block of one or more characters is allowed. Also allowed is the reading of one or more character data blocks.
- *Set Low Read Threshold* — This bit set to one allows the read threshold detection to be reduced during read operations only.
- *Set Diagnostic Mode* — This bit set to one puts the 7- or 9-track subsystems into the Diagnostic mode. In this mode:
  - — Subsequently issued write orders generate even vertical parity on 9-track tape (for use in diagnosis; i.e., in the generation on tape of data and check characters with bad parity and blank characters and gaps of specific lengths).
  - — Subsequently issued write orders to 9-track devices generate incorrect CRC characters on tape (for use in diagnosis).
  - — Subsequently issued non-forward motion (Output Task Word) command transfers data stored in the write FIFO adapter buffer to the adapter DLI transmitter/receiver logic and wraps the data around and into the read FIFO adapter buffer.

This bit set to zero puts the NRZI tape adapter subsystem attached to the MTC into its Normal Mode (non-Diagnostic Mode).

Command Output Interrupt Control

Function Code 03

Format



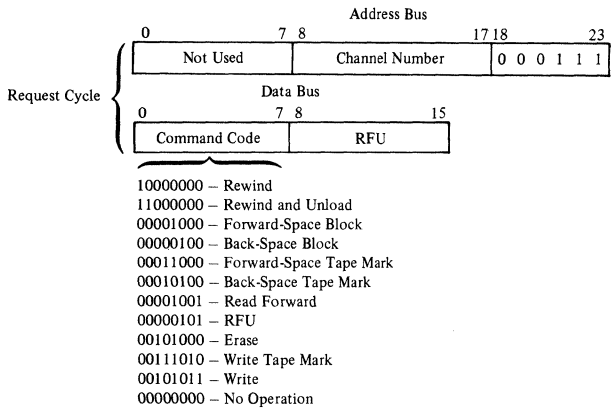
Function

Loads, for the referenced device, the interrupt level and the channel number of the CP to which subsequent interrupts should be sent. The level number is a 6-bit quantity and is positioned on the data bus as illustrated. Bits 0-9 of the data bus contain the channel number of the CP loading the interrupt level. If an interrupt level of zero is loaded, the subsystem will not generate or save interrupts for any events that occur while the interrupt level is zero. For example, if the attention bit in Status Word 1 is set to one with a stored interrupt level of zero, the subsystem will not generate an interrupt on the bus. The interrupt level is set to zero whenever the subsystem is initialized.

Command Output Task Word

Function Code 07

Format



Function

Outputs a Task Word to the referenced channel. The coding bits 0-7, illustrated above, represent the operations that are to be performed. When this command is accepted, the channel enters the Busy state. All configuration, addresses and range information must be loaded prior to execution of this command. The direction of data transfer indicated by the low-order bit of the most recent Output Address command must agree with the direction of transfer (read or write) specified by command code of the Output Task Word. If it does not, Status Word 1 bit 11 Operation Check will be set and a normal termination of the command without data transfer and tape motion will result. These commands addressed to a device not in the online state result in the setting of an Operation Check bit prior to a normal termination of the order.

- *Rewind* — This command rewinds the tape to the BOT marker if the most recent Output Task command was not a "write order" (Write, Write Tape Mark, Erase). If otherwise, an erase in the forward direction over approximately one inch of tape precedes the rewind operation. The drive remains in the Busy state until the completion of the rewind operation or the setting of a Time Out check. The subsequent ten commands will be NAKed. If the tape on the drive is at BOT when this order is issued, tape motion is not initiated and a normal termination of the order results. Note that the rewinding of a drive via the REWIND button on the drive does not put the device in the Busy state but activates rewinding (Status Word 2 bit 1), which affects the states of the Device Ready and Attention bits of Status Word 1. When the manually initiated rewind is complete, the Rewinding status condition resets, Device Ready changes state, and the Attention bit is set again.

  Note:

  A rewind of tape without any erase operation may be initiated manually via the REWIND button.

- *Rewind and Unload* — This command implements a Rewind command and, following detection of the BOT marker, activates the drive's unload sequence prior to termination of the order. If the tape on the drive is at BOT when this command is issued, then only the unload sequence is initiated prior to termination of the command. The unload sequence puts the selected tape device into the offline state, extinguishes the online indicator and moves tape in the reverse direction until it is wound off the take-up reel. The tape drive can manually be placed into the online state only from the device control panel.

  Note:

  A tape drive may be put in the offline state without any erase action or tape motion manually via the ONLINE button.

- *Forward-Space Block* — This command results in the drive spacing forward over the next block on tape if the most recent Output Task command was not a "write order." If otherwise, an erase in the forward direction over approximately one inch precedes the forward-space block operation. The order terminates when tape is positioned in the next interblock gap or as a result of a Time Out Check.
- *Backspace Block* — This command results in the drive spacing back over the previous block on tape if the most recent Output Task com-

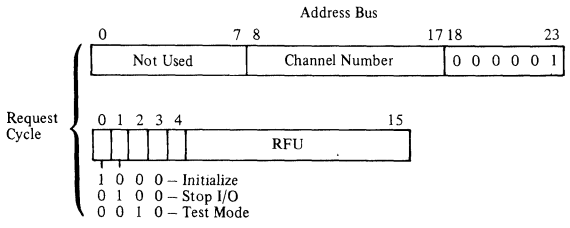
mand was not a "write order." If otherwise, an erase in the forward direction over approximately one inch precedes the backspace block operation. The order terminates when tape is positioned in the previous interblock gap, or when the tape is positioned at BOT, or as a result of a Time Out Check. If this command is issued when the tape is positioned at BOT, tape motion is not initiated and the order is terminated.

- *Forward-Space Tape Mark* — This command results in the drive spacing forward over one or more blocks until a Tape Mark or EOT status is detected on tape if the most recent Output Task command was not a "write order." If otherwise, an erase in the forward direction over approximately one inch precedes the forward-space tape mark operation. The command terminates when tape is positioned in the interblock gap following the block containing a Tape Mark or a data block when EOT (Status Word 1 bit 7) is set or as a result of a Time Out Check.
- *Backspace Tape Mark* — This command results in the drive spacing back over one or more blocks until a tape mark is detected on tape if the most recent Output Task command was not a "write order." If otherwise, an erase in the forward direction over approximately one inch precedes the backspace tape mark operation. The command terminates when the tape is positioned in the interblock gap preceding the block containing the tape mark or when the tape is positioned at BOT or as a result of a Time Out Check. If this order is issued when the tape is positioned at BOT, tape motion is not initiated and a normal termination of the order follows.
- *Read Forward* — This command results in the drive reading forward over the next block on tape if the most recent Output Task command was not a "write order." If otherwise, an erase in the forward direction over approximately one inch precedes the read forward operation. The order terminates when the tape is positioned in the next interblock gap or as a result of a Time Out Check. The format of the data transferred from tape to memory is a function of the stored Configuration Word. In addition to reading data, vertical parity, longitudinal parity, and the cyclic redundancy check character are read and integrity checks are made.
- *Erase* — This command results in the drive erasing tape in the forward direction producing a 2-inch gap on the tape, if the most recent Output Task command was a "write order." If otherwise, an erase in the forward direction over approximately two inches precedes the normal 2-inch erase operation. The channel of the device remains busy for the duration of the erase command and terminates normally.
- *Write Tape Mark* — This command results in the drive erasing tape in the forward direction producing a 2-inch gap on the tape followed by the recording of a Tape Mark block if the most recent Output Task command was a "write order." If otherwise, an erase in the forward direction over approximately two inches precedes the write tape mark operation (2-inch erase plus write tape mark block). The tape mark format for 9-track tape is shown in Figure 2-4. An attempt to write a Tape Mark Block on a tape unit in Write Protect results in no tape motion initiated or block written and the activation of the Operation Check bit of Status Word 1. The order terminates when the tape is positioned in the gap beyond the Tape Mark Block.
- *Write* — This command results in the drive writing, in the forward direction, a data block of the format, and equal to or greater than the minimum block length allowed, as specified by the Configuration Word most recently issued to this addressed channel if the most recent Output Task command was a "write order." If otherwise, an erase in the forward direction over approximately two inches precedes the write operation. In addition to writing data, vertical parity, longitudinal parity, and a cyclic redundancy check character (9-track only) are written in the data block and integrity checks are made. An attempt to write a data block of less than the minimum length or to write to a drive in Write Protect results in no data transfer, no tape motion initiated, and the activation of the Operation Check bit of Status Word 1. The order terminates when the tape is positioned in the gap beyond the last data block written.
- *No Operation* — This command or Output Task command code results in no data transfer, no tape motion initiated, the normal reset of Status Word bits upon reception of an Output Task command, and a normal termination of the command.

Command Output Control Word

Function Code 01

Format



Function

Loads a Control Word into the referenced channel. This command will be unconditionally accepted by the channel regardless of its Busy status.

- *Initialize* — This command will cause the MTC to reset to the same state that it enters after power up or Master Clear. When an initialize command is received by the MTC all of its channels are initialized (regardless of which channel the command was received over).

  Operations that are in progress in the MTC at the time of the Initialization will be abruptly terminated and all registers will be initialized, including control registers device select and control signals to the drives. No information about the terminated operations will be retained and no interrupts for the operations will be generated. The interrupt level for all channels will be set to Zero (interrupts blocked).

- *Stop I/O* — This command causes any operation currently active on the specified channel to be abruptly terminated. If a data transfer operation is in progress, it will not be completed. An Interrupt will be generated for the operation terminated by this command as if the operation had come to a normal ending point. Status, Configuration, and Range information, present in the MTC when this command is received, will be retained.

- *Test Mode* — When an Output Control Word command is received with the Test Mode bit on (while the MTC is in normal operating mode), the MTC will enter Test Mode. Once the MTC is in Test Mode, subsequent commands cause the contents of the Data Bus to be loaded into the MTC instruction register (the Data Bus contains the microinstruction). One clock cycle is then issued to execute the microinstruction loaded. This enables a sequence of microinstructions to be executed in a single step mode from a software test routine.

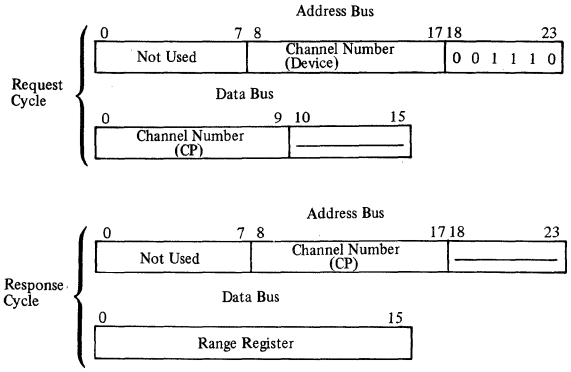
  Test Mode operates on an entire MTC and, therefore, precludes normal usage of other devices on the MTC at the same time. Normal mode is resumed when a "reset test mode" microinstruction is executed or when Master Clear is activated on the Bus. All function codes which are received over the Bus while the MTC is in the Test mode will cause the contents of the Data Bus to be loaded into the MTC instruction register as described above (function code field of the Address Bus is ignored). Note that Response cycles will not be generated for Input commands.

INPUT COMMANDS

Command Input Range

Function Code 0C

Format



Function

Causes the current contents of the referenced channel's Range Register to be transferred to the requesting channel.

During the Response cycle (Second Half Read), the MTC will return in bits 8-23 of the Address Bus the same data that was received in bits 0-15 of the Data Bus during the Instruction Cycle.

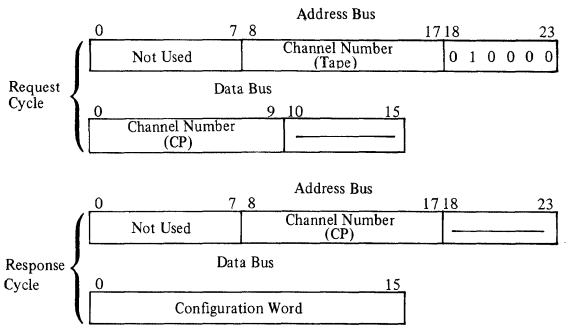
After the completion of a read operation, the contents of the Range Register reflect the status of that transfer with respect to the physical block read.

- If the contents are a positive value greater than zero and bit 8 of Status Word 1, Unequal Length Check is set to a logical One, the length of the physical block was less than the range.
- If the contents are zero and bit 8 of Status Word 1 is equal to One, the length of the physical block was greater than the original range.
- If the contents are zero and bit 8 of Status Word 1 is equal to Zero, the length of the physical block was equal to the original range.

Command Input Configuration Word

Function Code 10

Format



Function

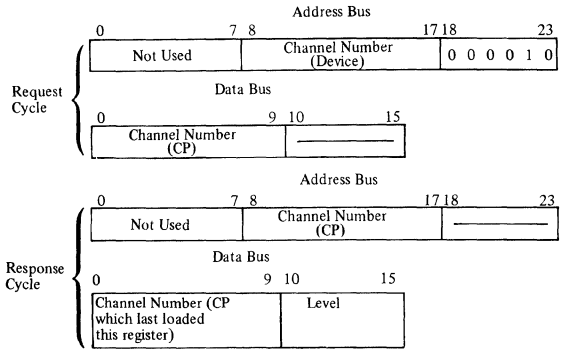
Causes the channel's Configuration Word to be transferred to the requesting channel.

During the Response cycle (Second Half Read) the MTC will return in bits 8-23 of the Address Bus the same data that was received in bits 0-15 of the Data Bus during the Instruction cycle. After the completion of a read operation, the contents of the Configuration Word register reflect the status of that transfer with respect to the physical block read.

Command Input Interrupt Control

Function Code 02

Format



Function

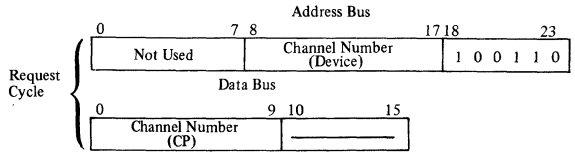
Causes the channel's interrupt level to be transferred to the requesting channel. The level value will be placed on Data Bus bits 10 through 15 with bit 15 as the least significant bit. This quantity is the value previously received in the Output Interrupt Control instruction or a default value of 00. The default value is the interrupt level assumed by the channel when initialized. Note that the channel number returned in bits 0-9 of the Data Bus might be different from the channel number of the CP executing this instruction if more than one CP is attached to the Bus.

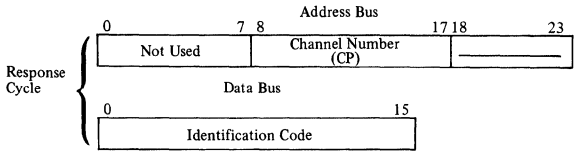
During the Response cycle (Second Half Read), the MTC will return in bits 8-23 of the Address Bus the same data that was received in bits 0-15 of the Data Bus during the request cycle.

Command Input Device ID

Function Code 26

Format





Function

Causes the referenced channel to transfer its identification code to the requesting channel. The codes for each type of tape device are defined as follows:

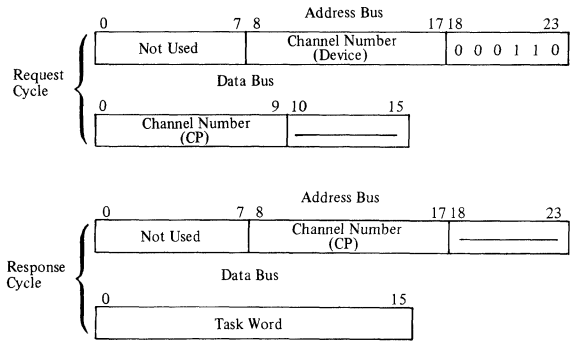
Code (Hex)	*Tape Unit*
2045	MTU9104 (45 ips, 800 bpi)
2046	MTU9105 (75 ips, 800 bpi)
2069	MTU9112 (45 ips, 556 bpi)
2071	MTU9112 (45 ips, 800 bpi)
206A	MTU9113 (75 ips, 556 bpi)
2072	MTU9113 (75 ips, 800 bpi)

During the Response cycle (Second Half Read), the MTC returns in bits 8-23 of the Address Bus, the same data that was received in bits 0-15 of the Data Bus during the Request cycle.

Command Input Task Word

Function Code 06

Format



Function

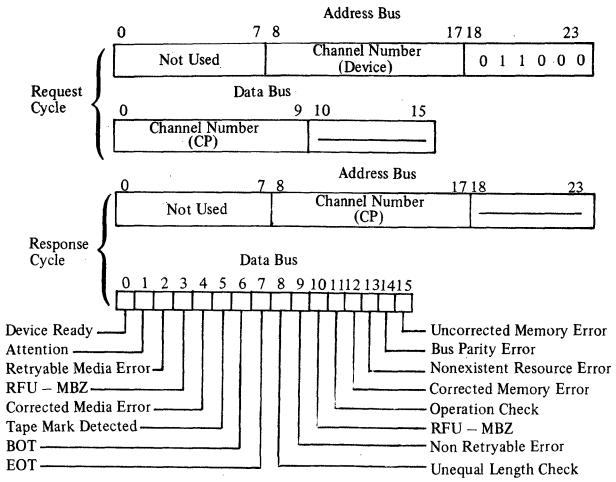
Causes the Task Word of the referenced channel to be transferred to the requesting channel. The Task Word transferred will contain the code for the last operation executed by the channel (unless an Initialize has occurred).

During the Response cycle (Second Half Read), the MTC will return in bits 8-23 of the Address Bus the same data that was received in bits 0-15 of the Data Bus during the Request cycle.

Command Input Status Word 1

Function Code 18

Format



Function

Causes the referenced channel's Status Word 1 to be transferred to the requesting channel. During the Response cycle (Second Half Read), the MTC will return in bits 8-23 of the Address Bus the same data that was received in bits 0-15 of the Data Bus during the Request cycle. Bits 0-7 of the Address Bus and the parity bit associated with these bits are the same data received during the Request cycle. See Table 2-2.

TABLE 2-2. STATUS BIT DEFINITIONS — WORD 1

Status Condition	Bit	Definition	Reset by
Device Ready	0	Unit is online with tape loaded, is not rewinding, and no further manual intervention is required to place it under program control. This bit will be zero, if either Status Word 2, bit 0 is a zero or Status Word 2, bit 1 is a one.	A change in condition
Attention	1	Indicates an event has occurred at the unit which requires software action. This event, moreover, was not related to a current task, but rather was unsolicited. This bit will be set whenever the device changes its ready condition as a result of a non-software initated command (i.e., enter or leave the online state, rewinding state, or media loaded state). Attention status may occur following a software initiated Stop I/O or initialize command if the device was performing a Rewind or Rewind and Unload Instruction. Whenever the Attention bit is set, an interrupt is attempted (if the interrupt level is nonzero). If a previously initiated operation is in progress when a device state change is sensed, the resultant interrupt (with the Attention bit set) will serve as notification of both the end of the operation and the device state change.	Initialize, Input Status Word 1, or Output Task Word command
Retryable Media Error	2	Indicates a data error has occurred and will be set whenever Status Word 2 bit 4, 5, 6 or 7 is active.	Initialize or Output Task Work Command
Reserved for Future Use	3	Must be zero.	—
Corrected Media Error	4	Indicates an error condition was detected on tape; however, the data read is not lost. For this subsystem, the detected condition is a noise area within an interblock or BOT gap. A noise area may comprise 1 to 11 detectable frames of magnetic transitions on the media when the subsystem is functioning in the minimum data block mode. In the nonminimum data block mode, all detected frames of magnetic transitions are processed as a block.	Initialize or Output Task Word command
Tape Mark	5	Indicates a Tape Mark has been detected during the execution of a Write Tape Mark, Forward-space Tape Mark, or a Backspace Tape Mark order. This status bit will also be active if the block encountered during execution of a Forward-space/Backspace/ Read block instruction is a Tape Mark.	Initialize or Output Task Word command

TABLE 2-2 (CONT). STATUS BIT DEFINITIONS — WORD 1

Status Condition	Bit	Definition	Reset by
BOT (Beginning of Tape)	6	Indicates the BOT marker is positioned at the BOT sensor. A backspace or rewind order issued to a unit with tape at BOT will result in no tape motion initiated and a normal termination of the order.	
EOT (End of Tape)	7	Indicates the EOT marker is positioned at, or has passed beyond, the EOT sensor. This status bit will remain active until the EOT marker passes back over the sensor as a result of a Tape Backward Motion command (e.g., backspace, rewind). The state of this status bit has no effect on forward motion commands, except the Forward-Space to Tape Mark in which forward motion is terminated in the next interblock gap.	
Unequal Length Check	8	Indicates that for the previous Read operation, the physical block was either greater or less than the value in the range register, at the beginning of the Read operation. This bit, a 1 and a residue in the range register, indicates that a short block was transferred. This bit active and a range register contents of zero indicate that a long block was transferred.	Initialize or Output Task Word command
Non-Retryable Error	9	Indicates that the position of media under the tape read/write and erase heads is unknown. This bit will be set when a write order RAW[a] failure occurs (i.e., the detection of magnetic transitions on tape before the start or following the completion of a recorded data block or the failure to detect magnetic transitions in the area where a data block is being written or the failure to detect an NRZI density identification area on tape when writing an NRZI tape). This bit will also be set when an erase order RAW failure occurs (i.e., the detection of magnetic transitions in the area on tape being erased) or when, during a read order, a split block is detected. A split block is a data block in which its beginning and end positions cannot be guaranteed detectable because of a detected unrecorded area within the block. This status bit also becomes active when Status Word 2 bit 10 (Time Out Check) is set.	Initialize or Output Task Word command
Reserved for Future Use	10	Must be zero.	—
Operation Check	11	Indicates a write type order (Write, Write Tape Mark, Erase) was issued to a tape drive in Write Protect (see state of Status Word 2 bit 2); that upon acceptance of an Output Task Word data transfer command, the direction of data transfer is not the same as that specified by the direction bit of the channel number issued by the previous Output Address command; that upon acceptance of an Output Task Word data transfer command, the contents of the range register is zero (for Read or Write) or less than 18 (for write) when the subsystem is in the ANSI configuration mode; or that a command (other than No Operation) was issued to a channel on which the device is in the offline or Not Ready state.	Initialize or Output Task Word command
Corrected Memory Error	12	Indicates that during execution of the previous operation, main memory detected and corrected a memory read error. The data that was delivered to the MTC was assumed to be correct.	Initialize or Output Task Word command

TABLE 2-2 (CONT). STATUS BIT DEFINITIONS — WORD 1

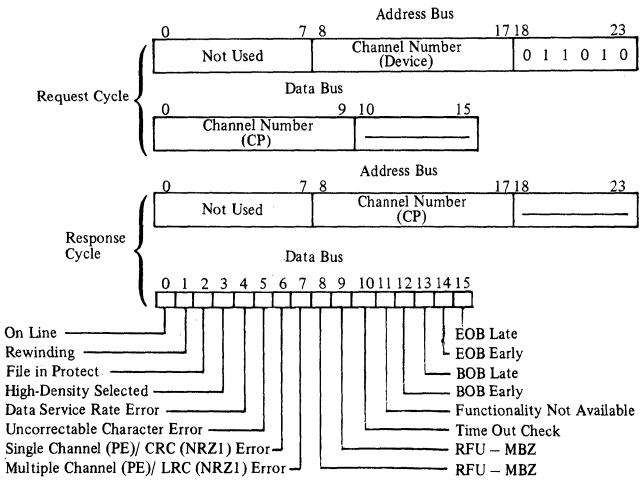
Status Condition	Bit	Definition	Reset by
Nonexistent Resource Error	13	Indicates the MTC attempted a Write or Read request bus cycle and received a NAK response. Occurrence of this condition does not cause a termination of the operation in progress; however, it can result in bad data being written on the tape.	Initialize, Input Status Word 1, or Output Task Word command
Bus Parity Error	14	Indicates the MTC detected a parity error on either byte if the Data Bus during any output bus cycle (i.e., odd function code), during a second-half memory read cycle or when a parity error is detected in bits 0-7 of the Address Bus during an Output Address command. Occurrence of this condition does not cause a termination of the operation in process; however, it can result in bad data being written on tape.	Initialize, or (error free) Input Status Word 1 command
Noncorrectable Memory Error	15	Indicates that during execution of the previous operation, the main memory detected a memory read error which the EDAC algorithm could not correct. The data that was delivered to the MTC was incorrect. Occurrence of this condition does not cause a termination of the operation in progress; however, it can result in bad data being written on tape.	Initialize or Output Task Word command

[a]Read After Write

Command Input Status Word 2

Function Code 1A

Format



Function

Causes the referenced channel's Status Word 2 to be transferred to the requesting channel. During the Response cycle (Second Half Read), the MTC will return in bits 8-23 of the Address Bus the same data received in bits 0-15 of the Data Bus during the Request cycle. Bits 0-7 of the Address Bus and the parity bit associated with these bits are the same data received during the Request cycle. See Table 2-3.

TABLE 2-3. STATUS BIT DEFINITIONS — WORD 2

Status Condition	Bit	Definition	Reset by
Online	0	Indicates the unit is online to the subsystem via the ONLINE switch on the unit. The unit can also be put into offline status via the Rewind and Unload instruction.	—
Rewinding	1	Indicates the unit is processing a rewind operation either via a command issued by the subsystem or the REWIND switch on the unit.	—
File in Protect	2	Indicates the unit is in write protect (i.e., the write permit ring is not in position on the mounted file reel).	—

TABLE 2-3 (CONT). STATUS BIT DEFINITIONS — WORD 2

Status Condition	Bit	Definition	Reset by
High Density Selected	3	Indicates that in a dual-density unit the HI DEN switch is set to the high-density position. This bit is not set if high-density is not selected or the unit has only a single density.	—
Data Service Rate Error	4	Indicates that during a Read or Write operation, data transfer to/from main memory and the unit via the MTC could not maintain the rate in demand. Either data was lost on input because of failure to keep up with device demands or data was unavailable on output when required by the device. The detection of this error condition does not affect the execution of the data transfer operation in process.	Initialize or Output Task Word command
Uncorrectable Character Error	5	Indicates that during a Read or Write operation either a Vertical Redundancy Check (VRC) error and/or a dropped character error was detected. In a VRC error, one or more data characters were detected with incorrect vertical parity. Data character parity is odd unless bit 3 in the stored configuration word is set. In a dropped character error, one or more data characters following the first contiguous segment of data characters in the block were not read.	Initialize or Output Task Word command
CRC (Cyclic Redundancy Check) Error	6	Indicates that during a Read or Write operation (9-track NRZI only), the tape CRC character failed to compare with the reconstructed value.	Initialize or Output Task Word command
LRC (Longitudinal Redundancy Check) Error	7	Indicates that during a Read or Write operation, an incorrect longitudinal parity was detected for any track read. The LRC character written at the end of each block will result in even track parity.	Initialize or Output Task Word command
Reserved for Future Use	8	Must be zero.	—
Reserved for Future Use	9	Must be zero.	—
Time Out Check	10	Indicates that during a Read or Space operation, an excessive delay prior to detecting a block has occurred and has resulted in a termination of the order. This delay is equivalent to passing over approximately 25 feet of tape. This bit is also set during a Rewind or Rewind and Unload operation following an excessive delay without the device entering a Rewind sequence or at BOT. Positioning of the tape under the read/write and erase heads is unknown. Activation of this bit during a Rewind and Unload operation indicates that an excessive delay has been detected without the device entering the offline state.	Initialize or Output Task Word command
Functionality Not Available	11	Indicates for the subsystem specified herein that the Output Task Word — Read Backwards order is not available. A termination of the order without tape motion takes place.	Initialize or Output Task Word command
Beginning of Block (BOB) Early	12	Indicates that the block written on tape was detected by the RAW circuitry to have begun earlier than that specified for the selected device.	—
Beginning of Block (BOB) Late	13	Indicates that the block written on tape was detected by the RAW circuitry to have begun later than that specified for the selected device.	—
End of Block (EOB) Early	14	Indicates that the block written on tape was detected by the RAW circuitry to have terminated earlier than that specified for the selected device.	—
End of Block (EOB) Late	15	Indicates that the block written on tape was detected by the RAW circuitry to have terminated later than that specified for the selected device.	—

Section 3
Controls and Indicators

This section describes the various controls and indicators necessary to the operation of the tape units.

OPERATOR CONTROL PANEL

Magnetic tape unit controls and indicators are shown in Figure 3-1 and described in Table 3-1.

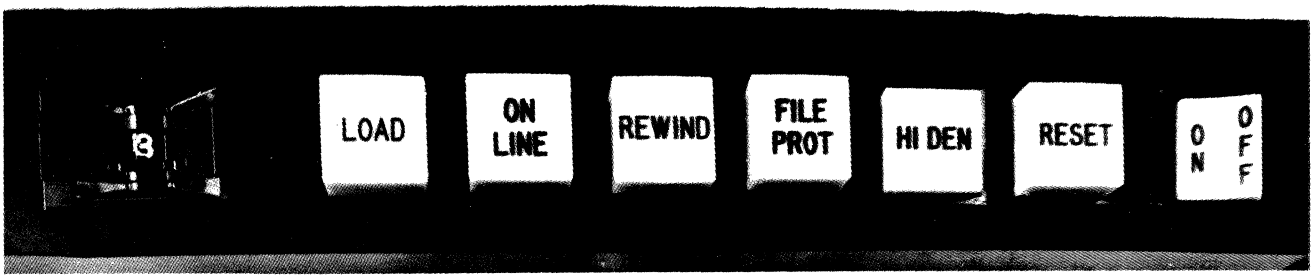


Figure 3-1. Operator Control Panel

TABLE 3-1. OPERATOR CONTROL PANEL CONTROLS AND INDICATORS

Control/Indicator	Description
Unit Select Switch	This thumbwheel switch is used to assign the desired logical unit number (0, 1, 2, or 3). The unit number should only be changed when the tape unit is offline.
LOAD	Pressing LOAD applies vacuum to the loop chamber (after the tape is threaded) and cycles-up the unit. LOAD lights when the unit is fully cycled up and the tape is positioned at BOT. LOAD is extinguished whenever the tape moves off BOT.
ON LINE	Pressing ON LINE places the tape unit online if it is offline, or offline if it is online. ON LINE lights whenever the tape unit is online.
REWIND	Pressing REWIND rewinds the unit to BOT. REWIND lights until BOT is sensed. The button is operative only when the unit is offline. The tape rewinds past the BOT tab, then reverses and advances to the BOT tab and stops. If the tape is at BOT when REWIND is pressed, the tape rewinds slowly off the take-up reel.
FILE PROT	Lights to indicate that the tape mounted and cycled up is protected from being written on (write-permit ring not installed).
HI DEN	Pressing selects the higher density in those tape units with dual density. HI DEN lights when the higher density is in effect. (This button is inoperative on single density units.)
RESET	Pressing stops tape motion if the tape unit is in the forward, reverse, or rewind mode and places the unit offline if it is online. RESET lights whenever the tape unit is selected.
ON/OFF	Pressing the ON side of the button applies power to the tape unit and the button lights. Pressing the OFF side of the button removes power from the unit.

Section 4
Operation

This section describes the operation and maintenance procedures.

APPLYING POWER

Press the ON/OFF switch to ON. ON/OFF lights.

REMOVING POWER

Press the ON/OFF switch to OFF. ON/OFF extinguishes.

TAPE MOUNTING

To mount a tape, follow this procedure.

1. Open the front glass door on the tape unit.
2. Prior to mounting the supply reel, visually examine the condition of the tape. It should be free of kinks and creases. Check condition of the reel as well. It must not be warped or damaged in any way.

   Note:

   If tape is to be written on, install a write-permit ring in back of the tape reel.
3. Open the supply reel hub loading latch and place the supply reel on the hub. Handle the reel by its hub and not by the flanges. Since the flange is the weakest part of the reel, it is more susceptible to damage.
4. Gently press the supply reel onto the supply reel hub and close the loading latch.
5. In the same manner, install an empty reel (take-up reel) on the remaining hub.
6. Refer to "Tape Threading."

TAPE THREADING

1. Using a clockwise direction of rotation, unwind approximately three feet of tape from the supply reel.
2. Thread and feed the tape over the upper roller guides, through the tape head area, and under the capstan and lower roller guide directly over to the take-in reel; see the tape threading diagram located on the inside cover of the handler door and Figure 4-1.

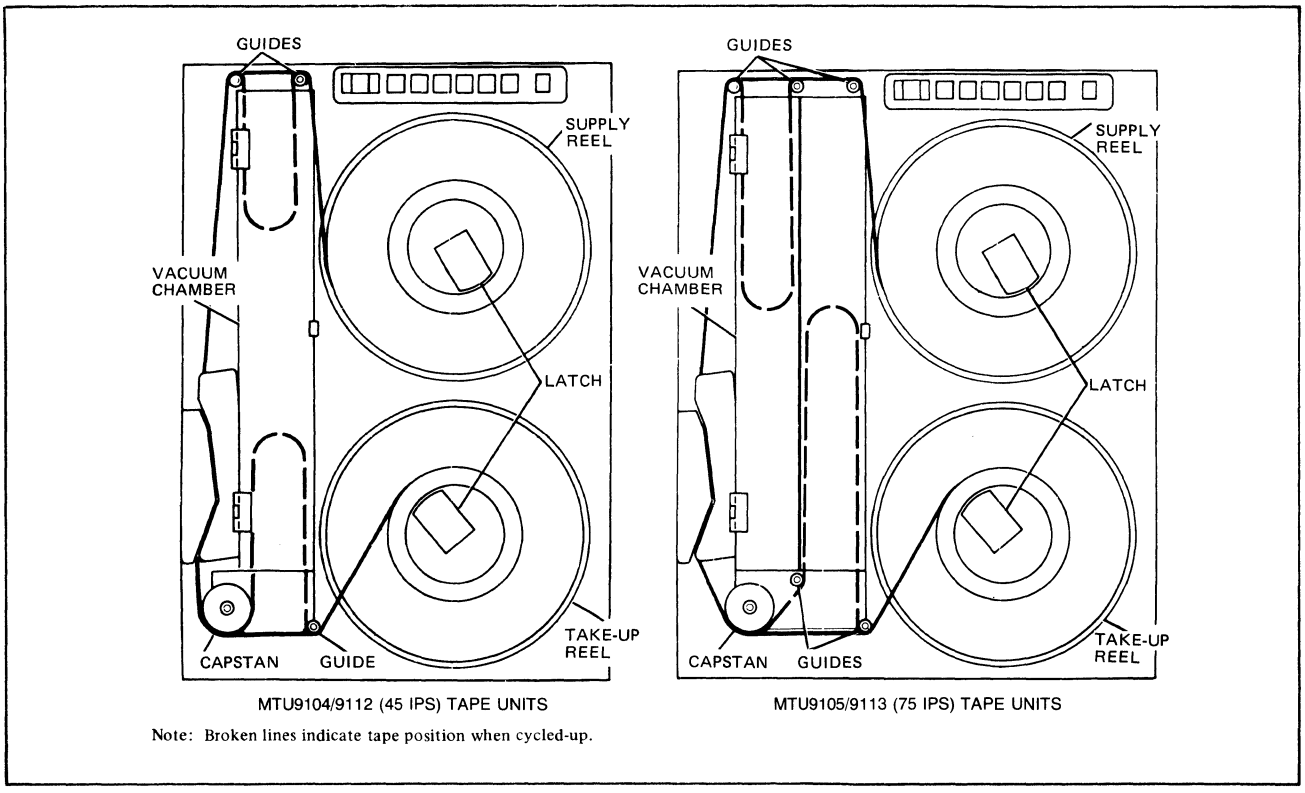


Figure 4-1. Tape Threading Diagram

3. Loop the free end of tape up over the take-up reel in a clockwise direction, making sure that the tape is not twisted or creased in the process. Secure tape end to the reel by holding the tape end with a finger through one of the holes in the reel flange and rotate the take-up reel clockwise, until at least one complete turn of tape is firmly seated on the reel.
4. Remove finger and manually continue to turn the take-up reel clockwise until there is sufficient tape on the take-up reel to tension the tape.

   Note:

   Do not manually rotate the file reel while turning the take-up reel, since friction provides the necessary windup tension required on the take-up reel.
5. Make sure the tape is properly aligned on the roller guides and turn the file reel slightly to take up any remaining slack.
6. Close the front door and press LOAD. Vacuum chamber(s) will activate and tape will be tensioned and advanced to the BOT marker.
7. Select the proper recording density, if applicable, via the HI DEN button.
8. Set unit select switch to desired unit address.
9. Check FILE PROT indicator. If tape is to be written on, the indicator should be unlit.
10. Press ON LINE. Handler is powered and cycled; ready for online operation.
11. Close front glass door on the tape unit.

TAPE REWINDING

The tape unit can unwind tape in either the online or offline mode. During online operation, the handler rewinds tape to the BOT marker under program control.

Offline the handler automatically rewinds tape to the BOT marker. However, to perform such a function, the handler must be in the offline mode.

1. Press ON LINE button. The indicator will extinguish indicating that the handler is offline.
2. Press REWIND to rewind tape to the BOT marker.

   Note:

   Tape rewinds at 200/250 inches per second and continues at this rate until light is sensed by the reel sensor. At this point the tape decelerates to the normal read speed and continues to rewind at this rate until the BOT reflective marker is sensed.

TAPE DEMOUNTING

The following procedure should be performed with the tape unit in the offline mode. (The ON LINE indicator should be extinguished, indicating that the unit is offline.)

- If the tape is positioned at BOT:
  a. Press REWIND to unwind remaining tape from take-up reel back onto the file reel.
  b. Open the front glass door on the tape unit.
  c. Open the supply reel hub loading latch and gently pull the supply reel from its reel mount by grasping the opposite sides of the reel with your fingers while pressing firmly with the thumbs against the reel hub.
  d. Close the supply reel hub loading latch and front glass door, unless another tape is to be mounted.
- If the tape is positioned past the BOT marker:
  a. Press REWIND to rewind tape to the BOT marker. Tape motion will automatically stop when the BOT reflective marker is sensed.
  b. Press REWIND again to unwind the remaining tape from take-up reel back onto the supply reel.
  c. Open the front glass door on the tape unit.
  d. Open the supply reel hub loading latch and gently pull the supply reel from its reel mount by grasping the opposite sides of the reel with your fingers while pressing firmly with the thumbs against the reel hub.
  e. Close the supply reel hub loading latch and front glass door, unless another tape is to be mounted.

OPERATOR MAINTENANCE

Operators are required to perform a limited amount of maintenance in order to keep the tape unit(s) functioning properly. This maintenance consists of cleaning the following major areas: read/write head, tape guides, capstan, tape cleaner, vacuum chamber, erase head and tape unit surfaces. Cleaning should be performed once a day or as often as required.

Prior to cleaning the unit, remove both supply and take-up reels and then power down the unit.

CLEANING

1. Open front glass door.
2. Remove both head covers (see Figure 4-2).
3. Use a lint-free cloth moistened with Honeywell Magnetic Tape Cleaner (Part No. 9704-2048-001) or equivalent solution (such as Freon "TF" solvent) and clean all exposed surfaces of the read/write, head, tape cleaner, erase head, and tape guides shown in Figure 4-2. Cotton swabs or a ½-inch acid-free brush

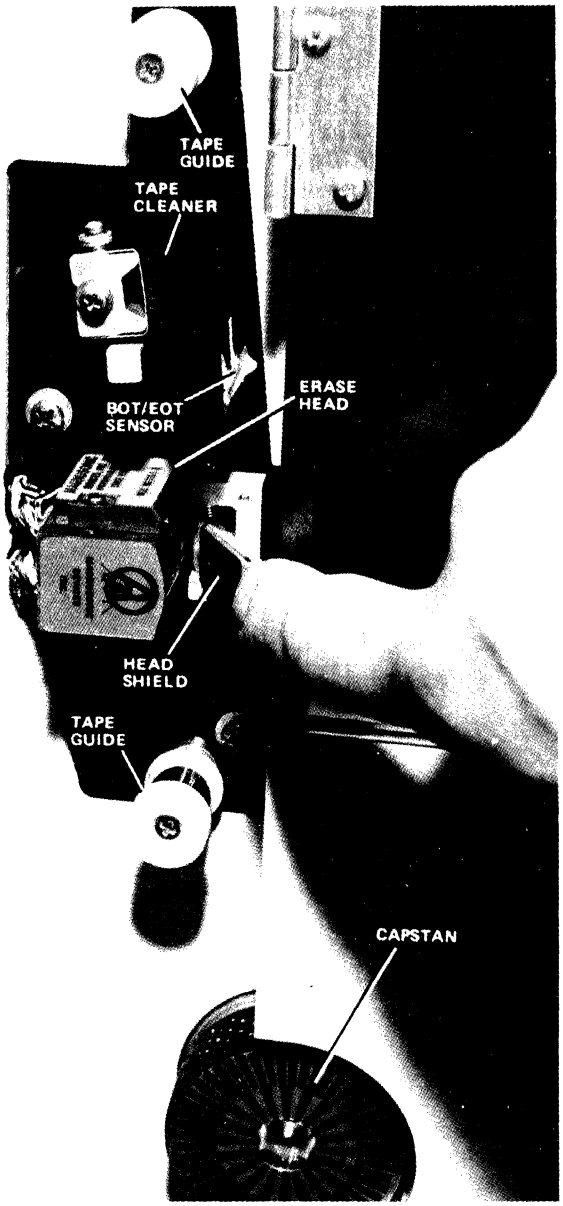


Figure 4-2. Tape Head Assembly

dipped in these cleaner solvents can be used to remove oxide buildup in the slotted areas of the tape head as well as on the rubber surface of the capstan.

Note:

Heads are susceptible to damage. Keep all metallic objects away from tape head area.

4. Replace both head covers.
5. Open the vacuum chamber door and clean vacuum column(s). Use a clean lint-free cloth dampened in one of the cleaner solvents. Cotton swabs may be used to clean walls of the vacuum column(s). Visually check that the air holes are clear.
6. Clean the vacuum chamber glass door and front glass door on the unit of all smudge marks with a lint-free cloth and a nonspray liquid window cleaner.
7. Close the vacuum chamber door.
8. The tape unit can now be put back into service.

BOT PATCH MOUNTING

The beginning and end of the working storage area on the tape are marked by small, inch-long reflective markers. Marker dimensions are:

Length:	1.1 inch ± 0.2
Width:	0.19 inch ± 0.02
Thickness:	0.0008 inch (max.)

The BOT and the EOT markers are placed on the Mylar-base side of the tape. Take care when placing the markers. They must be within 0.03 inch (0.08 cm) of, but not protrude beyond, the reference edge of the tape, and be free of wrinkles and adhesive.

The tape between BOT and the physical beginning of tape is referred to as the leader. If bad spots develop on the tape toward the leading edge, the BOT marker can be moved down so that the damaged section of the tape can still be used for information storage in the normal manner. A leader length of about 16 feet (5 m) is recommended for automatic threading.

TAPE HANDLING AND STORAGE

The following rules are prerequisite for proper magnetic tape handling and storage.

Keep tapes clean. Dust and dirt can reduce the intensity of reading or recording signals by altering the distance between the head and the tape. Therefore:

- Never touch the tape's oxide coating; body oils on tape attract dust and lint.
- Keep the tape in its dust-proof container until just prior to use on the tape drive.
- Keep tape containers clean and dust-free *inside* and *out*. Don't leave containers open when tape is in use.
- Keep the tape transport door closed when the tape drive is not in use.
- Avoid dangling the free end of the tape on the floor when changing reels.
- Don't smoke in the computer room. Smoke and ashes are dirt; hot ashes are destructive to magnetic tape. Food and drink should not be put near the tape devices.
- Identify reels with adhesive stickers, which are easily removed and leave no residue. Eraser particles are dirt. Change the label; don't erase it.

Handle and store tapes with care. Avoid damaging tapes and reels or placing tapes where temperature,

dust, or magnetic fields affect them adversely. Follow these recommendations:

- When rewinding tape, be sure wind tension is approximately 6 to 8 ounces (168 to 224 grams) for ½-inch (1.27 cm) wide tapes. Loosely or tightly wound tape causes wrinkles and creases to appear on the tape, which in time disrupt contact between tape and tape drive head.
- Make sure that the tape leader is properly wound when tape is returned to its container. This avoids accidental crushing of the tape leader edges and possible damage to the tape itself.
- Avoid dropping reels. If a tape is dropped, the reel may become broken or dirty, resulting in possible damage to the tape. Reel damage can be determined by a visual inspection. Never use a reel that may cause damage to the tape or to the tape drive.
- Always store tapes in containers in a dust-free cabinet. The containers should be placed on edge so that the reel is in an upright position. Do not stack tape reels one on top of the other since the bottom containers could be damaged by the weight of the stacked reels.
- Never place reels of tape on top of a tape drive as this exposes them to heat and dust from the cooling system.
- Whenever possible, store tapes in the controlled environment where they are to be used, so the tapes are not subjected to excessive variations in temperature and humidity. For short-term tape storage, the surrounding atmosphere should be controlled within the following limits:

  Operating Relative Humidity: 40% to 60%
  Operating Temperature: 60°F to 80°F (16°C to 27°C)

- For long-term storage, the reel of tape in its container should be hermetically sealed in a moisture-proof bag. Temperature should be constant somewhere between 60°F and 80°F (16° to 27°C).
- When mounting or demounting tapes, handle the tape reels by the hub and not by the flanges. Squeezed or bent flanges result in damaged tape edges and eventual loss of contact with the magnetic head.
- A routine library inspection of tape reels should be made. Check for protruding tape edges. Exposed edges are vulnerable to damage and cause loss of contact with the tape drive head.

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