Prime Computer
User Guide

MAN 1940

For

Magnetic Tape Controller

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MAGNETIC

TAPE

CONTROLLER

USER GUIDE

February 1975

PRIME
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ILLUSTRATIONS

FOREWORD

This manual is designed to bridge a gap between a strict hardware
approach to the description of magnetic tape in Prime computer config-
urations and a strict software approach to the description of magnetic
tape. It gives the user information on installation, operation, and
programming magnetic tape. To eliminate bulk and where applicable,
references are made to adequate descriptions in the vendor's manual
or other Prime manuals. The general plan of this document is as follows:

Section 1   is a general description of the physical characteristics
              of magnetic tape transports that may be configured to
              a Prime computer.

Section 2   is a summary of the physical operation of the magnetic
              tape units.

Section 3   gives installation instructions. It references the
              vendor's manual frequently. However, this section
              compiles lists of both the vendor's interface signals
              to the controller and the Prime computer's interface
              connection to the controller.

Section 4   is a detailed description of a number of high-level
              language programming features for the reading and
              writing of magnetic tape.

Section 5   describes assembly language instructions that are used
              for magnetic tape I/O. This section also describes
              the magnetic tape format in detail.

Section 6   summarizes the standard test programs provided with
              magnetic tape.

Appendix A   lists IOCS error messages for magnetic tape operations.

Appendix B   lists the Prime internal character codes, which may be
              useful to programmers concerned with conversion
              considerations as a result of reading and writing raw
              data.

This manual also contains a subject index after the appendices. Finally,
please note that if a Prime user wishes to communicate any problems or
questions concerning the document, the last page is a stamped return-
addressed comment sheet.

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SECTION 1

GENERAL INFORMATION

SCOPE

This manual describes magnetic tape that may be configured to a Prime computer system and discusses the software instructions and system commands used to interface the tape to the Prime computer. Where applicable, it references related manuals that discuss tape or I/O hardware in detail (Refer to Table 1-1).

Table 1-1. Related Documents

Title	Order No.
Models 8x40 and 8x60 Synchronous Write and Synchronous Read Tape Transports - Pertec Peripheral Equipment	MAN 1641
General Purpose Interface Manual	MAN 1676
Prime Installation and Maintenance Manual	MAN 1677
Logic Diagrams for Type 4020 Magnetic Tape Controller	LDS 1811
Microcode Listing for Type 4020	MIC 1657
Prime Macro Assembler Manual	MAN 1673
Prime System Reference Manual	MAN 1671
Prime Software Library User Guide	MAN 1880
Prime Disk & Virtual Memory Operating System	MAN 1675
RTOS	MAN 1856

CAPABILITIES

Magnetic Tape Transports

Magnetic tape transports configured to Prime computing systems have the capability of recording data, using either 7- or 9-track drives. Tape speed is 45 ips in an ANSI or NRZI IBM-compatible format. For physical details about the magnetic tape transports, refer to the technical manual (Table 1-1).

The following figure (Figure 1-1) summarizes magnetic tape configuration.

1-1

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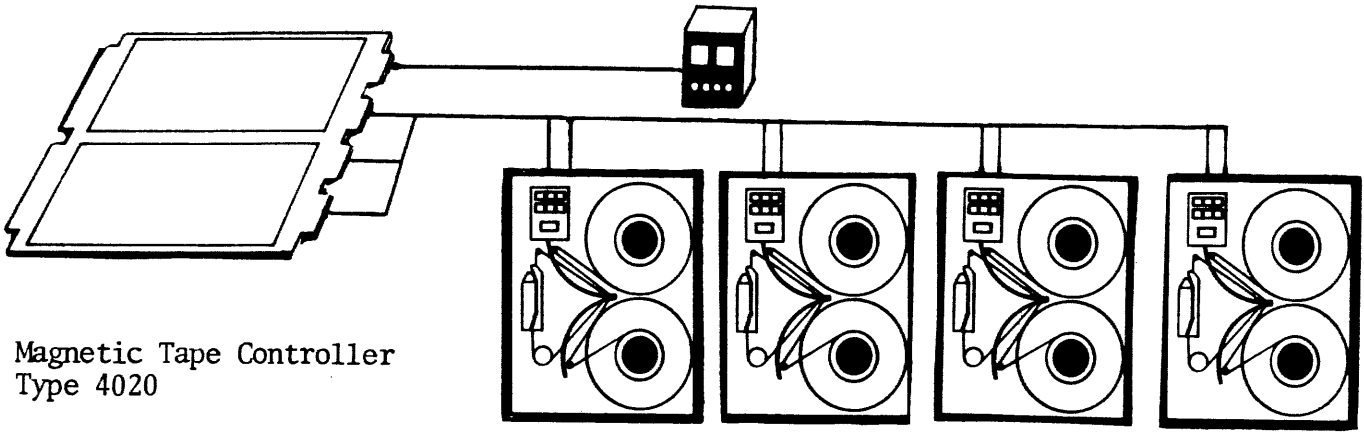
Magnetic Tape Controller
Type 4020

11.3 Amps @ 5Vdc

Controller accepts any combination of four
7- and 9-track transports and uses one DMA
or DMC channel.

Figure 1-1.   Schematic View of Prime Magnetic Tape Configuration

Magnetic Tape Controller

The magnetic tape controller controls reading, writing and spacing operations of up to four magnetic tape transports.

The following functions are provided in the controller:

Write binary record at one character per word.
Write binary record at two characters per word.
Write BCD record (seven-track only) at one character per word.
Write BCD record (seven-track only) at two characters per word.

Read binary record at one character per word.
Read binary record at two characters per word.
Read BCD record (seven-track only) at one character per word.
Read BCD record (seven-track only) at two characters per word.

Read binary record (nine-track only) at one character per word and correct errors.
Read binary record (nine-track only) at two characters per word and correct errors.

Write file mark.
Space forward one record.
Space forward one file.
Backspace one record.
Backspace one file.
Rewind.
Select transport.

SOFTWARE INTERFACE

Magnetic tapes are supported in the Prime Disk Operating Systems DOS (and DOS/VM), by the system commands MAGSAV and MAGRST. MAGSAV and MAGRST are for disk backup, primarily. Formatted I/O routines are supported by the FORTRAN compiler, and magnetic tape operation sub-routines are available in the IOCS Library. (IOCS =: Input & Output Control System.) Also, the user may employ assembly language programming to drive magnetic tapes and interface with the system through SVC (Supervisor Calls). The specific assembly language instructions that are used in magnetic tape operation are disucssed in Section 5. Magnetic tape is also supported via drivers in the Prime Real Time Operating System (RTOS). For details, refer to the RTOS User Guide (Table 1-1). The software interfaces are summarized in Section 4 and discussed in detail in the applicable manuals (Refer to Table 1-1).

PHYSICAL DESCRIPTION

Tape Transport Features

Table 1-2 gives the general physical features of the magnetic tape transports. For a visual concept of magnetic tape configuration, see Figure 1-1.

Table 1-2. Summary of Magnetic Tape Features.

Specifications	Seven Track-Transport (556/800 bpi,45ips)		Nine-Track Transport (800 bpi, 45ips)	
Type	4141	4141-A	4143	4143-A
Voltage(low-high)	95-125	190-250	95-125	190-250
Hz(low-high)	48-400	48-400	48-400	48-400
Amps(run-start)	3.0-10.5	1.5-5.3	3.0-10.5	1.5-5.3
Btu/hr.	1,025		1025	
°F(low-high)	35°-90°		35°-90°	
Rel.humidity (no cond.)	90%		90%	
Weight	85 lbs.		85 lbs.	
WxHxD	19"x24-1/2"x12-1/2"		19"x24-1/2"x12-1/2"	
Mounting	Rack		Rack	

Type	Description	Prerequisites
4020	Controller for up to four magnetic tape transports	Any Prime CPU
4141	Magnetic Tape transport: 7 track, 45ips, 556/800 bpi, industry compatible.	4020
4143	Magnetic tape transport: 9 track, 45 ips, 800bpi, industry compatible.	4020
4149	Magnetic tape, 2400 feet on 10" reel.	
CBL1468-001	Cables from 4020 controller to magnetic tape transport (12")	None
9501	Field exerciser panel(FEP): display unit, control unit, and cable	Any Prime CPU

Cables are supplied with the devices.
The FEP is an optional maintenance aid for the 4020 controller's Microprocessor.
Device types listed above are for 60 Hz, 117 Vac operation.

SECTION 2

OPERATION

OPERATING PROCEDURES

The vendors manual (See Table 1-1) describes how to operate the magnetic tape transports. The following operations are summarized in this section and discussed in detail in the vendors manual.

CLEANING HEAD AND GUIDES

LOADING TAPE ON THE TRANSPORTS

BRINGING TAPE TO LOAD POINT (BOT)

UNLOADING TAPE

Cleaning Heads and Guides

Instructions in the vendors manual must be followed carefully to avoid damaging the magnetic tape units.

Loading Tape on Transports

Figure 2-1 illustrates the path that the tape follows when loaded on the transport; it is included here for quick reference. The supply reel (tape reel to be read or written) is placed at the top of the transport next to the manual controls. Tape must unwind from the reel when it is turned clockwise. A WRITE ENABLE ring is required if the magnetic tape on the supply reel is to be written upon.

Tape loading is accomplished through a quick release hub. The vendors manual has photographs of this in the unlocked and locked positions.

To load a reel of tape, proceed as follows:

1. Unlock the quick release latch on the supply reel.

2. Position the reel of tape over the quick release hub; six reel retaining pawls provide alignment. The WRITE ENABLE ring (or slot) of the tape reel must be toward the transport.

3. Lock the quick release latch.

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POWER
CONTROL

FIXED
TAPE GUIDE

TAPE
CLEANER

PHOTO
TAB SENSOR

MAGNETIC
TAPE HEAD

FLUX GATE

FIXED
TAPE GUIDE

CAPSTAN

SUPPLY REEL

TAKE-UP REEL
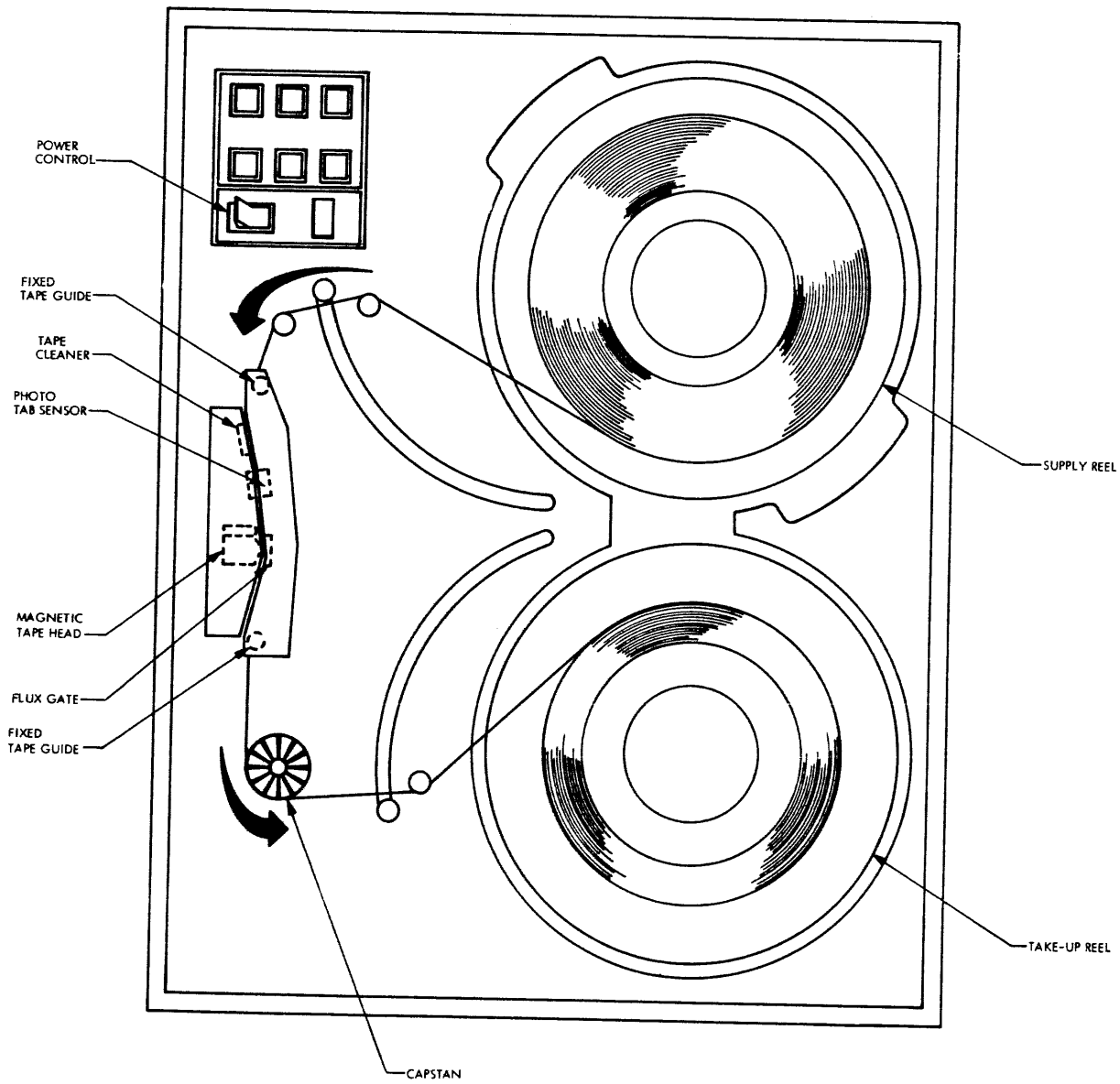
Figure 2-1.   Tape Path

4. When the reel is properly mounted, the tape is threaded along the path shown in Figure 2-1.

5. Wrap tape leader on the take-up (bottom) reel so that the tape is wound on the reel when it is rotated clockwise.

6. Wind several turns on the take-up reel; then turn the supply reel counter clockwise to take up slack.

Bringing Tape to LOAD Point (BOT)

CAUTION

Keep dust cover closed when tape is on the take-up reel. Otherwise, data reliability may be impaired.

1. Turn power ON; the indicator lights up.

2. Press and release LOAD.

CAUTION

Check that tape is positioned correctly on all guides, or tape damage may result.

3. Press and release LOAD a second time.

4. When the reflective tab is at the LOAD point (BOT), the tape stops.

The tape transport is now ready to receive external commands.

Unloading Tape

If power has been turned OFF:

1. First, turn power ON.

2. Press and release LOAD.

If power is ON:

3. Press and release REWIND, when tape has re-wound to BOT it comes to a controlled stop.

4. Press and release REWIND a second time; the tension arms move to the threading position after the remaining tape has been wound onto the supply reel.

5. Open the dust cover.

2-3

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6. Unlock the quick release latch, remove the reel of tape, and close the dust cover.

MANUAL CONTROLS

The manual controls on the Console at the front of the tape transport are discussed in detail in the applicable vendor's manual; refer to Table 1-1. Briefly, the manual controls are:

ON/OFF   Toggle action switch that turns power ON/OFF, illuminated when ON.

LOAD   Pressing and releasing LOAD for the first time after power is ON starts the tension arms moving into the operating area; depressing and releasing LOAD for the second time causes the tape to move to the load point (BOT). While the tape is positioned at the BOT, the LOAD indicator is lit, indicating that the transport is ready for use.

ON LINE   Pressing and releasing ON LINE after a LOAD or REWIND sequence switches the tape transport to ON LINE mode and illuminates this indicator. In this condition, the tape transport can accept external commands, provided it is SELECTED.

Tape transports revert to OFF LINE mode if:

1. ON LINE is pressed and released a second time.
2. Tape tension is lost.
3. The RESET switch is pressed.

REWIND   Pressing and releasing REWIND causes the tape to rewind. REWIND is enabled only in OFF LINE mode.

At the end of the normal rewind, tape is at BOT and the Load sequence is entered. If REWIND is pressed and released again, tape is slowly moved to the supply reel until there is no more tape on the take-up reel.

WRT EN   Indicator illuminated when power is on, and protect
                ring is inserted in the supply reel.

HIGH DEN   Alternate action switch-indicator used in seven-track
                operation to specify character packing density. This
                switch indicator signifies 800 BPI when indicator is lit.

SELECT   A 10-position rotary switch that provides selective
                addressing of four transports.

MAINTENANCE SWITCH

The MAINTENANCE switch at the rear of each transport is a three-position
.toggle switch that provides manual control of tape motion when the tape
is in the OFF LINE mode. MAINTENANCE switch positions and effects are:

        Position   Effect

          up   Tape moves in forward direction.

        center   Stops tape motion.

         down   Tape moves in reverse direction.

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SECTION 3

INSTALLATION

UNCRATING AND INSTALLATION

The applicable vendor's manual (See Table 1-1) gives detailed instruc-
tions for uncrating and installing the tape transports. These instruc-
tions discuss installation of all standard and optional aspects of
the transports and must be followed wherever applicable. It is
recommended that these sections of the vendors manual be read and
understood before attempting to uncrate and install a tape transport.

INTERCONNECTION AND CABLING

Trap Transport Cabling

The vendor's manual (Table 1-1) has an illustration showing how to
make the interface cable installation. For convenience, Table 3-1
lists interface connections for Prime computer configurations between
the Model 8x40 tape transports and the controllers, and the succeeding
paragraphs define the interface functions that are listed. Following
the descriptions, Table 3-5 shows the interfaces between the controllers
and the Prime computers, and cross references these Prime signals
with the vendor signals.

Interface Inputs (Controller to Transport)

For interface inputs, the logical true level is 0 volts and the logical
false level is +3 volts. The names of the inputs and meanings of
their logical levels are discussed in Table 3-3.

Interface Outputs (Transport to Controller)

It is assumed that the outputs described in Table 3-4 are gated with
SELECT and ON LINE.

3-1

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Table 3-1.   Interface Connections, Pertec Model 8X40.

Transport Connector Mating Connector			36 Pin Etched PC Edge Connector 36 Pin ELCO 00-6007-036-980-002
Connector	Live Pin	Ground Pin	Signal*
J101 Tape Control PCBA	1	2	⟶ LOAD ON LINE (LOL)
	J	8	⟶ SELECT 0 (SLT0)
	A	3	⟶ SELECT 1 (SLT1)
	18	16	⟶ SELECT 2 (SLT2)
	V	17	⟶ SELECT 3 (SLT3)
	C	3	⟶ SYNCHRONOUS FORWARD Command (SFC)
	E	5	⟶ SYNCHRONOUS REVERSE Command (SRC)
	H	7	⟶ REWIND Command (RWC)
	K	9	⟶ SET WRITE STATUS (SWS)
	T	16	⟵ READY (RDY)
	M	11	⟵ ON-LINE Command
	N	12	⟵ REWINDING (RWD)
	U	17	⟵ END OF TAPE (EOT)
	R	14	⟵ LOAD POINT (LDP)
	P	13	⟵ FILE PROTECT (FPT)
	F	6	⟵ DATA DENSITY INDICATOR (DDI)
J102 Data PCBA	A	1	⟶ WRITE DATA STROBE (WDS)
	C	3	⟶ WRITE AMPLIFIER RESET (WARS)
	L	10	⟶ WRITE DATA PARITY (WDP)
	M	11	⟶ WRITE DATA 0 (WD0) ⎫ Omit for 7-Track
	N	12	⟶ WRITE DATA 1 (WD1) ⎭
	P	13	⟶ WRITE DATA 2 (WD2)
	R	14	⟶ WRITE DATA 3 (WD3)
	S	15	⟶ WRITE DATA 4 (WD4)
	T	16	⟶ WRITE DATA 5 (WD5)
	U	17	⟶ WRITE DATA 6 (WD6)
	V	18	⟶ WRITE DATA 7 (WD7)
J103 Data	2	B	⟵ READ DATA STROBE (RDS)
	1	A	⟵ READ DATA PARITY (RDP)
	3	C	⟵ READ DATA 0 (RD0) ⎫ Omit for 7-Track
	4	D	⟵ READ DATA 1 (RD1) ⎭
	8	J	⟵ READ DATA 2 (RD2)
	9	K	⟵ READ DATA 3 (RD3)
	14	R	⟵ READ DATA 4 (RD4)
	15	S	⟵ READ DATA 5 (RD5)
	17	U	⟵ READ DATA 6 (RD6)
	18	V	⟵ READ DATA 7 (RD7)

Table 3-2. Interface Connections, Pertec Model 8X60

	Transport Connector Mating Connector		36 Pin Etched PC Edge Connector 36 Pin ELCO 00-6007-036-980-002
Connector	Live Pin	Ground Pin	Signal*
J101 **Tape** **Control** **PCBA**	1	2	———▶ LOAD ON LINE (LOL)
	J	8	———▶ SELECT 0 (SLT0)
	A	3	———▶ SELECT 1 (SLT1)
	18	16	———▶ SELECT 2 (SLT2)
	V	17	———▶ SELECT 3 (SLT3)
	C	3	———▶ SYNCHRONOUS FORWARD Command (SFC)
	E	5	———▶ SYNCHRONOUS REVERSE Command (SRC)
	D	4	———▶ DATA SENSITY SELECT (DDS)
	H	7	———▶ REWIND Command (RWC)
	L	10	———▶ OFF-LINE Command (OFFC)
	K	9	———▶ SET WRITE STATUS (SWS)
	B	2	———▶ OVERWRITE Command (OVW)
	T	16	◀——— READY (RDY)
	M	11	◀——— ON-LINE Command
	N	12	◀——— REWINDING (RWD)
	U	17	◀——— END OF TAPE (EOT)
	R	14	◀——— LOAD POINT (LDP)
	P	13	◀——— FILE PROTECT (FPT)
	F	6	◀——— DATA DENSITY INDICATOR (DDI)
J102 **Data** **PCBA**	A	1	———▶ WRITE DATA STROBE (WDS)
	C	3	———▶ WRITE AMPLIFIER RESET (WARS)
	E	5	———▶ READ THRESHOLD (RTH)
	L	10	———▶ WRITE DATA PARITY (WDP)
	M	11	———▶ WRITE DATA 0 (WD0) ⎫ Omit for 7-Track
	N	12	———▶ WRITE DATA 1 (WD1) ⎭
	P	13	———▶ WRITE DATA 2 (WD2)
	R	14	———▶ WRITE DATA 3 (WD3)
	S	15	———▶ WRITE DATA 4 (WD4)
	T	16	———▶ WRITE DATA 5 (WD5)
	U	17	———▶ WRITE DATA 6 (WD6)
	V	18	———▶ WRITE DATA 7 (WD7)
J103 **Data** **PCBA**	2	B	◀——— READ DATA STROBE (RDS)
	1	A	◀——— READ DATA PARITY (RDP)
	3	C	◀——— READ DATA 0 (RD0) ⎫ Omit for 7-Track
	4	D	◀——— READ DATA 1 (RD1) ⎭
	8	J	◀——— READ DATA 2 (RD2)
	9	K	◀——— READ DATA 3 (RD3)
	14	R	◀——— READ DATA 4 (RD4)
	15	S	◀——— READ DATA 5 (RD5)
	17	U	◀——— READ DATA 6 (RD6)
	18	V	◀——— READ DATA 7 (RD7)

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Table 3-3.   Interface Inputs to Tape Transport

Input	Results Summary
SELECT (SLT)	When TRUE; enables all interface drivers and receivers in the transport, thus connecting the transport to the controller.
SYNCHRONOUS FORWARD COMMAND (SFC)	When TRUE and the transport is READY and ON-LINE, moves the tape forward. When FALSE, tape motion ceases.
SYNCHRONOUS REVERSE COMMAND (SRC)	When TRUE and the transport is READY and ON LINE, moves tape in reverse. When FALSE, tape motion ceases.
REWIND (RWC)	If READY, this is a pulse that causes tape to move in reverse at 200 ips after a 0.1 second delay. Upon reaching BOT, the rewind ceases; and the LOAD sequence is initiated (tape moves forward and comes to rest at BOT).
SET WRITE STATUS (SWS)	Must be TRUE for 20 µsec after an SFC or SRC when the WRITE mode of operation is required. If READ mode of operation is required, SWS must be FALSE.
WRITE DATA LINES (For nine-track: WDP, WD0,...,WD7; For seven-track: WPP, WD2,...,WD7)	These levels when TRUE at WDS time, result in a flux reversal being recorded in the corresponding tape track. These lines must be held steady during the WDS and for 0.5 µsec before and after the WDS pulse.
WRITE DATA STROBE (WDS)	Samples each WRITE DATA LINE and toggles the appropriate flip flops when a "1" is written. (Refer to the vendor's manual for more details).
WRITE AMPLIFIER RESET (WARS)	Causes the LRCC (Longitudinal Redundancy Check Character) to be written.
LOAD AND ON LINE (LOL)	When TRUE, enables a remote LOAD sequence and causes the transports to be ON LINE.

Table 3-4. Interface Outputs to Tape Transports

Output	Results Summary
READY (RDY)	TRUE when transport is ready to accept any external command.
READ DATA (For nine-track: RDP, RDP0,...,RDP7; for seven-track: RDP, RDP2,...RDP7)	The bits of each data character are assembled into parallel form in a register. The register outputs drive the READ DATA lines. The complete character is read by sampling the appropriate RDP lines simultaneously with RDS.
READ DATA STROBE (RDS)	Samples the RDP lines and sets the appropriate bits when a "1" is read.
ON LINE	When TRUE, the transport is under remote control; when FALSE, it is under manual control.
LOAD POINT (LDP)	When TRUE, the transport is READY and tape is at rest at BOT.
END OF TAPE (EOT)	When TRUE, indicates tape is positioned to EOT.
REWINDING (RWD)	Set TRUE when transport is engaged in any rewinding operation or the LOAD sequence following a REWIND.
FILE PROTECT (FTP)	TRUE when power is ON and a reel of tape without a WRITE ENABLE ring installed is mounted on the transport.
DATA DENSITY INDICATOR (DDI)	TRUE when the READ electronics are conditioned to operate in the high-density mode.

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Table 3-5

MAGNETIC TAPE MNEMONIC CROSS-REFERENCE CHART

CABLE J103, READ DATA, MPC CONN 2:

SIGNAL NAME			PRIME		TRANSPORT	
Transport	Prime	LBD	Signal	Ground	Signal	Ground
RD0	BDC51-	33A	1	2	3	C
RD1	BDC52-	33A	3	4	4	D -
RD2	BDC53-	33A	5	6	8	J -
RD3	BDC54-	33A	7	8	9	K
RD4	BDC55-	33A	9	10	14	R
RD5	BDC56-	33A	11	12	15	S
RD6	BDC57-	33A	13	14	17	U
RD7	BDC58-	33A	15	16	18	V
			17	18		
			19	20		
			21	22		
			23	24		
			25	26		
			27	28		
			29	30		
			31	32		
RDS	BDC83-	27A	33	34	2	B
			35	36		
			37	38		
			39	40		
RDP	BDC87-	27A	41	42	1	A
			43	44		

Table 3-5 (Cont)

CABLE J102, WRITE DATA, MPC CONN C:

SIGNAL NAME			PRIME		TRANSPORT	
Transport	Prime	LBD	Signal	Ground	Signal	Ground
WD0	BDC11-	31A	1	2	M	11
WD1	BDC12-	31A	3	4	N	12
WD2	BDC13-	31A	5	6	P	13 -
WD3	BDC14-	31A	7	8	R	14 -
WD4	BDC15-	31A	9	10	S	15
WD5	BDC16-	31A	11	12	T	16
WD6	BDC17-	31A	13	14	U	17
WD7	BDC18-	31A	15	16	V	18
WD8	BDC21-	31A	17	18	L	10
			19	20		
			21	22		
			23	24		
			25	26		
RTW2	BDC26-	31A	27	28	F	6
WARS	BDC27-	31A	29	30	C	3
WDS	BDC28-	31A	31	32	A	1
			33	34		
			35	36		
			37	38		
			39	40		
			41	42		
			43	44		

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Table 3-5 (Cont)

CABLE J101, CONTROL, MPC CONN D:

SIGNAL NAME			PRIME		TRANSPORT	
Transport	Prime	LBD	Signal	Ground	Signal	Ground
SFC	BDC31-	32A	1	2	C	3
SRC	BDC32-	32A	3	4	E	5 -
RWC	BDC33-	32A	5	6	H	7 -
SWS	BDC34-	32A	7	8	K	9
SLT0	BDC35-	32A	9	10	J	8
SLT1	BDC36-	32A	11	12	A	8
SLT2	BDC37-	32A	13	14	18	8
SLT3	BDC38-	32A	15	16	V	8
RDY	BDC41-	32A	17	18	T	16
ONL(RTN)	BDC42-	32A	19	20	M	11
EOT	BDC43-	32A	21	22	U	17
RWD	BDC44-	32A	23	24	N	12
LPD	BDC45-	32A	25	26	R	14
FPT	BDC46-	32A	27	28	P	13
LOL	BDC47-	32A	29	30	I	3
OFFC	BDC48-	32A	31	32	L	10
			33	34		
			35	36		
DDI	BDC78	27A	37	38	F	6
			39	40		
			41	42		
			43	44		

CABLE NUMBERING

The cables provided with the Prime controller are numbered in a manner that depends upon the number of transports attached to the controller. (The connectors are marked J101, J102, J103, etc.) Table 3-6 summarizes these cable numbers.

Table 3-6. CONTROLLER CABLES

Number	Cable Function	No. of Transports
CBL0659-XXX	CONTROL CABLE	1
CBL1282-001	CONTROL CABLE	2
CBL1282-002	CONTROL CABLE	3
CBL1282-003	CONTROL CABLE	4
CBL0660-XXX	WRITE CABLE	1
CBL1283-001	WRITE CABLE	2
CBL1283-002	WRITE CABLE	3
CBL1283-003	WRITE CABLE	4
CBL0661-XXX	READ CABLE	1
CBL1284-001	READ CABLE	2
CBL1284-002	READ CABLE	3
CBL1284-003	READ CABLE	4

NOTE: XXX, in the case of a cable to a single transport, varies according to the cable length, where:

XXX=	Length=
001	4 ft.
002	12 ft.
003	30 ft.

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SECTION 4

SYSTEM LEVEL PROGRAMMING

This section discusses magnetic tape operation from four higher levels of programming: operating system command language, Input/Output Control System (IOCS) subroutines, FORTRAN formatted I/O, and BASIC language programs.

COMMAND LANGUAGE CONSIDERATIONS

Tape Assignment

When using the DOS/VM operating system, which is a multi-user system, before executing any program that reads, write, or controls magnetic tape; the ASSIGN command must be issued to assign the device to the user. Examples are shown in Table 4-1.

Table 4-1. ASSIGN Command

Command	Function
AS MT0	Assigns Magnetic Tape Unit 0; Dial = 0
AS MT1	Assigns Magnetic Tape Unit 1; Dial = 1
AS MT2	Assigns Magnetic Tape Unit 2; Dial = 2
AS MT3	Assigns Magnetic Tape Unit 3; Dial = 3

For further information, refer to the Disk and Virtual Memory Operating Systems User Guide (Table 1-1).

Record Size

If using DOS/VM, magnetic tapes record size must be 512 words or less.

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MAGSAV & MAGRST

MAGSAV and MAGRST are utility programs that move disk files to nine-track magnetic tape and vice versa. The files may be SAM, DAM, segment directories, UFD's, or an entire disk. Whenever a directory is specified, the directory and all sub-components are transferred.

Logical Tapes

A logical tape consists of a header record, a file mark, file records, and two file marks. A logical tape may span multiple physical tapes or a single physical tape may contain multiple logical tapes. The header record contains the tape name, data, and revision number. All tape records are 512 words long, the maximum size permitted by DOS/VM.

Tree Names

A disk file appears on tape as a record containing a tree name followed by as many data records as are required for the file. The tree name contains the path from the file specified by the user to the current file. When an entire disk is saved, all tree names begin in the MFD. Thus, an ordinary SAM file might have a tree name of MFD>UFD>JUNK or MFD>UFD>SUBUFD>JUNK.

MAGSAV USAGE

The user invokes MAGSAV by typing: MAGSAV. MAGSAV requests information in the following order:

TAPE UNIT:	The proper response is the physical unit number as dialed on the device.
ENTER LOGICAL TAPE NUMBER:	The response is 1 for the first logical tape, 2 for the second, etc. MAGSAV rewinds the tape, then positions itself correctly. A response of 0 implies the tape is already positioned correctly and MAGSAV takes no action.
TAPE NAME:	Any six character name.
DATE:	The response format is MMb00bYY where b represents a blank.
REV. NO:	An arbitrary number.
CLASS:	The responses are 1 or 2. A class 1 save is a save of an entire disk and assumes the current home UFD to be an MFD; a class 2 save is a selective save of specifically named files.

NAME: The response is either a file name or one
                               of three alternate action commands: $A, $R,
                               $Q. $A changes the home UFD via an attach,
                               e.g., $A USER3 PASSWD 5. $Q and $R termi-
                               nate a logical tape and return to the
                               operating system. $R also rewinds the tape.
                               NAME: is typed whenever writing has
                               completed so that further writing may be
                               requested or the current logical tape
                               may be terminated.

MAGRST USAGE

All restore operations take place in the home UFD. MAGRST asks for the
tape unit and logical tape number exactly as in MAGSAV. MAGRST then
prints the name, date, and revision on the user console and asks:

READY TO RESTORE: The responses are YES, NO, or PARTIAL
                               (abbreviated Y, NO, PA). YES causes
                               a restore of the entire tape. NO causes
                               a request for another tape unit and logical
                               tape combination. PARTIAL permits a
                               restore of part of the tape.

TREE NAME: This is typed when a partial restore is
                               requested. The response is in the form:

                                   NAME1>NAME2> .... NAMEn

                               Any file on the tape whose tree name begins
                               with the sequence entered is restored.
                               Example: All tree names in a class 1 save
                               begin with MFD; so the tree name to
                               restore an entire UFD would be MFD>UFDX.

PHYSICAL END OF TAPE

When this condition is encountered in either MASSAV or MAGRST, a message
is logged on the system console and a new tape unit is requested. The
new unit may be the same as the old unit.

ERRORS

Tape read or write errors are retried five times and are then considered
unrecoverable. Both recovered and unrecovered errors are logged. The
first record on a tape is not retried.

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EXAMPLES OF MAGSAV & MAGRST

Users input is underscored.

OK: STARTUP 0   4
OK: A MFD XXXXXX
OK: MAGSAV
GO
TAPE UNIT: 0
ENTER LOGICAL TAPE NUMBER: 1
TAPE NAME: MD7V1
DATE: 02 18 75
REV NO: 1
CLASS: 1
NAME: $2

OK: A MFD XXXXXX 1
OK: MAGSAV
GO
TAPE UNIT: 0
ENTER LOGICAL TAPE NUMBER: 0
TAPE NAME: MD7V2
DATE: 02 18 75
REV NO: 1
CLASS: 1
NAME: $R

OK: MAKE
GO
PHYSICAL DISK: 70250
RECORDS (OCTAL): 14540
DEVICE NUMB   RECORD COUNT
   070250   014540
PARAMETERS OK? YES
VIRGIN DISK? NO
VERIFY DISK? NO
DISK CREATE
OK: STARTUP 0 70250
OK: A MFD XXXXXX
OK: A MFD XXXXXX 1
OK: LISTF

UFD=MFD   1

DSKRAT MFD   BOOT   CMDNC0 DOS

OK: CNAME DSKRAT MD7

```
OK: MAGRST
GO
TAPE UNIT: 0
ENTER LOGICAL TAPE NUMBER: 1
NAME: MD7V1
DATE: 02-18-75
REV NO:        1
REEL NO:       1
READY TO RESTORE: YES
RESTORE COMPLETE

OK: MAGRST
GO
TAPE UNIT: 0
ENTER LOGICAL TAPE NUMBER: 2
NAME: MD7V2
DATE: 02-18-75
REV NO:        1
REEL NO:       1
READY TO RESTORE: YES
RESTORE COMPLETE

OK: MAGRST
GO
TAPE UNIT: 0
ENTER LOGICAL TAPE NUMBER: 1
NAME: MD7V1
DATE: 02-18-75
REV NO:        1
REEL NO:       1
READY TO RESTORE: PA
TREE NAME: MFD > LIB > FTNLIB
RESTORE COMPLETE

OK: DELETE FTNLIB
OK: SHUTDN
OK:
```

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IOCS SUBROUTINES

On the master disk (supplied with the Prime Computer), two files
M$IO05 and M$IO10, contain IOCS subroutines for nine-track and
seven-track magnetic tape operation, respectively. Table 4-2 lists
these subroutines and their functions.

Table 4-2. IOCS Subroutines

Subroutine Name	Function
C$M10	Control for seven-track
C$M05	Control for nine-track
I$AM10	Read ASCII, seven-track
I$AM05	Read ASCII, nine-track
O$AM10	Write ASCII, seven-track
O$AM05	Write ASCII, nine-track
I$BM10	Read binary, seven-track
I$BM05	Read binary, nine-track
O$BM10	Write binary, seven-track
O$BM05	Write binary, nine-track
T$MT	Raw data transfer (called by magnetic tape driver in the operating system).

Control Subroutines

The control subroutines are C$M05 and C$M10 (Refer to Table 4-2); calling
sequence is:

    CALL C$M05 (Key, Name, Unit, Altrtn)

    CALL C$M10 (Key, Name, Unit, Altrtn)

where:

```
Key   =           -4  for Rewind to BOT (Beginning of Tape)
                  -3  for Backspace one file mark
                  -2  for Backspace one record
                  -1  for Write file mark
                   1  for Open to read
                   2  for Open to write
                   3  for Open to read/write
                   4  for Close (Write file mark and rewind)
                   5  for Move forward one record
                   6  for Move forward one file mark
                   7  for Rewind to BOF (Beginning of File)
                   8  for Select device and read status

Name  =           Not Applicable (may be anything)

Unit  =           0, 1, 2, or 3 (Depending on which device is ASSIGNED)

Altrtn =          Is the alternate return.  If ALTERN=0, it means
                  that alternate return is not desired.  Alternate
                  returns are taken with the A-Register set as
                  shown in Table 4-3.
```

Table 4-3.   Alternate Returns

A Register	Condition
1	End of File (EOF) detected
2	End of Tape (EOT) detected
3	Magnetic Tape Drive (MTD) not operational
4	Parity error or raw data error
5	Hardware error
6	Bad call to driver

If ALTERN=0, and if the A-Register=3, 4, or 5, a two-line error
message is printed at the terminal. Its format is as follows:

        MTU ERROR:

        Status-Word   Instruction-Word

Read and Write Subroutines

A number of subroutines are available to read and write ASCII and
binary from and to magnetic tape (refer to Table 4-2). The calling
sequence is the same for all I/O drivers:

        CALL <Subroutine> (Unit, Ba, N, Altrtn)

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Possible values substituted for <subroutine> are: I$AM10, I$AM05, O$AM10, I$AM05, I$BM10, I$BM05, O$BM10, and O$BM05. Refer to Table 4-2 for the function of these subroutines. They all call to the general tape driver subroutine T$MT. The meanings of the arguments to the read and write subroutines are:

Unit	Unit number = 0, 1, 2, or 3
Ba	Buffer Address (e.g., BUFF)
N	Number of words to be read or written. If N=0, then the subroutine is to write a file mark.
Altrtn	Is the alternate return. If ALTRTN=0, it means that alternate returns are not desired. Alternate returns are taken with the A-Register set as shown in Table 4-3.

T$MT

The calling sequence is:

    CALL T$MT (Unit, Pba, Word-Count, Instruction, Status-
              Vector)

The T$MT routine is the raw data mover that moves a record of information from one of four magnetic tape drives to the user address space, or vice-versa. T$MT is called by the IOCS routines concerned with controlling, reading and writing both seven- and nine-track magnetic tapes. (For details, refer to the Subroutine Library Manual and/or the Magnetic Tape Transports User Guide). The user normally controls, reads, and writes magnetic tape under program control using either FORTRAN READ, WRITE, REWIND, and END FILE statements or using calls to the appropriate IOCS driver. However, it is possible to call T$MT directly. The arguments are:

Unit	Magnetic Tape Drive (=0, 1, 2, or 3)
Pba	A pointer to a buffer address from which to read or or write a record of information (e.g., LOC (BUFF))
Word-Count	Number of words to transfer. This number must be between 0 and 512 words.
Instruction	The instruction request to the magnetic tape drivers. Valid instructions are:

Octal	Hexadecimal	Meaning
'40 -	$20	rewind to BOT, 7 & 9 track
'22100 -	$2440	backspace one file mark, 9 track
'20100 -	$2040	backspace one file mark, 7 track
'62100 -	$6440	backspace one record, 9 track
'60100 -	$6040	backspace one record, 7 track
'22220 -	$2490	write file mark, 9 track
'20220 -	$2090	write file mark, 7 track
'62200 -	$6480	forward one record, 9 track
'60200 -	$6080	forward one record, 7 track
'22200 -	$2480	forward one file mark, 9 track
'20200 -	$2080	forward one file mark, 7 track
'100000-	$8000	select transport, 7 & 9 track
'42220 -	$4490	write record, one character per word, 9 track
'42620 -	$4590	write record, two characters per word, 9 track
'42200 -	$4480	read record, one character per word, 9 track
'42600 -	$4580	read record, two characters per word, 9 track
'52200 -	$5480	read and correct record, one character per word, 9 track
'52600 -	$5580	read and correct record, two characters per word, 9 track
'40220 -	$4090	write binary record, one character per word, 7 track
'40620 -	$4190	write binary record, two characters per word, 7 track
'44220 -	$4890	write BCD record, one character per word, 7 track
'44620 -	$4990	write BCD record, two characters per word, 7 track
'40200 -	$4080	read binary record, one character per word, 7 track
'40600 -	$4180	read binary record, two characters per word, 7 track
'44200 -	$4880	read BCD record, one character per word, 7 track
'44600 -	$4980	read BCD record, two characters per word, 7 track

STATUS VECTOR = 3 word vector containing status flag, hardware status of magnetic tape controller, and number of words actually transferred.

STATUS FLAG = 1 operation started
0 operation done

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```
STATUS = Controller Status Word
where Bit 01 - vertical parity error
         02 - runaway
         03 - CRC error
         04 - LRC error
         05 - false gap/insufficient DMA range
         06 - uncorrectable error
         07 - raw error
         08 - file mark - detected
         09 - selected transport ready
         10 - selected transport on-line
         11 - selected transport end of tape detected
         12 - selected transport rewininding
         13 - selected transport beginning of tape detected
```

Magnetic tape I/O is not buffered under DOS/VM. A call to T$MT returns immediately before the operation is complete. When the magnetic tape operation is completed, the Status Flag in the user space is set to 0. Therefore, a user program may loop waiting for completion and do another computation while waiting. If a user initiates another call to T$MT before the first call has completed its magnetic tape operation, the second call does not return to the user until the first magnetic tape operation has been completed.

Under DOS, T$MT does not return to the user until the magnetic tape operation is completed.

FORTRAN FORMATTED I/O

Provided the tape unit is ASSIGNed (if under DOS/VM), a FORTRAN program may read or write magnetic tape, as well as rewind, move, and backspace the tape. For details, refer to the Prime FORTRAN User Guide (Table 1-1).

BASIC LANGUAGE

Provided the tape unit is ASSIGNed if under DOS/VM, the user of BASIC may read and write from and to magnetic tape. The following BASIC program language example illustrates the method to accomplish this.

```
5       Print 'SIMPLE TAPE TO PRINTER CONVERSION'
10      DEFINE FILE #1 = '(MT1)'
11      REM MAY BE MT0, 1, 2, or 3
20      DEFINE FILE #2 = '(LPR)'
30      FOR I = 1 to 10000
40      READ #1, A$
45      WRITE #1, A$
50      ON END 90
60      NEXT I
90      Print 'TAPE TO PRINT': I : 'RECORDS'
99      END
```

For further details, refer to the Prime BASIC User Guide (Table 1-1).

SECTION 5

ASSEMBLY LANGUAGE PROGRAMMING

FUNCTION DESCRIPTION

Figure 5-1 is a block diagram of the magnetic tape transport and its
interface showing functional elements that are controlled by signals
from the controller; and consequently, functional elements in the
controller that are controlled by I/O instructions.

The meaning of these signals is discussed in Section 3.

Tables 5-3 through 5-8 summarize the magnetic tape programming instruc-
tions and important data for programming magnetic tape described in this
section. At the end of this section is an example that illustrates the
ordering and usage of instructions and data.

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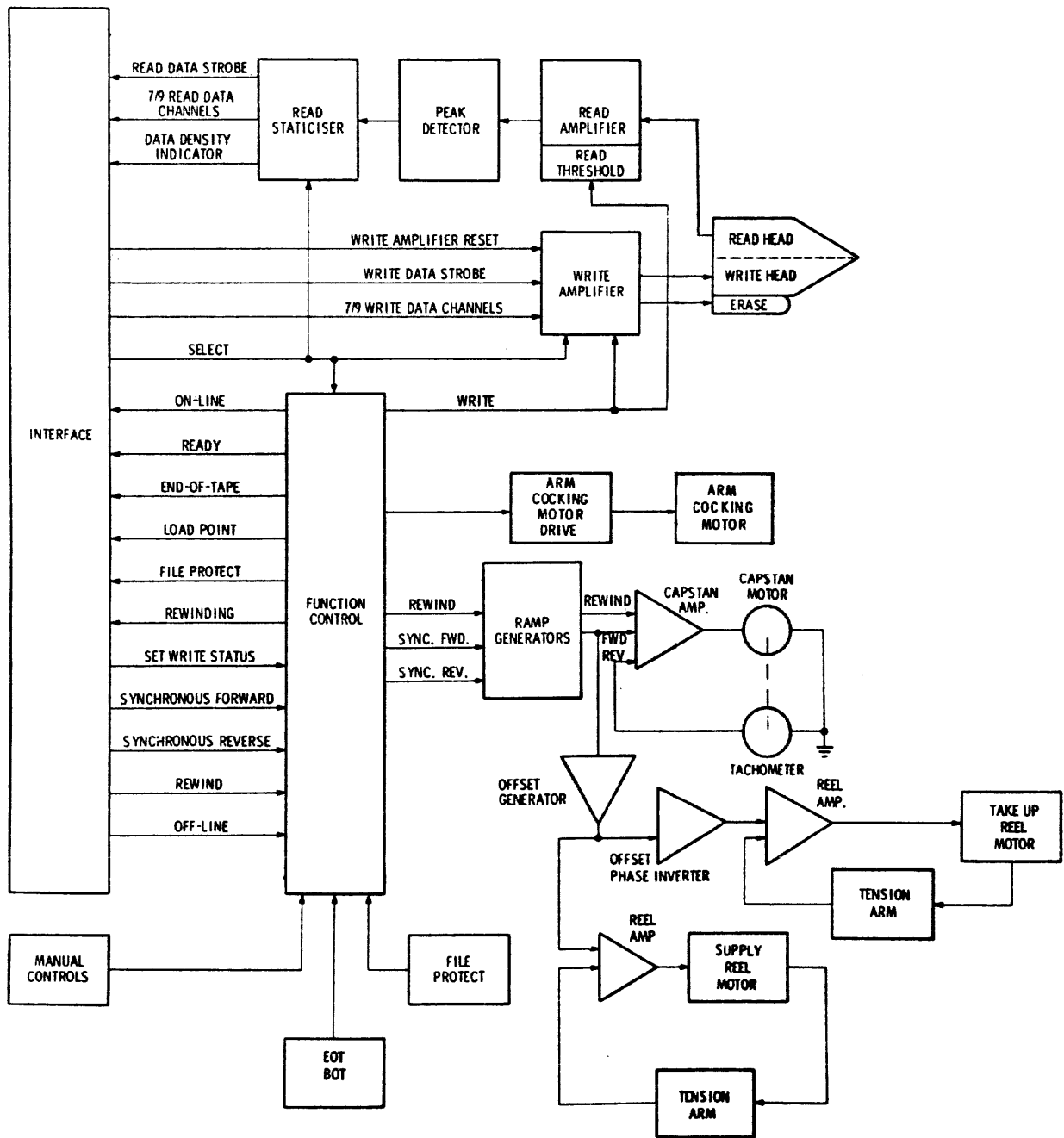
Figure 5-1.   Model 8X40 Tape Transport, Block Diagram.

MAGNETIC TAPE FORMAT

Character Packing

Figure 5-2 shows the 16-bit computer word and tape channel relationship for one-character per word packing. For nine-track recording, bits 9-16 are written on tape; for seven-track recording, bits 11-16 are written on tape.

When reading from nine-track tape in one-character per word packing mode, the left byte is transferred to the computer as zeros. When reading from seven-track tape in one-character per word packing mode, both the left byte and bits 9 and 10 are transferred to the computer as zeros.

Figure 5-3 shows how two-character per word packing is organized. When reading data from a seven-track transport, in two-character per word packing mode, bits 1, 2, 9 and 10 are transferred to the computer as zeros.

Format on Tape

The tape formats for seven- and nine-track recording are shown in Figure 5-4. Principal differences between the two are described in the following paragraphs.

Since nine- and seven-track formats use the same width tape, track width and inter-track spacing are narrower for nine-track than for seven-track.

The minimum data record sizes shown in Figure 5-4 are IBM standards. The Prime system is capable of writing (and reading) records as short as three characters.

Nine-track format has a cyclic redundancy check character (CRCC) inserted between the end of the record and the longitudinal redundancy check character (LRCC). The CRCC, in addition to providing a greater degree of data integrity, gives the capability of error correction.

The inter-record gap is 0.15 inches shorter for nine-track operation and thus gives more data storage per reel of tape.

Track numbering is different between the seven- and nine-track formats, but in each case numbering agrees with the track numbers given in Figures 5-4 and 5-5. The nine-track numbering scheme gives an incremental reliability advantage by placing the most important tracks in the center of the tape.
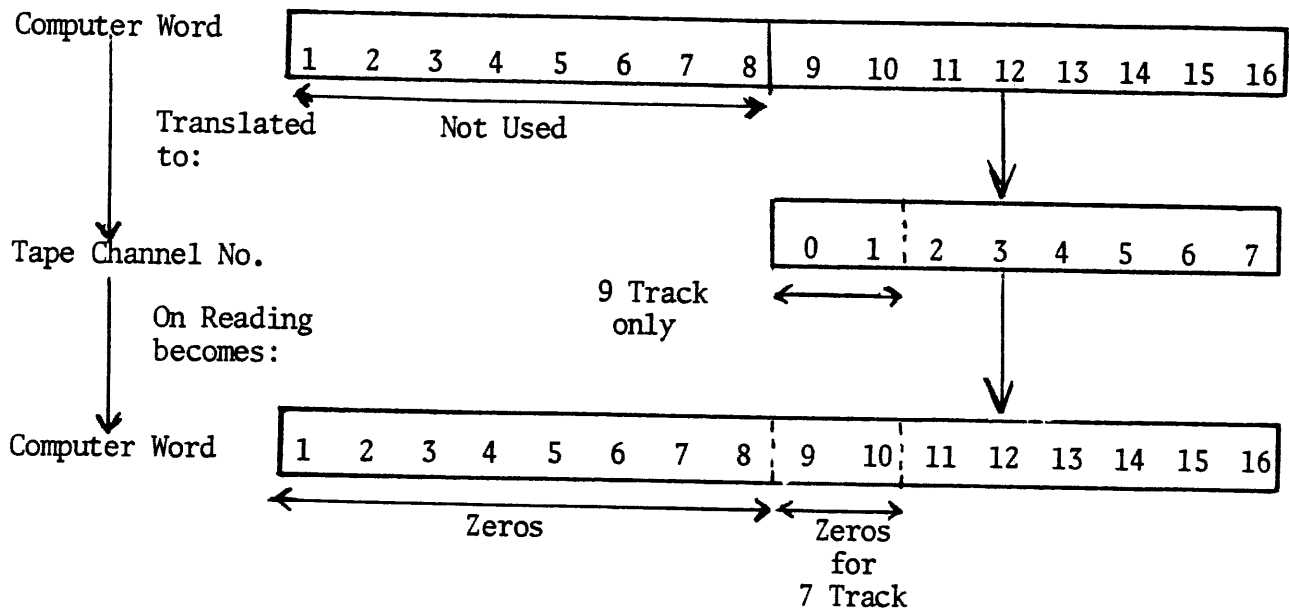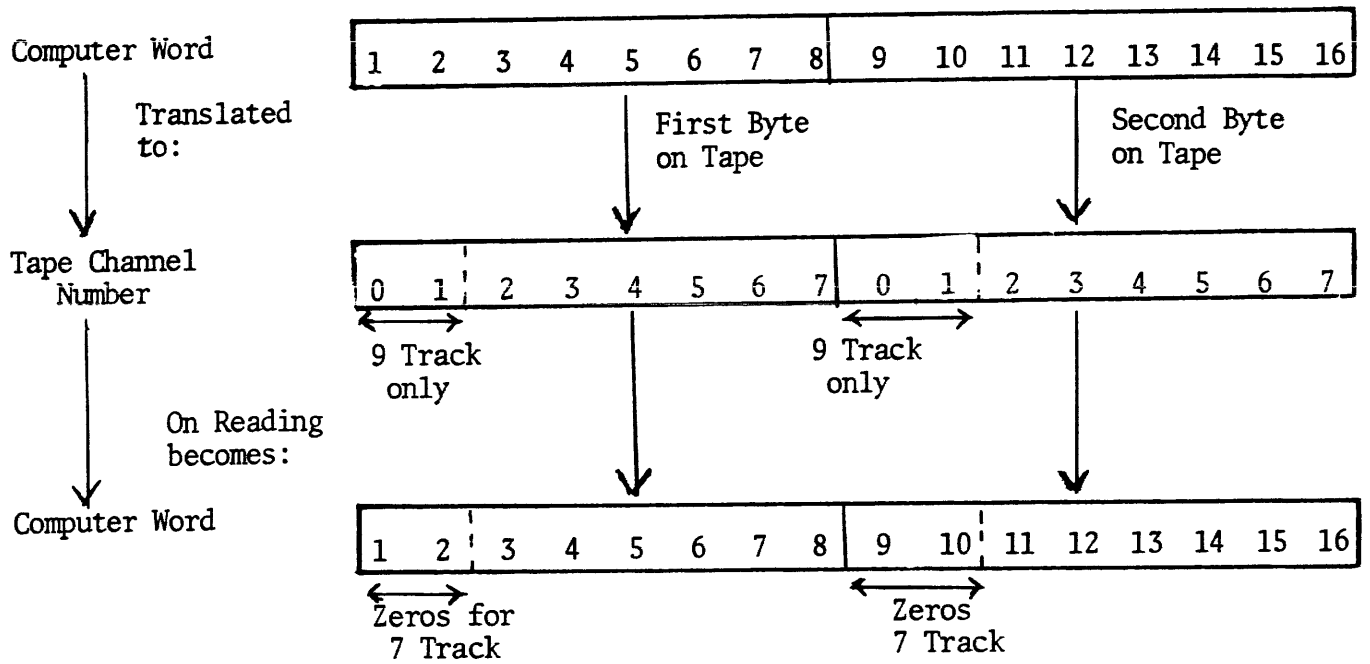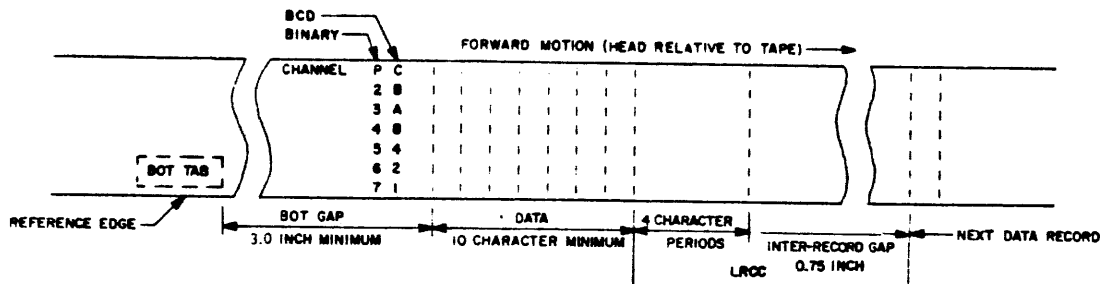
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Figure 5-2. One-Character per Word Packing.

Computer Word

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |

Translated
to:

First Byte
on Tape

Second Byte
on Tape

Tape Channel
Number

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

9 Track
only

9 Track
only

On Reading
becomes:

Computer Word

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |

Zeros for
7 Track

Zeros
7 Track

Figure 5-3. Two-Character Per Word Packing

NOTES

1. TAPE SHOWN WITH OXIDE SIDE UP.

2. CHANNELS 2 THROUGH 7 CONTAIN DATA BITS IN DESCENDING ORDER OF SIGNIFICANCE.

3. CHANNEL P (PARITY) CONTAINS ODD DATA PARITY FOR BINARY TAPES, OR EVEN PARITY FOR BCD TAPES.

4. EACH BIT OF THE LRCC IS SUCH THAT THE TOTAL NUMBER OF "1" BITS IN THAT TRACK (INCLUDING THE LRCC) IS EVEN. IT IS POSSIBLE IN THE 7-TRACK FORMAT FOR THIS CHARACTER TO BE ALL ZEROES, IN WHICH CASE A READ DATA STROBE WILL NOT BE GENERATED.

5. A FILE MARK IS A SINGLE CHARACTER RECORD HAVING "1" BITS IN CHANNELS 4, 5, 6 AND 7 FOR BOTH THE DATA CHARACTER AND THE LRCC. THIS RECORD IS SEPARATED BY 3.5 INCHES FROM THE PREVIOUS RECORD AND BY A NORMAL IRG (0.75 INCH) FROM THE FOLLOWING RECORD.

6. DATA PACKING DENSITY MAY BE 200, 556, OR 800 BITS PER INCH.
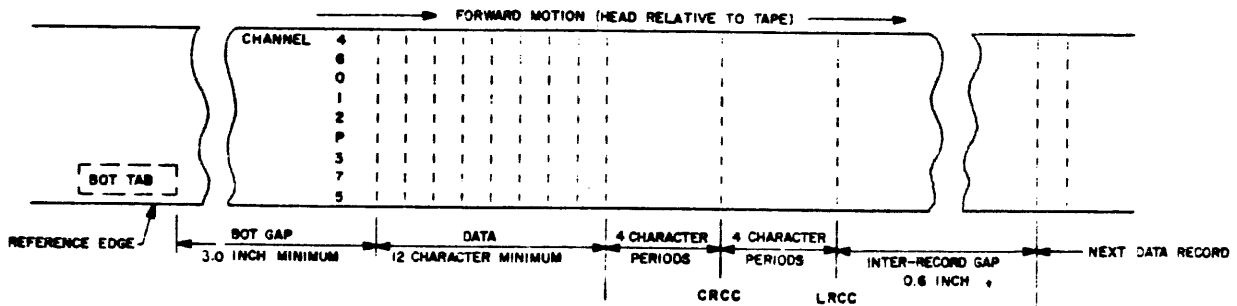
NOTES

1. TAPE SHOWN WITH OXIDE SIDE UP.

2. CHANNELS 0 THROUGH 7 CONTAIN DATA BITS IN DESCENDING ORDER OF SIGNIFICANCE.

3. CHANNEL P (PARITY) ALWAYS CONTAINS ODD DATA PARITY.

4. EACH BIT OF THE LRCC IS SUCH THAT THE TOTAL NUMBER OF "1" BITS IN THAT TRACK (INCLUDING THE CRCC AND THE LRCC) IS EVEN. IN THE 9-TRACK FORMAT THE LRCC WILL NEVER BE AN ALL-ZEROES CHARACTER.

5. IT IS POSSIBLE FOR THIS CRCC CHARACTER TO BE ALL ZEROES, IN WHICH CASE A READ DATA STROBE WILL NOT BE GENERATED

6. A FILE MARK IS A SINGLE CHARACTER RECORD HAVING "1" BITS IN CHANNELS 3, 6, AND 7 FOR BOTH THE DATA CHARACTER AND THE LRCC. THE CRCC CONTAINS ALL ZEROES. THIS RECORD IS SEPARATED BY 3.5 INCHES FROM THE PREVIOUS RECORD AND BY A NORMAL IRG (0.6 INCH) FROM THE FOLLOWING RECORD.

7. DATA PACKING DENSITY IS FIXED AT 800 BITS PER INCH.
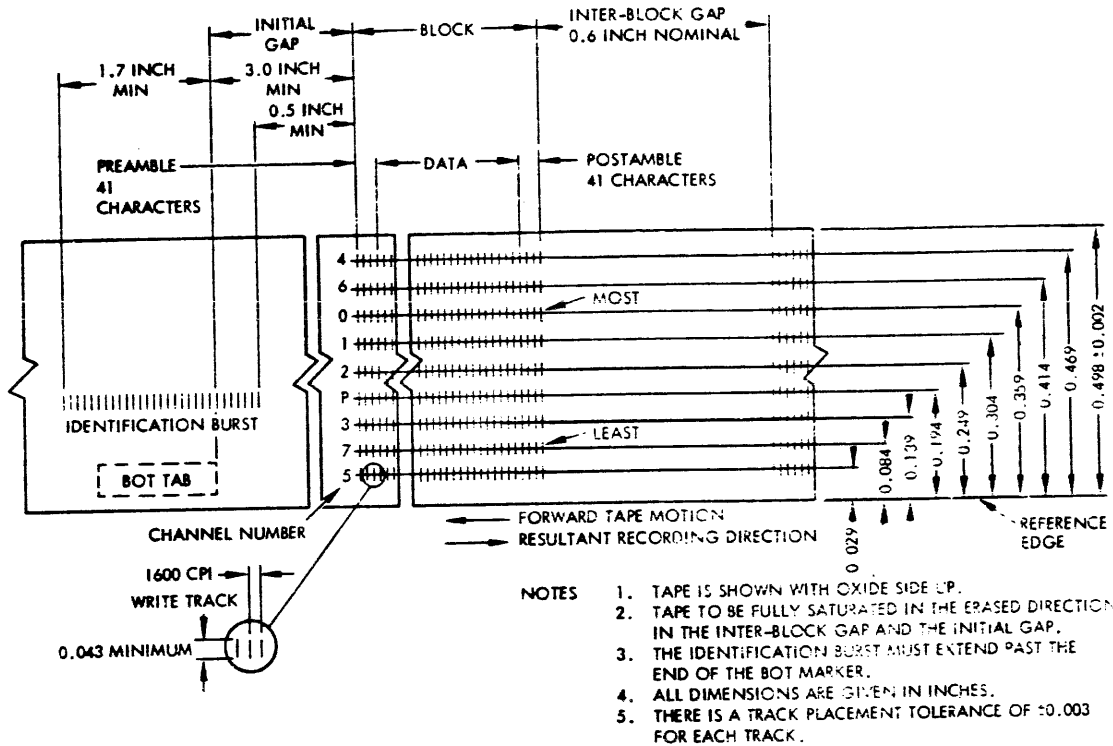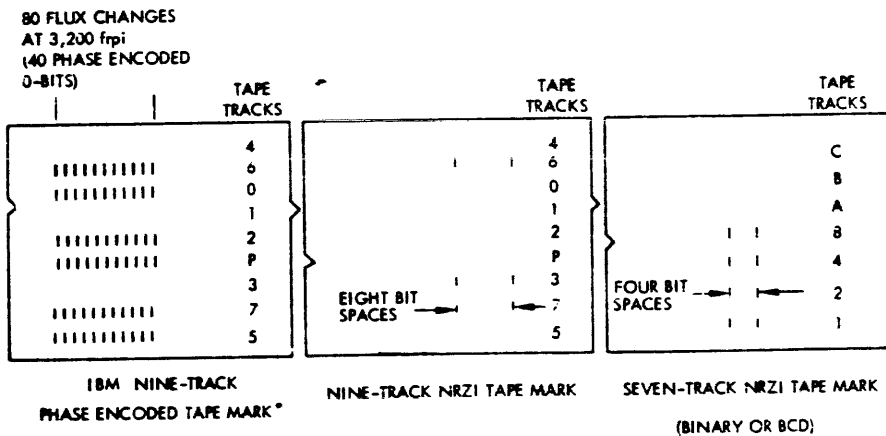
Figure 5-4. Tape Format

Figure 5-5. PE Recording Format

Figure 5-6. File Mark Format

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Binary/BCD Records

Writing and reading binary and/or BCD records, applies to seven-track transports only. A binary record has odd vertical parity (channel P on tape). A BCD record has even vertical parity on tape. The code (00) octal from or to memory is translated to (12) octal when written on or read from tape. This translation is performed by the controller and eliminates the problem of an all-zeros character on tape appearing as a missing frame.

File Mark (Tape Mark)

One or more records on tape form a file. Files are designated by two characters recorded on tape and these are shown in Figure 5-6.

The file mark is separated from the previous record by 3.5 inches of blank tape and by the normal inter-record gap from the next record (0.6 or 0.75 inches). The file mark is recorded with the tape moving forward only.

Spacing Operations

The tape transport can be instructed to space forward or backwards either a record or a file. No data is transferred to the central processor for any of these operations although the controller reads data from the tape to determine when to stop tape motion. In the case of a backspace file operation, tape motion stops with the transport read/write head in the 3.5-inch gap between the last record written and the file mark.

Writing and Reading Operations

Magnetic tape reading and writing are done in the forward direction only. The controller does not write or read records in reverse.

Tape Updating

It is not possible to selectively update records written on the tape, even if the new record is the same length as the old one. After starting to rewrite a tape from a record, all further records down the tape are considered invalid and unreadable. This restriction (typical for all IBM-compatible tape systems) results from concern with inter-gap noise transients and worst case tolerances.

Read and Correct Operations

A CRCC (redundancy check character) is recorded on tape at the end of each record written on a nine-track transport. The CRCC provides a more powerful error detection scheme than that provided with the seven-track format, which has vertical parity and LRCC (longitudinal redundancy check character) only.

When a record is read, the CRCC is computed frame by frame and is effectively compared with the CRCC recorded on the tape. If the CRCC values are not equal, this indicates the record has been read incorrectly and the tape controller is able to determine the track in error, provided the error(s) has occurred in a single track. (Since track to track spacing is 44 times greater than the bit to bit spacing, errors in multiple tracks are unusual.) To correct the error, the record must be re-read in the forward direction. As each character is read from tape, its vertical parity is checked (as usual) and if found to be in error, a correction is made to the data in the track determined to be in error during the previous read operation. If the read error occurs on a different track during the second read operation, the CRCC calculation will not balance and a second re-read is required.

Before the controller is instructed to read and correct a record, standard error recovery techniques must be tried by the user. An example follows:

Read forward one record. Backspace a record if an error is detected, and re-read forward. Try this procedure up to a total of six times.

If unsuccessful, backspace four records (or to load point if less than four records away), space forward three records, and then read the problem record. This sequence draws the tape over the tape cleaner and could dislodge a possible dirt particle. Try this sequence a total of six times.

If unsuccessful, attempt to read and correct the record via the controller, if the controller has determined that the error can be corrected. There are situations, other than a multi-track error, that can cause the record to be uncorrectable.

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PROGRAMMED INPUT/OUTPUT (PIO) COMMANDS

Table 5-1 shows the PIO commands that are implemented in the controller. Data transfers between the controller and memory are by DMA/DMC only. The OCP commands are explained in the Prime MPC User Guide (Refer to Table 1-1). Other commands are described in the following paragraphs:
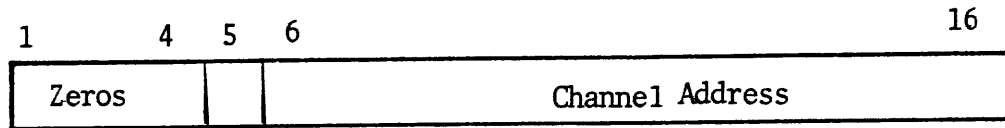
Table 5-1

PIO Commands

Function Code Bits 7-10 \ Op Codes Bits 1-6	14_8 (OCP)	34_8 (SKS) (SKIP IF)	54_8 (INA)	74_8 (OTA)
00		Ready	Input data register	
01		Not Busy		Motion Setup
02				Housekeeping Setup
03				Power On
04		Not Interrupting		
05				
06				
07		Status Incorrect		
10				
11				
12				
13				
14	Acknowledge Interrupt			DMA/C Channel #
15	Set Int Mask			
16	Clear Int Mask			Int Vector Add
17	Initialize			

Controller Address

The controller responds to the address 14 octal.
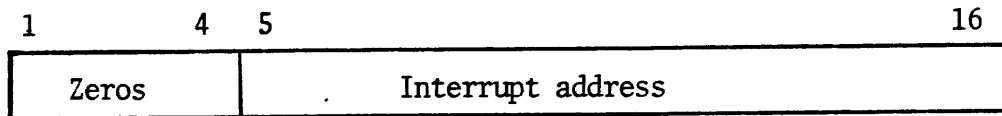
OTA 14   DMA/C Channel Number

The format for the OTA 14 instruction is standard and is as follows:

```
1          4   5   6                                          16
┌──────────────┬───┬─────────────────────────────────────────┐
│   Zeros      │   │           Channel Address                │
└──────────────┴───┴─────────────────────────────────────────┘
```

                    bit 5 = 1 for DMC transfer
                    bit 5 = 0 for DMA transfer

OTA 16   Interrupt Vector Address

The format for the OTA 16 instruction is:

```
1          4   5                                              16
┌──────────────┬──────────────────────────────────────────────┐
│   Zeros      │   .        Interrupt address                  │
└──────────────┴──────────────────────────────────────────────┘
```

If an interrupt vector address is not specified, the controller assumes
an address of octal 114 and interrupts through this location. Following
an OTA 16, the controller maintains the specified interrupt address
until initialized; then the address reverts to octal 114.

OTA 01   Motion Setup

The OTA 01 instruction selects one of four transports and initiates
some action from that transport. For read and write orders, the DMA/C
Channel address OTA must be given before the OTA 01. The A register
bits of the OTA 01 are defined as follows:

Bit 1   "1" denotes SELECT transport only. All other bits of the
         setup word are ignored except bits 13-16. (See Section 3 for
         a description of SELECT).

Bit 2   "1" denotes a record operation.
         "0" denotes a file operation.
         For example, this bit is set for Backspace a Record but
         cleared for Write File Mark.

Bit 3   "1" denotes a spacing operation, such as Forward or Backspace
         a Record. Bit 3 must be cleared for read and write record
         operations.

Bit 4   "1" denotes that a read operation is to be a nine-track
         transport Read and Correct.

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Bit 5   Bit 5 applies to seven-track transport operation only, and it must be set (= 1) for BCD write and read orders and cleared (= 0) for binary write and read orders.

Bit 6   Bit 6 must be set when an order is directed to a nine-track transport. REWIND and SELECT orders ignore this bit.

Bit 7   Reserved.

Bit 8   Set for two-character/word data transfers.

Bit 9   Set for forward motion on the selected transport. Bits 10, 11 are cleared.

Bit 10   Set for reverse motion on the selected transport. Bits 9, 11, 12 are cleared.

Bit 11   Set for a REWIND (to LOAD point) or the selected transport. Bits 9, 10, 12 are cleared.

Bit 12   Set for a WRITE order on the selected transport. Otherwise, Bit 12 is cleared.

Bit 13   Set when an order is directed to transport 0. Bits 14, 15, 16 are cleared.

Bit 14   Set when an order is directed to transport 1. Bits 13, 15, 16 are cleared.

Bit 15   Set when an order is directed to transport 2. Bits 13, 14, 16 are cleared.

Bit 16   Set when an order is directed to transport 3. Bits 13, 14, 15 are cleared.

The following bit combinations give the suggested codes for OTA 01:

For a nine-track transport (all codes are hexadecimal):

Write record, one char/word	449Y
Write record, two char/word	459Y
Read record, one char/word	448Y
Read record, two char/word	458Y
Read and correct record, one char/word	548Y
Read and correct record, two char/word	558Y
Write file mark	249Y
Forward one record	648Y
Forward one file	248Y
Backspace one record	644Y
Backspace one file	244Y
Rewind	002Y
Select transport	800Y

Note: Y is the transport selection field and may have value of 1, 2, 4, or 8 for transport number 3, 2, 1, or 0 respectively.

For a seven-track transport (all codes are hexadecimal):

Write binary record, 1 char/word	409Y
Write binary record, 2 char/word	419Y
Write BCD record, 1 char/word	489Y
Write BCD record, 2 char/word	499Y
Read binary record, 1 char/word	408Y
Read binary record, 2 char/word	418Y
Read BCD record, 1 char/word	488Y
Read BCD record, 2 char/word	498Y
Write file mark	209Y
Space forward one record	608Y
Space forward one file	208Y
Backspace one record	604Y
Backspace one file	204Y
Rewind	002Y
Select transport	800Y

Note: Y is the transport selection field and may have value of 1, 2, 4,
       or 8 for transport number 3, 2, 1, or 0 respectively.

OTA 02   Housekeeping Setup

The OTA 02 instruction is used with INA 00 (which inputs the controller's
data register). Information received by the controller from the
A-register during the OTA is interpreted by the controller as follows:

Bit 1   If set, load the controller's data register with the current
         status word. The current status word is defined in Table 5-2.

Bit 2   If set, load the controller's data register with the ID
         number. The format of the ID number is:

1 3	4 8	9 16
0	Slot number	Device ID
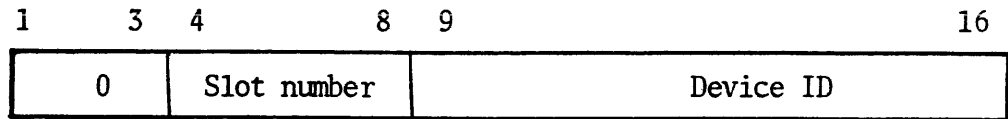
The device ID field is 0C hexadecimal or 014 octal. The slot
number field is standard and described in the General
Purpose Interface Board Design Guide (Table 1-1).

Bit 3   If set, load the controller's data register with the channel
         address. The channel address is defined in the paragraph
         describing OTA 14.

Bit 4   If set, load the controller's data register with the vector
         address. The vector address is defined in the paragraph
         describing OTA 16.

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The bits received by the controller as a consequence of OTA 02 are tested from left to right. If more than one bit is set, low-order bits are ignored in preference to high-order bits.

OTA 03   Load Tape

This OTA is used following an ac power failure and its function is to reload the tape and place the transport on an ON-LINE condition. Any of the four magnetic tape transports may be selected by A register Bits 13 and 16. The following codes are defined for this OTA (codes in hexadecimal):

    Power on transport 0   XX08

    Power on transport 1   XX04

    Power on transport 2   XX02

    Power on transport 3   XX01

    where: X means the bits are ignored by the controller.

    Note: Since this OTA takes several seconds to perform,
           it must be used with discretion.

INA 00   Input Data Register

The INA 00 instruction transfers the contents of the controller's data register to the processor. The instruction must be given following an OTA 02, which loads the data register with some meaningful information.

SKS 00   Skip if Ready

The controller sets READY when it has loaded the data register with information following an OTA 02. The controller expects the processor to issue an INA 00 to transfer information to the A register. READY is cleared by the INA 00.

SKS 01   Skip if Not Busy

The controller becomes busy on receipt of any OTA instruction and remains busy until completion of that OTA. Table 5-9 indicates the duration of the busy state for various orders.

SKS 04   Skip if Not Interrupting

The controller causes an interrupt request to be made under the following circumstances:

After the completion of any WRITE, READ or spacing operation.

When a transport completes a REWIND operation and the tape is positioned at LOAD point.

On receipt of any illegal or undecipherable OTA instruction.

If an attempt is made to instruct a transport that is not ON-LINE.

The mask flip-flop must be set by OCP 1514 for the interrupt request to reach the I/O bus. The interrupt request must be cleared by OCP 1414 following its servicing, or another false interrupt can take place.

Note: If the processor program is servicing the magnetic tape controller using SKS Busy (as opposed to waiting for an interrupt) the controller's interrupt request flip-flop must be cleared by OCP 1414 or an immediate false interrupt could occur whenever an Enable Interrupt instruction is subsequently given.

SKS 07   Skip if Status Incorrect

SKS 07 allows the program to determine whether the status word must be further analyzed following any transport motion OTA. For a description of the STATUS WORD, refer to Tables 5-2 and 5-5.

The controller examines the status word following every OTA 01 (except REWIND and SELECT) and causes the SKS 07 to skip unless it is equal to:

$$0000\ 0000\ 1100\ XZ00$$

where: Z = X for read or space orders
         Z = 0 for write orders.

Following any other OTA (02, 03, 14, 16) the status word is not meaningful and this SKS does not skip. However, SKS 07 skips if the controller receives an illegal or undecipherable OTA.

The state of an SKS 07 is only valid when the controller is non-busy.

STATUS WORD

The controller maintains a status word that is relevant to the operation just completed and the transport last selected. This status word may be transferred to the A register by issuing the appropriate OTA 02 followed by an INA 00.

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Table 5-2.

STATUS WORD SUMMARY

Bit	Significance
1	Vertical parity error
2	Runaway
3	CRC error
4	LRC error
5	False gap/Insufficient DMX range
6	Uncorrectable error
7	RAW error
8	File Mark Detected
9	Selected transport Ready
10	Selected transport On-Line
11	" " EOT
12	" " Rewinding
13	" " Load Point
14	" " File protected
15	DMX overrun
16	Rewind interrupt

Note: The Status word is not affected by a SELECT, OTA 01.

The bits of the status word are defined as follows:

Bit 1   Set for a vertical parity error that occurred during a READ operation.

Bit 2   Set when a tape runaway condition is detected. If during a READ operation no data is detected within a certain time, the tape runaway status is set. For a write operation, a tape runaway status occurs if the read-after-write head fails to detect the data written within the specified time.

Bit 3   Set when a CRC error is detected during a nine-track READ (or read and correct) order.

Bit 4   Set when an LRC error has been detected during a READ order. For nine-track operation, it is probable that Bit 3 is set also.

Bit 5   Set if: (1) a false gap was detected during the record read, or (2) DMX END OF RANGE occurred while reading a record before the physical END OF RECORD.

Bit 6   Uncorrectable error. Set following a nine-track READ record order when the controller determines that it will be unable to correct an error using a READ AND CORRECT order.

Bit 7   Set when a read-after-write error is detected during a
         WRITE record or WRITE FILE MARK order.

Bit 8   Set when a FILE MARK is detected during any read or spacing
         operation.

Bit 9   Set when the selected transport is READY to receive an
         order, i.e., it is ON-LINE and not REWINDing.

Bit 10   Set when the selected transport is ON-LINE, i.e., it has
         power ON, tape LOADed, etc., and requires no further
         operator attention.

Bit 11   Set when the selected transport has detected the END-OF-TAPE
         (EOT) reflective tab when moving tape in the forward
         direction. This sticker is placed 25 feet from the end
         of usable tape on the file reel. It is the user program's
         responsibility to ensure that the tape is not pulled off
         the file reel.

Bit 12   Set when the selected transport is REWINDing.

Bit 13   Set when the selected transport is at LOAD POINT, i.e., the
         reflective tab at the beginning of tape is under the
         detector.

Bit 14   Set when the selected transport is FILE PROTECTED, i.e., the
         file reel has had its WRITE ENABLE plastic ring removed.

Bit 15   Set when the controller has detected a DMX overrun condition.

Bit 16   Set when an interrupt was caused by the completion of a
         transport REWIND operation.

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SUMMARY OF PIO INSTRUCTIONS AND ASSOCIATED DATA

Table 5-3. Magnetic Tape Programming

Summary of Instructions

OCP 14XX	Acknowledge Interrupt
OCP 15XX	Set Interrupt Mask
OCP 16XX	Reset Interrupt Mask
OCP 17XX	Initialize
SKS 00XX	Ready (Data Register)
SKS 01XX	Skip If Not Busy
SKS 04XX	Skip If Not Interrupting
SKS 07XX	Skip If Status Incorrect
INA 00XX	Input Data Register
OTA 01XX	Motion Setup
OTA 02XX	Setup Data Register
OTA 03XX	Load Tape
OTA 14XX	DMA/C Channel #
OTA 16XX	Interrupt Vector Address

NOTE: XX in above table is the controller address.
Standard address is $(14)_8$.

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Table 5-4. OTA 02XX Setup Data Register

This OTA sets up the Data Register which is Input
via an INA 00XX.

1	2	3	4	5 6 7 8 9 10 11 12 13 14 15 16
				NOT USED

↳Load Vector Interrupt Address Into Data Register

└────→ Load DMX Channel Number Into Data Register

└────→ Load ID Number Into Data Register

└────────→ Load Current Status Word Into Data Register

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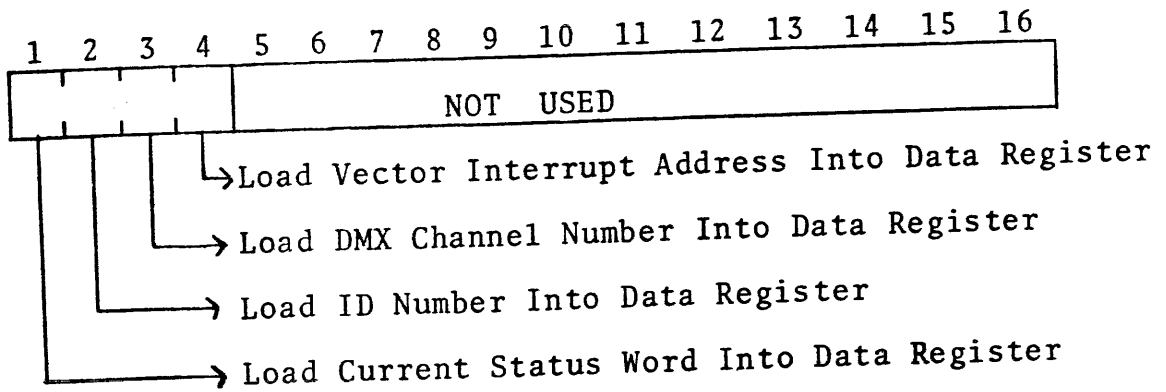
Table 5-5. Status Word

The Controller maintains a status of the operation just completed and the transport last selected.

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

1. Vertical Parity Error
2. Runaway
3. CRC Error
4. LRC Error
5. False Gap/Insufficient DMX Range
6. Uncorrectable Read Error
7. Raw Error
8. File Mark Detected
9. Selected Transport Ready (On Line and Rewinding)
10. Selected Transport On Line
11. Selected Transport EOT
12. Selected Transport Rewinding
13. Selected Transport Load Point (BOT)
14. Selected Transport Write Protected
15. DMX Overrun
16. Rewind Interrupt

Table 5-6. OTA 01XX Motion Setup

Bit positions: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Bit labels:
- 1: Select Transport Only
- 2: (Denotes Record Operation / File Operation)
- 3: Set = Space Operation
- 4: Set = Read and Correct
- 5: Set = 7 track BCD
- 6: Set = 9 track
- 7: Not Used
- 8: Set = 2 char./word
- 9, 10, 11: Motion
- 12: Write Order
- 13: Device 0
- 14: Device 1
- 15: Device 2
- 16: Device 3

Motion (Write Order):
1	0	0	Forward
0	1	0	Reverse
0	0	1	Rewind

1 Denotes Record Operation

0 Denotes File Operation

Setup Word combinations for OTA 01XX (nine-track only)

	HEX.	OCTAL
Write Record, one char/word	449Y	04222Y
Write Record, two char/word	459Y	05262Y
Read Record, one char/word	448Y	04220Y
Read Record, two char/word	458Y	04260Y
Read and Correct, one char/word	548Y	05220Y
Read and Correct, two char/word	558Y	05260Y
Write File Mark	249Y	02222Y
Forward One Record	648Y	06220Y
Forward One File	248Y	02220Y
Backspace One Record	644Y	06210Y
Backspace One File	244Y	02210Y
Rewind	002Y	00004Y
Select Transport	800Y	10000Y

NOTE: "Y" in the above table is the transport device number which must be 8, 4, 2, or 1 (hexadecimal) or 10, 4, 2, 1 (octal) for devices 0, 1, 2, or 3.

Table 5-7. MPC Register File Usage

RF0	Scratch
RF1	Scratch
RF2	Image of DR2
RF3	Status Word (LB)
RF4	Image of DR4/Status Word (RB)
RF5	Delay Count
RF6	Program Phase Bits (See below)*
RF7	Long Delay Count
RF8	Longer Delay Count
RF9	Char. Count Reg. 1 or 2 char./words
RF10	Left Data Byte
RF11	Right Data Byte
RF12	Bit 1, parity of RF11
RF13	Write Byte Count Register
RF14	Scratch used for CRC/EPR calculation
RF15	Cyclic redundancy check register (CRCR) $CRC_o \rightarrow 7$
RF16	Cyclic redundancy check register (CRCR) CRC_p(bit 1)
RF17	Error position register (EPR) $EPR_o \rightarrow 7$
RF18	Error position register (EPR) EPR_p (bit 1)
RF19	LRC register $LRC_o \rightarrow 7$
RF20	LRC register LRC_p in bit 7
RF21	Zero constant
RF22	9T/7T constant (Write), Frame count (Read)
RF23	Track error register ch p (bit 7)
RF24	DMX channel number (LB)
RF25	DMX channel number (RB)
RF26	Track error register channels 0-7
RF27	Interrupt vector address (RB)
RF28	Rewind status register
RF29	Setup word, left byte
RF30	Setup word, right byte (DR3 similar)
RF31	Interrupt vector address (LB)

*Note:

RF6	Bit 8	Odd/even count
	7	All data written
	6	Write CRCC
	5	Write LRCC
	4	Read CRCC
	3	
	2	
	1	

Table 5-8. Device Register Usage

DR1   Bits 1-8, WDo-7 Write Data

DR2   Bit 1, Parity of DR1, Wp
            Bit 7, WARS, LRCC STB
            Bit 8, WDS, WRITE STB

DR3   Bit 1 SFC Forward
            Bit 2 SRC Reverse
            Bit 3 RWC Rewind
            Bit 4 SWS Write
            Bit 5-8, Select 0-3

DR4   Bit 1 RDY, Online & not rewinding
                2 Online
                3 EOT End of Tape
                4 RWD Rewind
                5 LDP, BOT
                6 FPT, File Protect
                7 LOL, Load & Online

DR5   Bits 1-8 RDO-7 Read Data

DB8   Bit 7 Read Parity RDP
                3 RDS, Read STB

DB7   Bit 8 DDI Density

PROGRAM EXAMPLE

The previous paragraphs of this section have described the kinds of
instructions that may be used to read, write, and position magnetic
tape individually. Figure 5-7 is a simple test program that shows the
use of these instructions in context with one another.

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Figure 5-7

Program Example

```
                              (0001)  *     QUICK 9-TRACK MAGNETIC TAPE TEST
                              (0002)  *
                              (0003)  *
                              (0004)  *     SS1    WRITE
                              (0005)  *     SS2    BACKSPACE
                              (0006)  *     SS3    READ
                              (0007)  *     SS4    REWIND
                001000        (0008)        ORG    '1000
001000:         031514        (0009)  BGN   OCP    '1514
001001:         000013        (0010)        E32S
001002:         100240        (0011)        SNR    1
001003:  10.001013A           (0012)        JST    WRTE
001004:         100241        (0013)        SNR    2
001005:  10.001030A           (0014)        JST    BKSP
001006:         100242        (0015)        SNR    3
001007:  10.001036A           (0016)        JST    READ
001010:         100243        (0017)        SNR    4
001011:  10.001053A           (0018)        JST    FWD
001012:  01.001000A           (0019)        JMP    BGN
001013:  00.000000A           (0020)  WRTE  DAC    **
001014:  02.001105A           (0021)        LDA    ='20
001015:         171414        (0022)        OTA    '1414
001016:  01.001015A           (0023)        JMP    *-1
001017:  02.001102A           (0024)        LDA    RNGE
001020:  04.000020A           (0025)        STA    '20
001021:  02.001103A           (0026)        LDA    WBSA
001022:  04.000021A           (0027)        STA    '21
001023:  02.001106A           (0028)        LDA    =$4591
001024:         170114        (0029)        OTA    '114
001025:  01.001024A           (0030)        JMP    *-1
001026:  10.001064A           (0031)        JST    BYST
001027:  41.001013A           (0032)        JMP*   WRTE
001030:  00.000000A           (0033)  BKSP  DAC    **
001031:  02.001107A           (0034)        LDA    =$6441
001032:         170114        (0035)        OTA    '114
001033:  01.001032A           (0036)        JMP    *-1
001034:  10.001064A           (0037)        JST    BYST
001035:  41.001030A           (0038)        JMP*   BKSP
```

Figure 5-7 (Cont)

```
001036:   00.000000A   (0039)   READ   DAC    **
001037:   02.001110A   (0040)          LDA    ='22
001040:      171414    (0041)          OTA    '1414
001041:   01.001040A   (0042)          JMP    *-1
001042:   02.001102A   (0043)          LDA    RNGE
001043:   04.000022A   (0044)          STA    '22
001044:   02.001104A   (0045)          LDA    RBSA
001045:   04.000023A   (0046)          STA    '23
001046:   02.042601A   (0047)          LDA    $4581
001047:      170114    (0048)          OTA    '114
001050:   01.001047A   (0049)          JMP    *-1
001051:   10.001064A   (0050)          JST    BYST
001052:   41.001036A   (0051)          JMP*   READ
001053:   00.000000A   (0052)   RWD    DAC    **
001054:      031414    (0053)          OCP    '1414
001055:   02.000041A   (0054)          LDA    $21
001056:      170114    (0055)          OTA    '114
001057:   01.001056A   (0056)          JMP    *-1
001060:      070414    (0057)          SKS    '414
001061:      100000    (0058)   SKP    SKP
001062:   01.001060A   (0059)          JMP    *-2
001063:   41.001053A   (0060)          JMP*   RWD
001064:   00.000000A   (0061)   BYST   DAC    **
001065:      070114    (0062)          SKS    '114
001066:   01.001065A   (0063)          JMP    *-1
001067:      070714    (0064)          SKS    '714
001070:   41.001064A   (0065)          JMP*   BYST
001071:   02.001061A   (0066)          LDA    SKP
001072:      170214    (0067)          OTA    '214
001073:   01.001072A   (0068)          JMP    *-1
001074:      130014    (0069)          INA    '14
001075:   01.001074A   (0070)          JMP    *-1
001076:   04.001101A   (0071)          STA    STSW
001077:   000000      (0072)          HLT
001100:   41.001064A   (0073)          JMP*   BYST
001101:   00.000000A   (0074)   STSW   ***    **
001102:      177000    (0075)   RNGE   OCT    177000
001103:   00.010000A   (0076)   WBSA   DAC    '10000
001104:   00.020000A   (0077)   RBSA   DAC    '20000
           001105      (0078)          END    BGN

001105:   00.000020A
001106:   00.042621A
001107:   00.062101A
001110:   00.000022A
```

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Figure 5-7 (Cont)

```
BGN         001000A 0009   0019   0078
BKSP        001030A 0014   0033   0038
BYST        001064A 0031   0037   0050   0061   0065   0073
RBSA        001104A 0045   0077
READ        001036A 0016   0039   0051
RNGE        001102A 0024   0043   0075
RWD         001053A 0018   0052   0060
SKF         001061A 0058   0066
STS.        001101A 0071   0074
VBSA        001103A 0026   0076
WRTE        001013A 0012   0020   0032
```

```
0000 ERRORS (PMA-1080.015)
```

CONTROLLER TIMING

The controller becomes Busy on receipt of any OTA and remains so until all action requested by the OTA has taken place. Times to perform the OTA instructions are detailed in the following paragraphs.

Table 5-9. Timing for Non-Transport OTA Instructions

Instruction		Times to Complete Instruction	
		μs (min)	(max)
OTA Housekeeping Setup,	Status	5.1	11.1
	ID	6.9	12.9
	Channel No.	5.7	11.7
	Vect. Addr.	6.3	12.3
OTA Channel number		2.7	8.7
OTA Vector address		3.3	9.3

OTA Setup REWIND

The selected transport takes several minutes to rewind. However, the controller is not busy except when decoding the REWIND order and instructing the transport. This takes 17.1 μs minimum. This time can be extended.

When the controller goes not busy following any tape motion order, a time-out is started. This is the tape stop delay shown in Figure 5-8. The length of the time-out is proportional to tape speed and is 8.3 milliseconds for 45 ips transports. At the end of the time-out, tape motion will stop. However, orders to the same transport are permitted during the time-out provided (1) the direction of motion is not changed and (2) the order does not change from a read to a write or vice-versa. If these conditions are not met, the controller stores the new order for the balance of the 8.3 ms time-out and then executes the order.

When the controller goes not-busy and when the time-out for tape motion orders referenced above occur, the controller assumes its quiescent state. During this state, it executes a routine that tests for receipt of an OTA and then tests each transport in turn to see whether it has finished a REWIND operation. This routine takes 7.0 microseconds and is shown in Figure 5-8 as the transport rewind completion status.
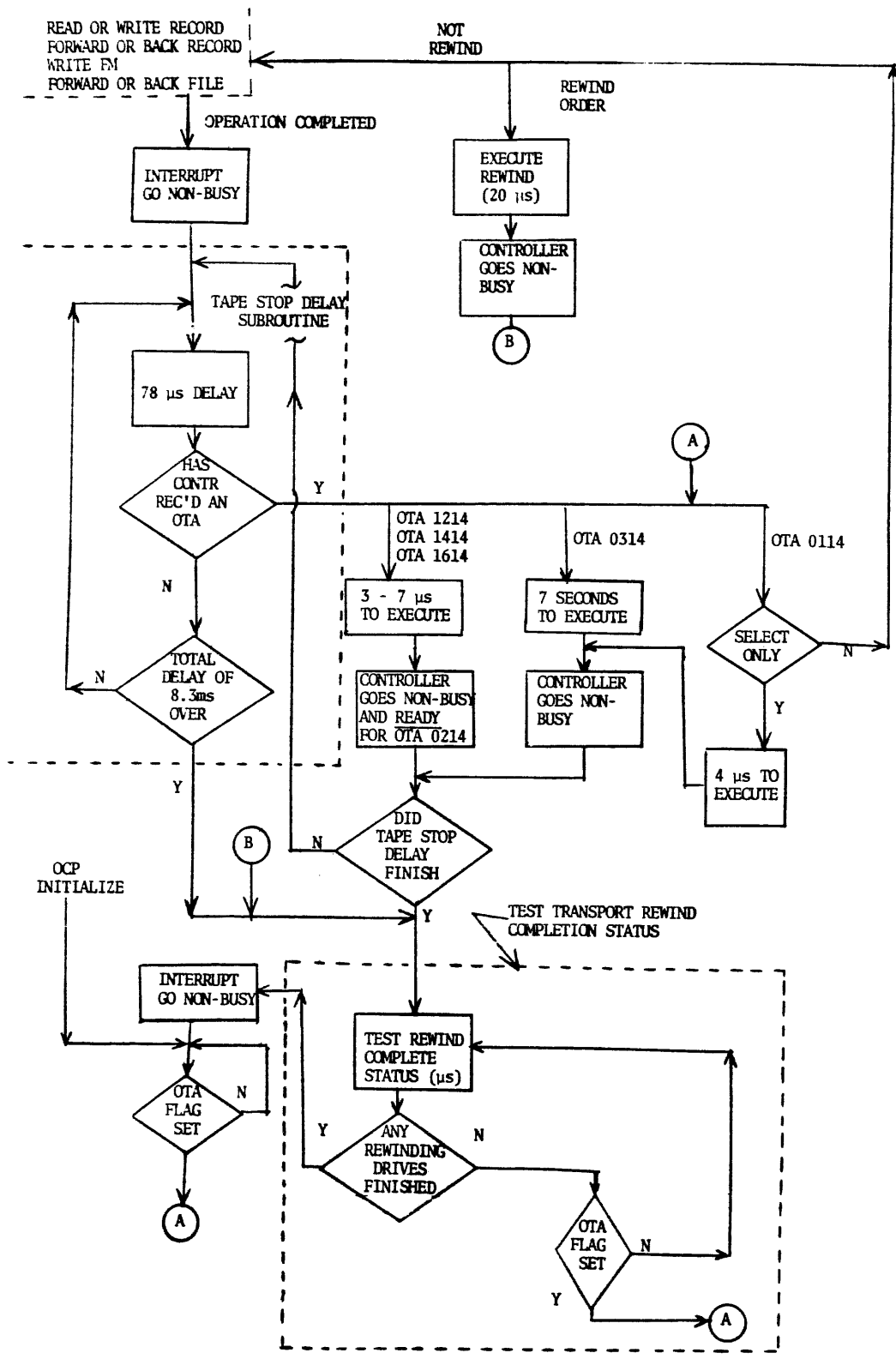
Figure 5-8. Timing Considerations for Magnetic Tape Operations

OTA Setup SELECT

The OTA Setup - SELECT is a non-motion transport command that causes the controller to be busy for 3.0 μs minimum and 9.0 μs maximum.

OTA Setup All motion commands except REWIND

The controller is busy for the duration of these commands and is interrupted following the end of the command. A time-out of 8.3 ms is started at the time of the interrupt. For consecutive READ (or WRITE) orders, up to 16.6 ms can be saved by issuing the next order as soon as possible following the interrupt from the previous order. Time is saved by not allowing the tape to slow down or stop between orders.

The time to complete tape motion instructions depends on the length of the record, the density of recording, and whether starti⸴ from LOAD POINT or not. Typical times are as follows:

Write 800 byte, 800 bpi record	33 ms
Write 800 byte, 800 bpi record from load point	149 ms
Write file mark	83 ms

Data Transfer Rates

Data transfers to and from the controller occur using DMA or DMC. The controller is provided with one level of data buffering. DMA/C requests for a data transfer must be honored within the times shown in Table 5-10 or bit 15 of the status word is set indicating a DMX overrun condition.

Table 5-10. Data Transfer Times

Mode	Times		
	800 bpi	556 bpi	200 bpi
1 char/word	26.5	38.8	110
2 char/word	54.2	78.8	221
3 char/word	81.9	118.8	332

The times listed in Table 5-10 are in microseconds and are for a WRITE operation. For a READ operation, add 0.9 μs to these times.

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TYPICAL PROGRAMMING SEQUENCE

A typical sequence to write a record would be as follows: (JMP *-1's omitted)

        Set up DMA Channel information
        OTA 14, output channel number
        SKS 01, wait until not-busy
        OTA 16, output vector address (if non-standard address required)
        SKS 01, wait until not-busy
        OTA 00, output motion

            Wait for interrupt

        SKS 04, test tape controller is interrupting

            Yes

        SKS 07, Check Status OK

If not OK, then:

        OCP 14, Acknowledge Interrupt
        OTA 02, Housekeeping set up to load status (or check status
                 with SKS 07)
        SKS 00, wait until Ready
        INA 00, Input status
        Check status and take appropriate action

ERROR CORRECTION

A CRCC is recorded following each written record for nine-track transports.
It is legitimate for the CRCC to be all zeros. Error correction is
possible except under the following circumstances:

    Errors have occured in more than one track.

    The "normalized" CRCC regenerated from the data plus the CRCC
    read from tape is equal to all zeros.

    Character dropouts of more than three consecutive frames occurred.

RECORD GAP DETECTION

The controller, when reading tape, must detect the end of recorded
data and the CRC and LRC characters. Figure 5-9 shows that the controller
searches for a 2-1/2 frame gap from the last data character. After this
point, the CRCC should be detected within 3 frames and the LRCC within
a further 5 frames. No data must be detected during the 16 frame period
following the LRCC. If data is detected during this interval, bit 5 of
the status word is set indicating that a false gap has (probably) been
detected. The consequence of this is that the tape head does not
correctly position in an inter-record gap. For seven-track transports,
the LRCC is expected instead of the CRCC shown in Figure 5-9. The
16-frame gape is then started.
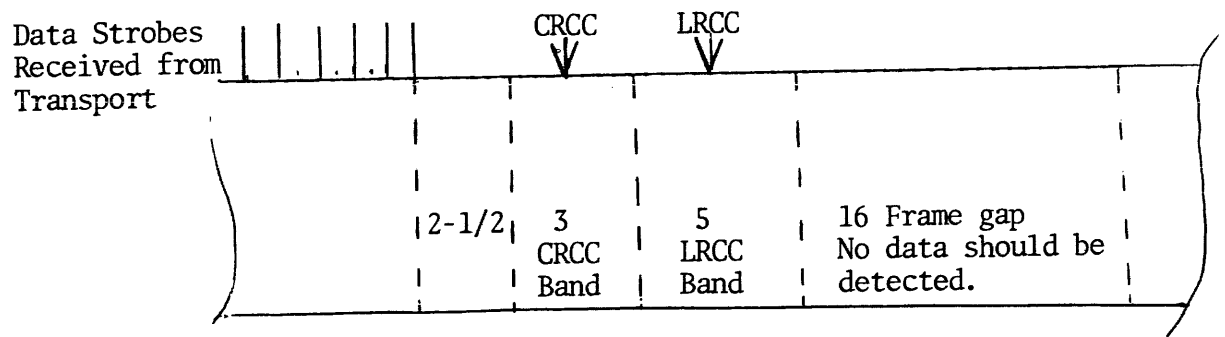
Figure 5-9 . End of Recorded Data

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TEST AND MAINTENANCE

TESTS

The Prime test program, MTUT1, is a magnetic tape verification program
that exercises the magnetic tape controller and one magnetic tape
transport.

Minimum hardware configuration to run the test program is any Prime CPU,
8K memory, Teletype with controller.

OPERATION OF MTUT1

The MTUT1 program starts at 1000; tape transport power must be on and
the tape threaded.

The user must set sense switches as follows:

Sense Switches 1-6 specify (in binary) the number of records
per file.

Sense Switches 7-16 specify (in binary) number of characters
per record.

After depressing start, the above information in the sense switches is
stored for use by the program and the computer halts after issuing an
OTA '03 (LOAD and ON LINE) to the transport.

Set Sense Switches as follows:

SS1 - Up   Type out, on ASR, message on status flag.

SS2 - Up   Type out, on ASR, message on data error.

SS3 - Up   Perform error recovery if error is detected while
                Reading. The record in question is reread.

SS4 - Up   For test 1 only, select random data pattern.
   - Down   Select ones pattern.

SS5 - Up   For 7-track transports only, select BCD mode.
     Down   Binary mode. (Leave down for 9-track transports.)

SS6 - Up   9-track transports.
     Down   7-track transports.

SS8 - Up   Select two character mode.
     Down   Select one character mode.

SS9 - Up   Use vectored interrupt mode.
     Down   Use standard interrupt mode.

SS10- Up   Run program in machine check mode.

SS13---	These four switches select one of eight tests
SS14---	(Detailed below). Tests are selected by binary
SS15---	settings of switches from 0000 to 1000. Other
SS16---	combinations are illegal and cause a halt.

If sense switches 13-16 are reset, the test currently being run will halt at the end of the sequence being performed. New record and file length information may be entered without returning to address 1000.

When the end of tape sensing sticker is detected, the program causes tape to rewind and the pass number (in decimal) is printed on the terminal. For test 3, an interrupt occurs when the rewind is complete and an appropriate status message is printed.

Tests Performed

The tests performed are as follows:

TEST 1	Write records of specified length. Data pattern depends on sense switch 4 setting.
TEST 2	Read records (normally generated by test 1). The program expects specified record length to be set to agree with the length of records on tape. Data expected is the same as that written by Test 1 provided this test follows Test 1 directly.
TEST 3	Write record of specified length; backspace record; read record. (Data pattern is binary sequential).
TEST 4	Write file marks.
TEST 5	Write file mark; backspace file; forward file; back record (expecting file mark); forward record (expecting file mark).
TEST 6	Write file mark; write specified number of records with each record of specified length; write file mark; backspace two files; forward file; read specified number of records; (data pattern used is a binary sequential one); backspace file (passing all the records); forward file (passing all the records); backspace file.
TEST 7	Write file mark; write variable number of records (from 1-63); with each record of variable length (from 1-1023 characters); write file mark; backspace two files; forward file; read records; (data pattern used is a random pattern. Characters per record and records per file are incremented by one following each file processed).

TEST 8   Positioning integrity test; write 100 file marks,
                backspace 50 files; go forward a file, go back a file,
                etc.; (tape reels should not move, Test has failed
                if they do).

TMUT1 Messages Printed At Terminal

The following messages are printed at the terminal:

1. For an unusual status condition:

    'STATUS FLAG XXXXXXXX XXXXXXXX   SETUP WORD XXXXXXXX XXXXXXXX'

2. For a data error:

    'DATA ERROR SHOULD BE XXXXXXXX XXXXXXXX WAS XXXXXXXX XXXXXXXX'

3. When end of tape is detected:

    'END OF PASS XXX' (Pass number in decimal)

4. When error correction is taking place:

    'READ AND CORRECT'

5. When an uncorrectable error is detected:

    'REREAD UNCORRECTABLE RECORD.

MAINTENANCE

Testing and maintenance of the magnetic tape transport is outlined in
the vendor's manual (refer to Table 1-1). Users are advised to perform
recommended cleaning on a regular schedule in the manner recommended by
the vendors manual.

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ERROR MESSAGES

Error Messages from IOCS Tape Control Routines

Typed Message	Meaning	A Register =
BAD C	Bad call to Driver	6
HERR	Hardware Failure	5
PERR	Parity Error	4
MTNO	MTU Not Operationsl	3
EOT	End of Tape Detected	2
EOF	End of File Detected	1

Error Messages from IOCS Read and Write Drivers

If Altrtn = 0 and A-Register = 3, 4, or 5, an error message is typed:

MTU ER:

<Status Word> <Instruction Word> <Error Count>

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APPENDIX B

PRIME INTERNAL CHARACTER CODES

Octal Representation	Internal ASCII Char.	Communications Code	Octal Representation	Internal ASCII Char.	Communications Code
200	NUL	NUL	300	@	@
201		SOH	301	A	A
202		STX	302	B	B
203		ETX	303	C	C
204		EOT	304	D	D
205		ENG	305	E	E
206		ACK	306	F	F
207	BEL	BEL	307	G	G
210	BS	BS	310	H	H
211	HT	HT	311	I	I
212	NL	LF	312	J	J
213	VT	VT	313	K	K
214	FF	FF	314	L	L
215	CR	CR	315	M	M
216	RRS	SO	316	N	N
217	BRS	SI	317	O	O
220	RCP	DLE	320	P	P
221	RHT	DC1	321	Q	Q
222	HLF	DC2	322	R	R
223	RVT	DC3	323	S	S
224	HLR	DC4	324	T	T
225		NAK	325	U	U
226		SYN	326	V	V
227		ETB	327	W	W
230		CAN	330	X	X
231		EM	331	Y	Y
232		SUB	332	Z	Z
233		ESC	333	[	[
234		FS	334	\	\
235		GS	335	]	]
236		RS	336	↑	↑
237		US	337		
240	SP	SP	340		
241	!	!	341	a	a
242	"	"	342	b	b
243	#	#	343	c	c
244	$	$	344	d	d
245	%	%	345	e	e
246	&	&	346	f	f
247	'	'	347	g	g
250	(	(	350	h	h
251	)	)	351	i	i
252	*	*	352	j	j
253	+	+	353	k	k
254	,	,	354	l	l
255	-	-	355	m	m
256	.	.	356	n	n
257	/	/	357	o	o
260	0	0	360	p	p
261	1	1	361	q	q
262	2	2	362	r	r
263	3	3	363	s	s
264	4	4	364	t	t
265	5	5	365	u	u
266	6	6	366	v	v
267	7	7	367	w	w
270	8	8	370	x	x
271	9	9	371	y	y
272	:	:	372	z	z
273	;	;	373	{	{
274	<	<	374				
275	=	=	375	}	}
276	>	>	376	~	~
277	?	?	377		DEL

B-1

3

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OK,

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