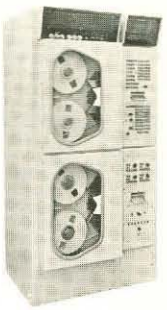
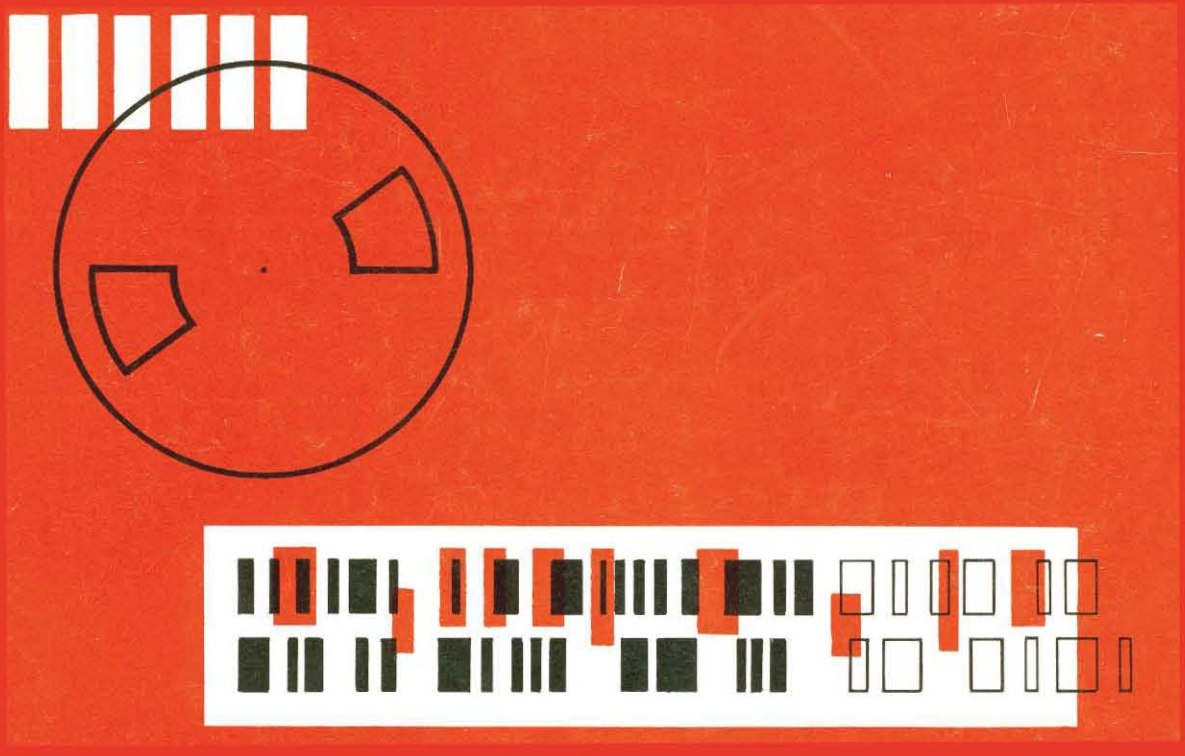
UNIVAC® 1240 MAGNETIC TAPE UNIT



TECHNICAL DESCRIPTION



UNIVAC
1240
MAGNETIC
TAPE UNIT

TECHNICAL DESCRIPTION

UNIVAC
DIVISION OF SPERRY RAND CORPORATION
DEFENSE OPERATIONS · UNIVAC PARK · ST. PAUL, MINN

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UNIVAC® 1240 MAGNETIC TAPE UNIT

1. GENERAL INFORMATION

The UNIVAC 1240 Magnetic Tape Unit is a large capacity, medium speed, auxiliary storage system. It may be operated on-line under complete computer program control as an input/output storage device or with a High-Speed Printer for off-line printing of tape recorded information. A flexible format allows recording and reading of four moduli (18, 24, 30 or 36-bit computer words) and two densities, and provides recording of magnetic tapes which is compatible in all respects with industry-accepted tape systems. Either even or odd frame parity may be utilized and for added reliability, the redundant octal format is provided. A Read after Write feature is provided to check each frame for parity immediately after recording. Longitudinal parity recording and checking is automatic.

Records of data may be of variable lengths and are separated by 3/4-inch inter-record gaps (IRG) unless otherwise extended by suitable programming. Records may be lengthened if suitable inter-record gaps were provided in previous recordings.

The UNIVAC 1240 Magnetic Tape Unit is compatible with all UNIVAC Military Computers and may be supplied with an 18, 24, 30 or 36-bit parallel input/output interface with either of two sets of logic levels.

The minimum configuration consists of one Magnetic Tape Control (MTC), one Tape Transport Control (TTC) in which are contained one Local Transport Control (LTC) for each of two

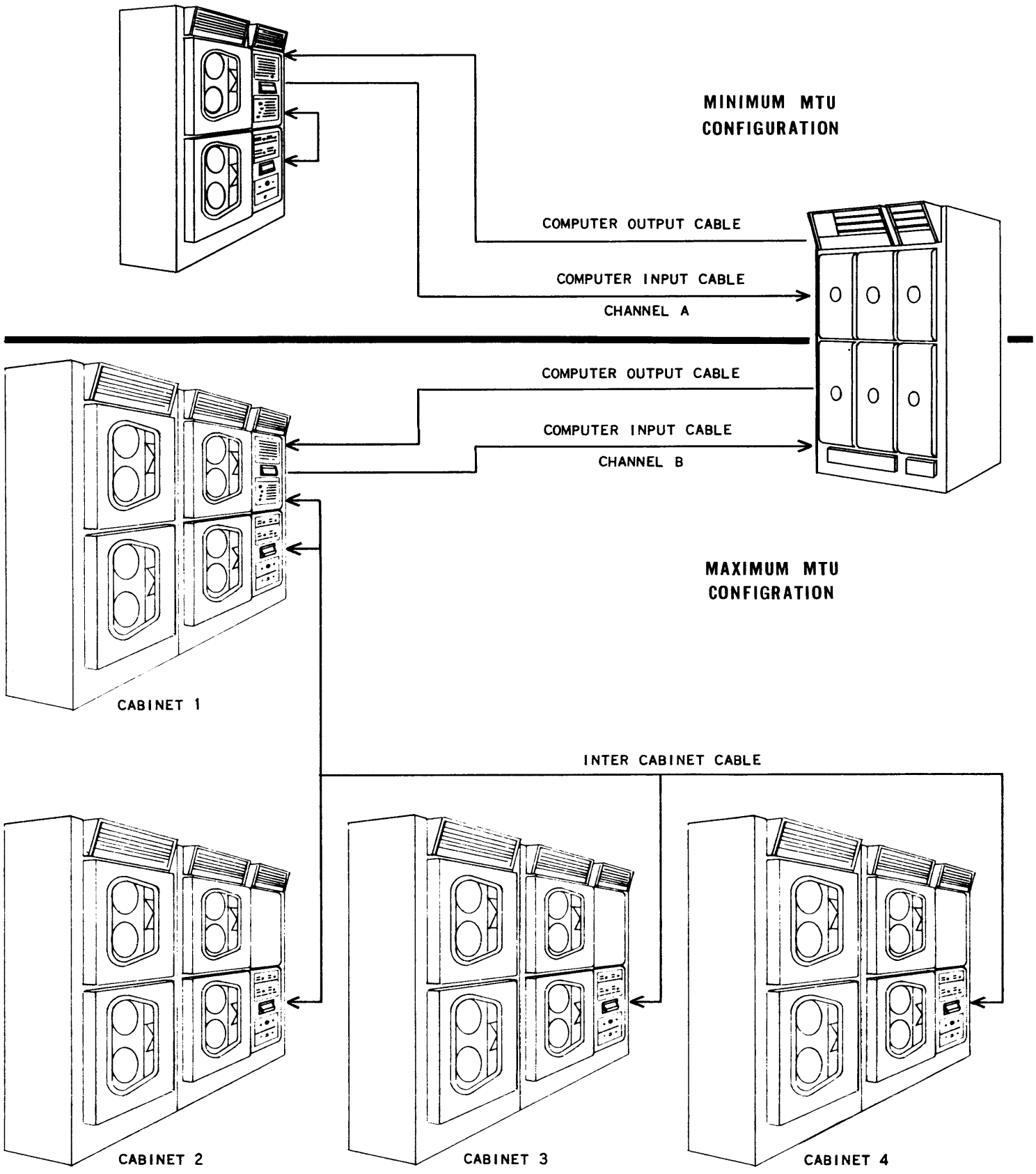

Figure 2. Magnetic Tape Unit and Computer Configurations

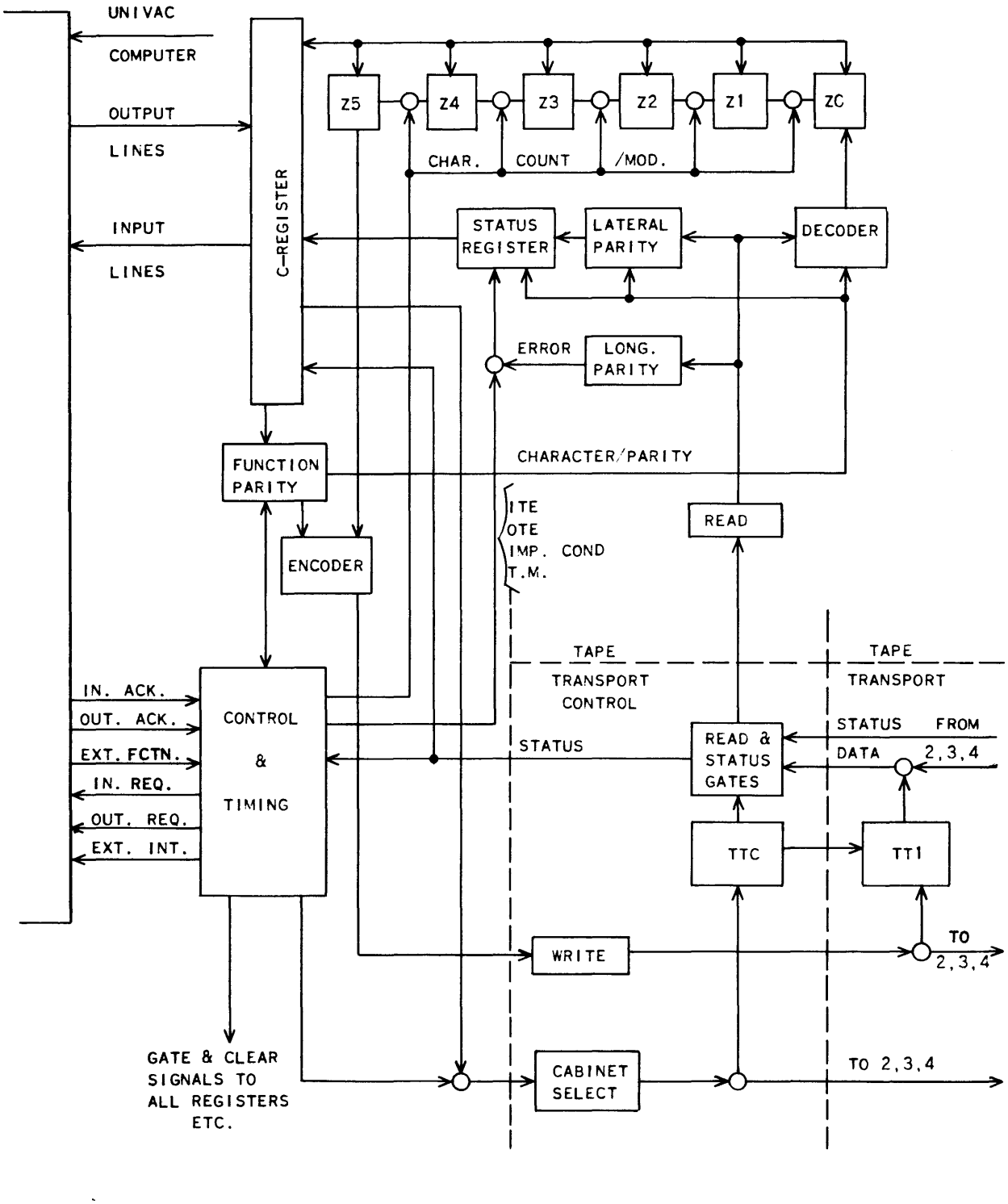

Figure 3. Functional Block Diagram 1240 Magnetic Tape Unit

or four Magnetic Tape Transports (MTT) as in Figure 1. The maximum configuration consists of one MTC, four TTC's and sixteen MTT's. Two or four MTT's are contained in one cabinet with one TTC. One MTC is used for any configuration on any one computer channel since its function is to communicate with the computer and with all TTC's. See Figure 2.

2. ELECTRONICS

The UNIVAC 1240 is a completely solid-state machine. The components are mounted on small, plug-in, printed-circuit cards which are assembled in a modular form for compactness. This building block technique, and the circuit cards utilized in the 1240, have a field-proven record of reliability in UNIVAC computers and peripheral equipment.

3. MAINTENANCE

The solid-state, plug-in modules, in conjunction with the manual controls and register and logic indicators, make maintenance of the UNIVAC 1240 fast and easy, keeping repair time to a minimum. Manual controls permit off-line maintenance of one tape unit during on-line operation of other units in the system. The tape transports and all electronics are easily accessible from the front of the unit.

4. TAPE UNIT SPECIFICATIONS

4.1 TAPE

Width - 1/2 inch
Type - "A" wound (oxide coating on inside of tape) - Mylar base
Length - 2400 feet
Reels - 10-1/2 inch, compatible hub type
Tape Markers - Load Point and End of Tape reflection markers

4.2 TAPE SPEED

Read/Write - 112.5 inches per second forward
Rewind - 225 inches per second
Start/Stop time - 1.5 to 2.5 milliseconds

4.3 RECORDING TECHNIQUES

Non-Return to Zero (change-on-one)

Seven tracks - Six data bits, one parity bit

Density - 200 or 555.5 frames per inch (Program Controlled)

Inter-Record Gap - 3/4 inch

Extended Inter-Record Gap - 3 1/2 inches

Record Length - Variable

Parity - Lateral and Longitudinal

Tape Mark - End of File (Program Controlled)

Write Lockout - Standard Type, upper reel

4.4 TRANSFER RATE

62,500 characters per second - High Density

22,500 characters per second - Low Density

4.5 FORMAT (PROGRAM CONTROLLED)

Moduli - 3, 4, 5, or 6

Frame Character - Bioctal or Redundant Octal

Parity - Odd or Even

4.6 TAPE COMPATIBILITY

Transport to transport

Other compatible systems

4.7 PHYSICAL

Size:	Height - 72 inches
	Width - 37 inches (2 tape transports)
	- 60 inches (4 tape transports)
	Depth - 30 inches
Weight:	1150 pounds (2 tape transports)
	1900 pounds (4 tape transports)

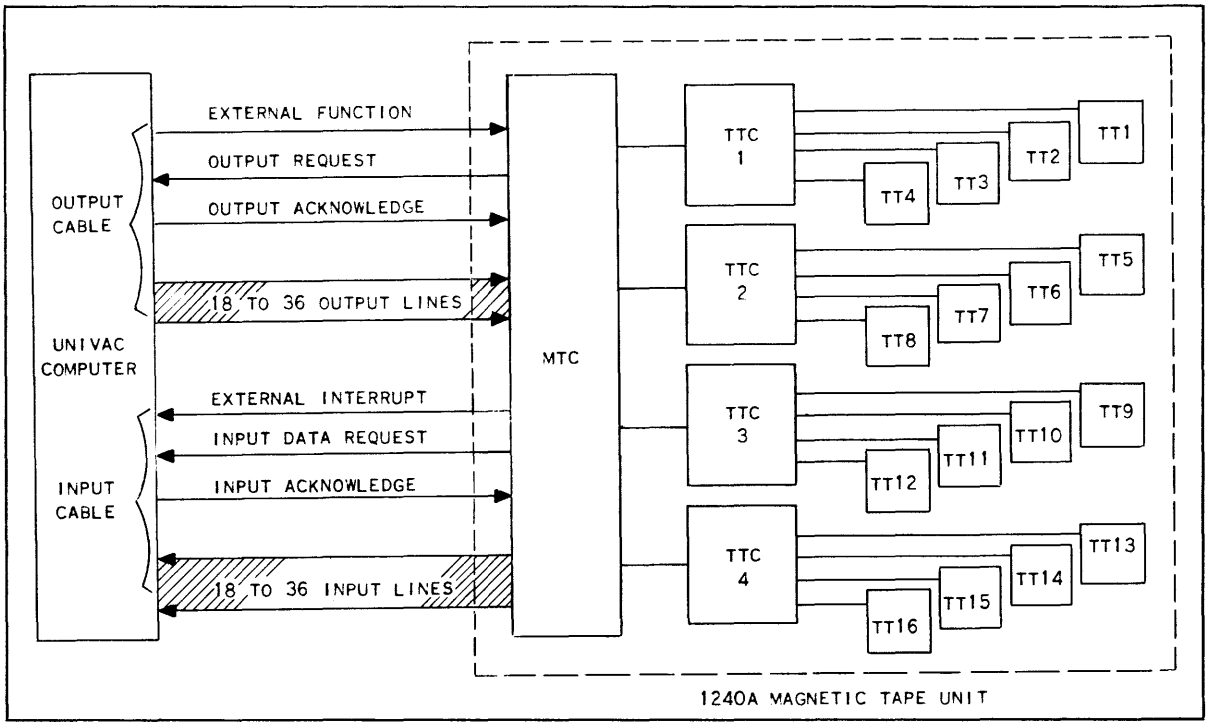

Figure 4. Magnetic Tape Unit — Computer Interface

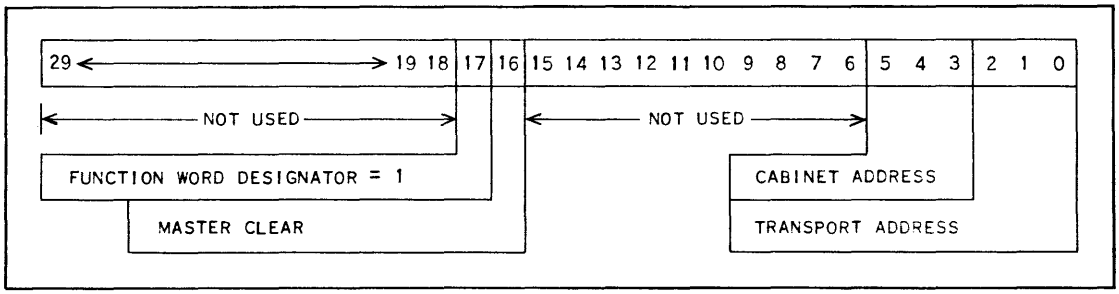

Figure 5. Function Word — Address Word Format

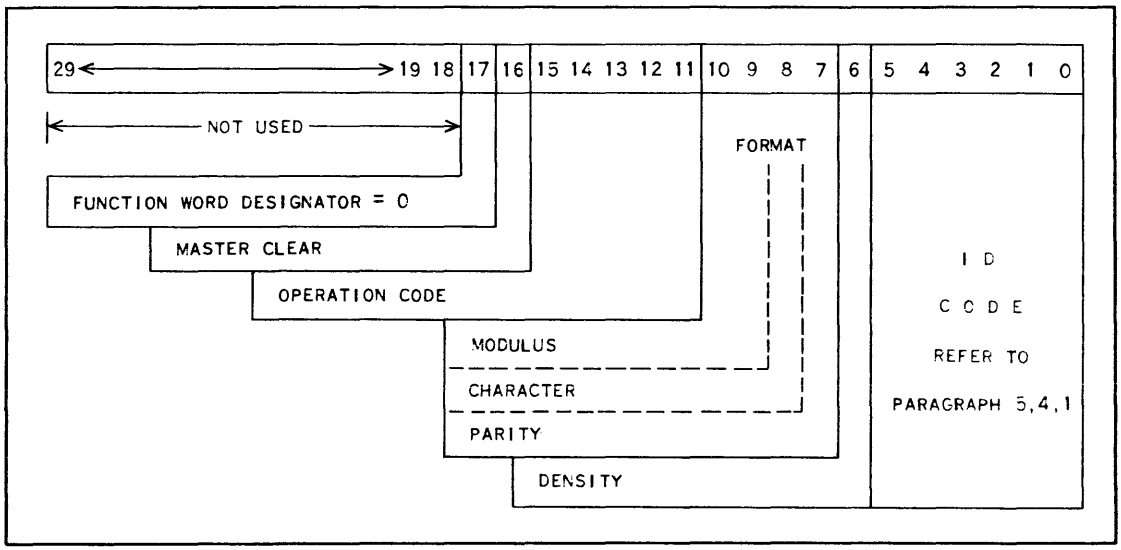

Figure 6. Function Word — Instruction Word Format

Cooling: Ambient Air - 800 CFM (2 transports)
- 1400 CFM (4 transports)

4.8 POWER

Air Cooled:	2 Transports	4 Transports
115 volts ± 10%, 1 phase, 60 cps ± 5%	3.4 KW	6.8 KW
115 volts ± 10%, 1 phase, 60 cps	.156 KW	.26 KW
115 volts ± 5%, 3 phase, 400 cps, Regulated	0.6 KW	0.6 KW

NOTE: For detailed specifications for the Tape Transports, refer to UNIVAC Document DS 4613.

5. MAGNETIC TAPE TO COMPUTER SPECIFICATIONS

5.1 PERFORMANCE OF FUNCTION

A functional block diagram of the UNIVAC 1240 appears in Figure 3. The Magnetic Tape Unit communicates with the computer in the Request-Acknowledge mode (see Figure 4). The computer issues commands to the MTU by means of the External Function signal and Function Words; thus computers with an 18-bit word structure (e.g., the UNIVAC 1218) can use the 1240 Tape Unit as well as computers with longer word lengths. Function Words may be in the ADDRESS WORD format (see Figure 5) or in the INSTRUCTION WORD format (see Figure 6). When the MTC inspects the word format and recognizes it as an Address Word, it selects the specified tape cabinet and tape transport.* When the MTC recognizes the Function Word as an Instruction Word, it performs the specified operation on the transport selected by the last interpreted Address Word. Each Tape Transport Control contains a four-position Address Switch for each tape transport so that each can be assigned a logical

*Refer to Paragraph 5.4.

number 1, 2, 3, or 4. Another four-position Cabinet Address Switch assigns that cabinet a logical number 1, 2, 3, or 4. The Address Word selection bits are interpreted by the Magnetic Tape Control according to physical position of these switches. No two transports in the same cabinet may be assigned the same logical number (i.e., to allow identical function on both units). If duplication does exist within the same cabinet, the lowest physically numbered tape transport is the one that will function. Example — if transport 1 and 2 are both set on 2, only transport #1 will respond to Address Word selection #2. Similarly, no two cabinets on the same computer channel may be assigned the same logical number. One exception is permitted. Writing on two tapes simultaneously may be accomplished if two cabinets on the same channel are assigned the same logical number and the "Write-Ignore Error Halt" command is issued to the MTU. In no instance can any function other than Writing be accomplished simultaneously on two transports. The operator must determine the logical addresses required by each program and set the switches accordingly.

The Instruction Word will contain the code for one of five basic operations — Read, Search, Write, Backspace, Rewind — or a combination of two basic operations. The Master Clear operation may be requested in either word format. This special operation has priority over all other operations and will terminate all others in process except Rewind, which will go to completion.* To accept an External Function Command other than Master Clear, the Magnetic Tape Unit must be in the IDLE state (i.e., operable but not performing a specific operation). The completion of an operation or a Master Clear places the MTU in the IDLE state.

The general sequence of events for on-line operation with a computer (the MTC in Automatic mode and in the IDLE state) is as follows:

- Computer issues an Address Word via the External Function command.
- The MTC selects the addressed tape cabinet and transport.
- Computer issues an Instruction Word via the External Function command.
- MTC samples the Instruction Word and becomes BUSY.
- The operations stated in the Instruction Word are initiated and carried to completion.
- MTC sets a Status Word on the input lines.**
- MTC interrupts the Computer with External Interrupt 222 microseconds after completion of the operation.

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*Refer to Paragraph 5.4.
**Refer to Paragraph 5.3.

- MTC issues STOP command to transport.
- Computer samples Status Word and acknowledges Interrupt whereby the MTU becomes IDLE.

(The latter two items may be interchanged, or may take place simultaneously.)

Status Words and Input Data are transferred on the Input Lines with identifying signals on the External Interrupt Line and the Input Request Line respectively. The computer acknowledges receipt of these transfers via the Input Acknowledge Line.

Function Words and Output Data are transferred on the Output Lines with identifying signals on the External Function Line and the Output Acknowledge Lines respectively. The Output Request Line notifies the computer of the MTU ability to accept Output Data.

5.2 TAPE MARKERS

The Load Point and End of Tape markers are adhesive-coated strips of aluminum one inch by 3/16 inch, placed on the base (uncoated) side of the tape with the one-inch dimension parallel to the tape edge. (See Figure 7 for Tape Format.) The Load Point marker is placed 1/32 inch from track "0" or outside edge of the tape and at least ten feet from the beginning of the tape. The End of Tape marker is placed 1/32 inch from track "6" or inside of the tape and at least 14 feet from the end of the tape. The markers are detected by reflective photoelectric sensors.

5.3 STATUS WORD AND INTERRUPT (STATUS INTERRUPT)

The computer program is interrupted after completion of every operation performed by the MTC, except Master Clear and Transport Address Selection. The MTC places a Status Word on the channel input lines and a signal on the channel External Interrupt line. The bit structure of the Status Word (see Figure 8) enables the computer program to determine the status of the Magnetic Tape Unit and whether or not the requested operation was completed successfully. Errors encountered during a requested operation, as well as the physical status of the MTU, are indicated in the Status Word. The term "Status Interrupt" is used to express this philosophy since the computer program is interrupted and the status of the MTU and the encountered errors are designated in the Status Word. Any such Interrupt sent to the computer

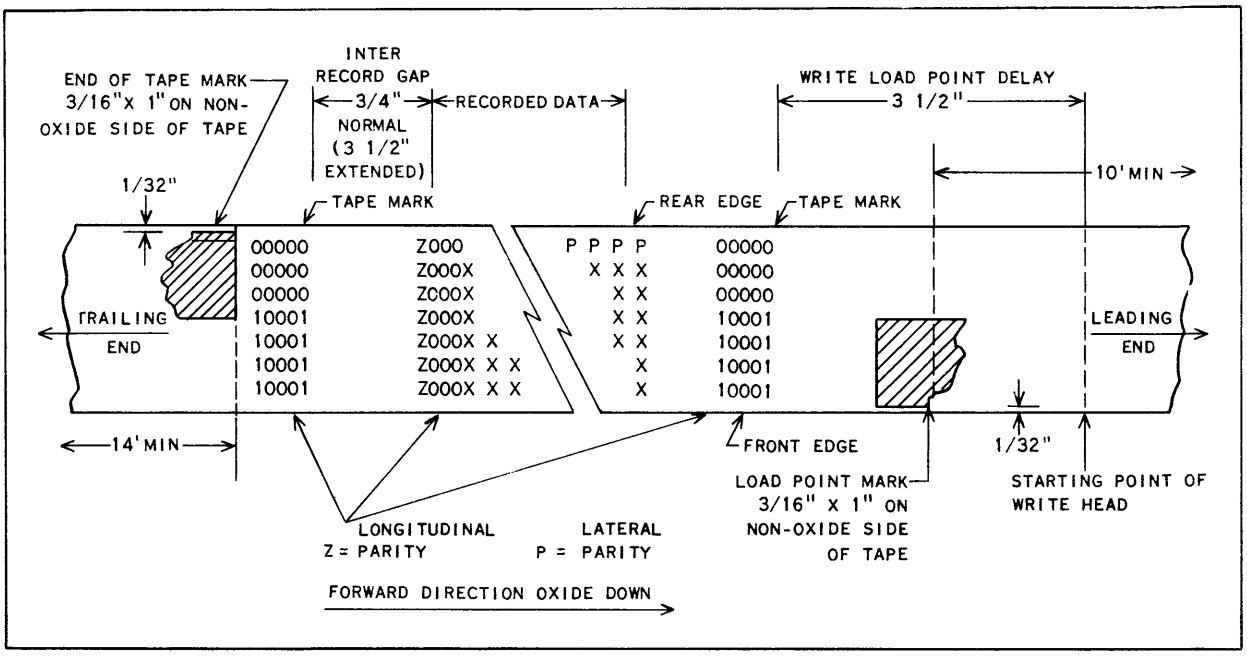

Figure 7. Tape Format

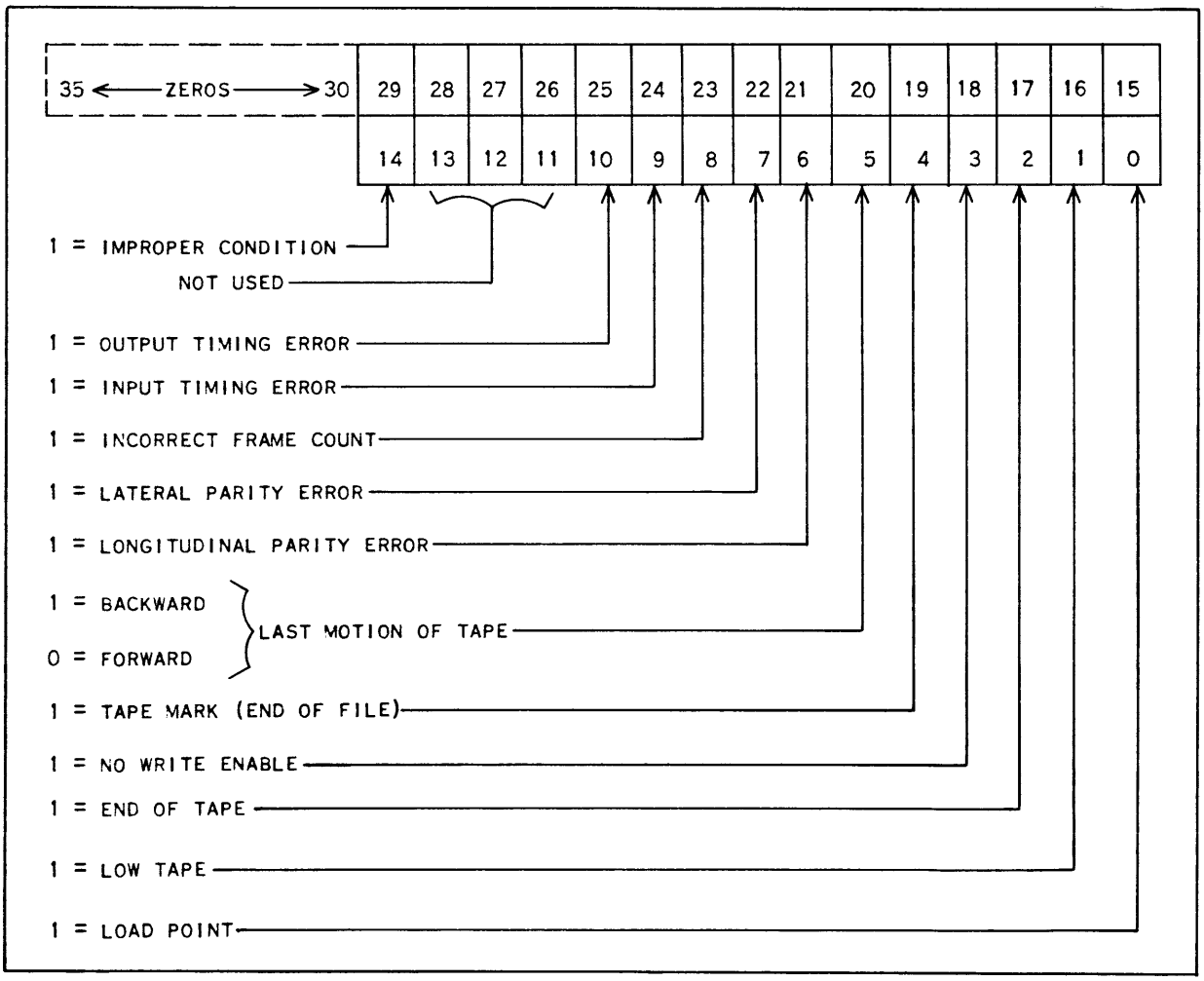

Figure 8. Magnetic Tape Unit — Status Word Format

must be acknowledged by the computer before another External Function with an Instruction Word will be recognized by the MTC. An External Function with a Master Clear or Address Word will be recognized at any time.

Successful completion of an operation will contain no error indications, but other indications of tape status may be present.

The Status Word requires a word of at least 15 bits. If the computer accepts words larger than 15 bits, the information is duplicated in the next higher order bits beginning at bit 15. The following paragraphs present the detailed explanation of each bit of the Status Word.

5.3.1 IMPROPER CONDITION (BITS 29 AND 14 = 1)

An Improper Condition will occur whenever:

- Selected tape transport is not in automatic condition. A tape transport not in automatic condition implies one of the following situations:

  Tape transport was manually removed from automatic

  Tape transport not in ready condition for one of the following reasons:

  Power off
  Tape broken
  Lamp burnout
  Tape load was not accomplished when tape was mounted

- No tape transport is selected when one is required.
- A forward command is sent to a tape transport whose tape is positioned at End of Tape.
- A reverse command, other than a Rewind Operation, is sent to a tape transport whose tape is positioned at Load Point.
- A WRITE instruction is issued to a tape transport that has NO Write Enable. (This situation also causes the No Write Enable bit in the Status Word to be set.) When the computer has been notified of an Improper Condition, the computer program may then refrain from issuing further External Function commands to the tape system to allow visual inspection of the trouble and operator intervention to overcome the difficulty, or it may issue another External Function command. An incoming External Function command to the tape system clears the Improper Condition indication.

5.3.2 OUTPUT TIMING ERROR (BITS 25 AND 10 = 1)

If the computer issued a Write Instruction to the MTC and did not transfer the first output data word or transferred a requested data word too late to be written in its proper place and before the Interrupt is sent to the computer following End of Record, an Output Timing Error occurs. This word transfer time is related to Format and Density as shown in Table 4. An Output Timing Error can occur during search operations if the MTC does not receive a Search Key before the start of reading the record. The time requirement may be as short as two milliseconds from the time the Instruction Word is received by the MTC until the Search Key or the first data word must be received.

5.3.3 INPUT TIMING ERROR (BITS 24 AND 09 = 1)

If the computer issued a Read Instruction and failed to accept a word placed on the input cable by the MTC before the next word was to be placed on the input cable, an Input Timing Error occurs. This error indicates that the computer lost one or more words of the last record since data transmission to the computer ceases for the remainder of the record. The tape continues to move to the End of Record at which time the MTC sends the Status Word indicating the error with an Interrupt to the computer.

5.3.4 INCORRECT FRAME COUNT (BITS 23 AND 08 = 1)

An improper modulus specified or some frames lost causes an Incorrect Frame Count Error. This may be caused by one or more of the following:

- There were not enough frames in the record to complete an integral number of computer words.
- One or more characters were not properly read or recorded.
- Bad spots on the tape caused characters to be lost.
- Reading the record with the wrong Format (for example, Reading Mod 4 with a tape record in Mod 5).

Longitudinal Parity Error can be expected with Incorrect Frame Count Error.

5.3.5 LATERAL PARITY ERROR (BITS 22 AND 07 = 1)

During a writing process a parity bit is added to each six-bit character according to a format specified and the seven bits are recorded as one frame. If the MTC detects a frame whose

Lateral Parity does not agree with that specified by the Format, during any read type operation or during the post-write check of the recording operation, a Lateral Parity Error occurs.

5.3.6 LONGITUDINAL PARITY ERROR (BITS 21 AND 06 = 1)

During a writing process a longitudinal even parity bit is generated by the MTC for each tape channel and recorded after the last frame of the record. If the MTC detects an error in this parity during any read type operation or during the post-write check of the recording operation, a Longitudinal Parity Error occurs. If a Frame Count Error ever occurs, the Longitudinal Parity Error usually occurs. Both would be indicated in the Status Word.

5.3.7 LAST TAPE MOTION (BITS 20 AND 05; 1 = BACKWARD, 0 = FORWARD)

Any Status Word with Interrupt sent to the computer at the completion of an operation will indicate the direction of the last tape motion. This bit indicator is especially useful to the program when a Back Space Read operation results in a parity error detection. The program can determine whether the tape is positioned at the beginning or the end of the record.

5.3.8 TAPE MARK (BITS 19 AND 04 = 1)

A recorded Tape Mark (Refer to Write Tape Mark) separates Files of information on the tape. Any Read, Space File, Search File or Back Space operation, that is limited to a File, and the post-write check of the Write Tape Mark operation, will indicate a Tape Mark in the Status Word.

5.3.9 NO WRITE ENABLE (BITS 18 AND 03 = 1)

When a Write operation is attempted on a selected transport that has its Write Enable cleared or the Write Enable Ring is not inserted in the tape reel, the No Write Enable is indicated in the Status Word.

5.3.10 END OF TAPE (BITS 17 AND 02 = 1)

When the End of Tape reflective marker is sensed by the MTU, a 1/2 second "Time-Out" begins after which no forward movement of tape is possible. Reverse direction tape motion past the tape marker is possible. The End of Tape indication will appear in the Status Word. If forward tape motion is reinitiated, the marker is sensed again and after the 1/2 second "Time-Out" the forward tape motion is stopped.

5.3.11 LOW TAPE (BITS 16 AND 01 = 1)

A pressure-sensitive detector has sensed less than 100 feet of tape remaining on the selected transport reel. The MTC will indicate a Low Tape any time a Status Word is sent to the computer with the tape positioned within 100 feet of End of Tape.

5.3.12 LOAD POINT (BITS 15 AND 00 = 1)

Recording on a tape begins at Load Point (a reflective tape marker placed at least ten feet from the physical beginning of the tape). The Write-Load Point delay allows for a gap of about 3/4-inch beyond the Load Point marker (in the forward direction) before the first record may be written. The MTC will indicate Load Point in the Status Word whenever an operation requesting backward motion of tape is attempted with the selected tape positioned at Load Point.

5.4 EXTERNAL FUNCTION COMMANDS — FUNCTION WORDS

5.4.1 MASTER CLEAR

Operations and tape selections are requested by Function Words being sent to the MTU with an External Function from the computer. A Master Clear of the Magnetic Tape Unit is performed when Bit 16 of the Function Word is "one". It differs from the other operations in these three respects:

- It may be performed at any time, even when MTU is BUSY.
- It has priority over all other operations in the Instruction Word, or Address Word. (See Figures 5 and 6.)
- It does not result in a Status Interrupt.

The Master Clear stops all tape motion (except a rewinding tape) and sets the MTU in the IDLE state. At any time after a Master Clear the MTC will accept another External Function. Since this function is not considered a normal operation, its use should be restricted to times when the MTU is believed to be in an illogical state or when its state cannot be determined. The Master Clear does not clear the Write Enable which is set manually. To clear the Write Enable, the "Rewind - Clear Write Enable" instruction must be used.

5.4.2 ADDRESS WORD

An individual tape transport is selected for operation by an Address Word and an External Function. Figure 5 shows the format of the Address Word. When Bit 17 of a Function Word is "one" and Bit 16 is "zero", it is sensed at the MTC as an Address Word. The address of the cabinet and tape transport to be selected is found in bits 05-00 of the Address Word. An MTU consists of a maximum of four tape transport cabinets, with two or four transports each which must be assigned logical numbers by the operator (refer to Paragraph 5.1). Within bits 05-00 of the Address Word, the cabinet is selected by bits 05-03 and the transport by bits 02-00 as shown in Tables 1 and 2. Bits 15-06 of the Address Word are not used by the selection circuitry. The Address Word does not cause a Status Interrupt and the MTC will accept another External Function command any time after the Address Word.

BITS 05	04	03	CABINET SELECTED
0	0	0	4
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	1
1	1	0	2
1	1	1	3

Table 1. Cabinet Address

BITS 02	01	00	TRANSPORT SELECTED
0	0	0	NONE
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	1
1	1	0	2
1	1	1	3

Table 2. Transport Address

5.4.3 INSTRUCTION WORD

Individual operations are performed by the MTU under the direction of an Instruction Word. Figure 6 shows the format of the Instruction Word. When Bit 17 of a Function Word is "zero" and Bit 16 is "zero", it is sensed at the MTC as an Instruction Word. The operation to be performed by the MTU is stated in bits 15-11 of the Instruction Word. Format when required is stated in bits 10-7, high or low Density in Bit 6, and in Selective Read and Write Tape Mark operations the Identification Key and Tape Mark first character respectively are stated in the Identifier Code bits 5-0.

FORMAT (Bits 10-7)

The Format portion of the Instruction Word contains Modulus, Character and Parity designators. A complete Format selection must be included in all Instruction Words which request a reading or recording operation with the exception that Modulus may be ignored in the Write

Tape Mark Instruction. The Modulus designator and the Character designator direct the MTC in the assembly and disassembly of computer words from or to tape frames.

Character designator (Bit 8), 1 selects Octal; 0 selects Bi-octal.

Bi-octal or octal (redundant) format is specified in operations requiring reading or writing. The bi-octal format disassembles 18-, 24-, 30-, or 36-bit computer words into 3, 4, 5, or 6 six-bit-plus-parity tape frames respectively during recording (vice-versa for reading). (See Figure 9.) The octal format disassembles 18-, 24-, 30- or 36-bit computer words into 6, 8, 10 or 12 tape frames respectively during recording (vice-versa for reading). Tape Channels

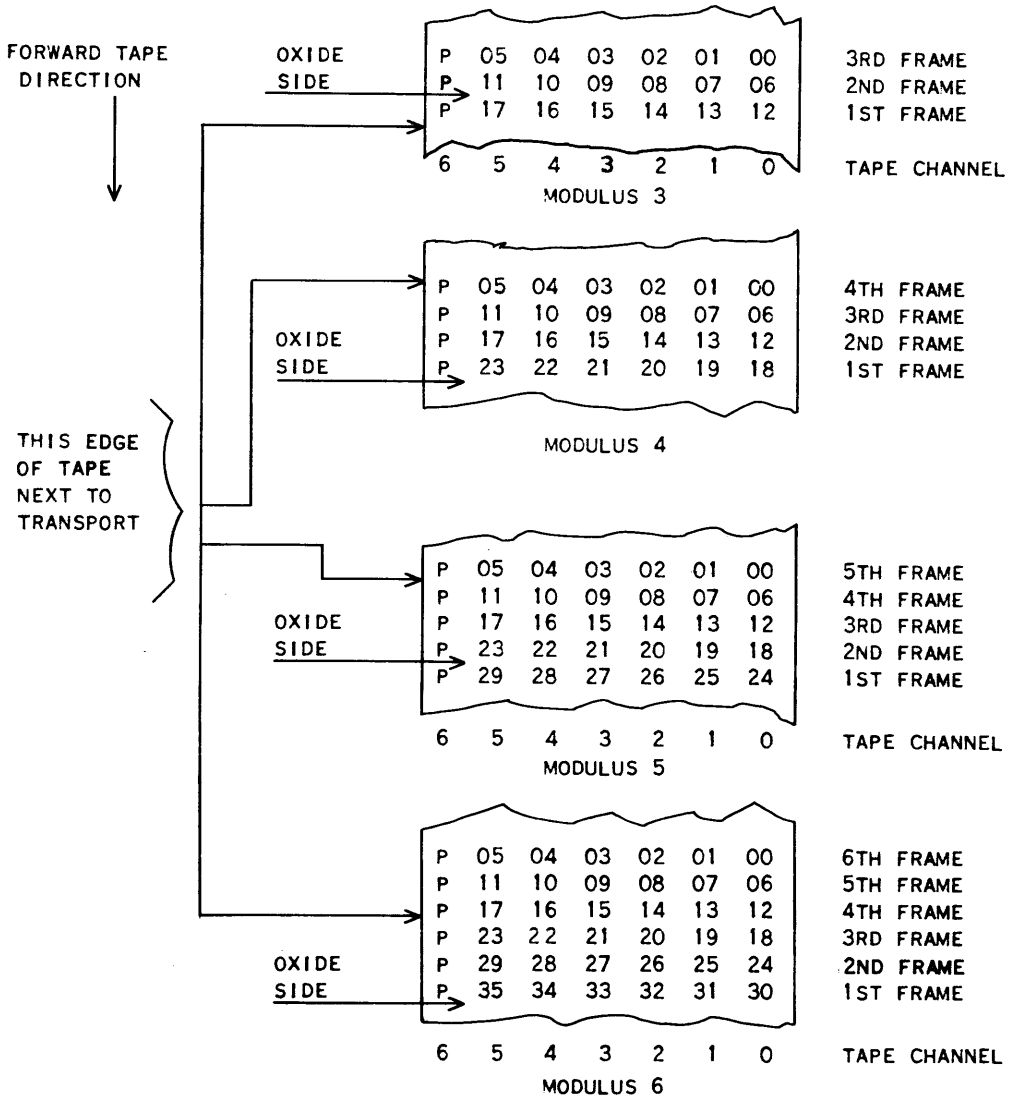

Figure 9. Bi-Octal Tape Format

3, 4, and 5 contain the same information as Channels 0, 1, and 2 respectively in each frame, except when Channels 0, 1 and 2 contain zeros, Channels 3, 4 and 5 contain ones. Odd parity is selected by the MTC when writing or reading Octal Characters. The redundant recording in octal format adds to the reliability (see Figure 10). For compatible tapes, data must be recorded in Bi-octal format.

The Modulus specifies the length of the computer word to be recorded on tape or read from the tape (See Table 3).

Modulus 3 (designator bits 10 and 09 = 00) — An 18-bit computer word is disassembled and recorded as three tape frames of Bi-octal character format or six tape frames of Octal character format. If a computer delivers a word larger than 18 bits for recording the MTC will record the lower order 18 bits of the word on the tape and discard the remaining high order bits. During Mod 3 reading operations, three tape frames are assembled as an 18-bit computer word for Bi-octal Character format, or six tape frames are assembled as an 18-bit computer word in Octal Character format. If the computer word size is larger than 18 bits, the frames are assembled in the lower order 18 bits and zeros are placed in remaining high order bits (see Figures 9 and 10).

Modulus 4 (designator bits 10 and 09 = 01) — A 24-bit computer word is disassembled and recorded as four tape frames of Bi-octal character format or eight tape frames of Octal character format. If a computer delivers a word larger than 24 bits for recording, the MTC will record the lower order 24 bits of the word on the tape and discard the remaining high order bits. During Mod 4 reading operations, four tape frames are assembled as a 24-bit computer word for Bi-octal Character format or eight tape frames are assembled as a 24-bit computer word for Octal Character format. If the computer word size is larger than twenty-four bits, the frames are assembled in the lower order twenty-four bits and zeros are placed in remaining high order bits (see Figures 9 and 10).

Modulus 5 (designator bits 10 and 09 = 10) — A 30-bit computer word is disassembled and recorded as five tape frames of Bi-octal character format or 10 tape frames of Octal character format. If a computer delivers a word larger than 30 bits for recording, the MTC will record the lower order 30 bits of the word on the tape and discard the remaining high order bits. During Mod 5 reading operations, five tape frames are assembled as a 30-bit computer word for Bi-octal Character format or 10 tape frames are assembled as a 30-bit computer

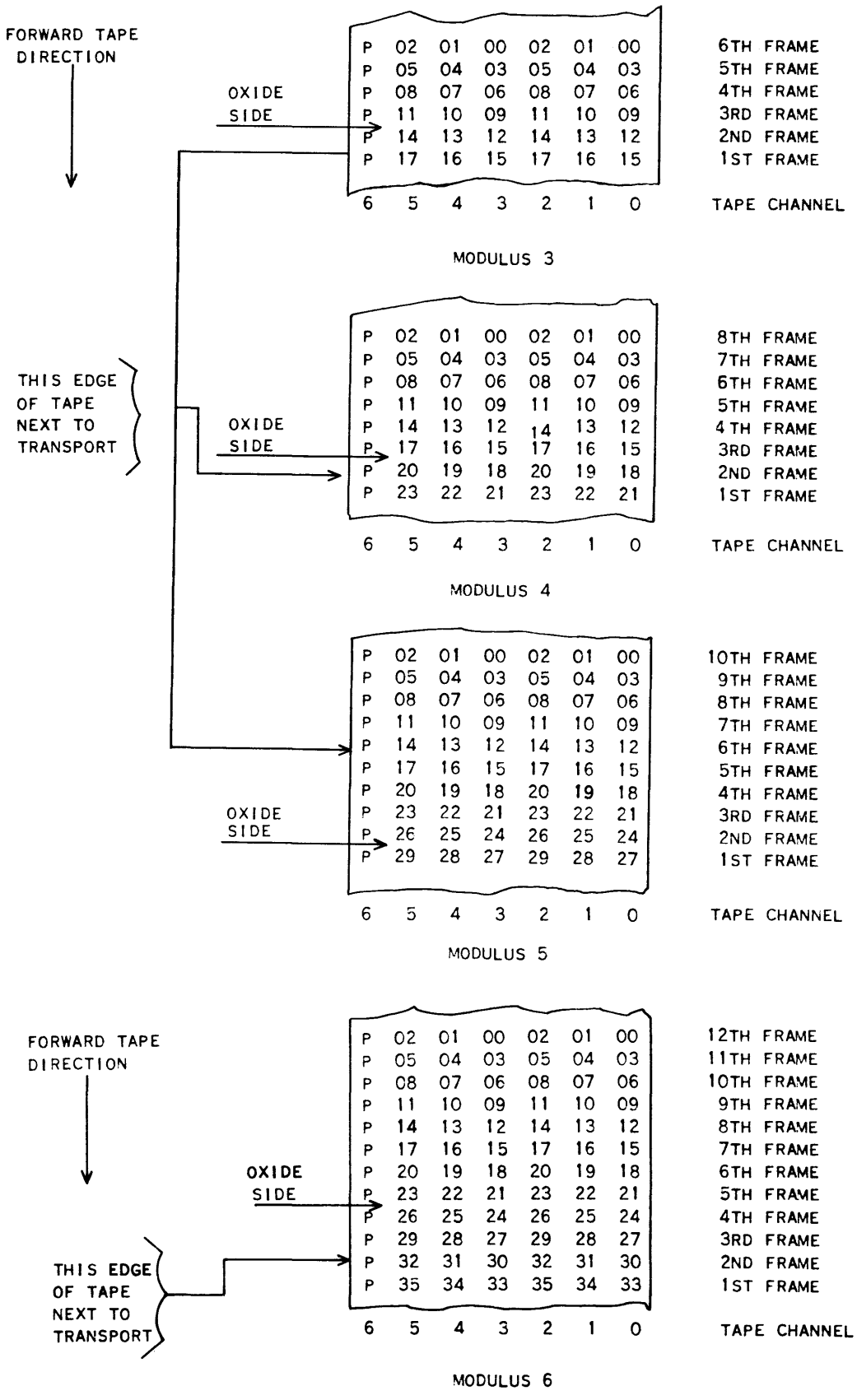

Figure 10. Octal Tape Format

	MOD 3 BCD WRITE	MOD 4 BCD WRITE	MOD 5 BCD WRITE	MOD 6 BCD WRITE
UNIVAC 1218 SINGLE CHANNEL (ONE 18-BIT WORD IS OUTPUT/REQUEST)	FOR EACH 18-BIT WORD RECEIVED, THE 1240 WRITES 3 FRAMES ON THE TAPE. MOD 3 IS RECOMMENDED FOR **UNIVAC 1218 SINGLE** CHANNEL OPERATION.	FOR EACH 18-BIT WORD RECEIVED, THE 1240 WRITES 4 FRAMES ON THE TAPE: 1 FRAME OF ZEROS FOLLOWED BY 3 DATA FRAMES.	FOR EACH 18-BIT WORD RECEIVED, THE 1240 WRITES 5 FRAMES ON THE TAPE: 2 FRAMES OF ZEROS FOLLOWED BY 3 DATA FRAMES.	FOR EACH 18-BIT WORD RECEIVED, THE 1240 WRITES 6 FRAMES ON THE TAPE: 3 FRAMES OF ZEROS FOLLOWED BY 3 DATA FRAMES.
UNIVAC 1218 DUAL CHANNEL (ONE 36-BIT WORD IS OUTPUT/REQUEST)	FOR EACH 36-BIT WORD RECEIVED, THE 1240 WRITES 3 FRAMES ON THE TAPE. SINCE ONLY THE 18 LSB ARE WRITTEN, THE 18 MSB ARE "LOST".	FOR EACH 36-BIT WORD RECEIVED, THE 1240 WRITES 4 FRAMES ON THE TAPE. SINCE ONLY THE 24 LSB ARE WRITTEN, THE 12 MSB ARE "LOST".	FOR EACH 36-BIT WORD RECEIVED, THE 1240 WRITES 5 FRAMES ON THE TAPE. SINCE ONLY THE 30 LSB ARE WRITTEN, THE 6 MSB ARE ''LOST''. MOD 5 IS COMMONLY USED WHEN PREPARING TAPES FOR THE 30-BIT COMPUTERS (CP-642B OR UNIVAC 1206).	FOR EACH 36-BIT WORD RECEIVED, THE 1240 WRITES 6 FRAMES ON THE TAPE. MOD 6 IS RECOMMENDED FOR 1218 DUAL CHANNEL OPERATION.
UNIVAC 1206 OR UNIVAC 1212 OR CP-642B (ONE 30-BIT WORD IS OUTPUT/REQUEST)	FOR EACH 30-BIT WORD RECEIVED, THE 1240 WRITES 3 FRAMES ON THE TAPE. SINCE ONLY THE 18 LSB ARE WRITTEN, THE 12 MSB ARE ''LOST''.	FOR EACH 30-BIT WORD RECEIVED, THE 1240 WRITES 4 FRAMES ON THE TAPE. SINCE ONLY THE 24 LSB ARE WRITTEN, THE 6 MSB ARE ''LOST''.	FOR EACH 30-BIT WORD RECEIVED, THE 1240 WRITES 5 FRAMES ON THE TAPE. MOD 5 IS RECOMMENDED FOR OPERATION WITH CP-642B OR 1206 COMPUTERS.	FOR EACH 30-BIT WORD RECEIVED, THE 1240 WRITES 6 FRAMES ON THE TAPE: 1 FRAME OF ZEROS FOLLOWED BY 5 DATA FRAMES. MOD 6 IS COMMONLY USED WHEN PREPARING TAPES FOR 36-BIT COMPUTERS.

LSB....LEAST SIGNIFICANT BITS
MSB....MOST SIGNIFICANT BITS

Table 3. Chart Showing the Effects of Various UNIVAC Computers Operating with the UNIVAC 1240 Magnetic Tape System

word for Octal Character format. If the computer word size is larger than 30 bits, the frames are assembled in the lower order 30 bits and zeros are placed in remaining high order bits (see Figures 9 and 10).

Modulus 6 (designator bits 10 and 09 = 11) — A 36-bit computer word is disassembled and recorded as six tape frames of Bi-octal character format or 12 tape frames of Octal character format. During Mod 6 reading operations, six tape frames are assembled as a 36-bit computer word for Bi-octal Character format or twelve tape frames are assembled as a 36-bit computer word for Octal Character format. (See Figures 9 and 10.)

Parity designator (Bit 7), 1 selects Odd; 0 selects Even

Either Odd (the total number of ones in a frame is odd) or Even (the total number of ones in a frame is even) Lateral Parity may be specified in the Instruction Word for Bi-octal character writing and reading operations; however, Odd Parity is selected by the MTC for the Octal character writing and reading operations. For compatible tapes, Odd Parity is chosen for Binary coded data and Even Parity is chosen for Binary Coded Decimal (BCD) data.

Density Designator (Bit 6), 1 selects High Density; 0 selects Low Density

At Low Density data are recorded on the tape at 200 frames per inch (22.5 KC rate). At High Density data are recorded on tape at 555.5 frames per inch (62.5 KC rate). Density must be specified in Instruction Words requesting reading or writing operations. Refer to Table 4 for word assembly and disassembly time.

FORMAT		WORD ASSEMBLY TIME	
MODULUS	CHARACTER	LOW DENSITY	HIGH DENSITY
3	BI-OCTAL	133 μSEC	48 μSEC
4	BI-OCTAL	177 μSEC	64 μSEC
5	BI-OCTAL	222 μSEC	80 μSEC
6	BI-OCTAL	267 μSEC	96 μSEC
3	OCTAL	266 μSEC	96 μSEC
4	OCTAL	355 μSEC	128 μSEC
5	OCTAL	444 μSEC	160 μSEC
6	OCTAL	534 μSEC	192 μSEC

Table 4. Word Assembly Time

OPERATION CODE

The Operation Code is located in Bits 15-11 of the Instruction Word. Legal operation codes exist for the five basic operations and for combinations of these operations. The five basic operations are Read, Search, Write, Backspace, and Rewind. Operation Codes using any basic operation (except Rewind) must be supplemented by Format and Density codes placed in bits 10-07 and bit 06 respectively of the Instruction Word. Table 5 is a listing of the Operation codes and Figure 6 shows the structure of the entire instruction Word.

Read Operations

The selected transport moves tape at 112.5 inches per second in the forward direction and transfers seven bit frames (read from tape) to the Magnetic Tape Control. Parity, even or odd, as specified in the Format is checked for each frame of the record. The six data bits are assembled into 18-, 24-, 30-, or 36-bit computer words according to the Modulus and Character designator of the Format. The assembled computer word is placed on the data lines of the computer input cable and the Input Request (IR) line is set. The computer samples the data lines at its convenience and sets the Input Acknowledge line to the MTC. The tape continues to move and new words are being assembled until the End of Record (Inter Record Gap) is reached. The computer must sample the input lines and acknowledge each IR within a specified time (governed by Density, Character and Modulus - Table 4) to prevent loss of one or more words in the record. If the computer fails to sample the input lines and acknowledge the IR within the allotted time during any type of Read Operation, an Input Timing Error will occur and the MTC will cease to transfer data to the computer for the remainder of the record. Following the detection of the End of Record the MTC will set an Input Timing Error Status word on the input lines and interrupt the computer program by setting the External Interrupt (EI) line on that channel. When the computer acknowledges the Interrupt the MTU becomes IDLE.

In all types of Read Operations, Format and Density selections must be made in each instruction.

Normal Read

The selected transport will read one record according to the Format stated and check each frame for parity. If a parity error is detected, the MTC will cease transferring data to the computer for the remainder of that record. After sensing the End of Record, the MTC will send a Status Word to the computer with a signal on the External Interrupt line. This Status Word will contain MTU status and any or all error indications encountered during the reading of the record.

OPERATION CODE	OPERATION
00000	READ
00001	READ; SELECTIVE
00010	READ; IGNORE ERROR HALT
00011	SPACE FILE
00100	SEARCH TYPE I
00101	SEARCH TYPE II
00110	SEARCH–FILE TYPE I
00111	SEARCH–FILE TYPE II
01000	WRITE
01001	WRITE; XIRG
01010	WRITE; IGNORE ERROR HALT
01011	WRITE XIRG, IGNORE ERROR HALT
01100	WRITE TAPE MARK
01101	WRITE TAPE MARK, XIRG
1000X*	BACKSPACE
10010	BACKSPACE–READ
10011	BACKSPACE–FILE
10100	BACKSEARCH TYPE I
10101	BACKSEARCH TYPE II
10110	BACKSEARCH FILE TYPE I
10111	BACKSEARCH FILE TYPE II
110X0*	REWIND
110X1*	REWIND, CLEAR WRITE ENABLE
111X0*	REWIND–READ
111X1*	REWIND–READ, CLEAR WRITE ENABLE

* X MAY BE EITHER 0 OR 1

Table 5. Operation Codes

Read-Ignore Error Halt

The selected transport will read one record according to the Format stated and will check each frame for parity. If a parity error is detected the complete record will be sent to the computer. The Status Word sent to the computer after detection of End of Record will contain MTU status and any or all error indications including parity error.

Selective Read

The selected transport will read one record according to the Format stated and check each frame for parity. The MTC will compare the least significant six bits (05-00) of each assembled computer word with the six bits of the Identification (ID) code in the instruction word. If the comparison is affirmative the word will be transmitted to the computer. If the comparison is negative the word will be discarded. If a parity error is detected the MTC will cease transferring data to the computer for the remainder of the record. The Status Word sent to the computer after detection of the End of Record will contain MTU status and any or all error indications.

Write Operation — General Information

When the MTC senses a WRITE function, the selected transport moves the tape forward at 112.5 ips and records the Inter-Record Gap (IRG). A signal is placed on the computer Output Request (OR) line. The computer, at its convenience, responds with a word on the data lines and places a signal on the channel Output Acknowledge (OA) line. The MTC recognizes the OA, samples the data lines and removes the Output Request. The word is transferred to the disassembly register and another Output Request is issued. The MTC disassembles each word according to the modulus selected in the Write Function Word, generates frame parity, and transfers the seven bits to the transport for recording on tape according to the density selected. As the recording frame passes over the read head it is checked for parity. If a parity error is detected, the MTC stops the Write operation and the tape motion. A Status Word indicating an error in recording is placed on the channel input lines with a signal on the External Interrupt line. If no error occurs during recording, the process continues until the computer no longer acknowledges the Output Request within the time allotted for another word to be disassembled and written. This time is dependent on Format and Density (see Table 4). When the computer does not respond within the allotted time, the End of Write is assumed by the MTC. Longitudinal parity is written and the recording process is terminated. Tape motion is stopped after a portion of the Inter-Record Gap is written on the tape. The MTC removes the Output Request and places a Status Word, indicating successful completion of the

Write, on the input lines and sets the External Interrupt line. When the computer acknowledges the Interrupt the MTS becomes IDLE. If the computer acknowledges the Output Request after the allotted time but before the Interrupt is sent, the MTC interprets the action as an Output Timing Error and notifies the computer in the Status Word.

NOTE: The normal Inter-Record Gap is approximately 3/4 inch in length and the Extended Inter-Record Gap is approximately 3-1/2 inches in length.

Write

The selected transport will Write on the tape according to the Format and Density stated in the Function Word. If no recording error is detected the normal operation continues until the computer no longer transfers data, at which time longitudinal parity is written and the Status Word with Interrupt is sent to the computer.

Write-Ignore Error Halt

The selected transport will Write on the tape according to the Format and Density stated in the Function Word but the MTC will not stop the writing process if lateral parity errors are detected as the recorded frames pass over the read head. The Status Word sent to the computer with Interrupt after completion will contain MTU Status and any or all errors encountered.

Write-Extended Inter-Record Gap (XIRG)

The selected transport will record an Extended Inter-Record Gap of 3-1/2 inches instead of the normal 3/4 inch IRG preceeding a normal Write portion of the operation. If no data are transferred from the computer for recording, the Extended Inter-Record Gap will be present on the tape and an Output Timing Error will occur. The Status Word sent to the computer after completion will contain MTU status and any or all error indications detected as in a normal Write operation.

NOTE: Special Length Inter-Record Gap

Under program control, Inter-Record Gaps other than the fixed 3/4-inch and 3-1/2-inch lengths may be written. Successive 3/4 or 3-1/2-inch gaps may be written by issuing the appropriate Write functions without initiating output buffers at the computer. The program must be prepared to handle the Output Timing Error that will be indicated in the Interrupt Status Word following each Write operation performed in this manner.

Write Tape Mark

The selected transport will write a fixed format Tape Mark. The Tape Mark is a special record having ones in only the 0, 1, 2, and 3-bit positions of the first frame, followed by three frames of zeros and one frame of longitudinal parity. The entire record is written by the MTC upon receiving the Instruction Word which must state Even Parity, Bi-octal Character and 17_8 as the ID Code. Modulus selection can be ignored. The ID Code is used as the first frame of the Tape Mark Record and longitudinal parity makes it the last. To be compatible with other tape systems, the Tape Mark must be exactly as specified above. However, the MTU will recognize Tape Marks which contain any first frame code other than zeros. A Status Word with Interrupt is sent to the computer after completion of the Write Tape Mark operation.

Back Space

The selected transport will move the tape in the reverse direction to the next IRG (back one record). The tape is properly positioned in the IRG for reading or writing. Format and Density must be stated in the Instruction Word since parity will be checked during the backward motion. Any error detected and MTU status will be indicated in the Status Word sent to the computer with Interrupt after completion. If the tape is at Load Point at the time the Back Space instruction is given, an Improper Condition exists and will be noted in the Status Word.

Rewind

The selected transport will rewind the tape backward to the Load Point at 225 inches per second. The Status Word with Interrupt is sent to the computer after the MTC initiates the Rewind and not at the completion of the Rewind. If the tape is at Load Point when the instruction is received, no tape motion or Improper Condition will result but the Status Word will indicate Load Point. This provides a method of testing for completion of the Rewind operation.

Multi-Function Operations (General Information)

Multi-Function Operations consist of combinations of basic operations of the MTU, and can be performed in response to one Instruction Word from the computer. Examples are the Search operations which combine the features of a Read with the ability to do a search on the first word of records, compare these words against an Identifier (Search Key) Word, and read on a "Find". Other Multi-Function Operations combine a Read with a Space or a Rewind operation. Combinations of functions such as these save on computer instructions, and provide some capabilities that cannot be achieved by using the basic operations one at a time.

Search (Type I and Type II — Forward/Backward)

The Search Operation combines the features of Normal Read and a Search. The selected tape transport will read records from the tape either forward or backward and compare the first word* of each tape record with a Search Key (Identifier Word) which is transmitted from the computer to the MTU by an output buffer of one word. When a compare is affirmative, that "FIND" record is transmitted to the computer as in a Normal Read.

Tape motion is started upon receipt of the Instruction word. If the MTU does not receive the Search Key from the computer before it starts reading the record, an Output Timing Error will occur. This reading start time may be as short as two milliseconds. The Search operation will be terminated by the MTU when a parity or timing error is detected by the MTC. The Status Word containing MTU status and any or all error indications will be sent to the computer upon detecting the end of the record in which the error occurred. When the tape motion is stopped due to an error, the tape will be positioned in the Inter-Record Gap (IRG) before the record in which the error occurred if the motion is backward, and after the record if the motion is forward. A parity error can result from a bad parity check on any frame of the tape being searched.

The ONES (Type I) compare is a "greater-than-or-equal" compare. If the first word of the record is greater than or equal to the Search Key Identifier word a "Find" is made. A six-bit example is shown below.

Search Key or Identifier Word	001101
FIND; if first word is	011101
FIND; if first word is	001101
NO FIND; if first word is	010101
NO FIND; if first word is	001100

The IDENTICAL (Type II) compare is an exact equal compare. The first word of the record must be exactly equal to the Search Key Identifier word to define the "FIND" record.

*In a forward Search the first word encountered in each record is the first word of the record. In a backward Search the last word encountered in each record is the first word of the record.

Search File Forward/Backward*

The MTC will perform a Search Forward/Backward Type I or Type II as directed by operation code, on the selected tape transport, until it detects a "Find" or a "Tape Mark".** If a Tape Mark is detected before a "Find", the Search File operation will be terminated and the Tape Mark Status Code will be present in the Status Word sent to the computer after detecting End of Record.

Space File Forward/Backward

The MTC will cause the selected transport to move the tape in the specified direction to the Inter-Record Gap beyond the next Tape Mark and will place a Tape Mark Code in the Status Word sent to the computer detecting the End of Record (see Figure 11). Space File Forward will position a tape at A upon Completion; Space File Backward will position the tape at B.

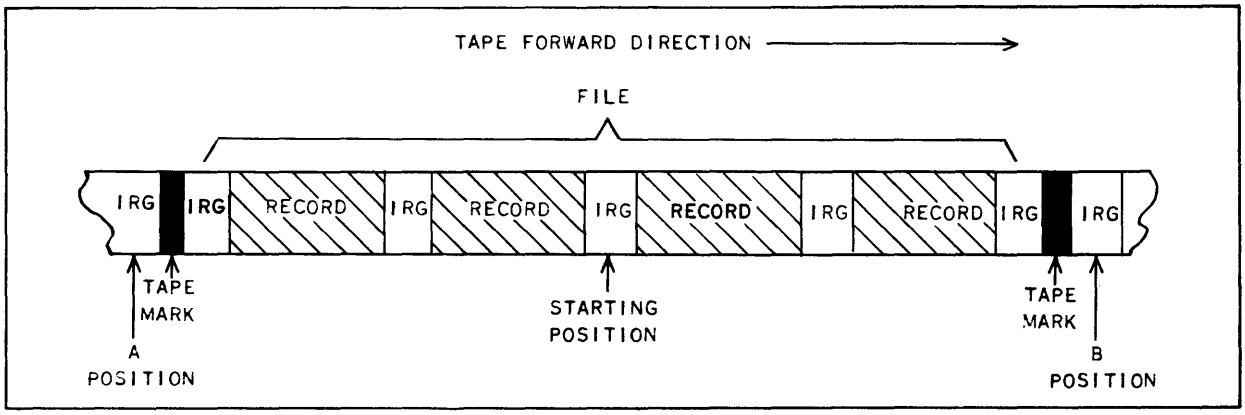

Figure 11. Magnetic Tape Unit — Tape File

Back Space Read

The selected transport will move the tape backward to the next Inter-Record Gap (back one record) and then performs a Normal Read according to Format and Density stated in the Instruction Word. Parity will be checked while backspacing; if an error is detected during backward motion, the operation will be terminated before the read operation is performed and the Status Word will contain the MTU status and the error indication. The computer program must determine if the error detection occurred during the backspacing operation or during the read operation by examining the 2^5 bit (last tape motion) of the Status Word received.

*A File is defined as one or more records separated by Tape Marks (see Figure 11).

**A Tape Mark is a special record on a tape placed there by the operation "Write Tape Mark" (refer to Figure 7).

Rewind-Read

The selected transport will Rewind the tape to the Load Point at 225 inches per second and then perform a Normal Read of the first record according to the Format and Density stated in the Instruction Word. A Status Word containing MTU status and any or all errors will be sent to the computer with Interrupt after detecting the End of Record.

Rewind-Clear Write Enable

The selected transport will perform a normal Rewind of the tape to Load Point and will clear the Write Enable. This selected transport will no longer perform a Write function without manual intervention. The Status Interrupt will be presented upon initiation of the rewind and not upon completion.

6. MAGNETIC TAPE UNIT—HIGH-SPEED PRINTER OFF-LINE CAPABILITY

The UNIVAC 1240 Magnetic Tape Unit is capable of communicating directly with the UNIVAC 1469 High-Speed Printer for OFF-LINE operation. The MTU communicates with the HSP unit in the Request-Acknowledge mode.

The Magnetic Tape-Printer Interface is shown in Figure 12.

Using terms based on Computer-MTU communication and Computer-HSP communication in this discussion the Output to the HSP interface is connected to the Input from the MTU interface,

i.e., the HSP Output Request line is connected to
the MTU Input Acknowledge line.
The MTU Input Request line is connected to

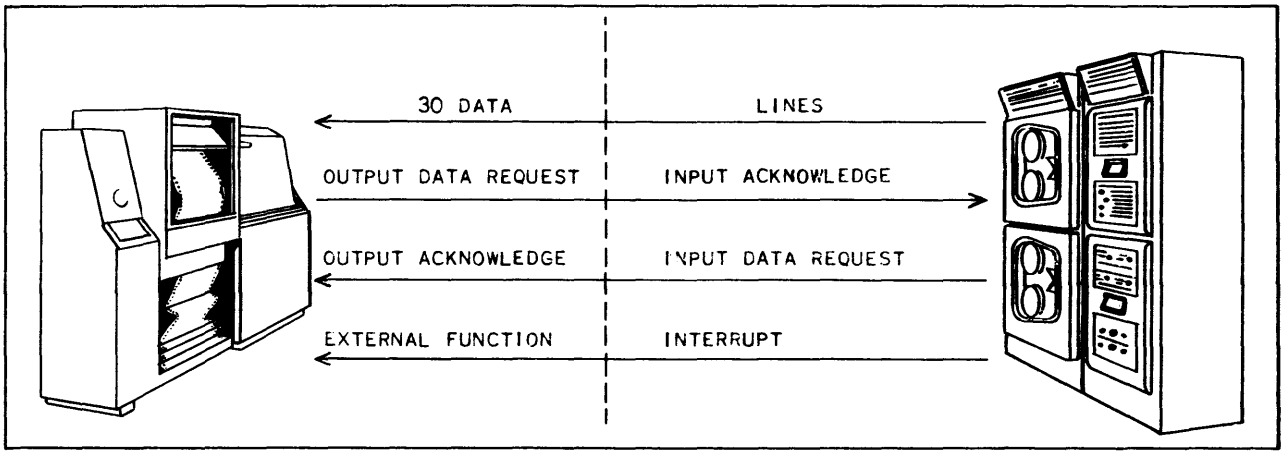

Figure 12. Magnetic Tape — Printer Interface

the HSP Output Acknowledge line.
The MTU Interrupt line is connected to the HSP External Function line.
The MTU data lines are connected to the HSP data lines.

The High-Speed Printer exercises control of the OFF-LINE system after the MTU is switched to Printer Mode, the desired tape transport is selected and the tape positioned at Load point. The HSP will initiate the operation when it is placed in OFF-LINE position.

The data on magnetic tape to be printed OFF-LINE must be recorded in 120 Fieldata character record lengths (120 characters per line on HSP). As each record is read from the tape and transmitted to the HSP, the 120 characters are printed as one line and the paper is advanced to the next line position. Each 30-bit word delivered to the HSP must contain five Fieldata Code (refer to Table 6) characters. These are in turn disassembled into six-bit characters and stored in the character core memory of the HSP Control Unit. When the core

OCTAL CODE	BINARY CODE	CHARACTER	OCTAL CODE	BINARY CODE	CHARACTER
00	000 000	| ABSOLUTE VALUE	40	100 000	)
01	000 001	↑ ARROW (UP)	41	100 001	–
02	000 010	8 SUBSCRIPT EIGHT	42	100 010	+
03	000 011	[BRACKET (OPEN)	43	100 011	<
04	000 100	] BRACKET (CLOSE)	44	100 100	=
05	000 101	SPACE (UNDERCUT)	45	100 101	>
06	000 110	A	46	100 110	≤ EQUAL TO OR LESS THAN
07	000 111	B	47	100 111	{ LEFT HAND BRACE
10	001 000	C	50	101 000	☆ STAR
11	001 001	D	51	101 001	(
12	001 010	E	52	101 010	≥ EQUAL TO OR GREATER THAN
13	001 011	F	53	101 011	'
14	001 100	G	54	101 100	} RIGHT HAND BRACE
15	001 101	H	55	101 101	∨ (OR)
16	001 110	I	56	101 110	,
17	001 111	J	57	101 111	≠
20	001 000	K	60	110 000	0
21	010 001	L	61	110 001	1
22	010 010	M	62	110 010	2
23	010 011	N	63	110 011	3
24	010 100	O	64	110 100	4
25	010 101	P	65	110 101	5
26	010 110	Q	66	110 110	6
27	010 111	R	67	110 111	7
30	011 000	S	70	111 000	8
31	011 001	T	71	111 001	9
32	001 010	U	72	111 010	∧ AND
33	011 011	V	73	111 011	;
34	011 100	W	74	111 100	/
35	011 101	X	75	111 101	.
36	011 110	Y	76	111 110	→ ARROW RIGHT
37	011 111	Z	77	111 111	X MULTIPLY SIGN

Table 6. Type Symbols and Codes

memory character counter indicates 120 characters, the print cycle is initiated and the line is printed. A record of less than 24 thirty-bit words will indicate to the HSP to stop the print operation. A record of five space codes (05) will stop the print operation without printing a line.

6.1 OPERATING INSTRUCTIONS

To prepare the OFF-LINE MTU-HSP system for operation the operator must select

- Character, parity and density, of the recorded tape, at the Magnetic Tape Unit cabinet.
- Switch the MTU to Printer Mode.
- Select the desired tape transport.
- Load and position the tape at Load Point.
- Place the HSP in OFF-LINE position.

6.2 SEQUENCE OF EVENTS

The normal sequence of events for transfer of data to the HSP is as follows:

- The HSP sets its Output Data Request.
- The MTS, in the IDLE state, recognizes the first ODR as a command to start the read operation.
- The MTU places a word on the data lines and sets its Input Data Request.
- The HSP recognizes this IDR as an Output Acknowledge.
- The HSP samples the data lines and clears its ODR.
- The MTU recognizes the clearing of the ODR as an Input Acknowledge.

The latter four steps are repeated until the complete record is transferred, at which time the line is printed, the paper is advanced and the cycle is reinitiated. The process continues until the End of File Tape Mark is read. The HSP recognizes the Tape Mark as a command to position the paper at Top of Form on the next page. The Interrupt line of the MTU being connected to the External Function line of the HSP permits the End of Record and the Tape Mark Codes to be sent to the HSP as commands to move paper one line space or Top of Form respectively.

UNIVAC
DIVISION OF SPERRY RAND CORPORATION
DEFENSE MARKETING
UNIVAC PARK, ST. PAUL, MINN. 55116
AREA CODE 612, 698-2451

UNIVAC Regional Offices

PX-3221

WASHINGTON, D. C., 20007, *2121 Wisconsin Avenue, 338-8510* ★ WALTHAM, MASS., 02154, *69 Hickory Drive, 899-4110* ★ COCOA BEACH, FLORIDA, 32931, *Suite 176, Holiday Office Center, 1325 No. Atlantic Avenue, 783-8461* ★ HOUSTON, TEXAS, 77058, *Suite 122, Alpha Building, 16811 El Camino Real, HU 8-2240* ★ LOS ANGELES, CALIFORNIA, 90045, *Suite 220, 5316 West Imperial Highway, 678-2531* ★ SAN BERNARDINO, CALIFORNIA, 92410, *Suite 219, 808 East Mill Street, 889-1096* ★ SAN DIEGO, CALIFORNIA, 92110, *3045 Rosecrans, 224-3333*