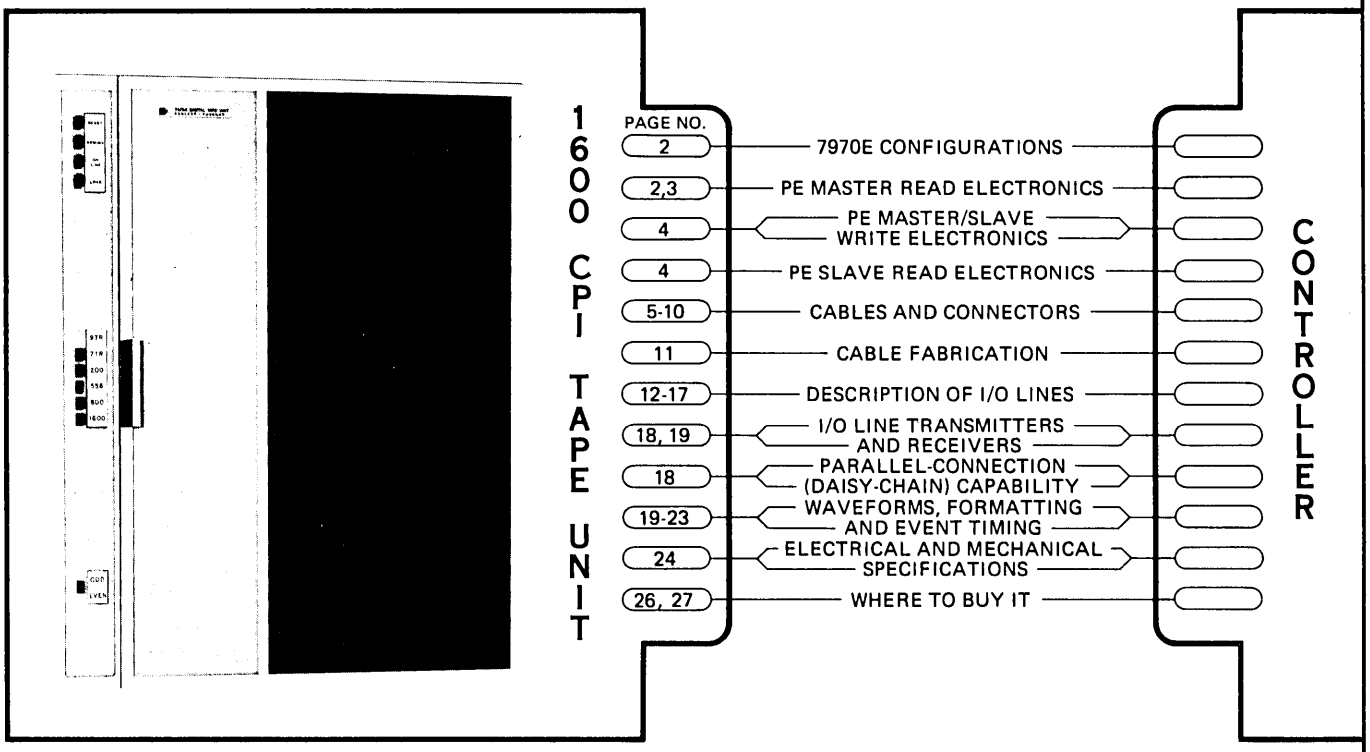
HEWLETT hp PACKARD

DATA SYSTEM PERIPHERALS

MODEL 7970E
DIGITAL MAGNETIC TAPE UNIT
INTERFACE GUIDE

MAY 1971



The Mountain View Division of Hewlett-Packard Company is now offering the 7970E Digital Magnetic Tape Unit with 1600 CPI Phase-Encoded capability in various configurations in speeds up to 45 ips.

Phase-Encoded capability enables the user to provide systems that are compatible with the 1600 CPI industry-standard recording format. In addition, increased data transfer rates are possible at present speeds, increasing throughput as compared to systems utilizing NRZI tape units.

The modularity of the 7970E construction provides the benefits of supplying phase-encoded units in a variety of configurations, including Read-After-Write, Read-Only, and special applications of Read/Read systems.

This interface guide provides the information for interfacing the 7970E Master and Slave Phase-Encoded tape transport and data electronics. The content of the document is directed toward the interface design engineer and system programmer and permits interface and controller design considerations prior to receipt of equipment.

In addition to this Interface Guide, Hewlett-Packard application engineering assistance is available.

We have been supplying digital magnetic units to OEM customers since 1961. These units and the new 7970 series are supported by a worldwide sales and service organization.

MOUNTAIN VIEW DIVISION *690 Middlefield Road, Mountain View, California 94040, U.S.A., Tel. (415) 968-7291*

1. HP MODEL 7970E MAGNETIC TAPE UNIT (MTU)

The HP Model 7970E Magnetic Tape Unit features 1600 CPI phase-encoded (PE) data capability at speed ranges of 10 to 45 ips. The 7970E is available as a master unit, as a slave unit, or in master/slave-unit combinations using the inherent parallel-connection (daisy-chain) capability. (See figures 1 thru 3.) The master unit contains the following phase-encoded read data functions (figure 4):

Identification Burst (IDB) Detection

Detect and Strip Preamble/Postamble

Tape Mark (TM) Detection

Read Deskewing

Detect Multiple Track Error (MTE)

Single Track Error Correction (STE)

Enc-Of-Block Detection (EOB)

1600 CPI Density Status (SD16)

The master/slave unit write data electronics contains the data channel write driver and control circuits, and requires input data and Write Clock as inputs. (See figure 5.) If you want to design your own PE read data electronics, the slave unit configuration is available; it includes only read preamplifiers and detection circuits, and write data electronics similar to the master unit. (See figure 6.)

There are three basic configurations of the 7970E (plus options for special requirements):

a. **READ-AFTER-WRITE** (9-Track PE Read-After-Write). Both master and slave units contain the same write and command-and-status electronics. (See figure 1.) All formatting and parity generation of the write data must be accomplished in the controller. (Optional write formatting is available.) Complete PE read data electronics is contained only in the master unit. Slave unit read capability is accomplished through the master read electronics for multi-unit parallel-connection operations.

b. **READ-ONLY** (9- Track PE Read-Only). Both master and slave units contain the same command-and-status electronics. (See figure 2.) Complete PE read data electronics is contained only in the master unit. Slave unit read capability is accomplished through the master read electronics for multi-unit parallel-connection operations.

c. **READ/READ**

(1) Read/Read 9-Track PE/NRZI (Figure 3a). Both master and slave units contain the same command-and-status and NRZI read electronics. Complete PE read data electronics is contained only in the master unit. The PE and NRZI controller interfaces may be used as separate connectors (figure 7), or in parallel from the PE connector when the parity option is used (figure 3a). This is accomplished by the daisy-chain method shown in figure 3a. Slave unit read capability is accomplished through the master unit for multi-unit parallel-connection operations. A constant transfer rate option is available in this configuration if a constant data transfer rate between PE and NRZI is required. Density selection is front-panel selectable.

(2) Read/Read/Read 7/9-Track PE/NRZI (Figure 3b). Both master and slave units contain the same command-and-status and 7/9T NRZI read electronics. Complete PE read data is in the master unit only. The slave unit PE read capability is accomplished through the master read electronics for multi-unit parallel-connection operations. The PE and NRZI controller interfaces may be used as separate connectors (figure 7), or in parallel from the PE connector when the parity option is used (figure 3b). This is accomplished by the daisy-chain method shown in figure 3b. Complete 7- and 9-track PE/NRZI read/read/read capabilities are contained in a single unit. A constant transfer rate option is available in this configuration if a constant data transfer rate between PE and NRZI is required. Density selection is front-panel selectable.

2. PE MASTER READ DATA ELECTRONICS

Preamplification and detection are provided in both the master and slave units. The PE read data electronics is provided only in the master unit. (See figure 4.) The Read Control monitors and directs the functions of data decoding, deskewing, error correction (ECR), and output buffering (OR). The PE read data electronics provides nine data lines, a Read Clock per PE tape byte, and block status signals to the controller interface.

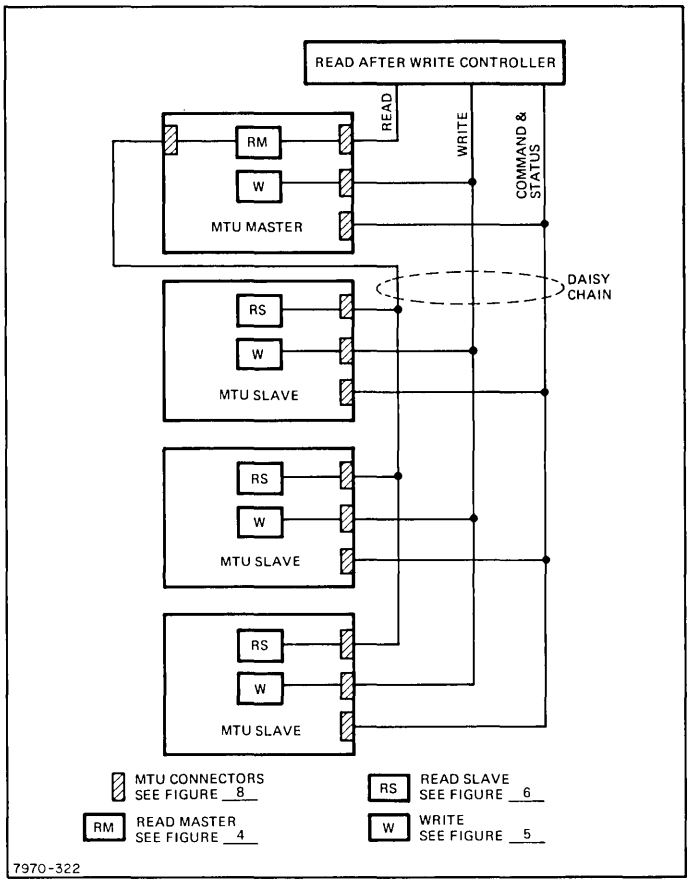


Figure 1. Read-After-Write 1600 CPI Phase-Encode Configuration

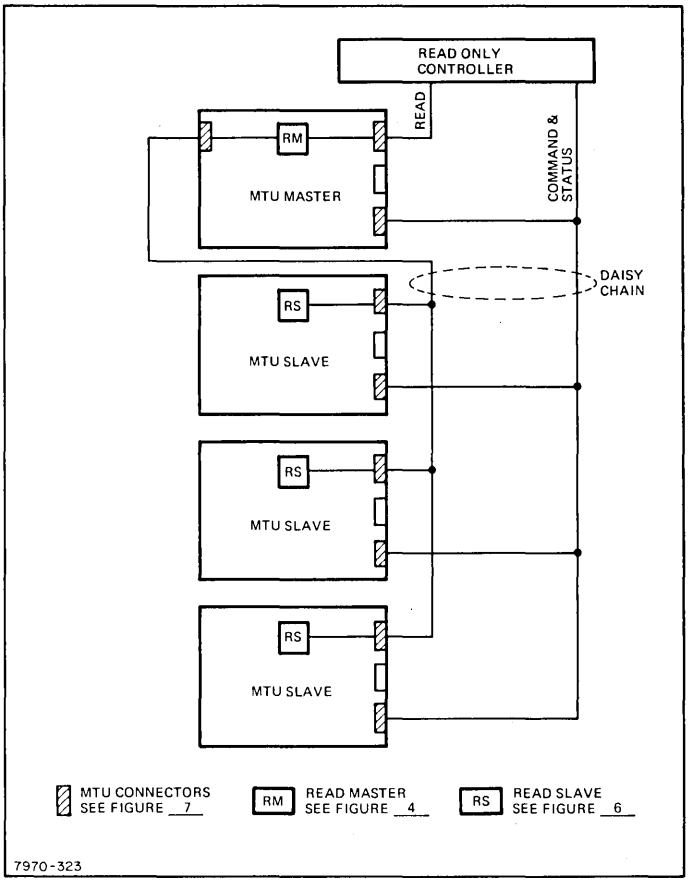


Figure 2. Read-Only 1600 CPI Phase-Encode Configuration

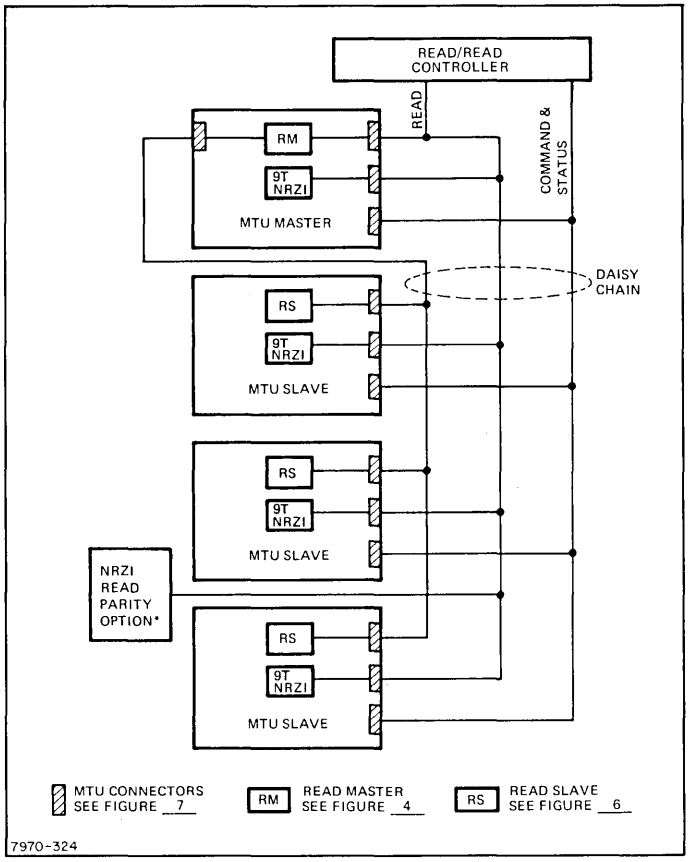


Figure 3a. Read/Read 9-Track PE/NRZI Configuration

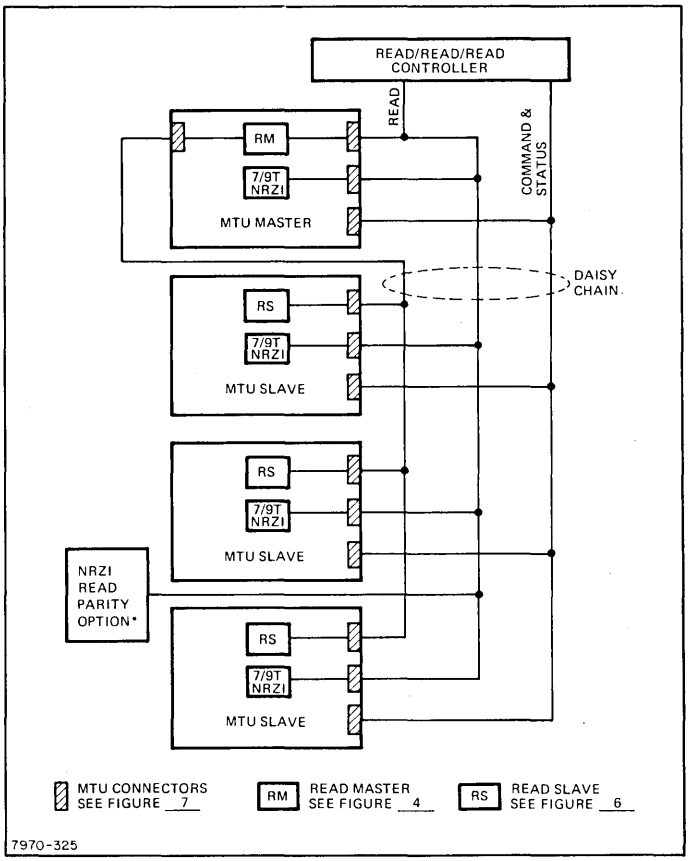


Figure 3b. Read/Read/Read 7/9-Track PE/NRZI Configuration

*Described in the NRZI Read Parity Option Interface Guide.

3. PE MASTER/SLAVE WRITE DATA ELECTRONICS

The write data electronics is the same in both master and slave units. (See figure 5.) Nine data lines and a Write Clock are required to operate the write data electronics. In general, two Write Clocks per PE tape byte are required.

4. PE SLAVE READ ELECTRONICS

Preamplification and detection are provided in the slave unit, as shown in figure 6. The data zero crossing and amplitude comparison, along with the slave status signals, are available at the slave read interface connector.

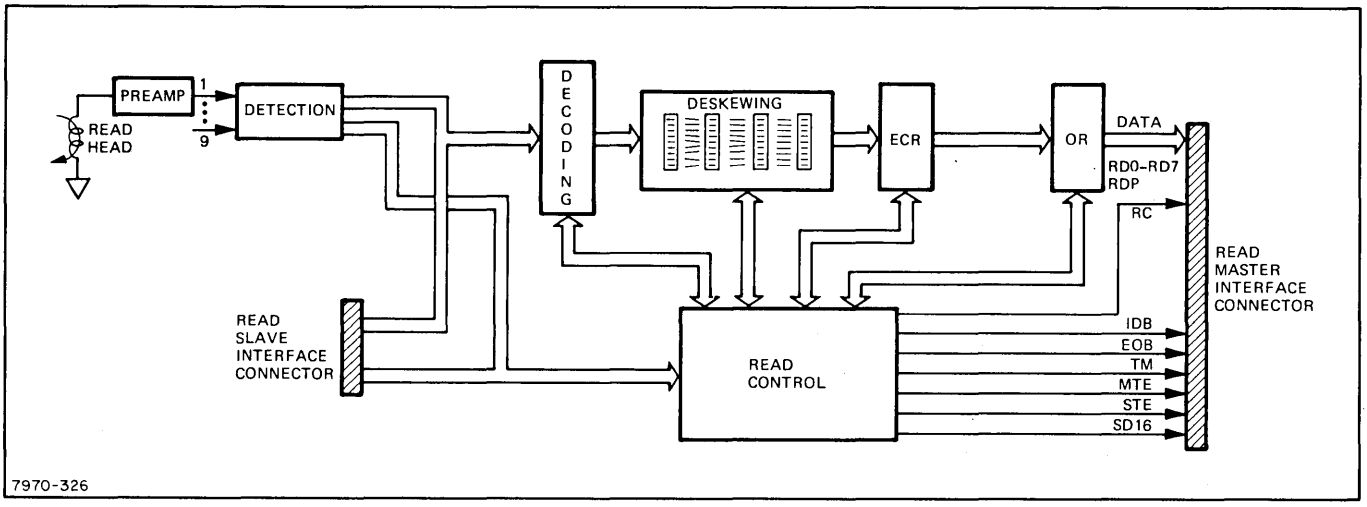


Figure 4. Master MTU 1600 CPI Read Data Electronics

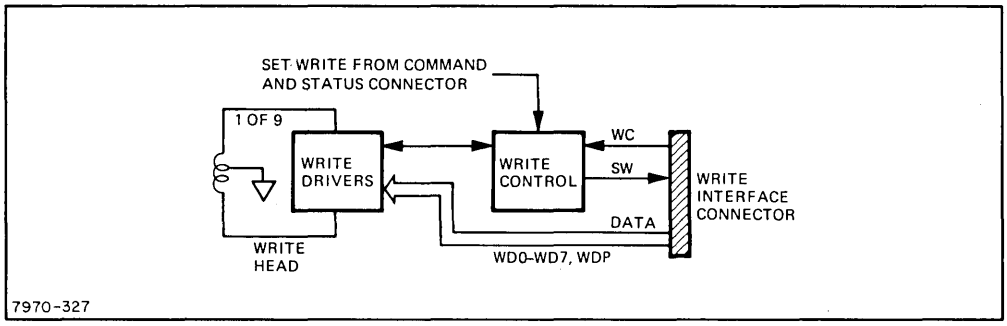


Figure 5. Master/Slave MTU 1600 CPI Write Data Electronics

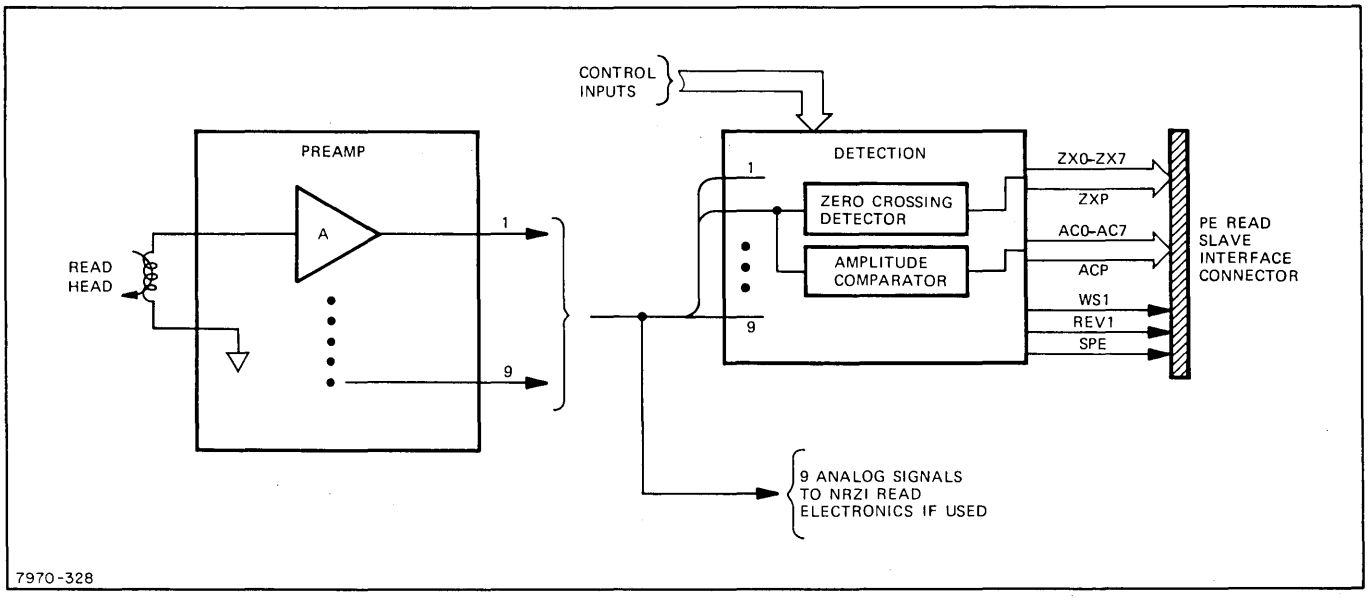


Figure 6. Slave MTU 1600 CPI Read Electronics

5. CABLES AND CONNECTORS

Interface mating connectors are supplied with the HP Model 7970E Magnetic Tape Unit. Each connector is specifically associated with one function (see figures 7 and 8):

a. **Command-and-Status**

b. **Write Data**

c. **Read Data**

d. **Read Slave**

The male portions of these connectors are presented to the interface cables, via supplied mating connectors, as etched tongue sections of printed-circuit boards. These boards are located within the rear section of the tape unit.

The female mating connectors supplied have a 48-pin (24 active line) capability. (See figure 9.) These mating connectors are intended to be directly connected to the user's interfacing cables. Strain-relief hardware also is provided. Tables 1 thru 5 list the schedule of pin assignments and line names. The lines are described in tables 6 thru 9.

The suggested maximum cable length is 20 feet from connector pin to connector pin. The interface cable should employ one set of twisted pairs for each I/O line function, with one of the pair being used for the active I/O line and the other being used for terminal grounding at both ends of the cable to reduce the magnitude of intercable crosstalk. Unless otherwise specified, all wires should be 26 AWG, minimum, with not less than one twist per inch, and with a minimum insulation thickness of 0.01 inch.

Table 1. Command-and-Status Connector*

ACTIVE PIN	GROUND PIN	SIGNAL NAME	MNEMONIC
1X (A)	1	ON-LINE STATUS	SL
2X (B)	2	LOAD POINT STATUS	SLP
3X (C)	3	REWIND STATUS	SRW
4X (D)	4	END-OF-TAPE STATUS	SET
5X (E)	5	READY STATUS	SR
6X (F)	6	FILE PROTECT STATUS	SFP
7X (H)	7	DENSITY 800 STATUS	SD8
8X (J)	8	DENSITY 556 STATUS	SD5
9X (K)	9	DENSITY 200 STATUS	SD2
10X (L)	10	SELECT UNIT 3	CS3
11X (M)	11	SELECT UNIT 2	CS2
12X (N)	12	SELECT UNIT 1	CS1
13X (P)	13	SELECT UNIT 0	CS0
14X (R)	14	REWIND COMMAND	CRW
15X (S)	15	OFF-LINE COMMAND	CL
16X (T)	16	FORWARD COMMAND	CF
17X (U)	17	REVERSE COMMAND	CR
18X (V)	18	HIGH SPEED COMMAND	CH
19X (W)	19	SET WRITE COMMAND	WSW
20X (X)	20	Reserved for Options and Spares	-----
through	through	↕	-----
24X (BB)	24	Reserved for Options and Spares	-----

*Same for all configurations.

Table 2. Write Data Connector*

ACTIVE PIN	GROUND PIN	SIGNAL NAME	MNEMONICS
1X (A)	1	Reserved for Options	----
2X (B)	2	↕	----
3X (C)	3		----
4X (D)	4		----
5X (E)	5	Reserved for Options	----
6X (F)	6	WRITE STATUS	SW
7X (H)	7	Reserved for Options	----
8X (J)	8	WRITE CLOCK	WC
		IBM DESIGNATIONS	
		9 TRACK	9 TRACK
9X (K)	9	WRITE DATA P	WDP
10X (L)	10	WRITE DATA 0	WD0
11X (M)	11	WRITE DATA 1	WD1
12X (N)	12	WRITE DATA 2	WD2
13X (P)	13	WRITE DATA 3	WD3
14X (R)	14	WRITE DATA 4	WD4
15X (S)	15	WRITE DATA 5	WD5
16X (T)	16	WRITE DATA 6	WD6
17X (U)	17	WRITE DATA 7	WD7
18X (V)	18	Reserved for Options and Spares	----
through	through	↕	----
24X (BB)	24	Reserved for Options and Spares	----

*Used only in PE Read-After-Write.

Table 3. PE Master Read Data Connector

ACTIVE PIN	GROUND PIN	SIGNAL NAME	MNEMONICS
1X (A)	1	Reserved for Options and Spares	----
2X (B)	2		----
3X (C)	3		----
4X (D)	4		----
5X (E)	5		----
6X (F)	6		----
7X (H)	7	Reserved for Options and Spares	----
8X (J)	8	READ CLOCK	RC
		IBM DESIGNATIONS	
		9 TRACK	**9 TRACK**
9X (K)	9	READ DATA P	RDP
10X (L)	10	READ DATA 0	RD0
11X (M)	11	READ DATA 1	RD1
12X (N)	12	READ DATA 2	RD2
13X (P)	13	READ DATA 3	RD3
14X (R)	14	READ DATA 4	RD4
15X (S)	15	READ DATA 5	RD5
16X (T)	16	READ DATA 6	RD6
17X (U)	17	READ DATA 7	RD7
18X (V)	18	PE STATUS	SD16
19X (W)	19	Reserved for Options and Spares	----
20X (X)	20	ERROR	MTE
21X (Y)	21	TAPE MARK	TM
22X (Z)	22	ERROR	STE
23X (AA)	23	ID BURST	IDB
24X (BB)	24	END-OF-BLOCK	EOB

Table 4. NRZI Read Data Connector

ACTIVE PIN	GROUND PIN	SIGNAL NAME		MNEMONICS	
1X (A)	1	Reserved for Options and Spares		----	
2X (B)	2	↕		----	
3X (C)	3			----	
4X (D)	4	Reserved for Options and Spares		----	
5X (E)	5	STATUS SEVEN TRACK		S7T	
6X (F)	6	Reserved for Options and Spares		----	
7X (H)	7	Reserved for Options and Spares		----	
8X (J)	8	READ CLOCK		RC	
		IBM DESIGNATIONS			
		9 TRACK	7 TRACK	9 TRACK	7 TRACK
9X (K)	9	READ DATA P	READ DATA C	RDP	RDC
10X (L)	10	READ DATA 0	----------	RD0	----
11X (M)	11	READ DATA 1	----------	RD1	----
12X (N)	12	READ DATA 2	READ DATA B	RD2	RDB
13X (P)	13	READ DATA 3	READ DATA A	RD3	RDA
14X (R)	14	READ DATA 4	READ DATA 8	RD4	RD8
15X (S)	15	READ DATA 5	READ DATA 4	RD5	RD4
16X (T)	16	READ DATA 6	READ DATA 2	RD6	RD2
17X (U)	17	READ DATA 7	READ DATA 1	RD7	RD1
18X (V)	18	Reserved for Options and Spares		----	
through	through	↕			
24X (BB)	24	Reserved for Options and Spares		----	

Table 4. Slave Read Data Connector*

ACTIVE PIN	GROUND PIN	SIGNAL NAME	MNEMONICS
1X (A)	1	ZERO CROSSING DATA	ZXP
2X (B)		AMPLITUDE COMPARATOR DATA	ACP
3X			ZX0
4X			AC0
5X			ZX1
6X			AC1
7X			ZX2
8X			AC2
9X			ZX3
10X			AC3
11X			ZX4
12X			AC4
13X			ZX5
14X			AC5
15X			ZX6
16X			AC6
17X		ZERO CROSSING DATA	ZX7
18X		AMPLITUDE COMPARATOR DATA	AC7
19X		Reserved for Options and Spares	----
20X		Reserved for Options and Spares	----
21X (Y)		Reserved for Options and Spares	----
22X (Z)		WRITE STATUS	WS1
23X (AA)		REVERSE	REV1
24X (BB)	24	PHASE-ENCODE STATUS	SPE

*These signals may be considered as internal signals if a master MTU is included in the configuration. They are here only for those who are designing their own 1600 CPI read data electronics and do not plan to use the 7970E master MTU.

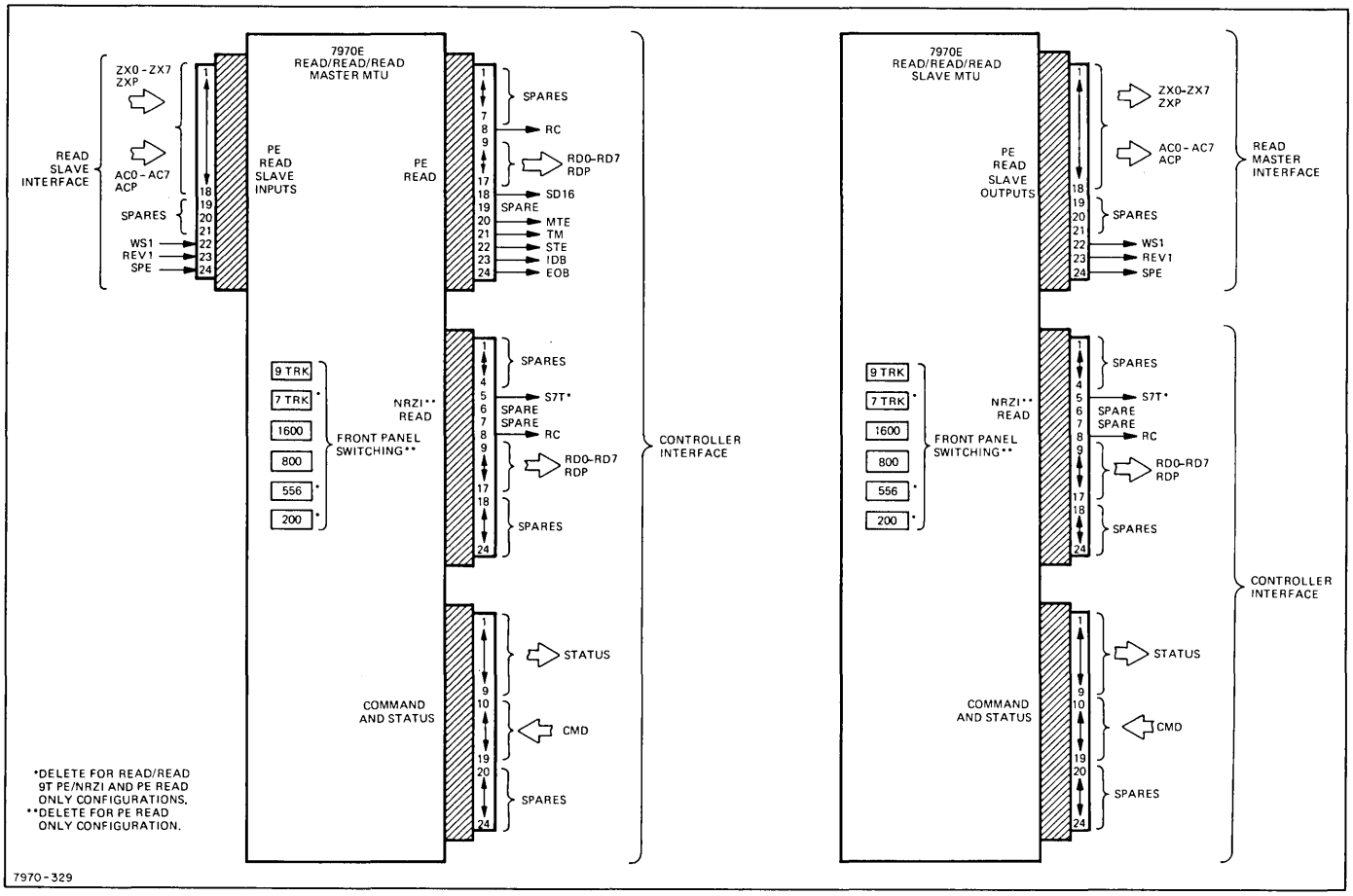


Figure 7. Read/Read/Read Configuration, Showing Connections

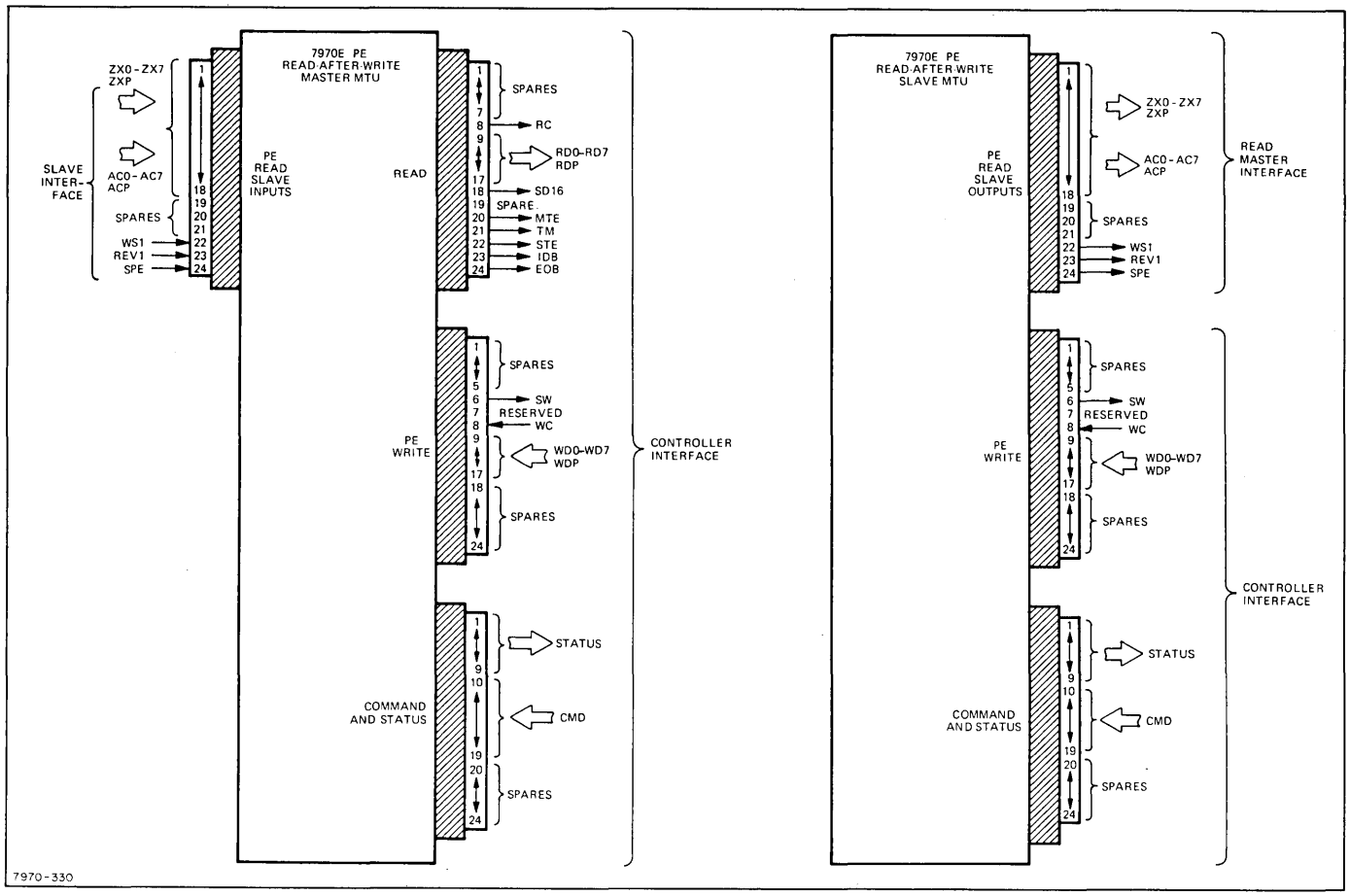
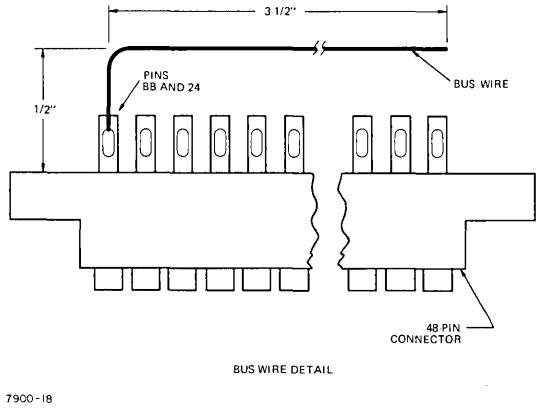


Figure 8. Read-After-Write 1600 CPI PE Configuration, Showing Connections

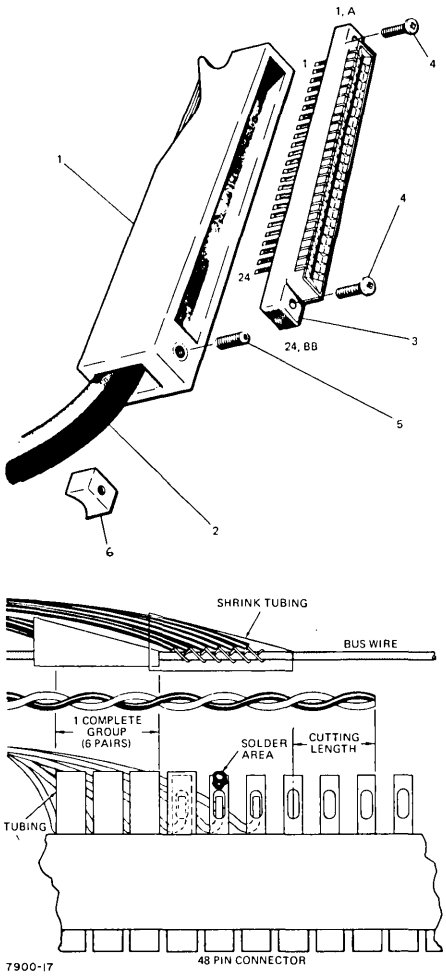
Table 6. Interconnect Cable Fabrication

CABLE AND CONNECTOR PARTS

ITEM	DESCRIPTION	HP PART NO.
1	Cable, 24 twisted pair	8120-1700 or equivalent
2	Connector hood	02116-4001
3	Self-tapping screw	0624-0098
4	Connector, 48-pin	1251-0335
5	Setscrew	3030-0143
6	Cable clamp	02116-4003



BUS WIRE DETAIL



CABLE FABRICATION

To fabricate the interconnect cable refer to the above information and proceed as follows:

a. Insert approximately 10 inches of cable (1) into connector hood (2).

b. Strip the outer jacket of the cable back 5 inches.

c. Prepare a bus wire from 22-gauge bare-copper wire and solder it to pins BB and 24 of the connector (4) as shown in bus wire detail above.

d. Divide the 24 twisted pairs into groups of six pairs each.

e. Starting at the end of the 48-pin connector nearest pins BB and 24, connect the first six pairs as follows:

(1) Solder the six signal (white) wires to the respective pins on the connector and insulate each pin with shrink tubing as shown above.

(2) Solder the six ground (black) wires to the bus wire and insulate with shrink tubing as shown above.

f. Repeat steps (1) and (2) with the remaining groups of wires until all wires are soldered to the connector and insulated.

g. Trim off any excess bus wire and install the 48-pin connector (4) in the connector hood (2) using the two self-tapping screws (3).

h. Install cable clamp (6) and tighten in place with the setscrew (5).

Figure 9. Interconnection Cable Fabrication

Table 6. Detailed Description of I/O Lines, Command-and-Status Connector

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
STATUS			
a. ON-LINE (SL = STATUS ON-LINE)	Acknowledges that the selected tape unit has been manually placed in an on-line condition.	Level	Output from tape unit
b. READY (SR = STATUS READY)	Indicates that the tape unit is selected, is on-line, the initial loading sequence is complete, and the tape unit is not rewinding.	Level	Output from tape unit
c. LOAD POINT (SLP = STATUS LOAD POINT)	Indicates that the tape unit is selected, is on-line, and the tape is positioned at the load-point reflective strip.	Level	Output from tape unit
d. DENSITY STATUS* (SD = STATUS DENSITY) NOTE: Three individual lines: SD2, SD5, and SD8.	Indicates the manual setting of a tape unit density switch: 200, 556, 800 CPI. Only one density at a time can be asserted from a selected and on-line tape unit.	Level	Output from tape unit
e. REWIND (SRW = REWIND STATUS)	Indicates that the selected and on-line tape unit is engaged in a rewind operation. This status remains true until the tape is positioned at the load-point reflective strip.	Level	Output from tape unit
f. FILE PROTECT (SFP = STATUS FILE PROTECT)	Indicates that the selected and on-line tape unit is not write enabled (write ring is not present in the file reel).	Level	Output from tape unit
g. END-OF-TAPE (SET = STATUS END-OF-TAPE)	Indicates that an end-of-tape reflective strip has passed under the photosense head of a selected and on-line tape unit. Assertion is maintained until cancellation of the end-of tape condition by the passage of the reflective strip in the reverse direction.	Level	Output from tape unit
FUNCTION COMMANDS			
a. SELECT (CS = COMMAND SELECT) NOTE: Four individual lines for units 0, 1, 2, and 3.	Selects a particular on-line tape unit from a group connected to a common interface cable.	Level	Input to tape unit

*These Density Status lines are for the 7970E Read/Read Configurations.

Table 6. Detailed Description of I/O Lines, Command-and-Status Connector (Continued)

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
FUNCTION COMMANDS (Cont)			
b. OFF-LINE (CL = COMMAND OFF-LINE)	Assertion of this line clears the write condition and terminates the on-line condition of the selected tape unit. Assertion should be maintained until acknowledged by the negation of the on-line status.	Level	Input to tape unit
c. SET WRITE (WSW = WRITE SET WRITE)	The assertion of CF causes the WSW line to be sampled. Assertion of the WSW line enables the setting of the selected and on-line tape unit's write condition, provided the tape unit is ready and enabled. Negation of the WSW line enables the clearing of the tape unit's write condition.	Level	Input to tape unit
MOTION COMMANDS			
a. FORWARD (CF = COMMAND FORWARD)	Providing the tape unit is selected, and ready, this command causes tape to be driven in the forward direction.	Level	Input to tape unit
b. REVERSE (CR = COMMAND REVERSE)	When asserted, clears the write condition and causes the tape to be driven in the reverse direction, provided that the tape unit is selected, and ready. Load-Point Status inhibits the response to this command.		Input to tape unit
c. REWIND (CRW = COMMAND REWIND)	Clears the write condition of the selected tape unit and initiates a rewind operation, provided that the tape unit is ready, and not at load point. Tape is positioned at load point at the end of this operation. Assertion should be maintained until acknowledged by Rewind Status (minimum 2 μs).	Level	Input to tape unit
d. HIGH SPEED (CH = COMMAND HIGH SPEED)	When asserted with forward or reverse on a selected and ready tape unit, will cause tape speed to accelerate to 160 ips.	Level	Input to tape unit

Table 7. Detailed Description of I/O Lines, Write Data Connector*

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
STATUS			
a. WRITE STATUS (SW = STATUS WRITE)	Indicates that the selected tape unit is write enabled and current is flowing in the write and erase heads. Tape flux shall be of inter-block gap polarity until a Write Clock pulse is received.	Level	Output from tape unit
DATA TRANSMISSION			
a. WRITE DATA (WD = WRITE DATA) WD0 -- WD7, WDP NOTE: Refer to Write Data connector for channel designation.	The logical state of each Write Data line at Write Clock time defines the polarity of the flux to be written on tape. Assertion enables writing flux of polarity opposite to that of the inter-block gap; negation enables writing inter-block gap flux. The Write Data lines at the transport receivers must be settled for 500 ns prior to and after the received Write Clock pulse edges.	Level	Input to tape unit
b. WRITE CLOCK (WC = WRITE CLOCK) NOTE: In general, two Write Clock pulses are required to generate a PE tape byte. (See figure 13.)	Assertion edge causes flux polarity on tape corresponding to the logical state of the individual Write Data lines.	Pulse	Input to tape unit

*Write and erase condition is controlled via the WSW signal on the motion control connector.

Table 8. Detailed Description of I/O Lines, PE and NRZI Read Data Connectors

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
READ DATA TRANSMISSION			
a. STATUS SEVEN TRACK (NRZI only)	Indicates selection of 7-track Read operation.	Level	Output from tape unit
b. READ DATA (RD = READ DATA) RD0 - RD7, RDP NOTE: Refer to Read Data connector for channel designation. (PE and NRZI)	(Any 1 of 9 lines.) These lines transmit detected characters read from the tape and present them to the interface. NRZI The Read Data lines are settled at the assertion transition time of Read Clock and remain settled until 1 μs, maximum, before the next Read Clock. PE The logical state of the 9 Read Data transmitters at RC assertion defines a deskewed tape byte. Assertion or negation occurs a minimum of 2 μs prior to RC assertion and is maintained for 500 ns, minimum, following RC negation.	Level	Output from tape unit
c. READ CLOCK (RC = READ CLOCK) (PE and NRZI)	Indicates that a character has been read from tape and is present on the Read Data lines. Assertion time is 2 μs, minimum; 3 μs, maximum. Read Clock is not given for preamble and postamble bytes, nor during Tape Mark and Identification Burst blocks.	Pulse	Output from tape unit
d. PE STATUS (SD16) (PE only)	Originates in the selected tape unit (master or slave). Assertion signifies that the selected tape unit is on-line and can operate on 1600 CPI PE tape. Negation inhibits all transmitters in the common read electronics.	Level	Output from tape unit
e. END-OF-BLOCK (EOB) (PE only)	A pulse of minimum width (2 μs) signaling that a Data Block, TM, or IDB has been read. Assertion occurs 20 bit times following the last detected flux reversal in the block. Flux reversals must be present a minimum of 20 character times to enable EOB generation. Optional jumper inhibits EOB following an IDB.	Pulse	Output from tape unit

Table 8. Detailed Description of I/O Lines, PE and NRZI Read Data Connectors (Continued)

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
READ DATA TRANSMISSION (Continued)			
e. END-OF-BLOCK (Continued)	EOB can be used as a strobe for TM, IDB, MTE, and STE.		
f. TAPE MARK (TM) (PE only)	TM will be true at EOB time if the block was a Tape Mark. Assertion occurs nominally 20 bit times after the start of the Tape Mark block and is maintained for 500 ns, minimum, following the negation edge of EOB.	Level	Output from tape unit
g. IDENTIFICATION BURST (IDB) (PE only)	IDB will be true at EOB time if the block was an Identification Burst block. Assertion occurs nominally 20 bit times after the start of the ID burst and is maintained for 500 ns, minimum, following the negation edge of EOB.	Level	Output from tape unit
h. MULTIPLE TRACK ERROR (MTE) (PE only)	Signal indicates that an uncorrectable error situation was detected and the block must be re-read. Assertion occurs when the error is detected and maintained for 500 ns, minimum, following the negation edge of EOB.	Level	Output from tape unit
i. SINGLE TRACK ERROR (STE) (PE only)	Signal indicates that a single track error condition was detected. Assertion occurs when the error is detected and is maintained for 500 ns, minimum, following the negation edge of EOB. If MTE is not asserted at EOB time, the error condition was correctable and the block need not be re-read.	Level	Output from tape unit

Table 9. Detailed Description of I/O Lines, Slave PE Read Data Connector

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
These signals are enabled when the tape unit is selected, on-line, executing FWD or REV motion commands, and conditioned for 1600 CPI tape (false otherwise).			
READ SLAVE TRANSMISSION			
a. ZERO CROSSING DATA (ZX = ZERO CROSSING) ZX0 - ZX7, ZXP	Assertion edge corresponds to a change of tape flux from IBG* polarity (reset flux) to the opposite, when reading tape in the forward mode. Negation edge corresponds to a change of tape flux from non-IBG polarity when reading forward. When reading areas of tape where the density of flux reversals is less than 200 CPI, the logical state of the ZX outputs may fluctuate randomly. Static interchannel time displacement will be less than 200 μinches equivalent when reading IBM alignment tape.	Level	Output from slave
b. AMPLITUDE COMPARATOR (AC = AMPLITUDE COMPARATOR) AC0 - AC7, ACP	Signal is asserted if the instantaneous analog voltage from the differentiator exceeds the threshold of the bipolar amplitude comparator. Signal is negated when analog voltage is less than this threshold. The acceptance threshold corresponds to 15% of the nominal Read-After-Write 1600 CPI output when not writing. During a Write operation, the threshold is increased to 40%.	Pulse	Output from slave
c. WRITE STATUS (WS1)	Assertion indicates the tape unit has been conditioned to Write, and current is flowing in the write head. This signal is used by the common read electronics as opposed to the SW in the write connector used by the controller interface.	Level	Output from slave
d. REVERSE (REV 1)	Assertion indicates the tape unit is executing a Reverse motion command.	Level	Output from slave
e. PHASE-ENCODE STATUS (SPE)	Assertion indicates the tape unit is conditioned to operate on 1600 CPI tape.	Level	Output from slave

*IBG = Inter-Block-Gap

6. I/O LINE TRANSMITTERS AND RECEIVERS

Figures 10 and 11 illustrate the type and electrical parameters of the I/O line transmitters and receivers.

7. PARALLEL-CONNECTION (DAISY-CHAIN) CAPABILITY

The command-and-status, write, and NRZI read interface connector boards are manufactured with parallel connectors.

The PE read interface connector board is parallel only for the slave units. This is because the 7970E PE master/slave configuration includes the PE read data electronics only in the master tape unit. (See figure 1.) The PE master and PE slave read interface connectors are therefore different and not connected in parallel.

The Unit Select address is operator-selectable from the operator control panel -- if the tape unit has the Unit Select option. Otherwise, the Unit Select address is jumper-selectable on the control board.

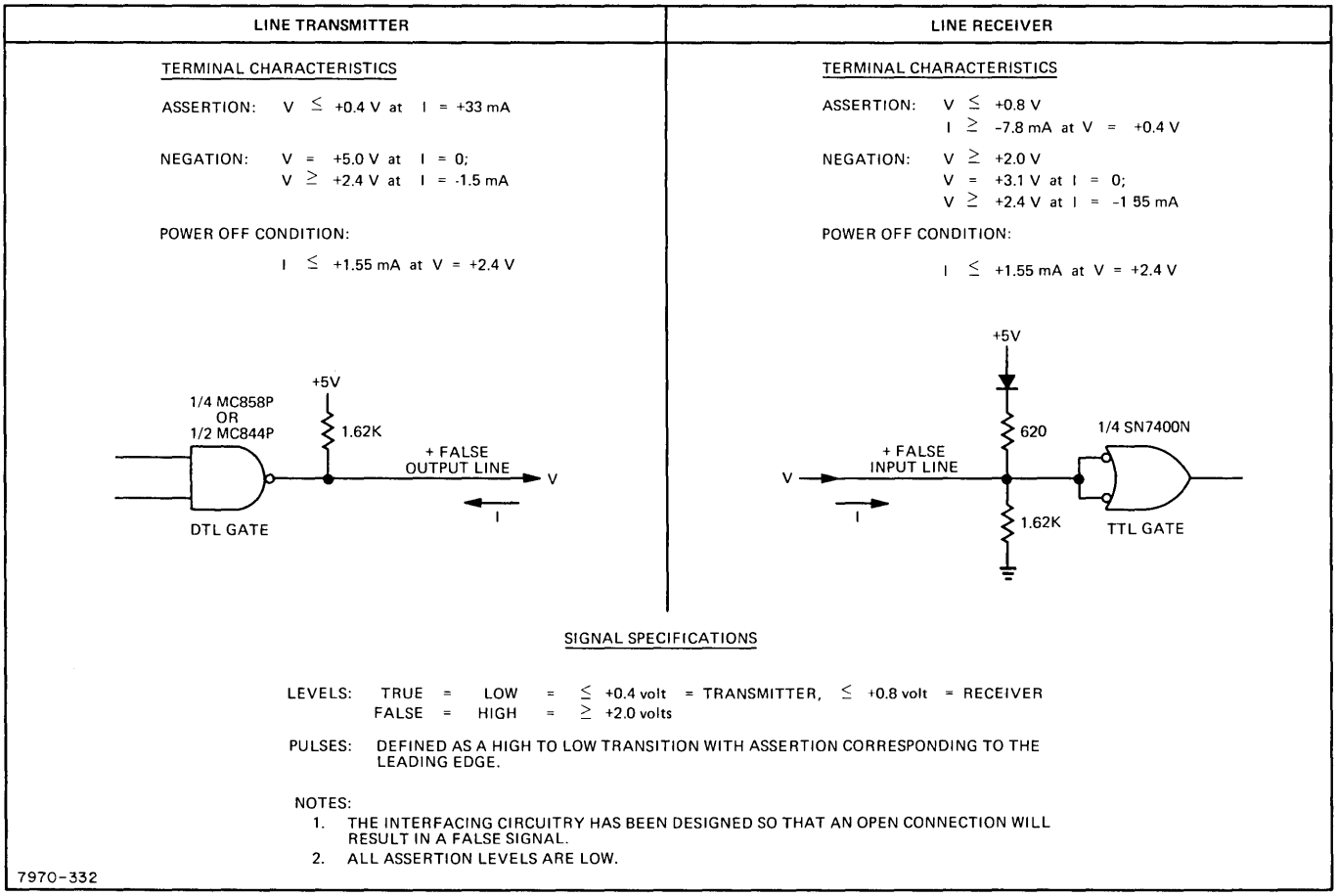


Figure 10. Electrical Parameters of the I/O Line Transmitters and Receivers for all except the PE Read Slave Interface

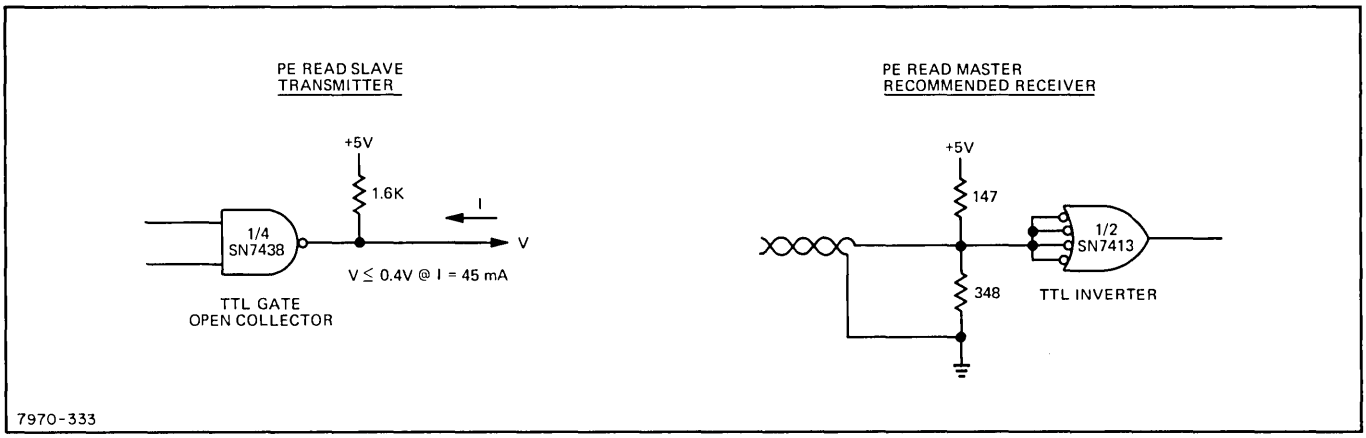


Figure 11. Electrical Parameters of the I/O Line Transmitters for the PE Read Slave Interface

8. WAVEFORMS, FORMATTING, AND EVENT TIMING

Figures 12 through 16 show the write and read timing for both PE and NRZI. The read-after-write verification time equals the $\frac{\text{head spacing}}{\text{velocity}}$, or approximately 4.0 milliseconds at 37.5 ips.

Figure 17 illustrates the position of the photosense head assembly with respect to the location of the write head in the tape path.

During the rewind function, the load-point reflective strip is first sensed at a tape speed of 160 ips. The leader edge (the edge of the strip first encountered from the physical beginning of the tape) negates the rewind function and initiates the load sequence. The load sequence is performed at a tape speed of 20 ips and is terminated when the leader edge of the load-point reflective strip is detected. Between the termination of rewind and the time tape motion ceases, approximately 4 feet of tape is traversed.

The End-of-Tape Status level is generated and remembered by the tape unit. When the end-of-tape reflective strip is sensed in the forward direction, a flip-flop is set and remains set until the reflective strip is sensed in the reverse direction. At this time, the status will be cleared.

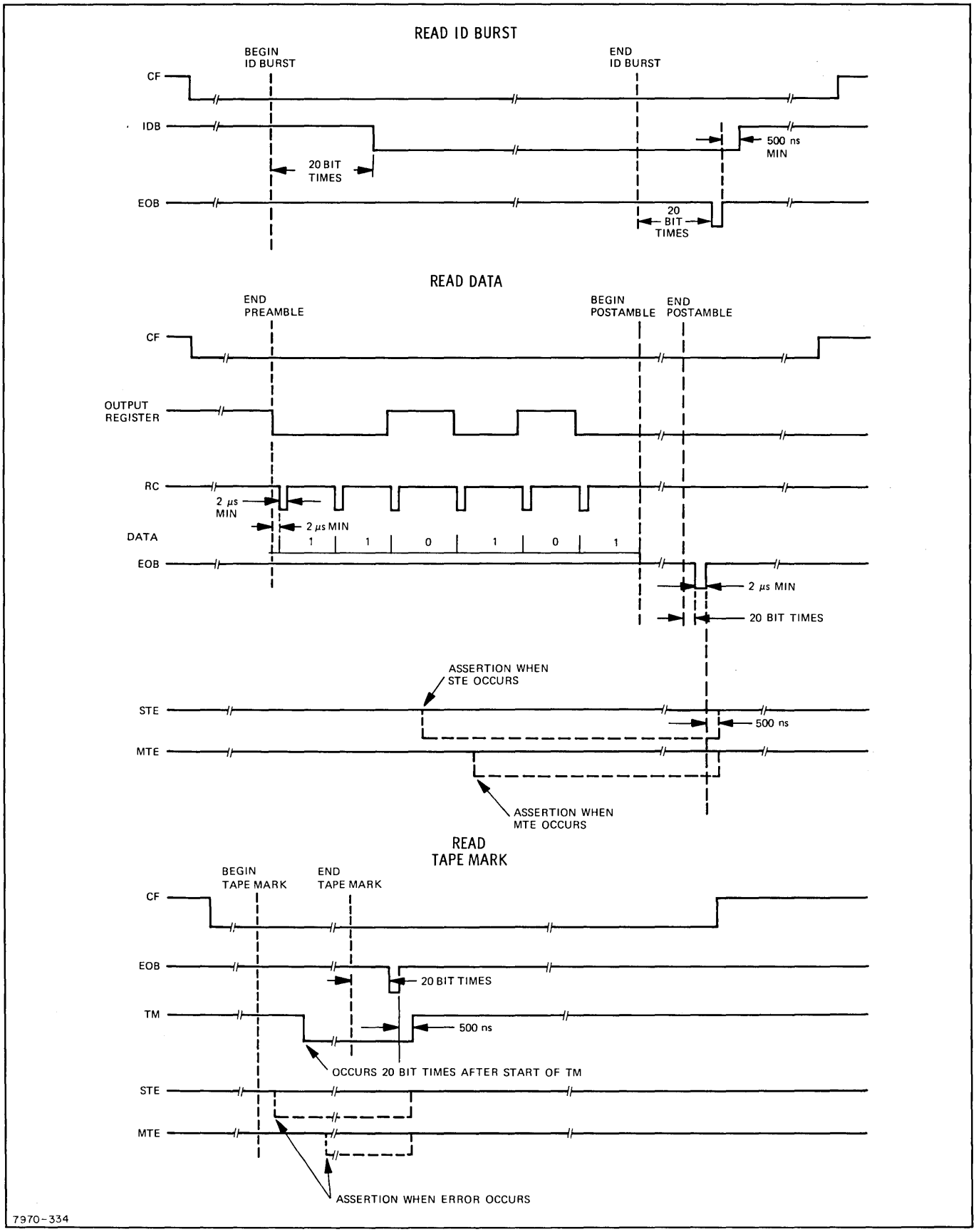


Figure 12. Master MTU PE Read Data Waveforms

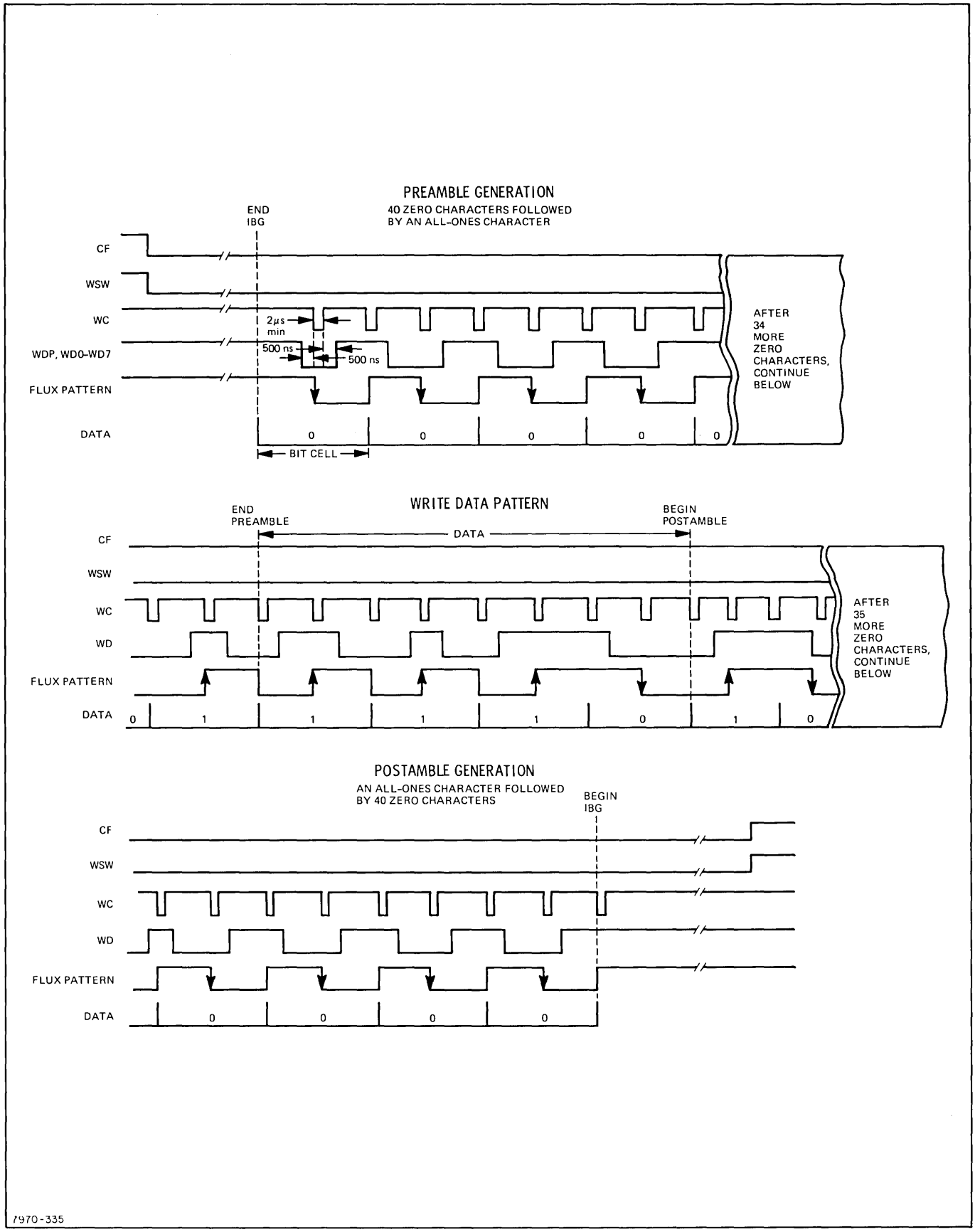


Figure 13. Generation of PE Write Data Waveforms and Preamble/Postamble Formats for the Master/Slave MTU

The Tape Mark is a special control block that consists of 80 flux reversals in tracks 1, 2, 4, 5, 7, and 8. Tracks 3, 6, and 9 are dc erased. The ID burst consists of alternate ones in track 4 and erasure in all other tracks.

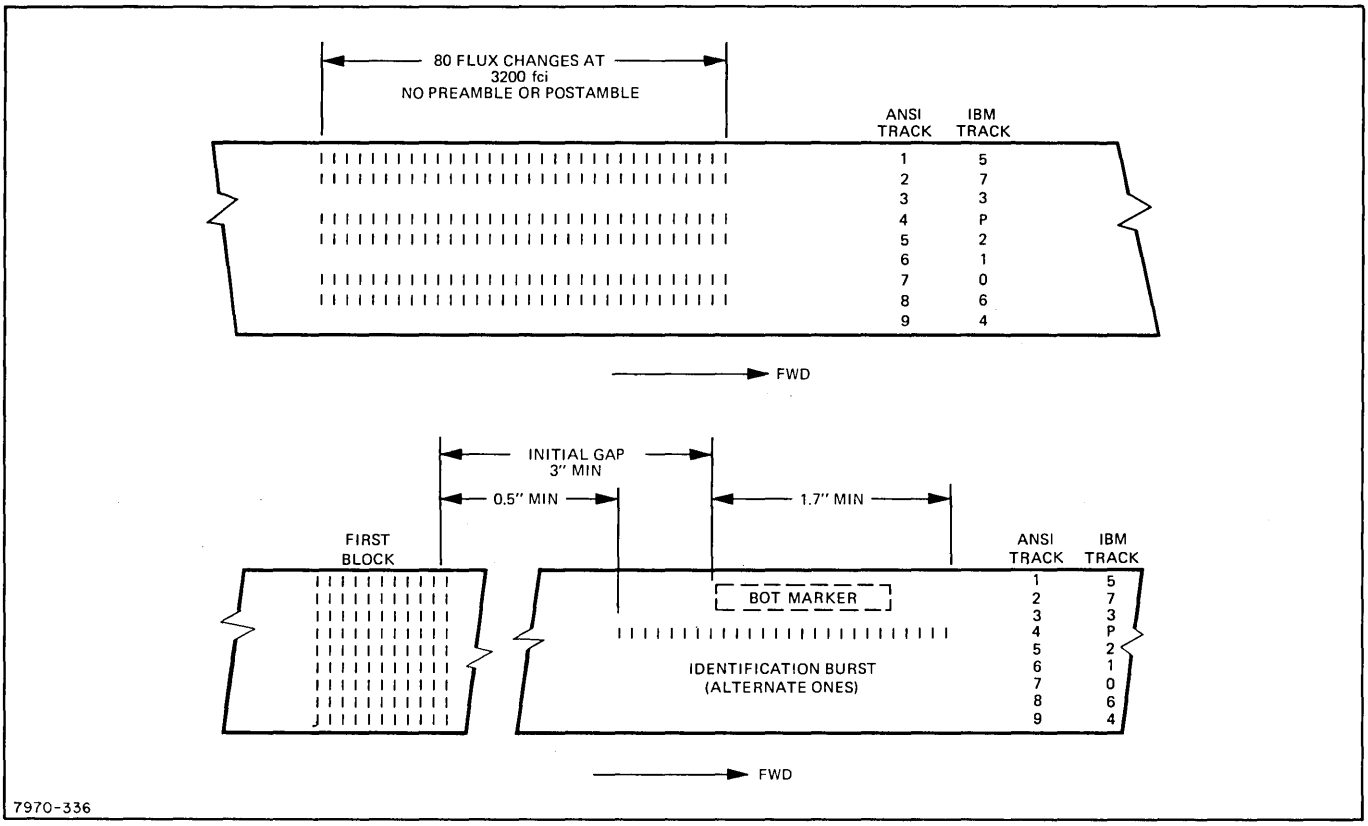


Figure 14. Write Tape Mark and Identification Burst Generation (IBM Compatible)

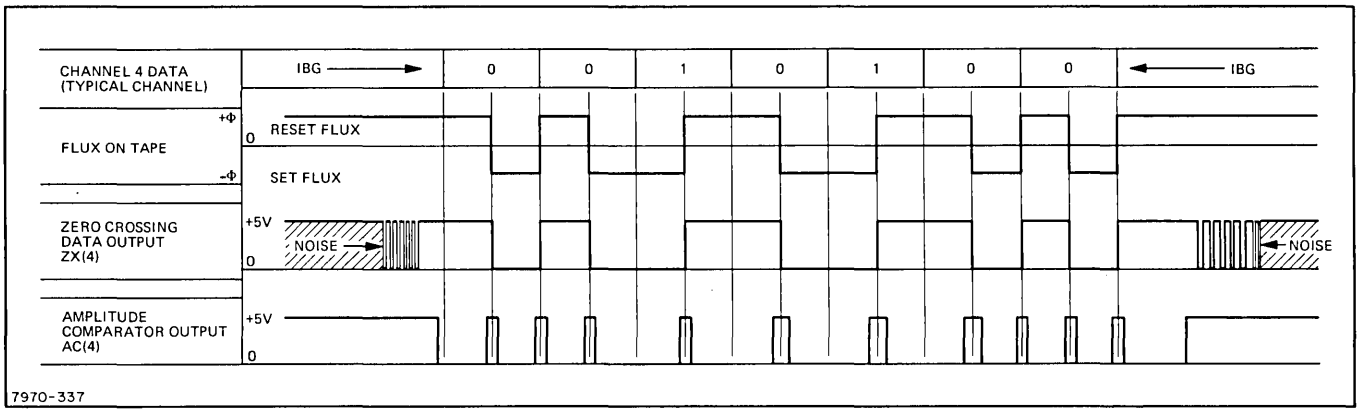


Figure 15. Slave MTU PE Read Data Waveforms

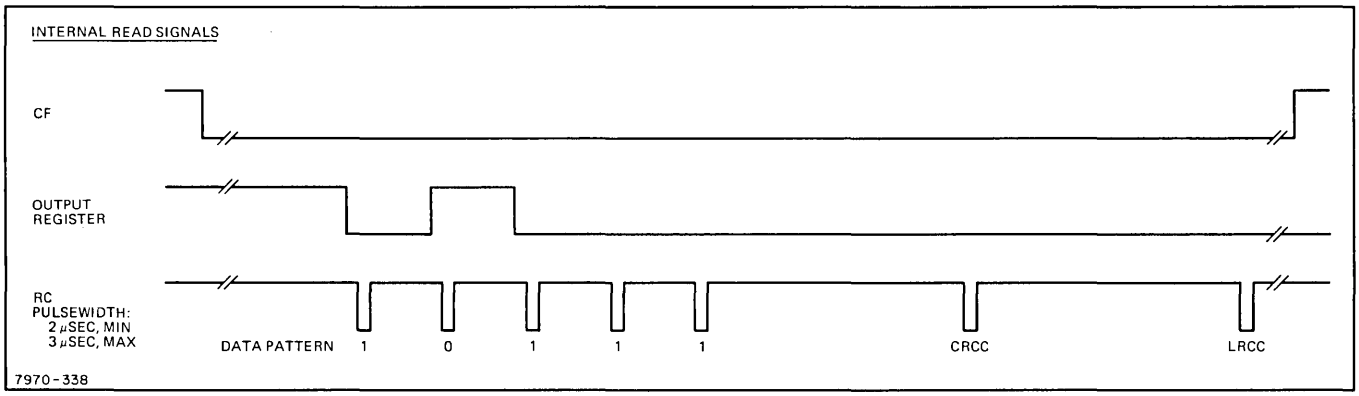


Figure 16. Master/Slave MTU NRZI Read Data Waveforms

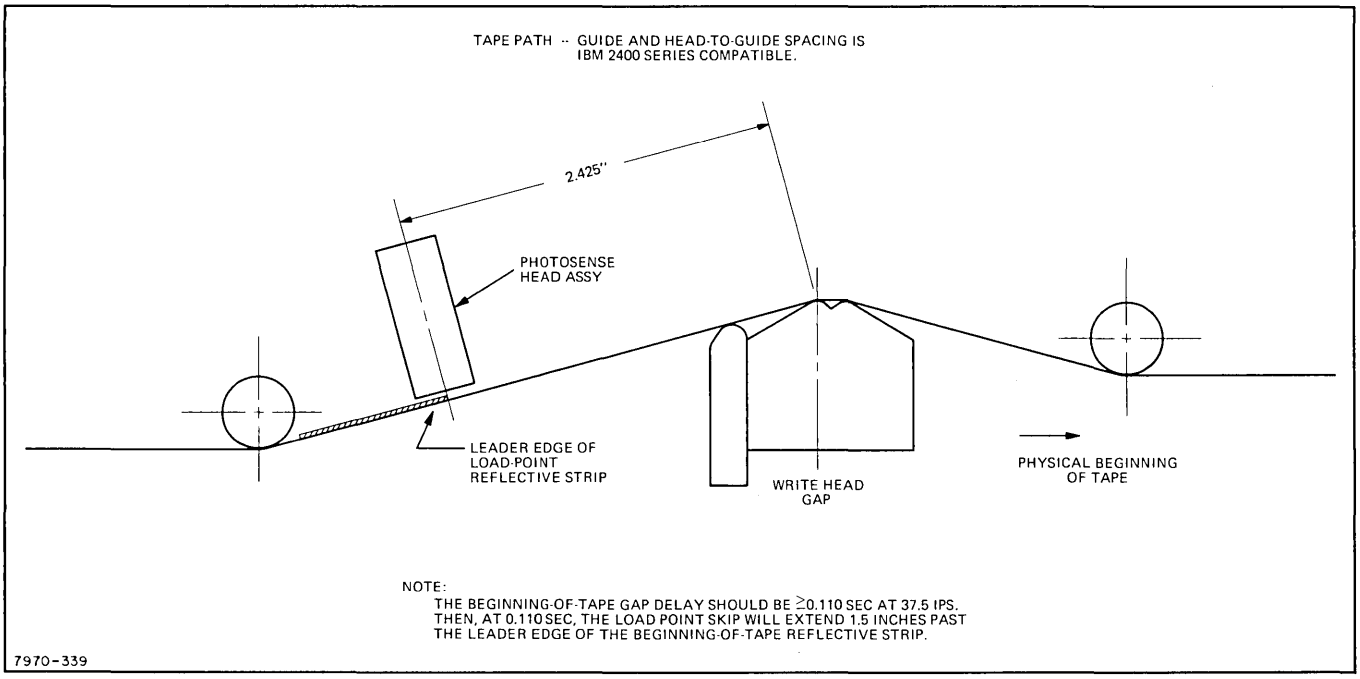


Figure 17. Location of Photosense Head Assembly

9. ELECTRICAL AND MECHANICAL SPECIFICATIONS FOR HP MODEL 7970E

Specifications for the electrical and mechanical characteristics of the 7970E Tape Transport are as follows:

TAPE (Computer Grade):

Width:	0.5"
Thickness:	1.5 mils

TAPE TENSION: 8.5 oz, nominal

REEL DIAMETER: Up to 10-1/2 "

TAPE SPEED: 10 to 45 ips

INSTANTANEOUS SPEED VARIATION: ±3%

LONG-TERM SPEED VARIATION: ±1%

REWIND SPEED: 160 ips

FAST FORWARD, FAST REVERSE: 160 ips

FAST FORWARD, FAST REVERSE, START/STOP CHARACTERISTICS (37.5 ips):

Distance:	69" start, nominal
	31" stop, nominal
Time:	0.7 second, maximum

START/STOP TIMES: 10 ms (at 37.5 ips)

START/STOP TAPE TRAVEL: 0.187" ± 0.020"

REEL MOTOR BRAKING: Dynamic

RECORDING MODE: PE (IBM compatible)
NRZI (IBM compatible)

BOT AND EOT REFLECTIVE STRIP DETECTION:

Photoelectric, IBM compatible

WEIGHT: 130 lb, maximum (59 kg)

DIMENSIONS:

Height:	24" (610 mm)
Width:	19" (483 mm)
Depth (from mounting surface):	12" (305 mm)
Total Depth:	15-3/4" (400 mm)

OPERATING ENVIRONMENT:

Ambient Temp:	+32° to +131° F (0° to +55° C)
Relative Humidity:	20 to 80%
Altitude:	10,000 feet (3048 meters)

POWER REQUIREMENTS:

115 or 230 (±10%) Vac
48 to 440 Hz, single phase
500 watts, max (on high line)

TRANSPORT MOUNTING:

Vertical:	Std 19" (483 mm) RETMA rack
Horizontal:	24" (610 mm) rack (19" centers)

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