BELI

NORD 10/HP 7970

Mag. Tape Interface

REVISION RECORD

Revision	Notes
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Chapters:

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1 INTRODUCTION

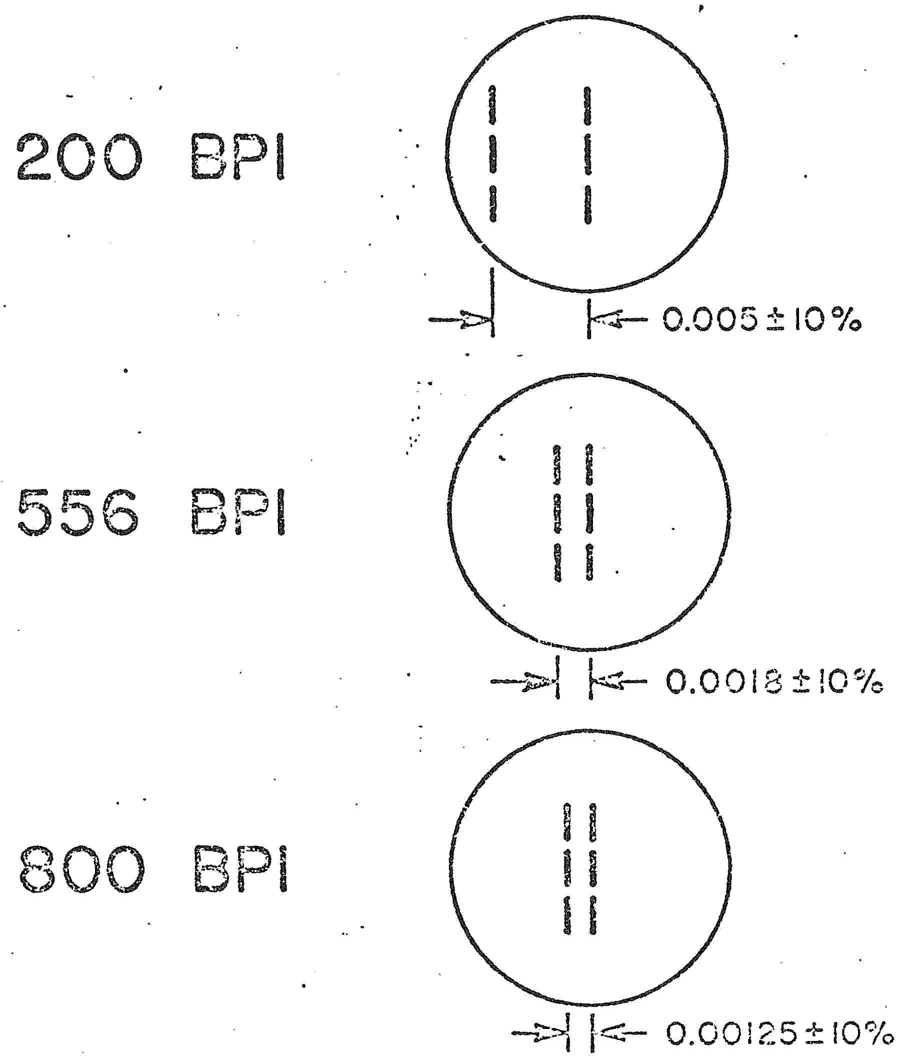
This documentation gives an course introduction to Mag-tape fundamentals such as concept, format and error checking. Then follows an explanation of the interface between HP 7970 and NORD-10.

The interface uses the programmed I/O for loading of registers and counters, and reading status information.

The main data transfer is done via direct memory access on a cycle-steal basis.

2 MAGNETIC TAPE CONCEPTS

2.1 Recording Density



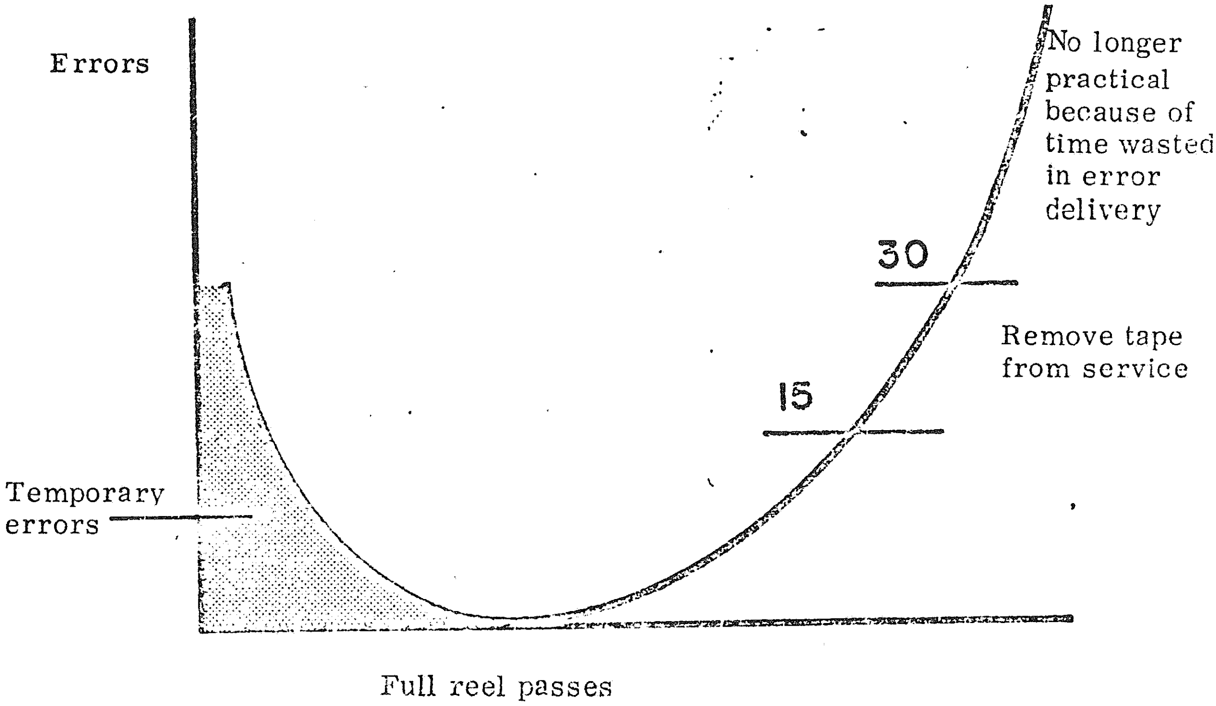
There are three common industry standard bit densities for digital Magnetic Tape recording.

Bit to bit spacing ranges from 0.005 ± 10% inches at 200 BPI, to 0.00125 ± 10% inches at 800 BPI.

The 7970A is capable of 200, 556, or 800 BPI.

Seven track tapes are recorded at 200, 556, or 800 BPI.

2.2 Magnetic Tape Performance



A new reel of tape will exhibit a number of temporary read errors when first used.

Passing the tape through a machine a few times causes it to wear in or polish down and achieve optimum performance.

After a period of time a tape will begin to experience permanent errors.

Typically a user will experience 15 to 30 errors before removing the tape from service.

Environmental conditions and tape handling practices greatly effect. The total number of passes a tape can withstand before being replaced.

After being removed from service a tape may be varified and cleaned or stripped back and a new load point sticker inserted.

2.3 Reasons for Tape Failure

Drop-outs are generally caused by a minute section of tape having lost its oxide coating. This causes the magnitude of the output to decrease and loose information.

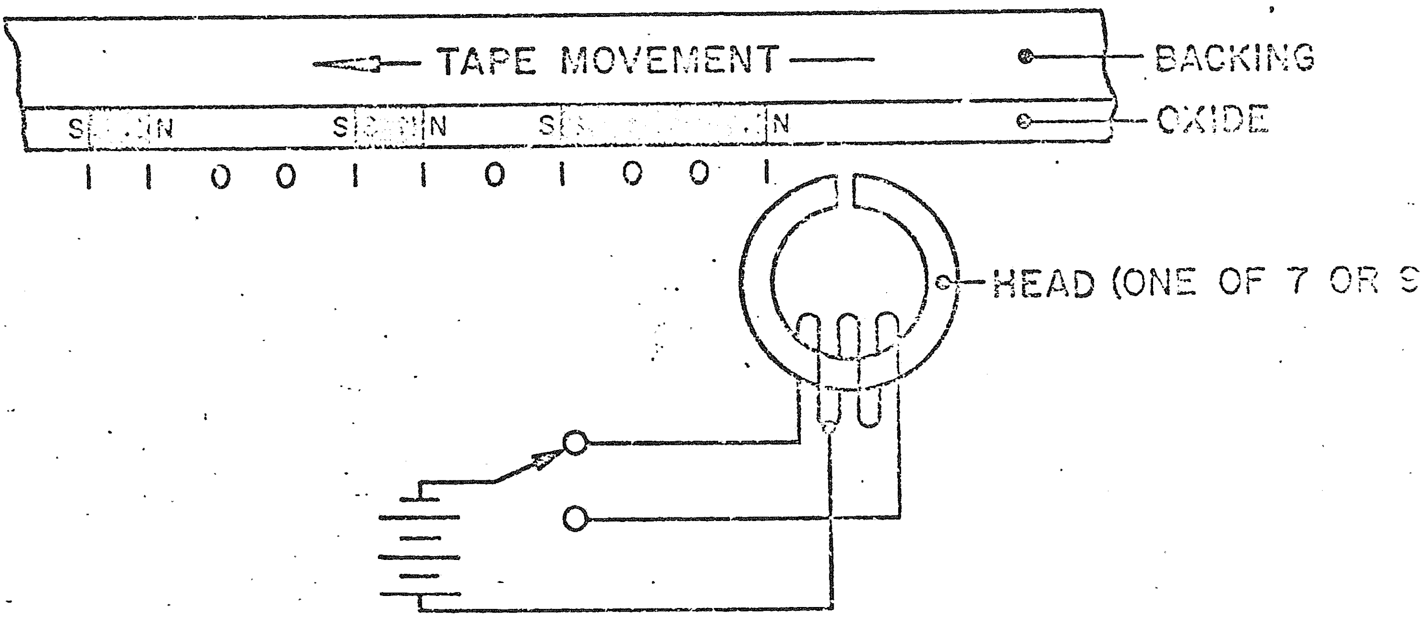
Self contamination is caused when oxide is removed from one area of tape and re-deposits in another area. This causes double thickness of oxide and lifts the tape.

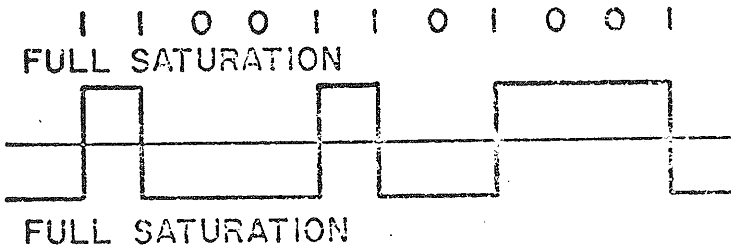
Low wrapping tension causes the tape to be too loose on the reel. This being the case, the hub may stop and the tape continue to move causing it to double over within the reel.

High wrapping tension may cause the tape to be stretched. This will alter the physical dimensions and cannot be handled by a tape unit.

Edge damage alters the physical width of tape and causes the tape to "snake" over the head.

2.4 NRZI Recording





OPERATION OF THE SWITCH. ONLY A CHANGE FOR A LOGICAL "ONE" NO CHANGE IN FLUX FOR A LOGICAL "ZERO".

NRZI means non return to zero invert. This method inverts (reverses) the direction of magnetic flux on tape each time a logical one is written.

NRZI saturates tape in the reset or set flux state.

Reversing the flux state is accomplished by reversing the direction of current thru the head.

The erase head is phased to erase tape by magnetizing it to the reset flux state.

No change in flux takes place for a logical zero and a complete reversal takes place for a logical one.

A tape that is erased to the reset flux state should be magnetized such that the north seeking pole of a compass will point from the beginning to the end of tape.

2.5 Industri Compatibility

If tapes are to be moved from system to system industry compatibility is necessary.

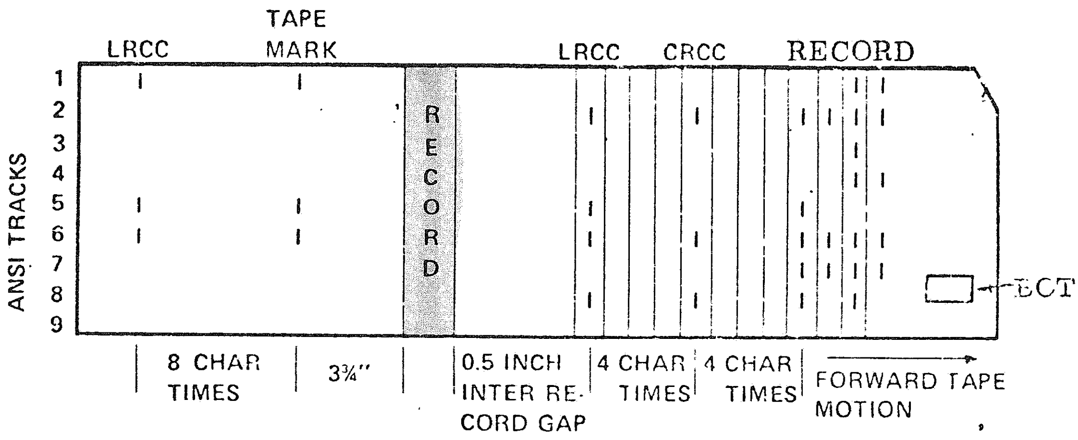
Industry compatibility is sometimes called IBM compatibility because IBM manufactures the majority of the digital magnetic tape units in use in the industry.

There are five basic elements to be considered in maintaining compatibility.

- The type of tape used.
- The format used in recording the information.
- The density at which the information is recorded.
- The method of magnetically recording the information on tape must be a common recording method.
- The coding of the digital data written on tape must be standardized.

3 MAGNETIC TAPE FORMAT

3.1 Nine Track 800 BPI NRZI Format



- ONE BYTE PER CHARACTER ON TAPE
- ALL NINE-TRACK OPERATIONS USE ODD VERTICAL (LATERAL) PARITY
- TRACK WIDTH .043 INCH
- SPACING .055 INCH CENTER TO CENTER

This data format was initially introduced by IBM along with their 360 computer series. It is by far the most commonly used format today. The layout of the data on tape is seen represented here. Individual records consist of a number of 8 bit bytes plus a parity bit followed by three character spaces the cyclical redundancy check character, three character spaces, and finally a longitudinal redundancy check character.

The vertical parity bit is often referred to as a lateral parity bit. It is a bit added to each individual character so that the sum of the bits in the character is odd.

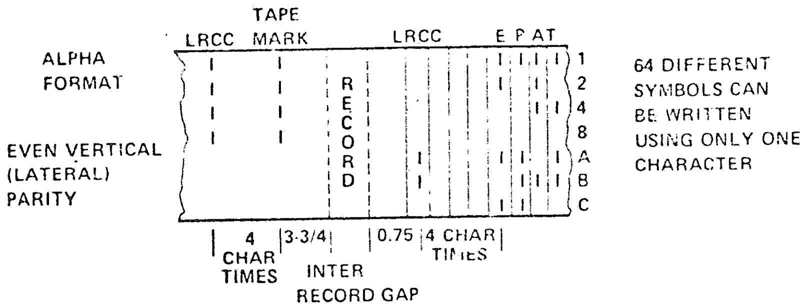
The cyclical redundancy is essentially a diagonal parity check which can be used to locate and correct single track errors. It is developed by adding each individual character in a record to the cumulative sum which has been shifted by one track according to the inverse of the bit assignments. When the sum is shifted rounding takes place in the center bit assignments if the highest order bit will become 1.

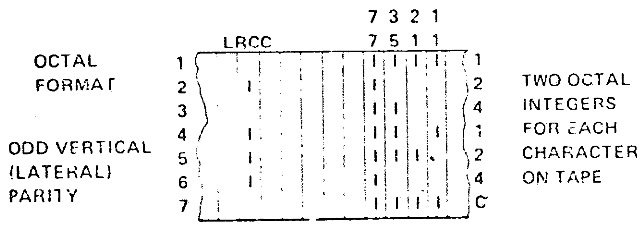
At the end of a record the CRCC will have a predetermined pattern. If it does not, the CRCC is matched against an error pattern register which has been accumulated in the data system. By shifting the CRCC a track at a time and continuing to match against the error pattern register, the track in error can be determined. That track is flagged and the record re-read. When the vertical parity error is detected the bit in the error track is inverted. This means of correcting errors will not work on multiple track errors. Many systems in use do not attempt to use the CRCC. The designers of these systems feel that permanent single track errors are uncommon and not worth the effort of implementing the use of the CRCC.

The longitudinal redundancy check character is obtained by adding all of the bits in a track for a record including the CRCC and adding a bit as necessary to make the sum even.

The space between the LRCC of the preceding record and the record following is a minimum of a 1/2" of unrecorded tape. To separate records on tape into files a tape mark is used. The tape mark consists of bits in tracks 2, 3 and 8 followed by the longitudinal redundancy check character 8 character times later. The cyclical redundancy check character or CRCC is not used in the tape mark. The tape mark is preceded by 3-3/4" of blank tape. The numbering of the tracks on tape starts at the top when the beginning of tape mark or BOT is on the right hand side with the oxide surface facing the viewer.

3.2 Seven Track NRZI Triple Density Format





This is the recording format used prior to IBM's introduction of its 360 line. The densities in this format are 200 BPI, 556 BPI, and 800 BPI. The bits per inch (BPI) designation is used here rather than CPI because a character is generally interpreted to be eight bits even though a character may be represented by a six bit code. These steps in increasing density represent individual milestones in the development of digital tapes and digital tape transports. Individual bytes are represented by a 6 bit character plus a parity bit. The vertical parity in 7 track format may be either odd or even parity. A record is followed by a longitudinal redundancy check character 3 character spaces after the last byte. The inner record gap is a minimum of 3/4 of an inch. The tape mark used to separate the files is preceded by 3-3/4 inch of blank tape and is represented by one bit in tracks 1-4 followed 3 character spaces later by the longitudinal redundancy check character.

Track numbering is consistent with the 9 track scheme, however, there is no scrambling of the significant bits. The least significant bits start at the edge of the tape and move inward to the center as do the zone bit which is the equivalent to a punched card on magnetic tape. An octal format is also seen in 7 track. This format consists of 2 octal characters placed side by side with a parity bit.

THE CORRESPONDENCE BETWEEN A NORD-10 WORD AND THE TRACKS ON AN IBM COMPATIBLE TAPE

NORD-10 WORD:

Bit No.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

9-TRACK TAPE:

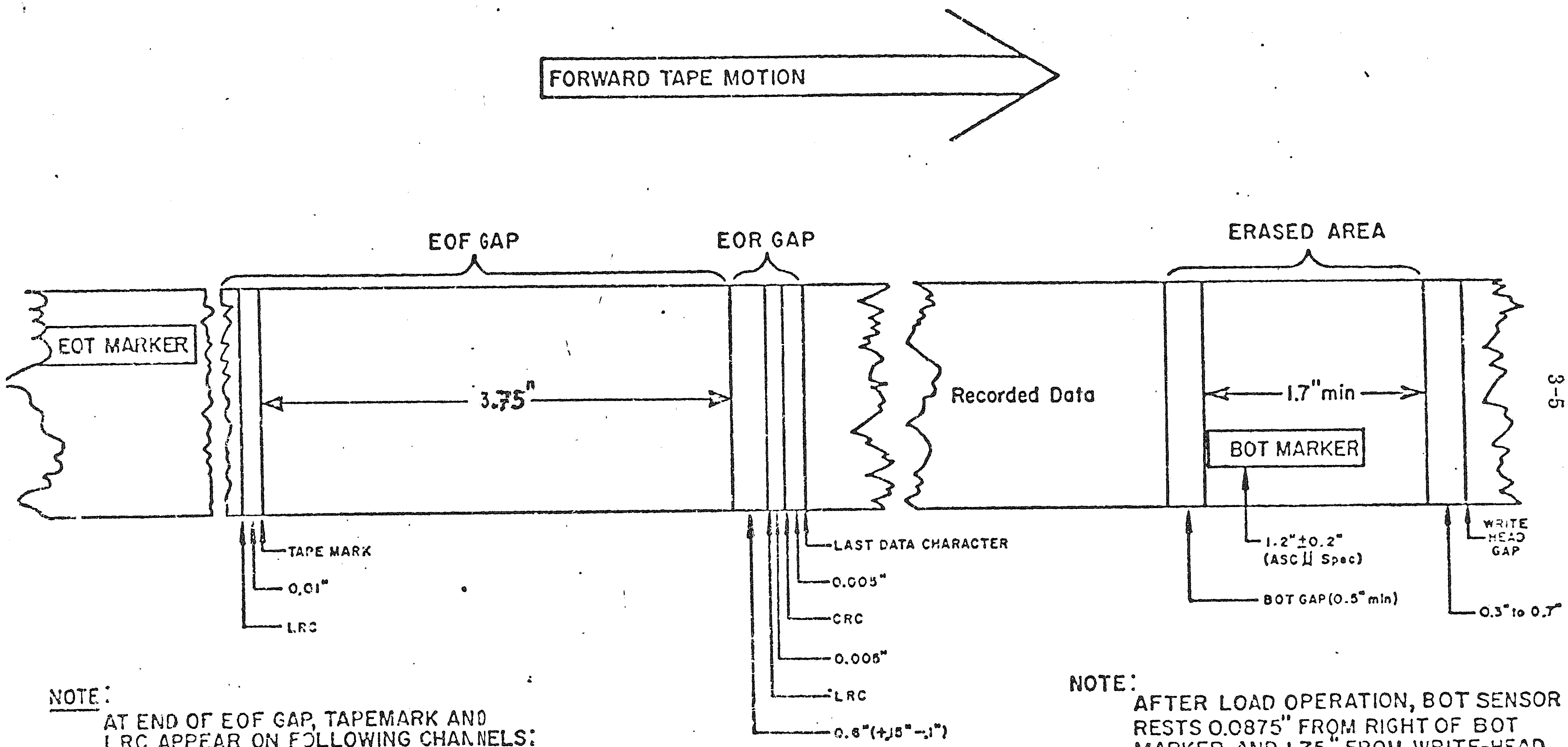
Track No.

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

7-TRACK TAPE:

Track No.

		B	A	8	4	2	1			B	A	8	4	2	1
		Byte 1									Byte 2				



NOTE:
AT END OF EOF GAP, TAPEMARK AND LRC APPEAR ON FOLLOWING CHANNELS:
7 TRACS = 1,2,4,8
9 —"— = 6,3,7

NOTE:
AFTER LOAD OPERATION, BOT SENSOR RESTS 0.0875" FROM RIGHT OF BOT MARKER, AND 1.75" FROM WRITE-HEAD GAP.

Figure 10. Tape Format (IBM-Compatible 800 bpi Operation)

4 ERROR CHECKING

There are three methodes of detecting an error on the tape.

1. Vertical parity
2. Longitudinal parity
3. CRC Character (only for 9 tracks)

4.1 Vertical Parity

Vertical parity checking is a method of detecting bit dropout in a character during read and write.

Seven tracks tape use even or odd parity depending on application.

Nine tracks tape use odd lateral parity): the total amount of 1 bits in a character written on the tape shall have an odd number.

4.2 Longitudinal Parity

Longitudinal parity check monitors all tracks to ensure the presence of an even number of one bits in each track.

A check bit is written at the end of each track having an odd number of bits, the total number of bit in the track, including the check bit is now even. The vertical combination of these longitudinal check bits makes up the longitudinal check character (LRC).

On seven tracks tape, this character is written four character spaces after the last data character.

On nine tracks tape, the LRC character is written four character spaces after the CRC character.

The LRC character is written on the tape by returning all the write heads to magnitzing tape in the reset flux state. During read and read after write, all data from tape is clocked into the LRC register.

If all tracks contains an even number of one bits, the LRC register will be set to zero when the LRC character is clocked into the register, if not, an LRC error is detected.

The vertical parity of the LRC character is ignored during Read.

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4.3 C R C - C h a r a c t e r

At the end of each record, a character is written on tape, four bit times after the last data character, and four bit times before the LRC-character, for possible recovery of single track errors.

This character is called the Cyclic Redundancy Check-Character (CRCC).

In end of file gaps, no CRC character is written. Consider the content of a 9 bits register to be:

- CRCP, CRC0 - CRC7.

The CRC character is derived as follows:

a) All data characters in the record are added to the CRC register (each bit position is exclusive OR'ed to CRC_n).

b) Between each addition the CRC register is shifted one position CRCP CRC0 and CRC0 CRC1 etc.

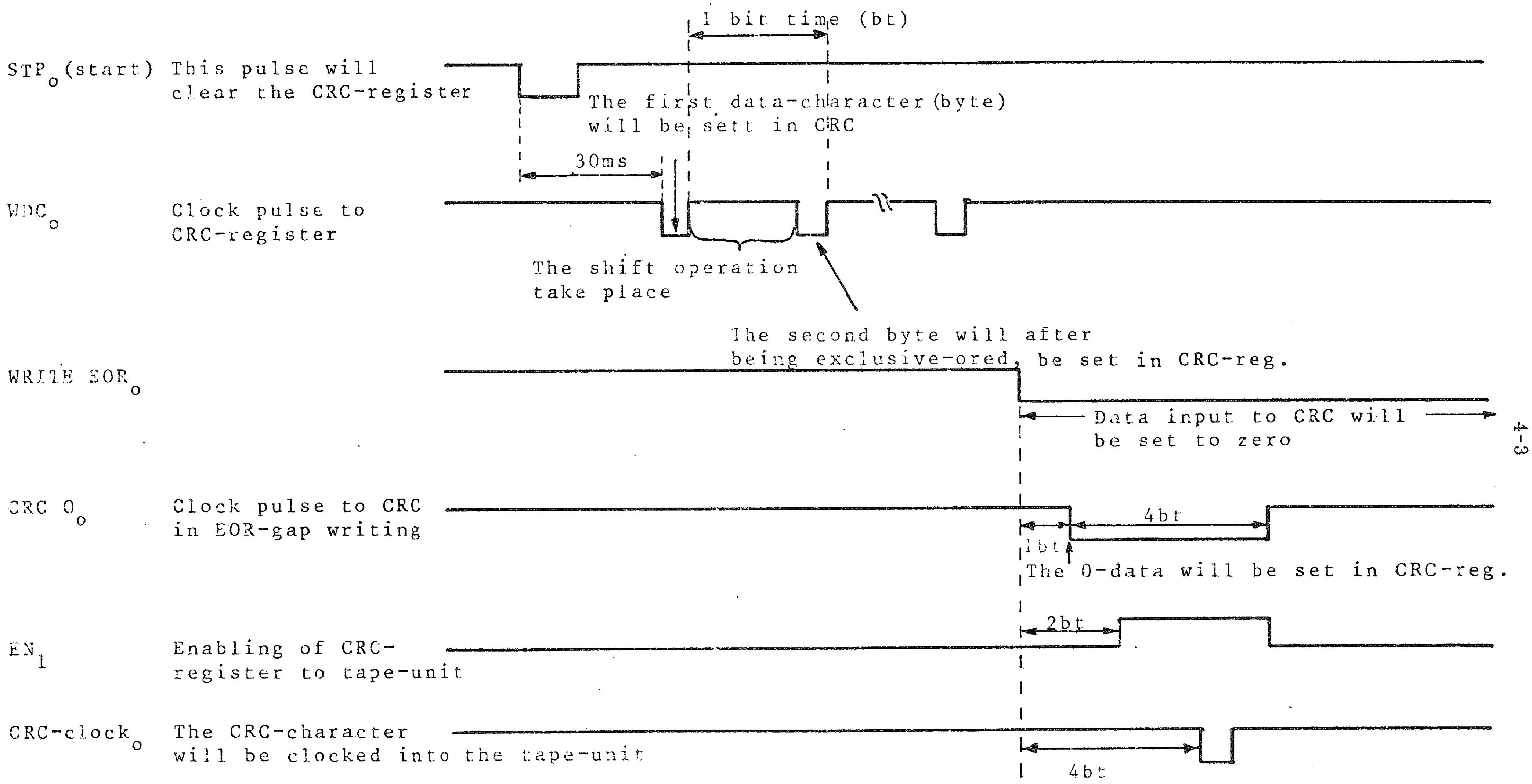
c) If shifting will cause CRC7 to become 1, then the bits being shifted into position CRC2, CRC3, CRC4 and CRC5 are inverted.

d) After the last data character has been added, the CRC register is shifted once more time (with the register input set to 0) according to 2,3 above.

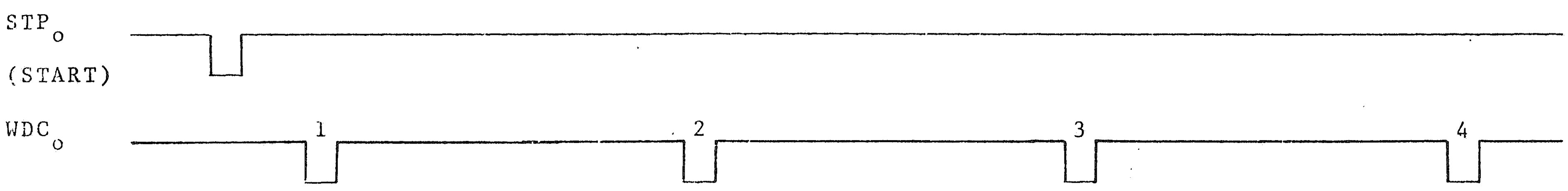
e) To write the CRC character on tape, the contents of all positions except CRC2 and CRC4 are inverted.

4.3.1 CRC-timing during Write

CRC-TIMING DURING WRITE



CRC TIMING



CRC P_1	0	1	1	0	0	1	1	0
CRC 0_1	0	1	1	0	0	1	1	0
CRC 1_1	0	1	1	0	0	1	1	0
CRC 2_1	0	1	0	1	0	1	0	1
CRC 3_1	0	1	0	1	1	0	0	1
CRC 4_1	0	1	0	1	1	0	1	0
CRC 5_1	0	1	0	1	1	0	1	0
CRC 6_1	0	1	1	0	1	0	0	1
CRC 7_1	0	1	1	0	0	1	0	1

The content of the CRC Register during write.
(Data input = all ones, parity is odd): one)

Redundancy Check Character (CRCC), as written on tape if block is ended after n steps.
(Data inputs = all ones, parity is odd): one)

n_8=	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17	20	21	22	23	24	25	26	27	30	31	32	33	34	35	36	37	40	41	42
n=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
P	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1
0	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1
1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1
2	0	0	0	1	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	1	1	0
3	1	0	1	1	1	1	0	0	0	1	1	1	1	0	1	1	0	0	1	0	0	0	0	1	1	1	0	0	0	0	1	0	0	1
4	0	1	1	0	1	1	1	0	1	1	0	0	1	1	1	1	0	0	1	1	0	1	1	1	0	1	1	0	0	1	1	1	1	0
5	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1
6	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1
7	0	1	1	0	0	0	0	1	1	1	1	0	0	1	0	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1

Cyclic Redundancy Check Character is periodic the character written on tape n = 35 is the same as that for n = 1; the character for n = 36 corresponds to n = 2, etc.

NOTE: The character written on tape is not the same as the character contained in the Cyclic Redundancy Check Register (CRCR) after n steps.

5 PROGRAMMING SPECIFICATION OF HP MAG. TAPE CONTROLLER

Mag. Tape device no.: 520 - 527

	IOX
READ CORE ADDRESS	520
LOAD CORE ADDRESS	521
READ STATUS	524
LOAD CONTROL	525
READ BAR (TEST)	526
LOAD WORD COUNT	527
LOAD BAR (TEST)	523

Read Status:

	Dec	Oct	
Bit	0	0	Ready interrupt enabled (cleared by the interrupt)
	1	1	Error interrupt enabled (cleared by the interrupt)
	2	2	Device active
	3	3	Device ready for transfer
	4	4	Inclusive or of error bit (6, 9, 10, 11 and 12) or if a reverse command is tried when the unit is at load point.
	5	5	Write enable ring present
	6	6	LRC error
	7	7	EOF detected
	8	10	Load point (this status is remained also after the first forward command after load point is detected)
	9	11	EOT detected
	10	12	Parity error
	11	13	DMA error
	12	14	Overflow in read
	13	15	Density select 1 = 800 bpi, 0 = 556 or 200 bpi
	14	16	Mag. Tape unit ready (selected, on line and not rewinding)
	15	17	Bit 15 loaded by previous control word

Load Control:

Bit	0	Enable interrupt on device ready for transfer
	1	Enable interrupt on errors
	2	Activate device
	3	Test mode
	4	Device clear
	5	Address bit 16
	6	Address bit 17
	7	Read odd number of character
	8	Even parity (only to be used while writing/reading ASC II information on 7 tracks)
	9	Unit select — Up to 4 units
	10	Unit select
	11	Device operation code
	12	Device operation code
	13	Device operation code
	14	Device operation code
	15	

Device Operation Code:

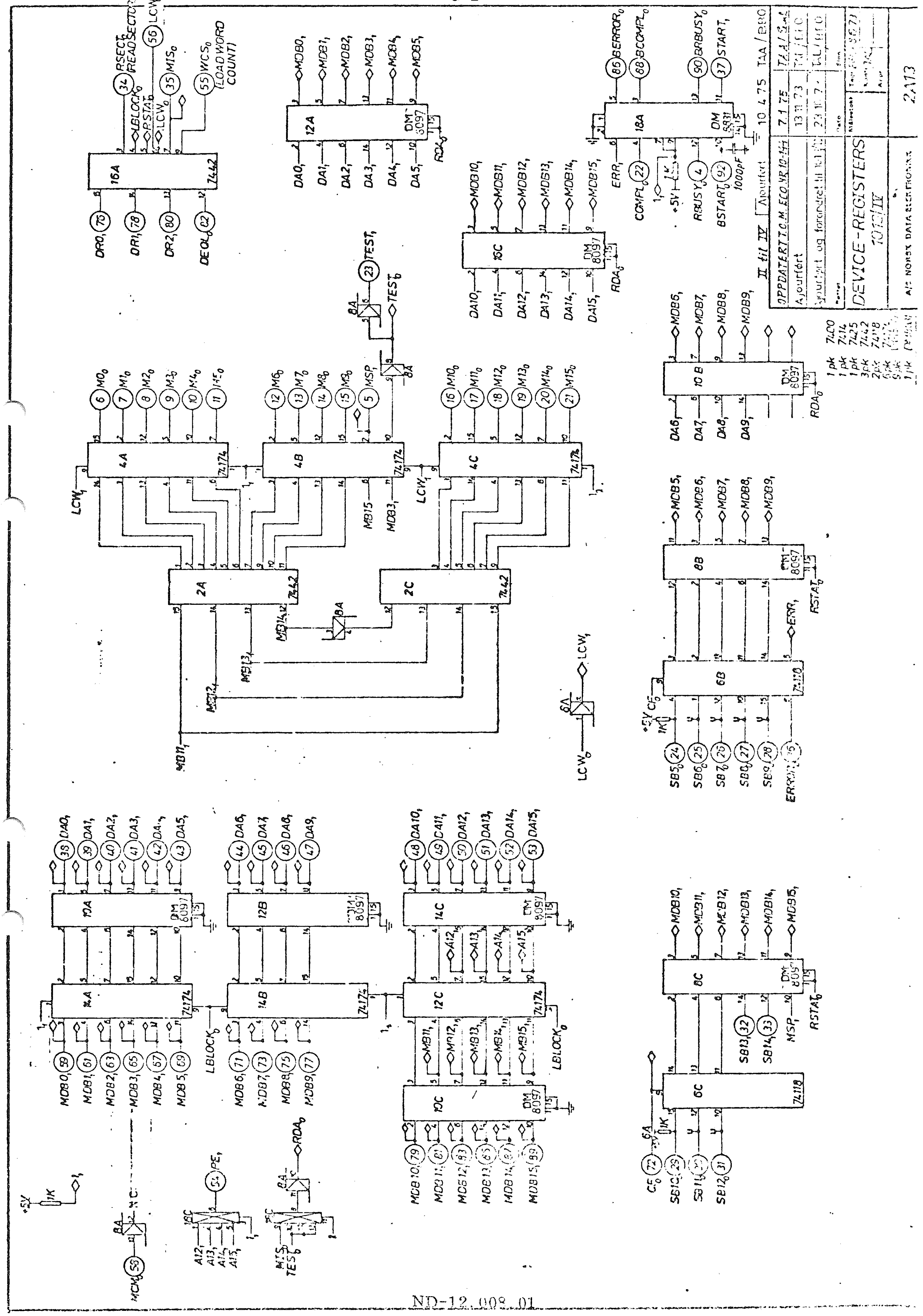
Bit:	14	13	12	11		
	0	0	0	0	Read one record	M0
	0	0	0	1	Write one record	M1
	0	0	1	0	Advance to EOF	M2
	0	0	1	1	Reverse to EOF	M3
	0	1	0	0	Write EOF	M4
	0	1	0	1	Rewind	M5
	0	1	1	0	Erase gap (4 inches)	M6
	0	1	1	1	Backspace one record	M7

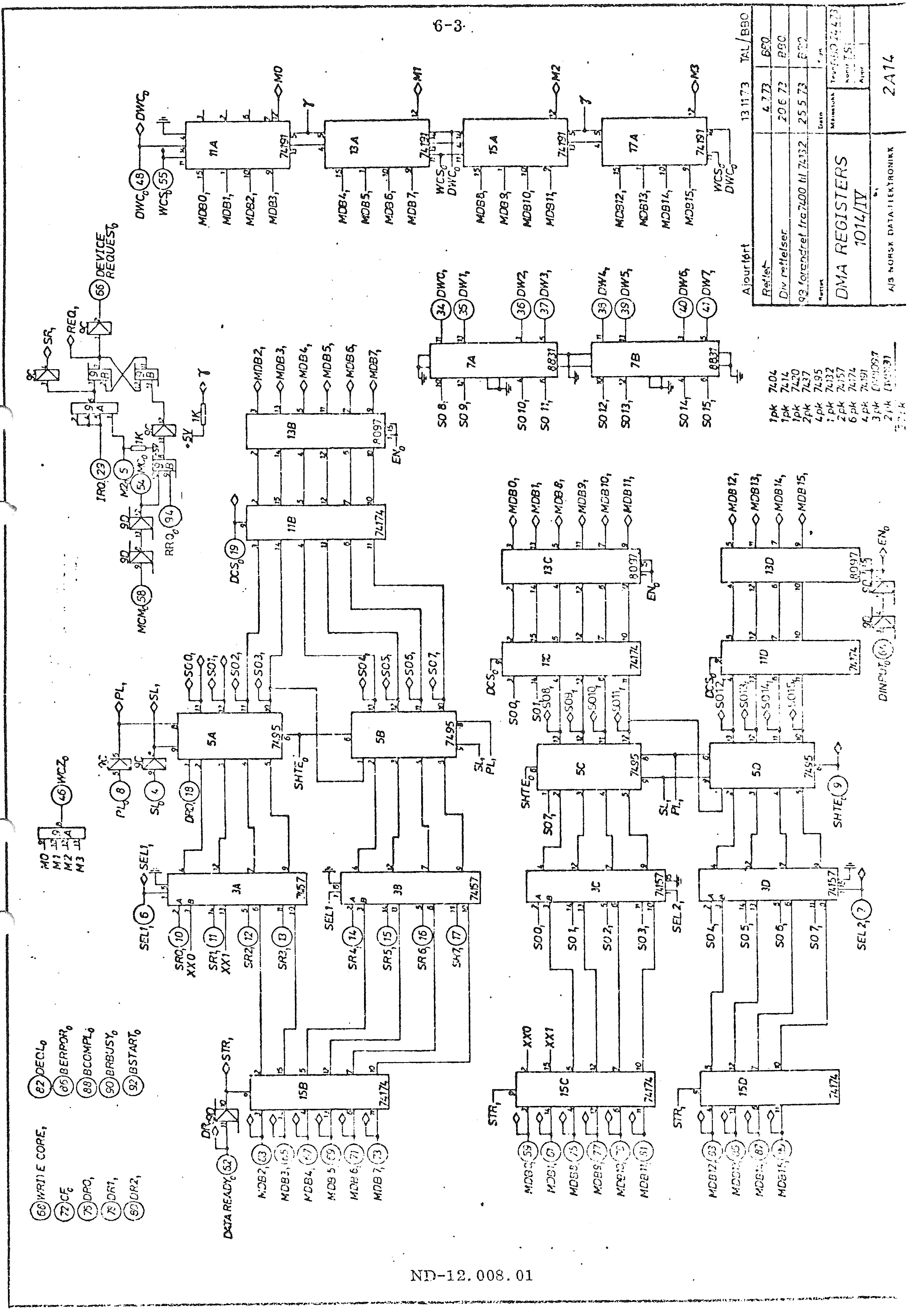
Interrupt

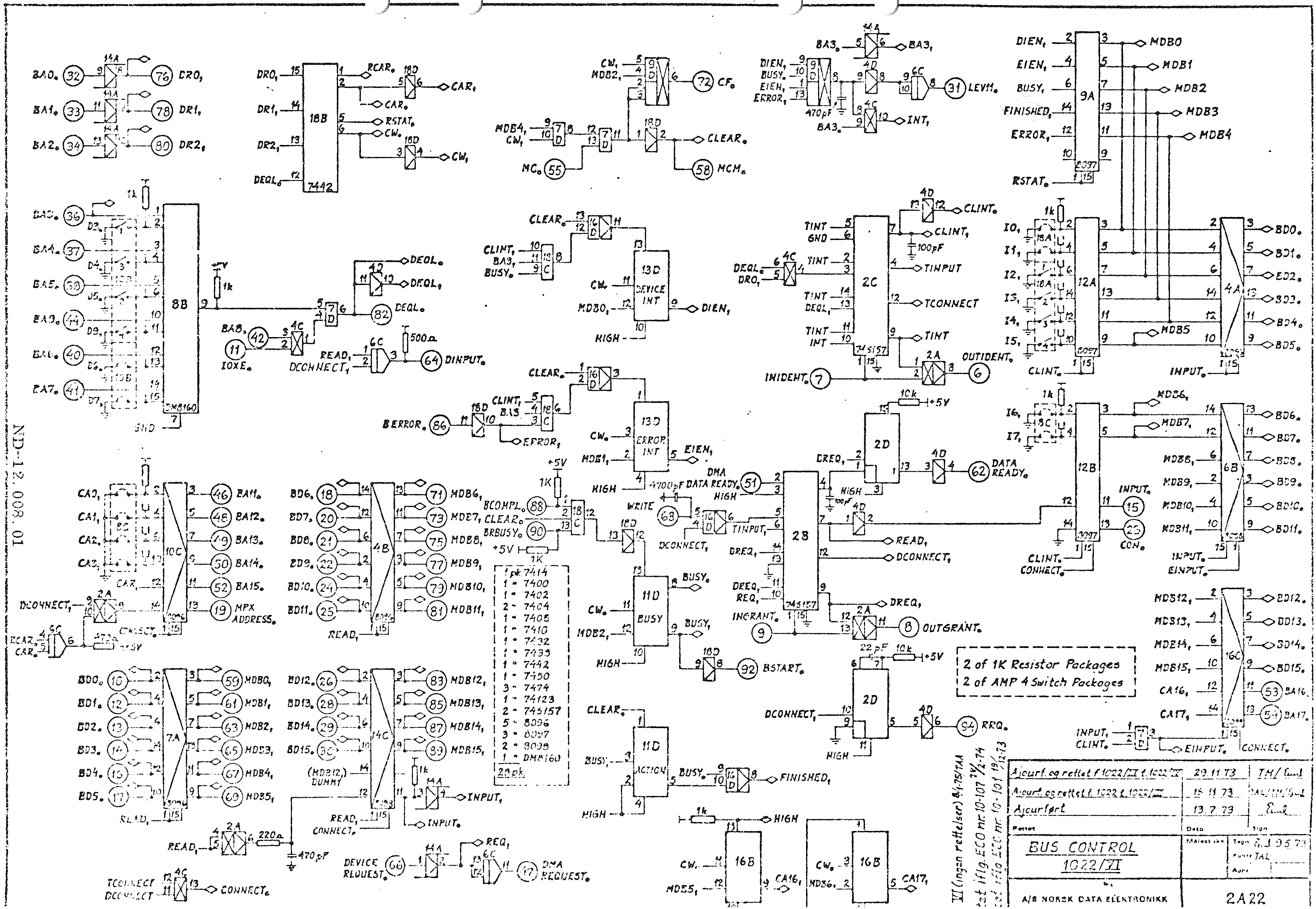
The MT interrupt level is 11 and the ident number for the first MT system is 3.

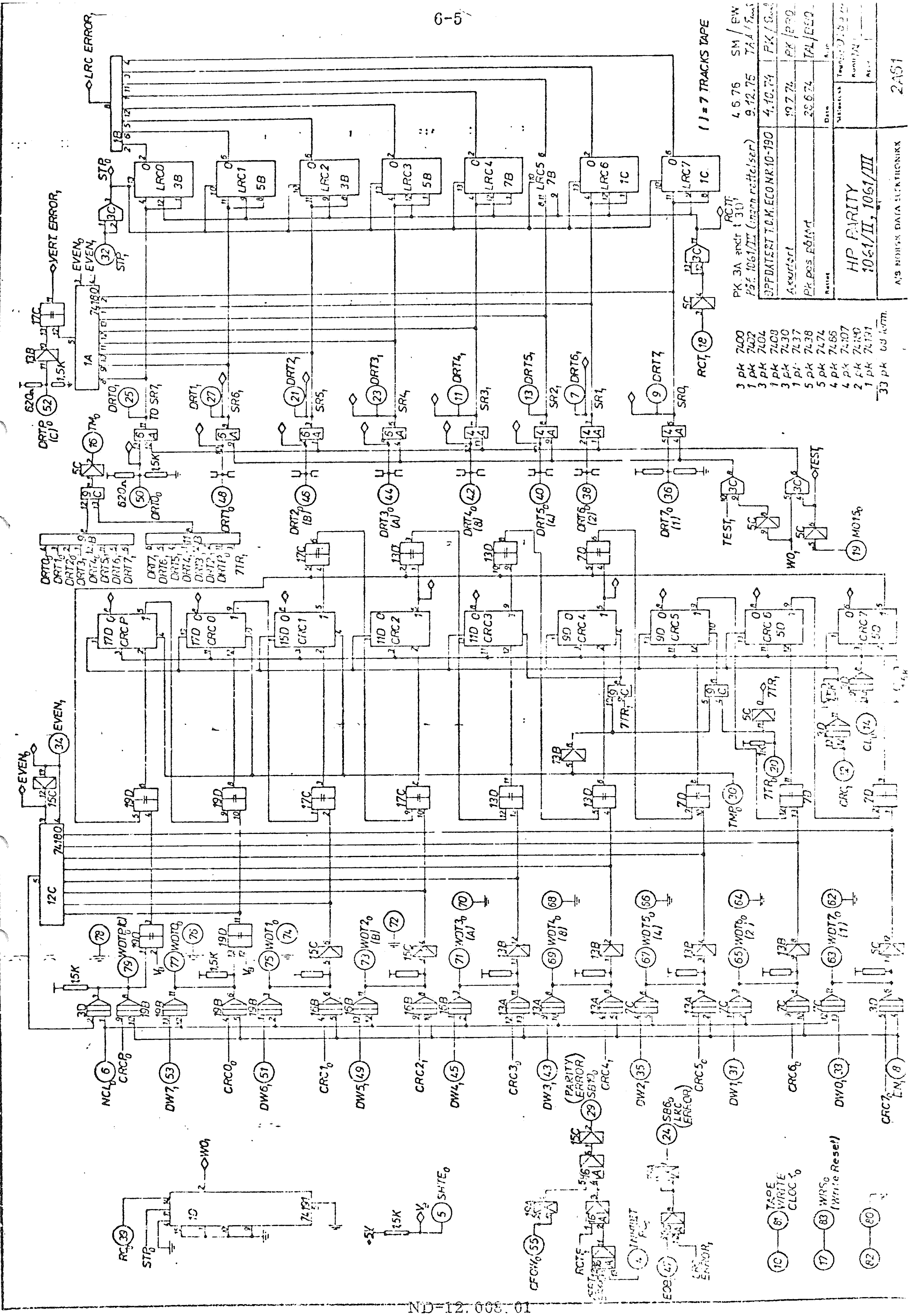
6 HARDWARE DESCRIPTION

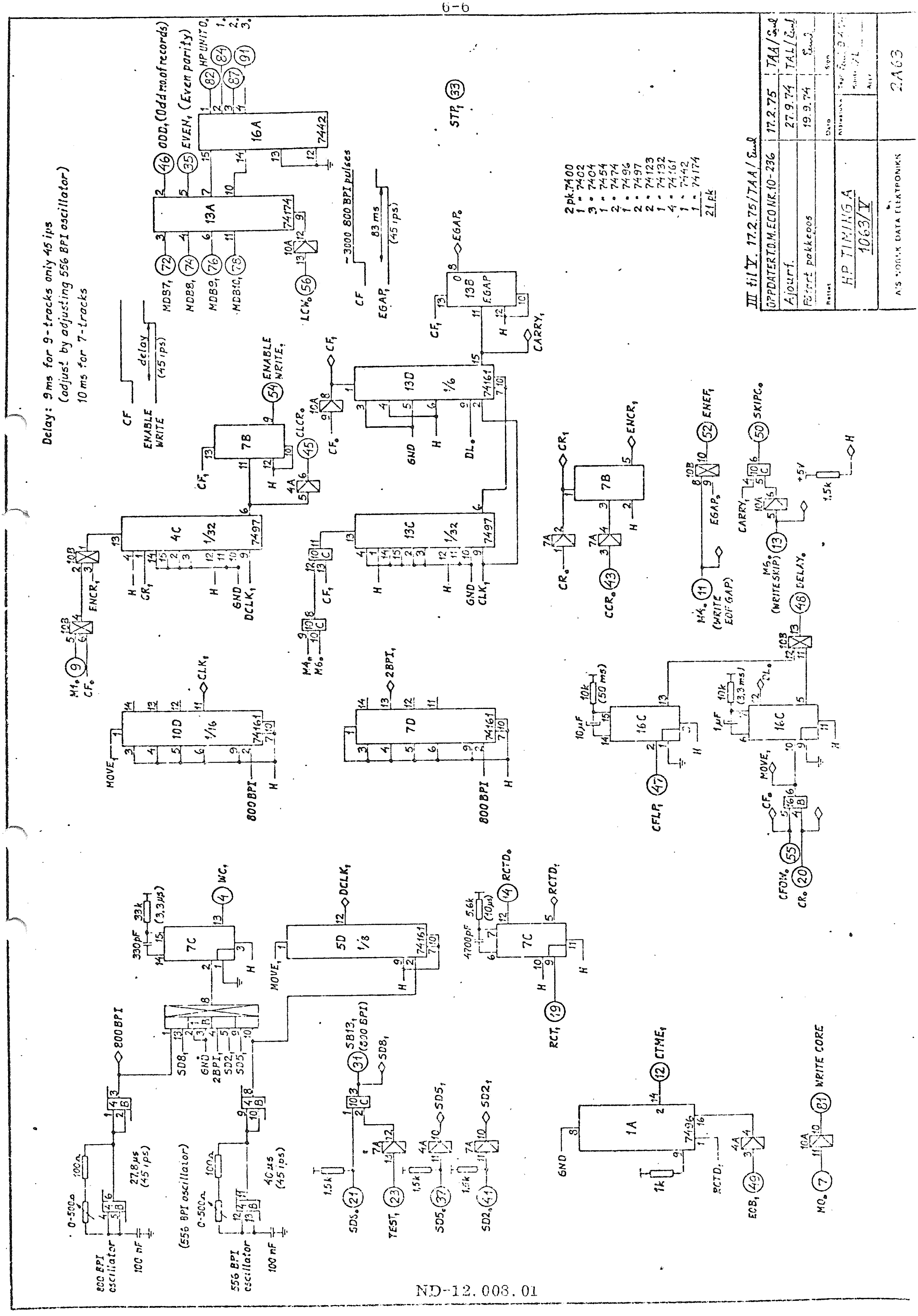
6.1 Logic Diagrams


DEVICE-REGISTERS
1013/IV
2A13

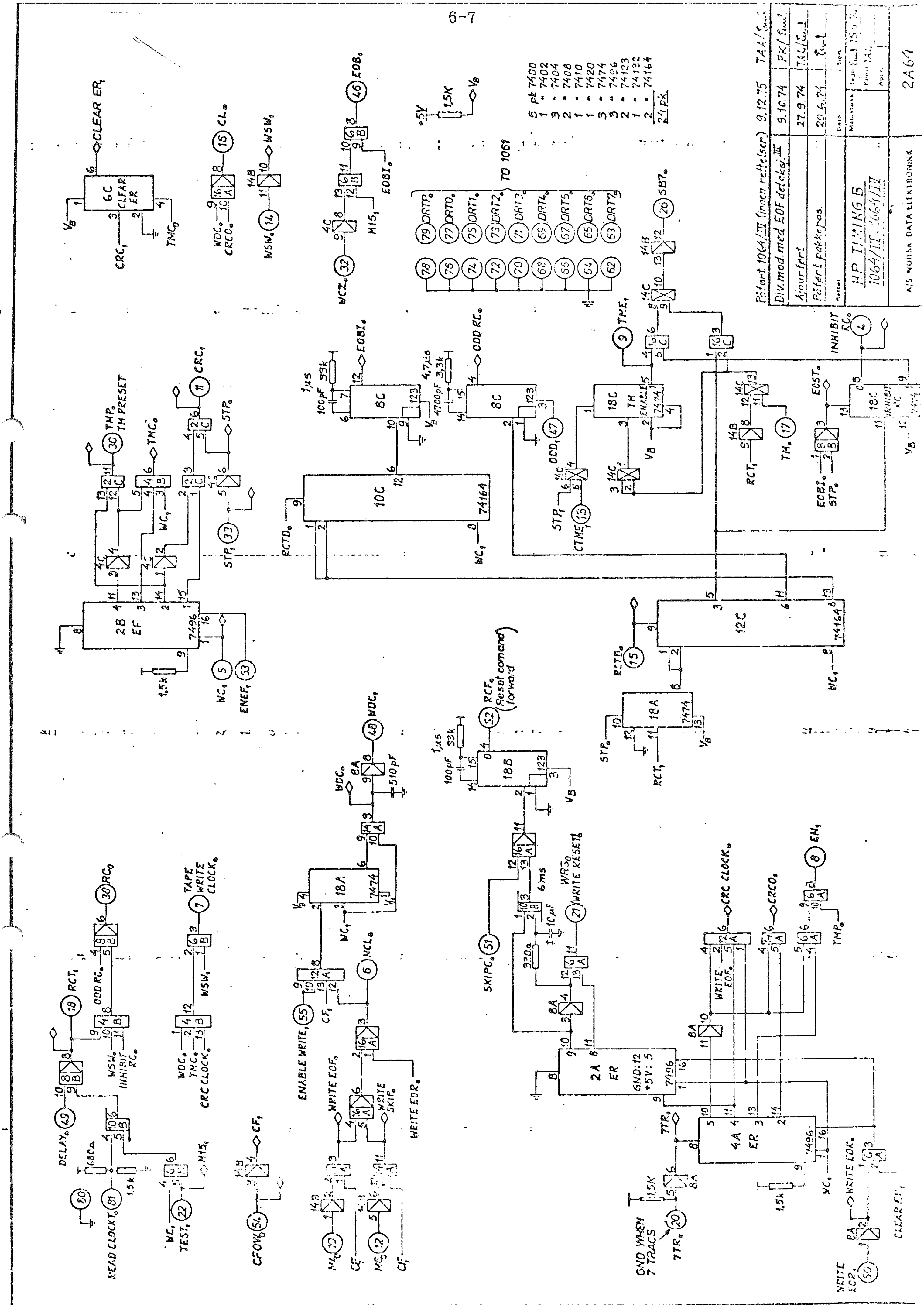

DMA REGISTERS
1014/IV
A/S NORSK DATA-ELEKTRONIKK
2A14
Ajourført
Rettet
Div rettelser
93 forandret fra 7400 til 7432
13.11.73
4.7.73
20.6.73
25.5.73
TAL/BBO
BBO
DEVICE REQUEST
DATA READY
WRITE CORE

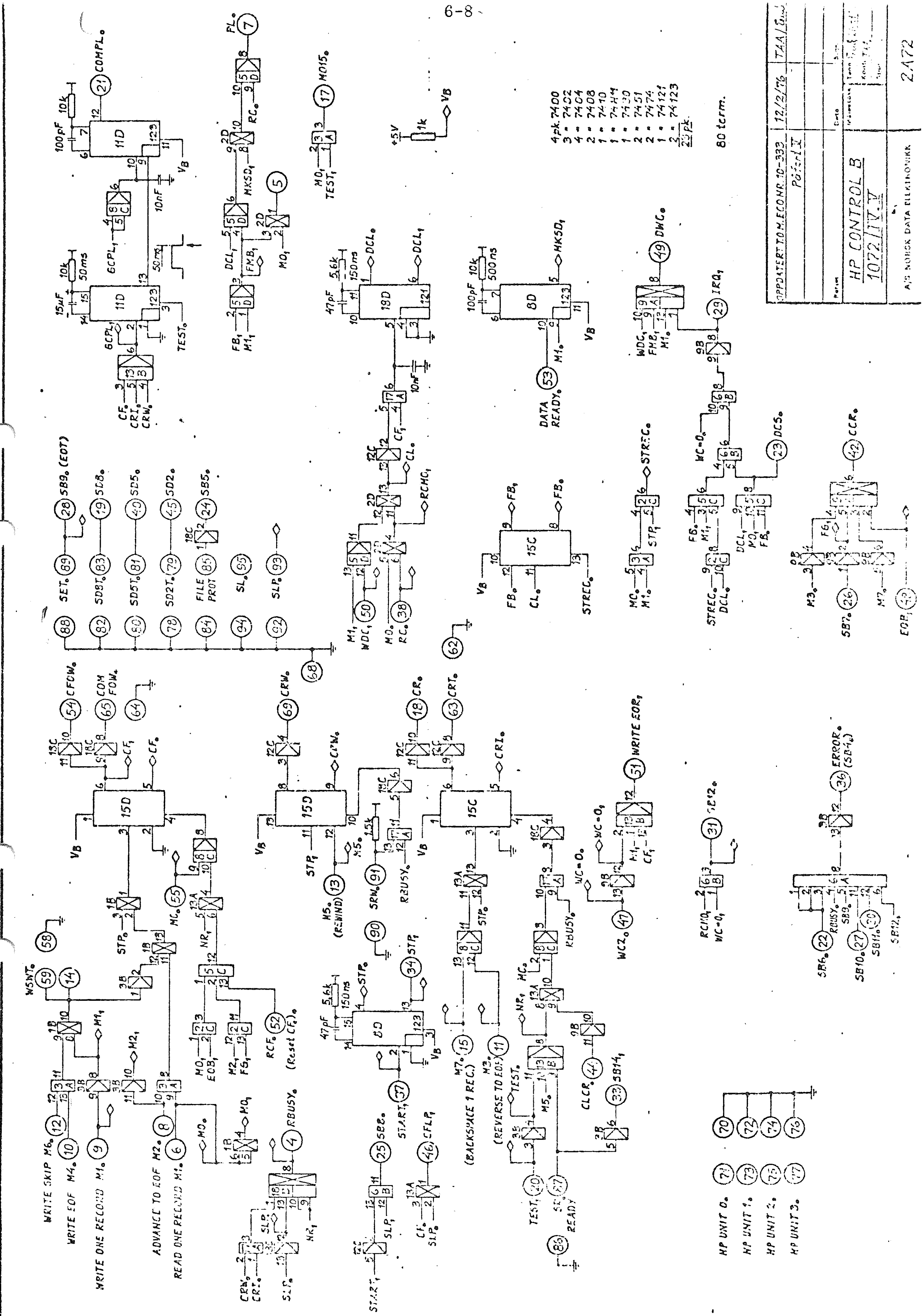

BUS CONTROL
1022/II
A/S NORSK DATA ELEKTRONIKK
2A22
Ajourf. og rettet f. 1022/II & 1022/III 29.11.73
Ajourf. og rettet f. 1022 & 1022/III 15.11.73
Ajourført 13.7.73
2 of 1K Resistor Packages
2 of AMP 4 Switch Packages
1 pk 7414
1 - 7400
1 - 7402
2 - 7404
1 - 7405
1 - 7410
1 - 7432
1 - 7433
1 - 7442
1 - 7450
3 - 7474
1 - 74123
2 - 745157
5 - 8096
3 - 8097
2 - 8098
1 - DM8160
28 pk.


LRC ERROR
VERT ERROR
(1) = 7 TRACKS TAPE
HP PARITY
1061/II, 1061/III
A/S NORSK DATA ELEKTRONIKK
2A51

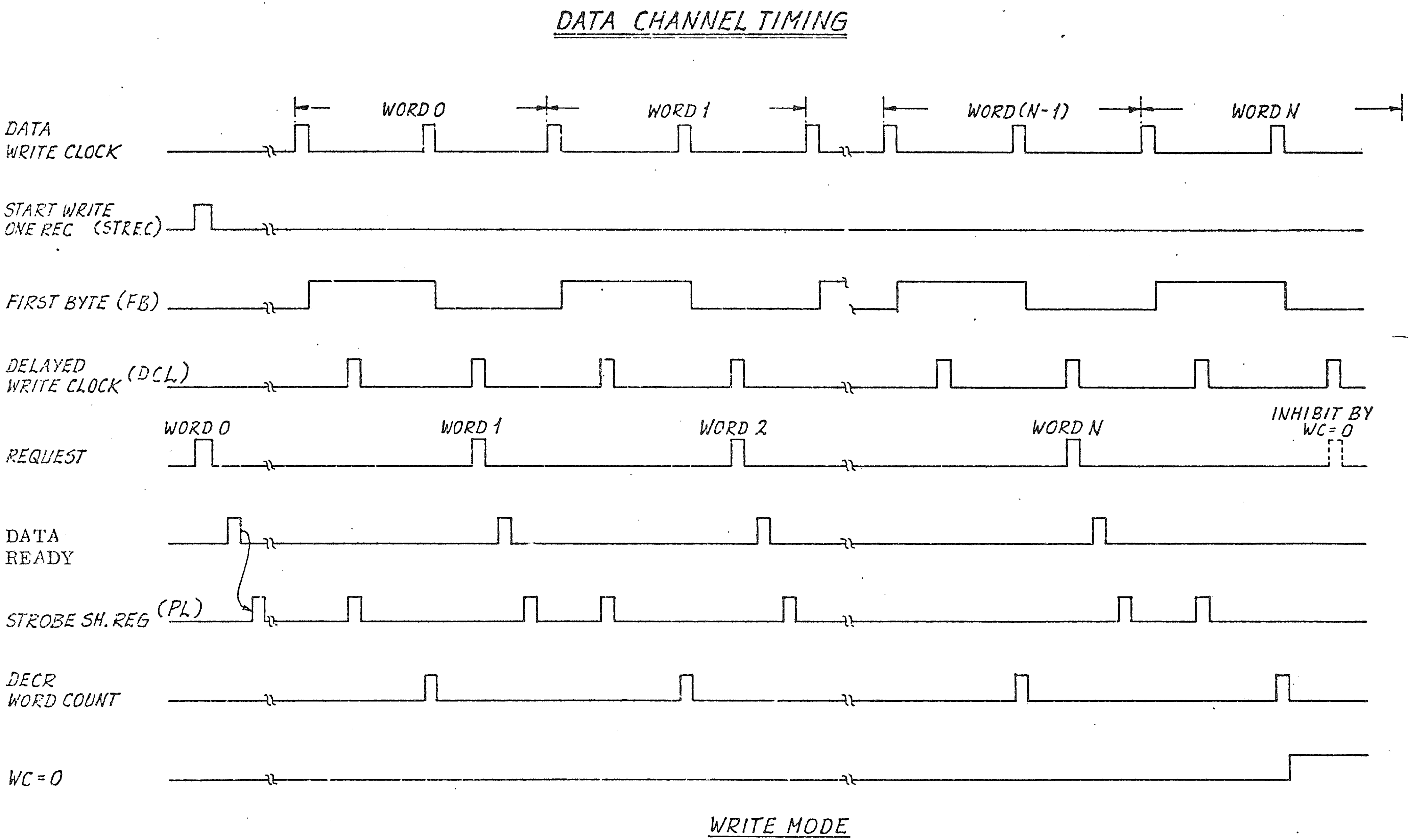


Delay: 9 ms for 9-tracks only 45 ips
(adjust by adjusting 556 BPI oscillator)
10 ms for 7-tracks
~3000 800 BPI pulses
83 ms
(45 ips)
800 BPI oscillator
556 BPI oscillator
WRITE CORE
2 pk 7400
1 " 7402
3 " 7404
1 " 7454
2 " 7474
2 " 7496
1 " 7497
2 " 74123
1 " 74132
4 " 74161
1 " 7442
1 " 74174
21 pk
III til V. 17.2.75/TAA
OPPDATERT O.M. ECO NR. 10-236
17.2.75
TAA
Ajourf.
27.9.74
TAL
Første pakke 005
19.9.74
HP TIMING A
1063/V
A/S NORSK DATA ELEKTRONIKK
2A63


HP TIMING B
1064/II, 1064/III
A/S NORSK DATA ELEKTRONIKK
2A64
Påført pakkepos.
Kjørt.
Div. mod. med EOF detekt. III
TO 1061
CLEAR ER
12C
10C
2B EF
2A ER
4A ER
18B
18A
8C
18C


HP CONTROL B
1072/IV.V
A/S NORSK DATA ELEKTRONIKK
2.172
80 term.
4pk 7400
3 = 7402
4 = 7404
2 = 7408
1 = 7410
1 = 7474
1 = 74121
2 = 74123

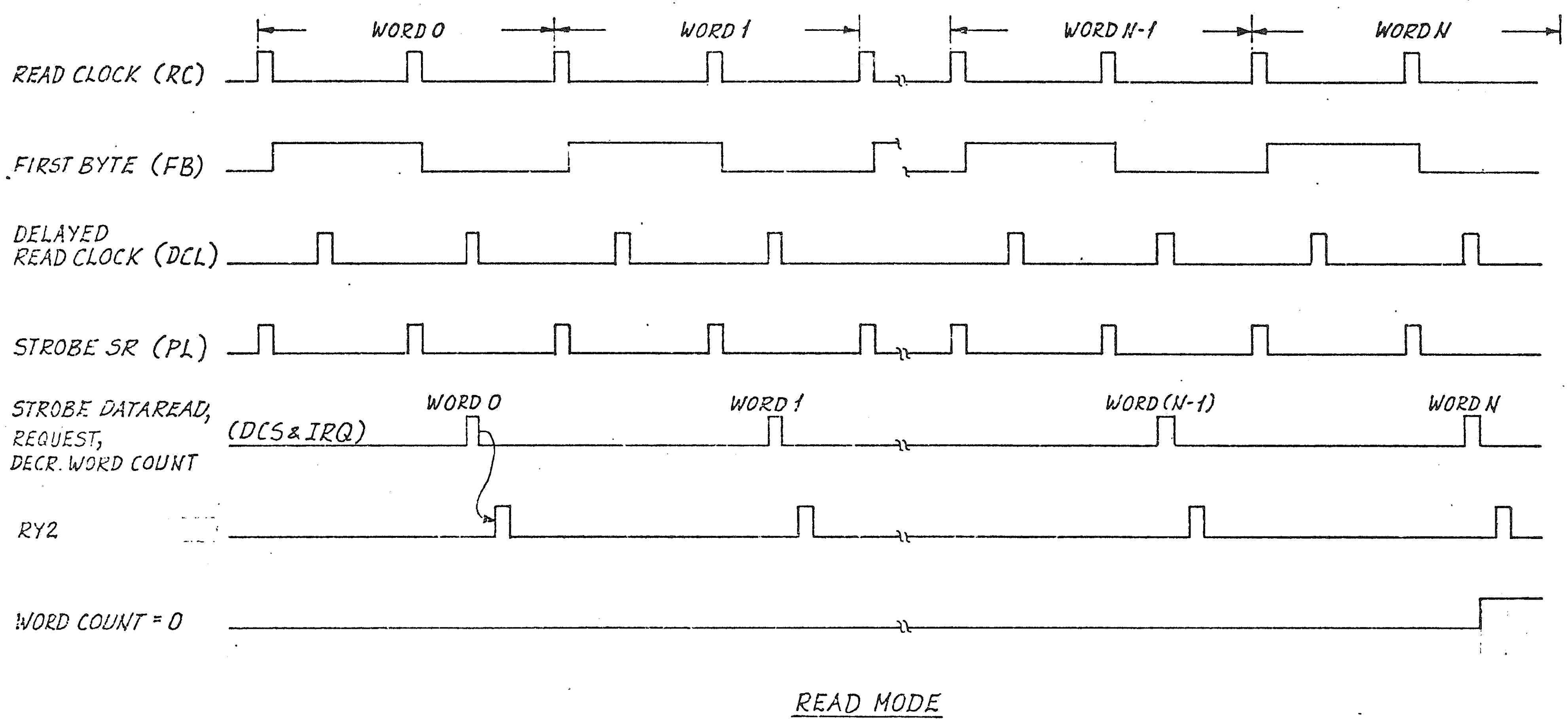
6.2 Timing Diagrams



6.2.1 Data Channel Timing Write Mode

22.12.70
TAL/Eeml

DATA CHANNEL TIMING

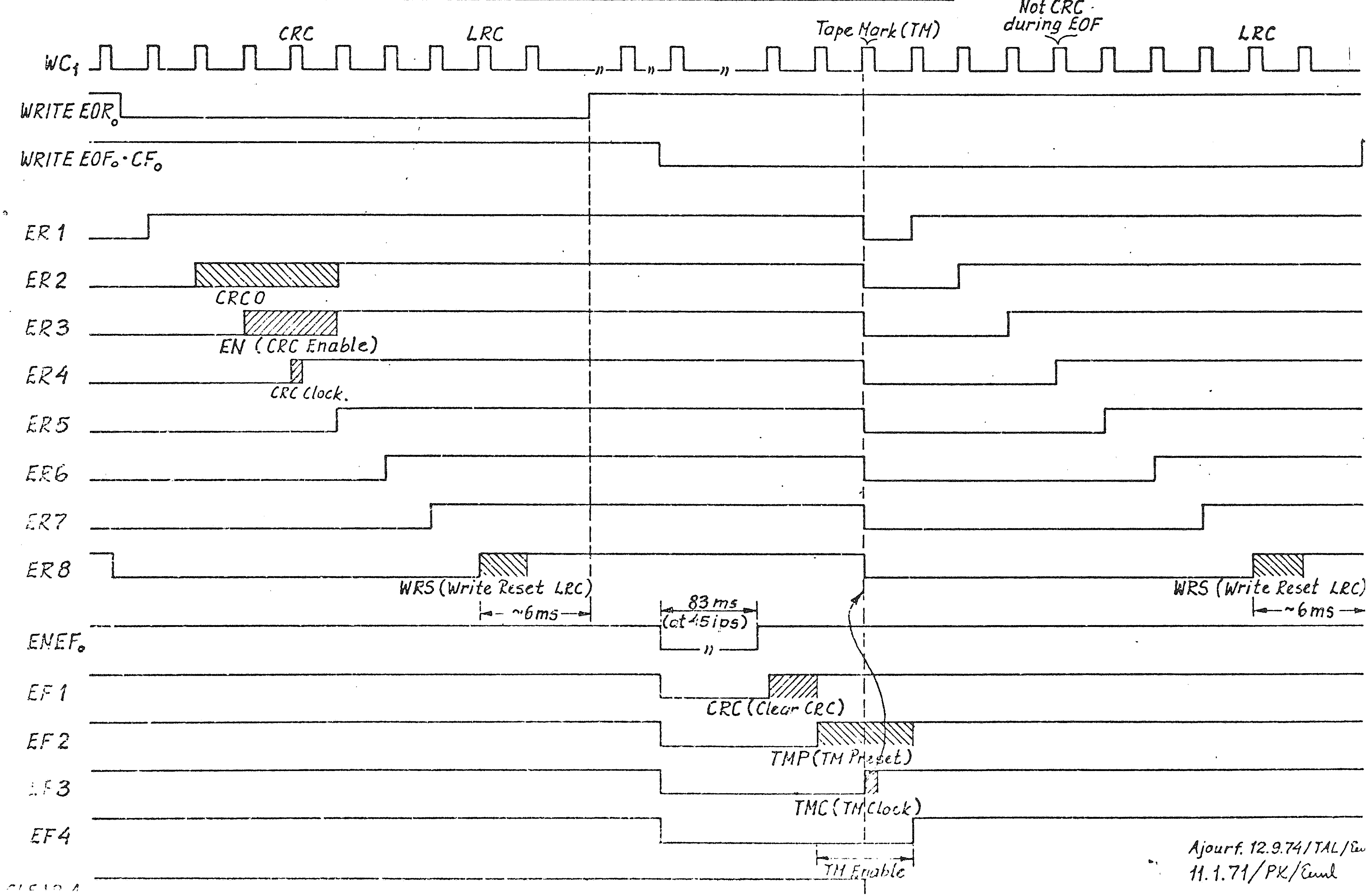


6.2.2 Data Channel Timing Read Mode

22.12.70
TAL/Eml

6.2.3 Write Gap Timing 9 Tracks

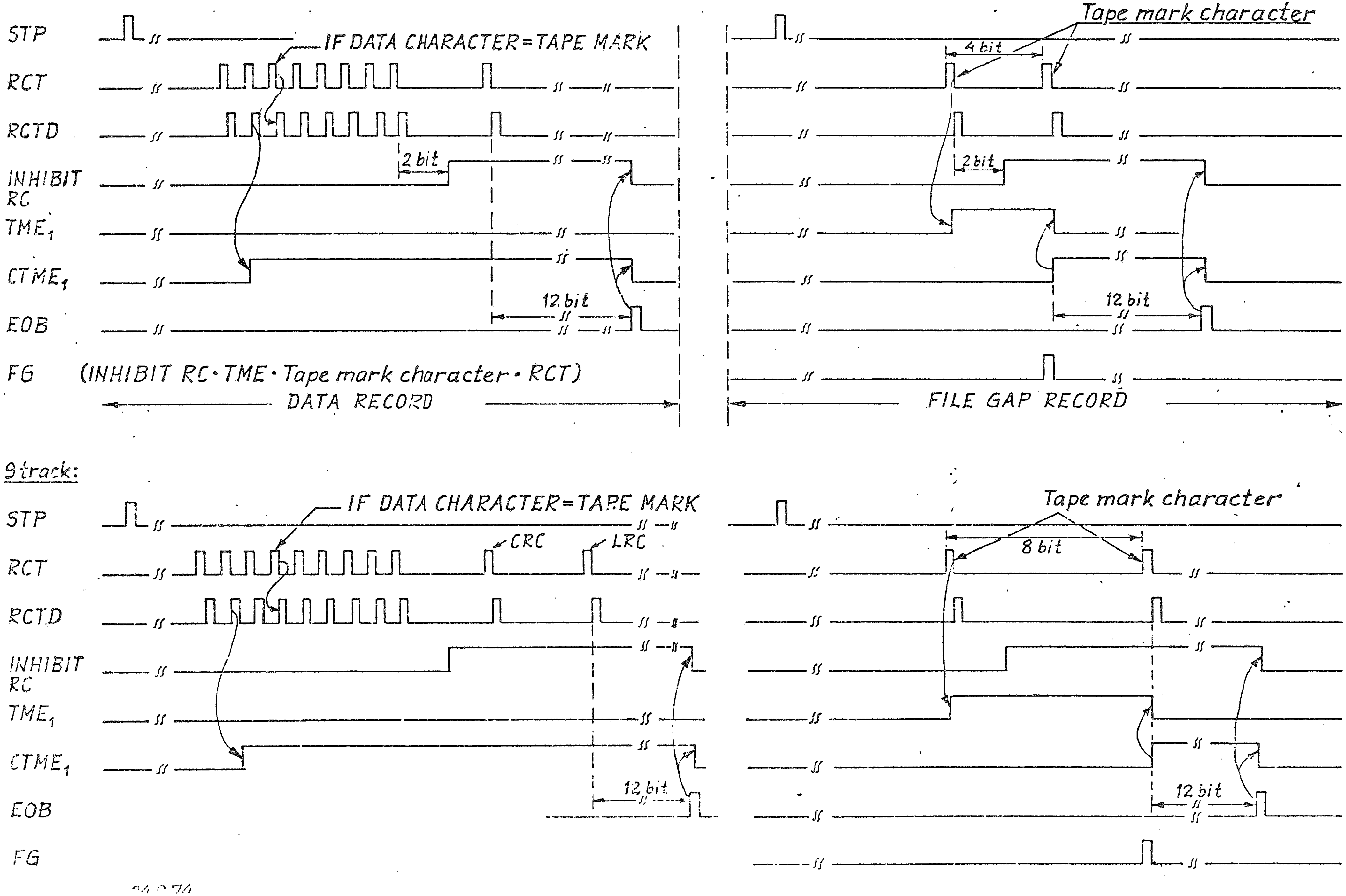
WRITE GAP TIMING (9 TRACKS) - HP MAG TAPE



Ajourf. 12.9.74/TAL/
11.1.71/PK/

6.2.4 Tape Gap Detection

TAPE GAP DETECTION - HP MAGTAPE



6.3 Signal Definitions

Name	Source	Description
CCR	1072	Necessary clear condition for CR (command reverse) M7•EOB+M3•SB7.
CFLP	1072	CF LOAD POINT.
CFOW	1072	Command forward .
CL	1064	Clocks to the CRC register.
CLCR	1063	Clear reverse command flip/flop generated ~10ms after EOB or file mark is detected .
COM FOW	1072	CFOW directly to tape unit.
COMPL	1072	Completion pulse 50 ms after a command is completed when not in test mode. In test mode the completion pulse is given immediately.
CR	1072	Command reverse
CRC	1064	Clear CRC register
CRT	1072	CR directly to tape unit
CRW	1072	Command rewind directly to tape unit
CTME	1063	Clear pulse to the TME flip/flop
DCS	1072	Strobe data into data read register (1014)
DELAY	1063	To prevent Read Clocks from the tape unit after 50 ms from the Load Point mark or until after 3,3 ms from a move command is given
DEV. REQUEST	1014	Device request. Transmitted to the 1022 card.
DRTX	1061	SR (7-X) Data bits from the tape unit or from the test pattern.
DWC	1072	Decrement word counter (1014)

Name	Source	Description
DWX	1014	Data bit X from the shift register.
EN	1064	Enable CRC-data (CRC check)
ENABLE WRITE	1063	Enables write clocks to the tape unit
ENEF	1063	Enable signal starts writing of the tape mark character
EOB	1064	1 pulse after 12 read clocks are missing
ERROR	1072	Status bit 4 (SB6+SB9+SB10+SB11+SB12+RBUSY)
EVEN	1063	The control command: read or write with even parity
HP UNIT X	1063	Select signal to select mag. tape unit X
INHIBIT RC	1064	Set if 2 READ CLOCK pulses are missing. Reset by (EOB + STP)
IRQ	1072	Initiate request
MC	1014	Master clear
MIS	1013	Read Block Address Register if testmodus is already set
MO15	1072	MO • TEST
MX	1013	Modus bit X loaded by the IOX LOAD CONTROL WORD M0 = Read one record M1= Write one record M2= Advance to EOF M3= Reverse to EOF M4= Write EOF M5= Rewind M6= Erase gap M7= Backspace one record
NCL	1064	No clocks. To prevent Write Data clocks during write EOR, EOF and SKIP. On the 1061 card the signal is used to disable the DWX data.

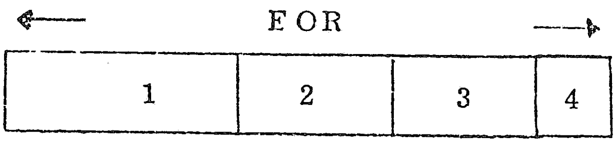
Name	Source	Description
ODD	1063	The control command: read odd number of characters
PL	1072	Parallel load of shift register (1014)
RBUSY	1072	Reset busy. Reset if the tape unit is not ready while not test modus or if a reverse command is given when the tape is positioned at load point
RC	1064	Read clock, either from the tape unit or from the clock oscillator in test mode
RCF	1064	Reset command forward during write operation. A pulse to reset CF appr. 6 ms after the CRC (WRS) is written if the operation was a write 1 record or write EOF, or the SKIPC signal if the command was a write skip.
RCF	1072	Reset CFOW (command forward)
RCT	1064	Read clocks from tape unit
RCTD	1063	Delayed read clock
SB5	1072	Write enable ring present
SB6	1061	Status bit 6, LRC error
SB7	1064	Status bit 7, file mark
SB8	1072	The unit is at load point and not busy
SB9	1072	End of tape detected (EOT)
SB10	1061	Status bit 10, parity error (vertical)
SB12	1072	Overflow in read, word count equals zero before the whole record is read
SB13	1063	Status bit 13, density = 800 BPI
SB14	1072	Mag. tape unit is ready and not rewinding
SD2	1072	Density selected is 200 BPI

Name	Source	Description
SD5	1072	Density selected is 556 BPI
SD8	1072	Density selected is 800 BPI
SEL	1072	Select core data to shift register (1014) $M0_o \cdot M1 \cdot FB$
SHTE	1061	Shift enable to shift register (1014) always false
SKIPC	1063	Completion signal for the write skip command
SRX	1061	Data bit X to the shift register (1014)
START	1013	Master enable signal set by the end of the instruction IOX LOAD CONTROL WORD with bit 2 (activate device), true.
STP	1072	500 ns pulse derived at positive transition of START.
TAPE WRITE CLOCK	1061	Write clock to the tape unit
TAPE WRITE CLOCK	1064	Write clock to tape unit (WDC + TMC + CRC CLOCK)
TEST	1013	Test modus
TME	1064	Tape mark enable. Set on detection of a tape mark character. Reset by (CTME + STP).
TMP	1064	Preset the CRC register with the tape mark character.
WC	1063	The main oscillator, 800, 556 or 200 BPI depending upon the density selected.
WCS	1013	Word count strobe.
WCZ	1014	Word counter equals zero.
WDC	1064	Write data clock.

Name	Source	Description
WDTX	1061	Data bits to the tape unit.
WRITE CORE	1063	Control signal to enable write to core.
WRITE EOR	1072	Writing of data characters is completed (WCZ·MI·CF)
WRITE RESET	1061	A pulse to the tape unit 8 clock pulses after EOR or tape mark clock for 9 tracks and 4 clock pulses after the above conditions for 7 tracks.
WRS	1064	Command to mag. tape unit to generate CRC character.
WSW	1072	Set write mode in tape unit (1 + M4 + M6)
WSWT	1072	WSW directly to tape unit.
7TR	1064	Seven tracks mag. tape unit.

6.4 GAP Generation

6.4.1 EOR GAP



1- delay of 0,3" (6ms at 45 ips) after EOR gap command is issued until the signal reset command forward (RCF) is generated. This is to insure complete readback during read after write- this gap compensates for the physical distance between read and write head:

7 tracks = 0,3"
9 tracks = 0,15"

2 - stop distance = 0,19" Start/stop time = 8.33 ms at 45 ips.

3 - Start distance = 0,19"

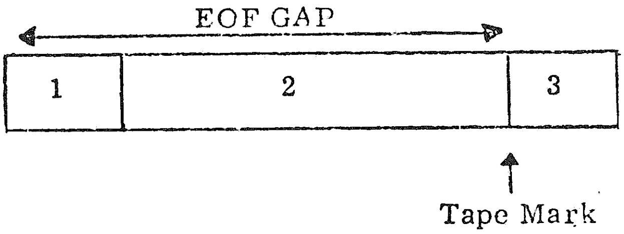
4 - delay after the tape is up to speed until it is actually written on. 9 tracks tape 0,6ms, 0,03", 7 tracks tape 1,6ms, 0,08" all at 45 ips.

Total length of EOR GAP is:

0,3 + 0,19 + 0,19 + 0.03 = 0,71" (9 tracks only)

0,3 + 0,19 + 0,19 + 0.08 = 0,76" (7 tracks or 7 and 9 tracks)

6.4.2 EOF GAP

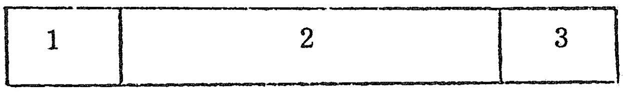


1 - start distance = 0,19"

2 - delay before tape mark is written ~ 2800 pulses of the 800 BPI clock = 3,5"

3 - EOR GAP

6.4.3 Erase GAP



1 - start distance = 0,19"

2 - erase distance ~ 2800 pulses of the 800 BPI clock = 3,5"

3 - stop distance = 0,19"

6.5 Clock Adjustments

9 Tracks only

The oscillators on the 1063 card should be adjusted as follows:

The 800 BPI oscillator should be adjusted to have a period = T

$$T = \frac{1}{\text{Density x Tape Speed}}$$

Tape speed (ips)	T (μs)	F (kHz)
25 option	50	20
37,5 option	33,3	30
45 standard	27,8	36

The 556 BPI oscillator is now used only to generate the delay from starting the tape until the tape is written on. This delay assures that the tape has reached full speed. The delay is measured by trigger on the CFOW : 55 and measureing the time to ENABLE WRITE : 54.

Tape speed ips	Start time (ms)	Delay (ms)
25 option	15	16
37,5 option	10	11
45 standard	8.33	9

9 & 7 tracks and 7 tracks only

If there is a system with a 7 tracks tape unit the 556 BPI oscillator has to be adjusted to give that density at the actual tape speed. This will automaticly give a somewhat longer delay between start of tape until tape is written on.

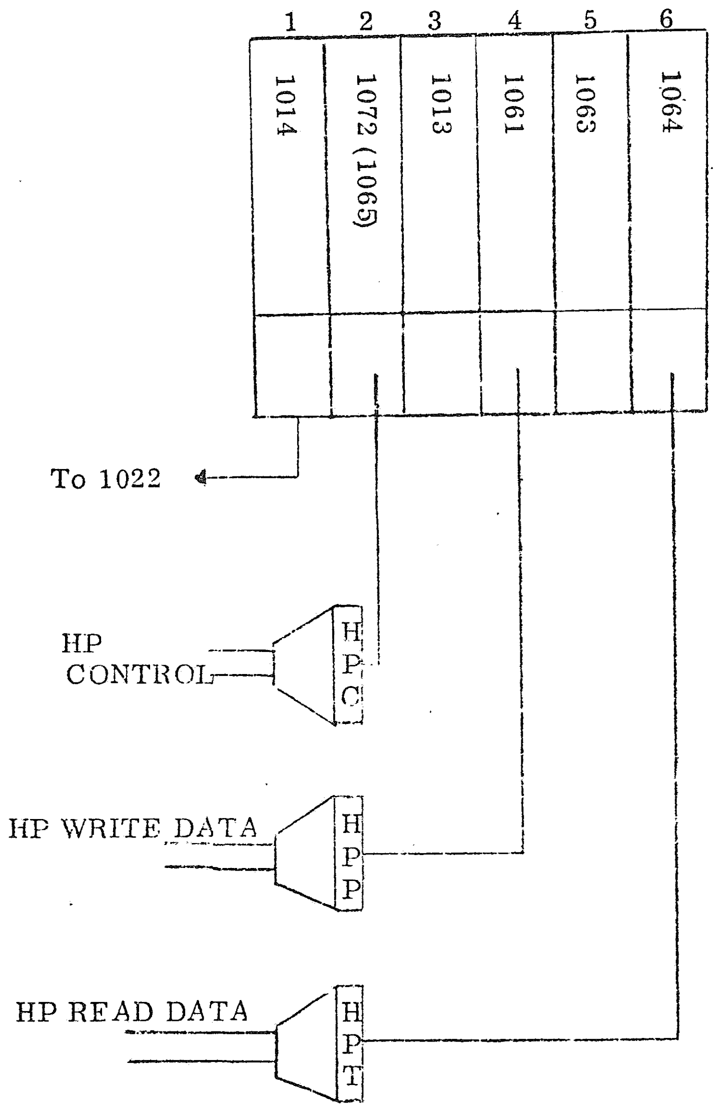
The 800 BPI oscillator is adjusted according to previous section.

The 556 BPI oscillator should be adjusted to have a period T.

$$T = \frac{1}{\text{Density x Tape Speed}}$$

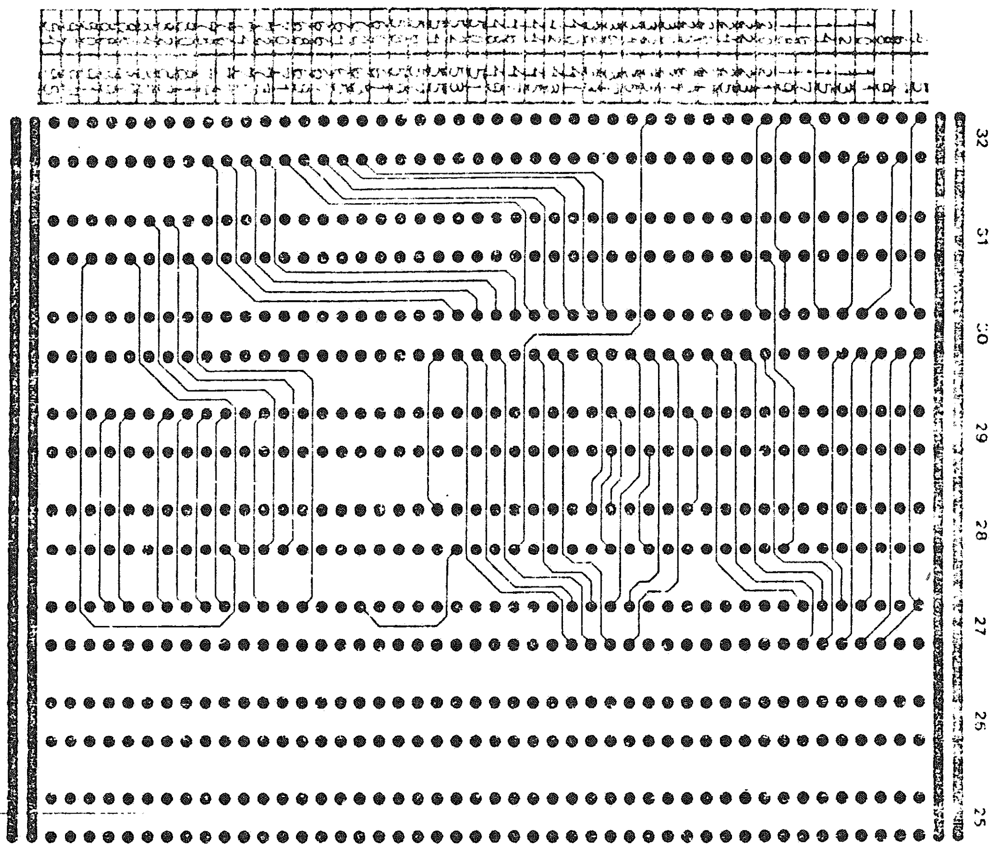
Tape speed (ips)	T (us)	F (kHz)
25	72	13,9
37,5	48	20,85
45	40	25,02

6.6 Card Positions and Plugs



6.7 Signal Interconnections

HP - MAG-TAPE BACKWIRING



1064

1063

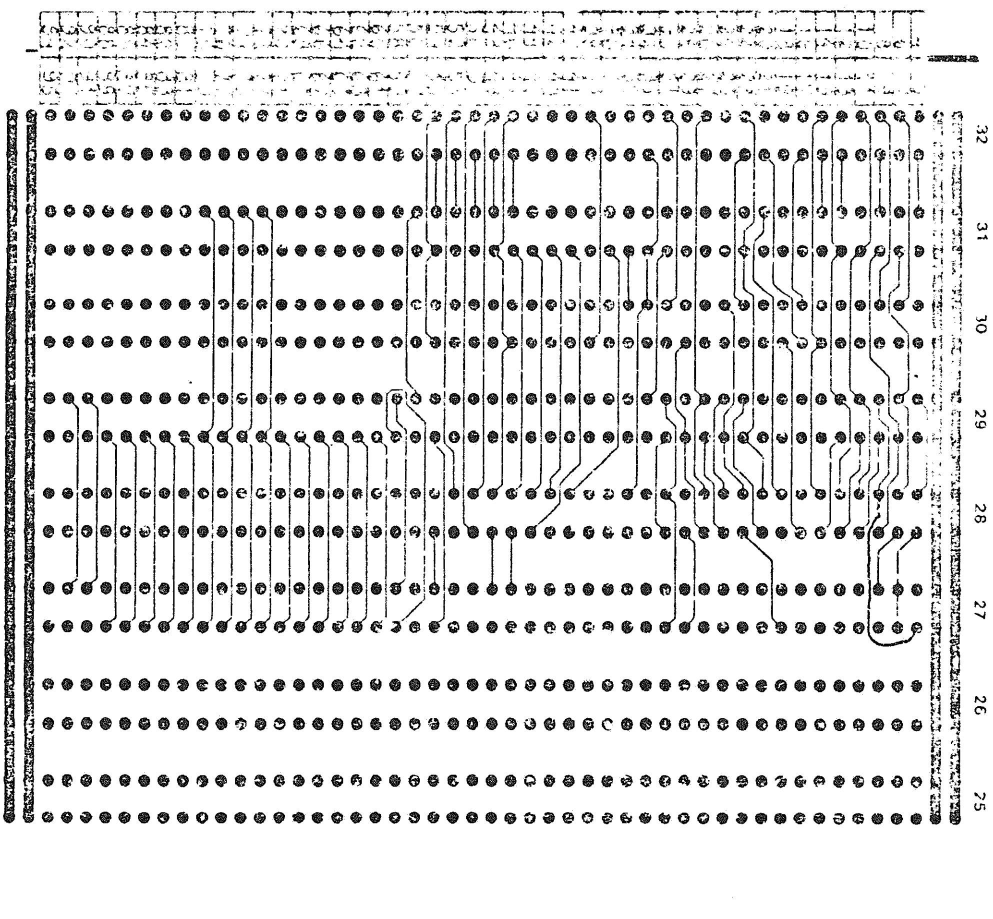
1061

1013

1072

1014

HP MAGTAPE



1064

1063

1061

1013

1072

1014

7 TEST PROGRAMS

7.1 Test of Registers

Block Addr. Test

			Drum tests:	Disc tests:	HP Mag. Tape:
10/	SAA	10	170410	170410	170410
	IOX	CONT	164545	164505	164525
	TRA	OPR	150002	150002	150002
	IOX	BAR	164543	164503	164523
	SAA	0	170400	170400	170400
	IOX	RBAR	164546	164506	164526
	COPY SA	DX	146157	146157	146157
17/	JMP* -7		124371	124371	124371

X-reg. should display OPR.

Check Ident Code

27/	CONT WORD	1	1	1
30/	LDA* -1	044377	044377	044377
	IOX LCONT	164545	164505	164525
	SAA 0	170400	170400	170400
	IDENT PL11	143611	143611	143611
	COPY SA DX	146157	146157	146157
35/	JMP* -5	124373	124373	124373

IDENT CODE in X-reg.

Test Prot. Reg. Not I/O Transceiver system.

40/	TRA OPR	150002	150002	150002
	IOX UPW	164003	164003	164003
	SAA 0	170400	170400	170400
	IOX RUPW	164002	164002	164002
	COPY SA DX	146157	146157	146157
45/	JMP* -5	124373	124373	124373

X-reg. should display OPR.

Test Car Reg.

47/	CAR			
50/	TRA OPR	150002	150002	150002
	IOX CAR	164541	164501	164521
	SAA 0	170400	170400	170400
	IOX RCAR	164540	164500	164520
	COPY SA DX	146157	146157	146157
55/	JMP* -5	124373	124373	124373

X-reg. should display OPR.

HP-MAG. TAPE TEST LOOP FOR NORD-10

```
0/100           % CAR (core address register)
2/5             % WC (word count)
4/4             % CW (control word)
20/044360       % LOAD CAR
   164521       % IOX CAR
   044360       % LOAD WC
   164527       % IOX WC
   044360       % LOAD CW
   164525       % IOX CW
   164524       % IOX Read Status
   175025       % BSKP ACTIVE
   124376       % JMP * -2
   146156       % COPY SA DT
   124366       % JMP * -12
```

Here, we can read 5 words from the tape to core from address. 100, CAR, WC and CW can be set as required.

Status is read in the T register.

When the loop is driven in Test Mode, words read in core will be 125252 and 52525 every other time.

Summary of Commands (control word):

CW	Real	Test	Modus
Read one record	4	14	M0
Write one record	4004	4014	M1
Advance to EOF	10004	10014	M2
Reverse to EOF	14004	14014	M3
Write EOF	20004	20014	M4
Rewind	24004	24014	M5
Write skip (erase gap)	30004	30014	M6
Backspace one record	34004	43014	M7

HP 7970

MAG. TAPE ADJUSTMENTS

I. Power supply (p5.3 part 2)

+ 5V DC ± 0.050V
+12V DC ± 0.360V
-12V DC ± 0.360V

II. Reel servo (initial adjustment).

III. Capstan servo (p.5-4 part 2)

1. Capstan motor offset current.
2. FWD.
3. REV.
4. High-speed FWD.
5. High-speed REV.
6. Ramp slope (start - stop time).

IV. Reel servo (final adjustment) (p 5-6 part 2).

V. Tape transport.

1. Preamplifier gain (page 2-3 part 3)
2. Read Skew. FWD / REV (page 2 - 4 part 3)
3. Gate 40 - 60 % (page 2 - 4 part 3)
4. Write skew (page 2 - 4 part 4)
5. Cross talk (page 2 - 3 part 4)

I. **Power supply**

Juster + 5V til innenfor ± 0,010V hvis spenning er utenfor toleransene ± 0,050V.

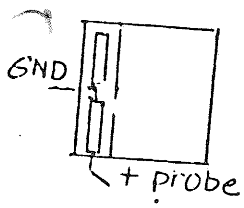
Sjekk ± 12V DC.

II. **Reel Servo**

Foreløbig sjekk at "tension arms" fungerer korrekt. d.v.s. midtstilling når reel er i ro. og symmetrisk utslag når kjøring i FWD / REV. samt at power brytes når arm når ytterstilling. Evnt. juster "optical system".

III. **Capstan servo**

1. **Offset current.**



Sett scope-proben over R21 el. R22 og juster potmeter. O/S til min. DC (± 0,100V)
Da skal capstan være i ro.
R21 er seriemotstand til capstan motor.

OBS . Proben må settes på riktig side ellers kortslutter motstanden.

2. **FWD speed test.**

"Load" speed tape . Denne har 10KHZ lagret på track no. 3 (9 track). Mål på chanal 3 preamplifier og juster potm. FWD.
Test switch FWD skal stå opp.
Frekvensen skal være 10 KHZ for 30 IPS.

Bit til bit avstanden er 0,0015 inch (for 30 IPS)
Konverteringstabell :

25	IPS	:	8333	± 16 HZ (just. hvis >± 65 H.)
30	IPS	:	10000	±
37,5	IPS	:	12500	± 25 HZ (← " → ± 10..)
45	IPS	:	15000	±
160	IPS	:	53333	± 100 HZ (← " → ± 80..)

REV speed test.

Test switch REV opp. Målepkt. ch. 3 pre-amplifier.
Juster potm. REV til riktig frekvens.

H.S. FWD

Test switch + 160 opp. Juster potm. H.S. FWD hvis frekvensen er utenom toleransen ± 800 HZ.
Juster til 53333 ± 100 HZ.

H.S REV

Bruk Rewind (≙ ÷ 160) på op. panel.
Juster potm. H.S. REV hvis nødvendig.
Samme toleranse som for H.S. FWD.

6. **Ramp Slope**

Load speed tape. Sett maskinen i FWD - STOP- FWD mode v.h.a. Switcher på control & status testkortet. (program mode).

Triggpkt : Testpkt. 9 på control & status PC assembly. (neg. flanke på FWD command).

Målepkt : Testpkt. FWD / REV på capstan servo board.

Sjekk 10 - 90 % tid. T = 6.6 ms for 45 IPS.

Juster RAMP potm. på servo - board til riktig start-stop tid. Se tabell side *5-6 part 2*. Det brukes samme potm. til REV som FWD slik at en kun sjekker at REV er OK. (triggpkt. 5).

IV. **Reel servo**

Sjekk at begge motorer står i ro når "tension arms" er i midtstilling. Evnt. juster optical system.
Sjekk at en har symmetrisk utslag i FWD / REV under følgende betingelser :

1. Mye tape på supply. Lite på take-up.
2. Mye tape på take up. Lite på supply.
3. Like mye tape på begge.

Hvis ikke symmetrisk utslag juster optic system.

V. **Tape transport**

1. **Preamplifier gain :**

Skriv bare 1 på tapen og sjekk at signalet fra samtlige forforsterkere er 6.4 pp V ± 0.2. Sjekk enten i read - after *write*. eller read- mode.

2. **Read static skew**

a) Load skew alignment tape. Sett maskin i FWD mode og READ. Mål på testpkt. for read amplifier og sjekk om alle kanaler kommer samtidig. Ref. kanal 2 som ligger midt på tape. Benytt ADD på scopet og sjekk neg. flanke.
Hvis delay . juster potm. FWD for respektive kanaler. Hvis fullstendig justering ikke oppnås, skru potm. for ref. kanal noe med klokka. (større delay) og sjekk/ juster de andre på ny. Hjelper heller ikke dette, så utfør fullstendig skew test. :

1. Skru alle FWD potm. helt mot klokka.

2. Sjekk avstanden mellom den kanal som kommer først og den som kommer sist (i tid). Hvis denne er 225 µinch er hodene dårlige og må byttes.

3. Hvis < 225 μinch bruk kanal 2 som ref. og juster denne lik den kanal som er senest. Juster alle de andre til å bli like.

Avstanden finnes slik :

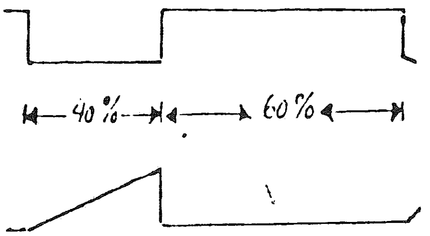
Avst. (μinch) = Avst. tid på scopet (μ sek.) X mag. tapens-hastighet ($\frac{inch}{sek.}$).

b) Samme test som FWD utføres i <u>REV mode</u>. Juster REV potm. for hver kanal (9 justeringer for 9 track).

3. <u>Read character gate</u>

Trigg pkt : NOR - testpkt. på read control card (neg. flanke).

Sjekk signalet på testpkt. GATE på samme kort at forholdet 40 - 60 % er tilstede. Hvis feil juster potm. RAMP (R29).



4. <u>Write static skew</u>

Målepkt. :
Skew testpkt. på read-amplifier.
Sett maskinen i FWD write mode og skriv "1" på hele tapen (husk write enable ring). Sjekk om det er avvik mellom kanalene for read. amplifier. og <u>juster</u> i tilfelle <u>potm. for tilsvarende write-amplifier.</u> (Ref. channel 2). Hvis ulikhet ikke oppnås, juster kan 2 litt og forsøk på ny.

Hvis det fortsatt er avvik utfør fullstendig write static skew test.
(OBS . Minst en gang i året).
Se read static skew test. men husk justering av write amp - potm.
Avstand mellom første og siste kanal < 225 μinch.

5. <u>Write crosstalk test</u>

a) Read noise :

1. Skriv 1 på hele tapen.
2. Tilbake til load point.
3. Ta ut write amplifier.
4. Sett maskinen i FWD write mode. Erase head er da aktivt. Vi visker ut data
5. Mål støy på preamplifier. Skal være < 320 mV. p.t.p.

Vi utfører altså read after write uten å skrive dvs. vi leser og sjekker om Erase head er bra . m.a.o. har visket ut det vi skrev tidligere.

b) Read - after write noise :

Sjekk om signal fra write-head forårsaker støy over til read-head.

1. Skriv 1 på hele tapen.
2. Tilbake til load point.
3. Fjern parity write amplifier.
4. Sett maskinen i FWD write mode.
5. Sjekk at støy fra preamplifier (parity channel) < 1,2V.

Vi utfører altså read-after - write og skriver på alle kanaler unntatt parity. Derfor høyere støynivå.

Tillatt støynivå :

1) READ : < 320 p.p.m.V.
2) READ-AFTER-WRITE : < 1,2 p.p.V

HP MAGTAPE TEST

	A	B	C	Check
1	046	051	055	CAR, BAR
2	045	050	054	Initial status
3	047	052	056	Ready
4	051	054	060	load point
Oos! 5	050	053	057	Test mode
6	052	055	061	Parity
7	053	056	062	write, read
8	054	057	063	overflow
9	055	060	064	Backs. read
10	056	061	065	Backs write
11	057	062	066	EOF
12	061	064	070	M.O.O.R
13	X	065	071	0, -1, 0, -1, . . .

HP MAG. TAPE TEST PROGRAM HAR 1532C

To Exclude Tests:

Set 0 in the corresponding address.

N.B.! Not in address 53.

Address:

```
000053    JPL   I SETIO   % SET IOX-INSTRS., B REG.,
                            SELECT UNIT
000054    JPL   I SJK2    % CHECK INITIAL STATUS
000055    JPL   I SJK1    % CHECK CAR AND BAR
000056    JPL   I SJK3    % CHECK READY FROM MORE
                            THAN ONE DEVICE
000057    JPL   I SJK5    % CHECK READ IN TEST MODE
000060    JPL   I SJK4    % CHECK RETURN TO LOAD POINT
000061    JPL   I SJK6    % CHECK PARITY
000062    JPL   I SJK7    % CHECK WRITE AND READ
000063    JPL   I SJK8    % OVERFLOW TEST
000064    JPL   I SJK9    % BACKSPACE TEST READ
000065    JPL   I SJK10   % BACKSPACE TEST WRITE
000066    JPL   I SJK11   % CHECK EOF
000067    LDX   MAXAD
000070    JPL   I SJK12   % CHECK MOOR
000071    JPL   I SJK13   % CHECK 0, -1, 0, -1, ···, 0 -1
000072    JMP   RESTA
```

Output:

```
002316    % WCHAR PRINTS ONE CHAR. ON PNT.
002316    %
002316    WCHAR,  STT    SAVET
002317            COPY   SL DT
002320            STT    SAVEL
002321            STA    SAVEA
002322    FILUT,  SAT    1
002323            JPL    I UTBYT
002324            JAP    *+2
002325            WAIT
```

If Not Output on TTY1:

Change Adr. 2322 to:	Output Media
171003	Punch
171005	Line Pr.
171007	TTY2

Restart address by reducing heading address 51.

A/S NORSK DATA-ELEKTRONIKK

Title: HP Mag. Tape write cable

Drawing no.

NO.	SIGNAL	POLARITY	PLUG BERG (CPU POS.)	PLUG BURNDY	HP PLUG	
1			BERG 95	A		
			" 94	C		
2			" 93	B		
			" 92	D		
3			" 91	E		
			" 90	H		
4			" 89	F		
			" 88	J		
5			" 87	K		
			" 86	M		
6	SW	0	" 85	L	F	
	GND		" 84	N	6	
7	WRS	0	" 83	P	H	
	GND		" 82	S	7	
8	WC	0	" 81	R	J	
	GND		" 80	T	8	
9	WDP(C)	0	" 79	U	K	
	GND		" 78	W	9	
10	WDO	0	" 77	V	L	
	GND		" 76	X	10	
11	WD1	0	" 75	Y	M	
	GND		" 74	AA	11	
12	WD2 (B)	0	" 73	Z	N	
	GND		" 72	BB	12	
13	WD3 (A)	0	" 71	CC	P	
	GND		" 70	EE	13	
14	WD4 (8)	0	" 69	DD	R	
	GND		" 68	FF	14	
15	WD5 (4)	0	" 67	HH	S	
	GND		" 66	KK	15	
16	WD6 (2)	0	" 65	JJ	T	
	GND		" 64	LL	16	
17	WD7 (1)		" 63	MM	U	
	GND		" 62	PP	17	
18			" 61	NN		
			" 60	RR		
19			" 59	SS		
			" 58	UU		
20			" 57	TT		
			" 56	VV		

( ) = 7 track tape unit

DRAWN BY	Remarks	Replacement for	Date
APPROVED BY	HP Parity 1061	Replaced by	Date
DATE			

A/S NORSK DATA-ELEKTRONIKK

Title: HP Mag. Tape Control and status cable

Drawing no.

NO.	SIGNAL	POLARITY	PLUG BERG (CPU POS.)	PLUG BURNDY	HP PLUG
1	SL	0	BERG 95	A	A
	GND		" 94	C	1
2	SLP	0	" 93	B	B
	GND		" 92	D	2
3	SRW	0	" 91	E	C
	GND		" 90	H	3
4	SET	0	" 89	F	D
	GND		" 88	J	4
5	SR	0	" 87	K	F
	GND		" 86	M	5
6	SFP	0	" 85	L	F
	GND		" 84	N	6
7	SD8	0	" 83	P	H
	GND		" 82	S	7
8	SD5	0	" 81	R	J
	GND		" 80	T	8
9	SD2	0	" 79	U	K
	GND		" 78	W	9
10	CS3	0	" 77	V	L
	GND		" 76	X	10
11	CS2	0	" 75	Y	M
	GND		" 74	AA	11
12	CS1	0	" 73	Z	N
	GND		" 72	BB	12
13	CS0	0	" 71	CC	P
	GND		" 70	EE	13
14	CRW	0	" 69	DD	R
	GND		" 68	FF	14
15			" 67	HH	
			" 66	KK	
16	CF0W	0	" 65	JJ	T
	GND		" 64	LL	16
17	CR	0	" 63	MM	U
	GND		" 62	PP	17
18			" 61	NN	
			" 60	RR	
19	WSW	0	" 59	SS	W
	GND		" 58	UU	19
20			" 57	TT	
			" 56	VV	

DRAWN BY

APPROVED BY

DATE

Remarks: HP Control 1072

Replacement for | Date

Replaced by | Date

A/S NORSK DATA-ELEKTRONIKK	Title: HP Mag. Tape read cable	Drawing no.

NO.	SIGNAL	POLARITY	PLUG BERG (CPU POS.)	PLUG BURNDY	HP PLUG
1			BERG 95	A	
			" 94	C	
2			" 93	B	
			" 92	D	
3			" 91	E	
			" 90	H	
4			" 89	F	
			" 88	J	
5			" 87	K	
			" 86	M	
6			" 85	L	
			" 84	N	
7			" 83	P	
			" 82	S	
8	RCT	0	" 81	R	J
	GND		" 80	T	8
9	DRT P (C)	0	" 79	U	K
	GND		" 78	W	9
10	DRT0	0	" 77	V	L
	GND		" 76	X	10
11	DRT1	0	" 75	Y	M
	GND		" 74	AA	11
12	DRT2 (B)	0	" 73	Z	N
	GND		" 72	BB	12
13	DRT3 (A)	0	" 71	CC	P
	GND		" 70	EE	13
14	DRT4 (8)	0	" 69	DD	R
	GND		" 68	FF	14
15	DRT5 (4)	0	" 67	HH	S
	GND		" 66	KK	15
16	DRT6 (2)	0	" 65	JJ	T
	GND		" 64	LL	16
17	DRT7 (1)	0	" 63	MM	U
	GND		" 62	PP	17
18			" 61	NN	
			" 60	RR	
19			" 59	SS	
			" 58	UU	
20			" 57	TT	
			" 56	VV	

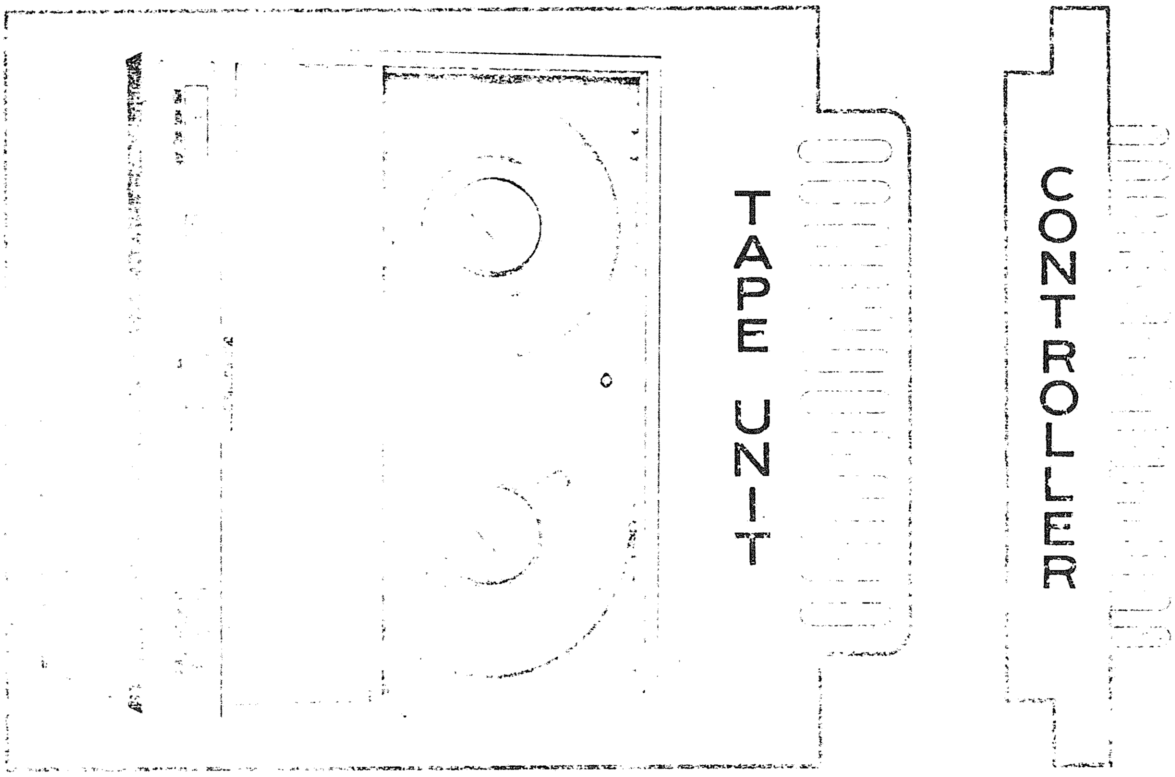
( ) = 7 track tape unit

DRAWN BY	Remar: HP Timing B 1064	Replacement for	Date
APPROVED BY		Replaced by	Date
DATE			

HEWLETT hp PACKARD

MODEL 7970A
DIGITAL MAGNETIC TAPE SYSTEM
INTERFACE GUIDE

FEBRUARY 1970



The following sections of the Preliminary Interface Manual will provide the necessary information for interfacing to the Hewlett-Packard 7970A tape transport and data electronics. The technical content is directed toward the interface design engineer and the system programmer as preliminary information prior to receiving hardware for interfacing. The topics discussed are:

1. Electrical and Mechanical Specifications
2. Cables and Connectors
3. Input/Output (I/O) Line Transmitters and Receivers
4. Waveforms and Event Timing
5. Daisy-Chaining Capability

A Preliminary Interface Manual will be furnished with the 7970A system during a product evaluation. Hewlett-Packard application engineering assistance also will be available.

The Mountain View Division of Hewlett-Packard has been building and supporting the Hewlett-Packard Model 2020 and 3030 OEM tape drives since 1961. These units and the 7970A are supported by a worldwide sales and service organization.

1. ELECTRICAL AND MECHANICAL SPECIFICATIONS

Specifications for the electrical and mechanical characteristics of the 7970A tape transport are as follows:

TAPE (Computer Grade):

Width: 0.5"

Thickness: 1.5 mils

TAPE TENSION: 8 oz, nominal

REEL DIAMETER: Up to 10-1/2"

TAPE SPEED: 10 to 25 ips, standard

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:

Distance: 80 inches, nominal

Time: 0.7 second, maximum

START/STOP TIMES: 15 ms (at 25 ips)

START/STOP TAPE TRAVEL: 0.187" ±0.020"

REEL MOTOR BRAKING: Dynamic

MAGNETIC HEAD ASSEMBLY:

Standard: 7- or 9-track, Erase, Write, and Read

Gap Scatter (Measured Optically):

Read Stack: 150 μ in., max

Write Stack: 150 μ in., max

STATIC SKEW: The per channel one-shot deskewing technique is utilized in the Write (forward) and Read (forward and reverse) circuitry, effectively eliminating static skew.

DYNAMIC SKEW: Total Dynamic Skew: ±200 μ in. (Read after Write), max

RECORDING MODE: NRZI (IBM compatible)

WRITE HEAD TO READ HEAD CROSSTALK:

≤ 5% (of read signal)

READ HEAD CHANNEL TO READ HEAD CHANNEL CROSSTALK: < -30 dB

BOT* AND EOT* REFLECTIVE STRIP DETECTION: Photoelectric, IBM compatible

WEIGHT: 100 lb, maximum

DIMENSIONS:

Height: 24"

Width: 19"

Depth (from mounting surface): 12"

Total Depth: 15-3/4"

OPERATING ENVIRONMENT:

Ambient Temp: +32° to +131°F (0° to +55°C)

Relative Humidity: 20 to 80%

Altitude: 10,000 feet

POWER REQUIREMENTS:

115 or 230 (±10%) VAC

50 to 400 Hz, single phase

500 watts, max (on high line)

TRANSPORT MOUNTING:

Vertical: Std 19" RETMA rack

Horizontal: 24" rack (19" centers)

2. CABLES AND CONNECTORS

There are three interface mating connectors supplied with the standard 7970A tape transport. Each is specifically associated with:

a. Control and Status
b. Write Data
c. Read Data

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.

Three female mating connectors are supplied, each have a 48-pin (24 active line) capability. These mating connectors are intended to be directly connected to the users interfacing cables. Strain relief hardware is also provided. Tables 1, 2, and 3 list the schedule of pin assignments and line names. These lines are described in tables 4, 5, and 6.

The suggested maximum cable length is 20 feet from connector pin to connector pin. The interfacing 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, 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, not less than one twist per inch, with a minimum insulation thickness of 0.01 inch.

*Beginning Of Tape and End Of Tape

3. I/O LINE TRANSMITTERS AND RECEIVERS

Figure 1 illustrates the type and electrical parameters of the I/O line transmitters and receivers.

4. WAVEFORMS AND EVENT TIMING

Figures 2 and 3 show the write and read timing. The read after write verification time equals the $\frac{\text{head spacing}}{\text{velocity}}$, or approximately 6.0 milliseconds.

Figure 4 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 15 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 6 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.

5. DAISY-CHAINING CAPABILITY

The three interface connector boards are manufactured with parallel connectors. This allows up to four tape units to be utilized from one controller.

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

Table 1. Control 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	---

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	WRITE RESET		WRS	
8X	(J)	8	WRITE CLOCK		WC	
			IBM CHANNEL DESIGNATIONS			
			9 TRACK	7 TRACK	9 TRACK	7 TRACK
9X	(K)	9	WRITE DATA P	WRITE DATA C	WDP	WDC
10X	(L)	10	WRITE DATA 0	-------------	WD0	---
11X	(M)	11	WRITE DATA 1	-------------	WD1	---
12X	(N)	12	WRITE DATA 2	WRITE DATA B	WD2	WDB
13X	(P)	13	WRITE DATA 3	WRITE DATA A	WD3	WDA
14X	(R)	14	WRITE DATA 4	WRITE DATA 8	WD4	WD8
15X	(S)	15	WRITE DATA 5	WRITE DATA 4	WD5	WD4
16X	(T)	16	WRITE DATA 6	WRITE DATA 2	WD6	WD2
17X	(U)	17	WRITE DATA 7	WRITE DATA 1	WD7	WD1
18X	(V)	18	Reserved for Options and Spares		---	
through		through				
24X	(BB)	24	Reserved for Options and Spares		---	

Table 3. 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 CHANNEL 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. Detailed Description of I/O Lines, Status and Motion Command 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
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
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
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 BPI. Only one density at a time can be asserted from a selected and on-line tape unit.	Level	Output
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
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
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

Table 4. Detailed Description of I/O Lines, Status and Motion Command Connector (Continued)

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
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
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
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
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.	Level	Input
c. REWIND (CRW = COMMAND REWIND)	Clears the write command on 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 μsec.)	Level	Input
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

Table 5. 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.	Level	Output
FUNCTION COMMANDS			
a. SET WRITE (WSW = WRITE SET WRITE)	The assertion of CF causes the WSW line to be sampled following a 20 μsec maximum delay period. Assertion transition 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 write enabled. Negation of the WSW line enables the clearing of the tape unit's write condition. The desired logic level of WSW shall be maintained for not less than 20 μsec after the assertion edge of CF.	Level	Input
DATA TRANSMISSION			
a. WRITE DATA (WD = WRITE DATA) WD0 -- WD7, WDP NOTE: Refer to write data connector for channel designation.	(Any 1 of 9 lines.) These lines receive data to be recorded on tape as a character and must be electrically stable at assertion transition time of write clock and for 2 μsec minimum, thereafter.	Level	Input
b. WRITE CLOCK (WC = WRITE CLOCK)	The assertion transition of this pulse causes the character, represented by the write data lines, to be written on tape. The tape unit must be in the write condition and the assertion of the write clock must be maintained for a minimum of 2 μsec.	Pulse	Input
c. WRITE RESET (WRS = WRITE RESET)	The assertion transition causes the LRCC character to be written on tape, provided the unit is in the write mode. Assertion must be maintained for a minimum of 2 μsec.	Level	Input

Table 6. Detailed Description of I/O Lines, Read Data Connector

I/O LINE	DESCRIPTION	SIGNAL TYPE	SIGNAL DIRECTION
READ DATA TRANSMISSION a. READ DATA (RD = READ DATA) RD0 - RD7, RDP NOTE: Refer to read data connector for channel designation.	(Any 1 of 9 lines.) These lines transmit detected characters read from the tape and present them to the interface. The read data lines are settled at the assertion transition time of read clock, and remain settled until 1 μsec, maximum, before the next read clock.	Level	Output
b. READ CLOCK (RC = READ CLOCK)	Indicates that a character has been read from tape and is present on the read data lines. Assertion time is 2 μsec, minimum, 3 μsec, maximum.	Pulse	Output

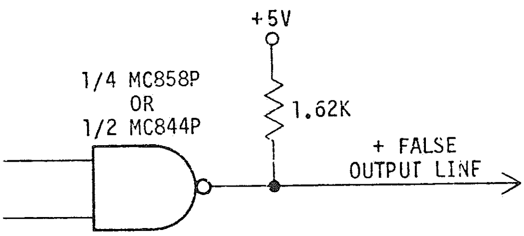
LINE TRANSMITTER

TERMINAL CHARACTERISTICS

Assertion: V ≤ +0.4 V at I = +33 mA

Negation: V = +5.0 V at I = 0;
V ≥ +2.4 V at I = -1.5 mA

Power Off Condition:
I ≤ +1.55 mA at V = +2.4 V



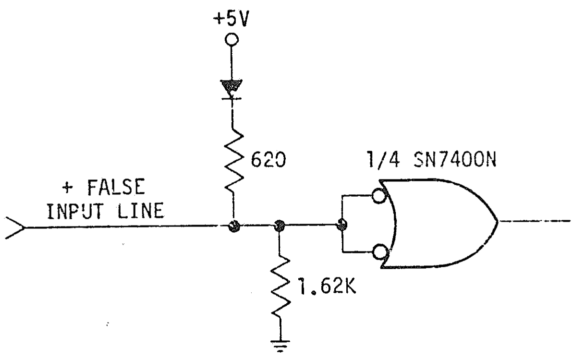
LINE RECEIVER

TERMINAL CHARACTERISTICS

Assertion: V ≤ +0.8 V
I ≥ -7.8 mA at V = +0.4 V

Negation: V ≥ +2.0 V
V = +3.1 V at I = 0;
V ≥ +2.4 V at I = -1.55 mA

Power Off Condition:
I ≤ +1.55 mA at V = +2.4 V



SIGNAL SPECIFICATIONS

Levels: TRUE = LOW = ≤ +0.4 volt = STATUS, ≤ +0.8 volt = COMMAND
FALSE = HIGH = ≥ +2.0 volts

Pulses: Defined as a high to low assertion transition corresponding to the leading edge.

NOTES: (1) The interfacing circuitry has been designed so that an open connection will result in a false signal. (2) All assertion levels are low.

Figure 1. Electrical Parameters of the I/O Line Transmitters and Receivers

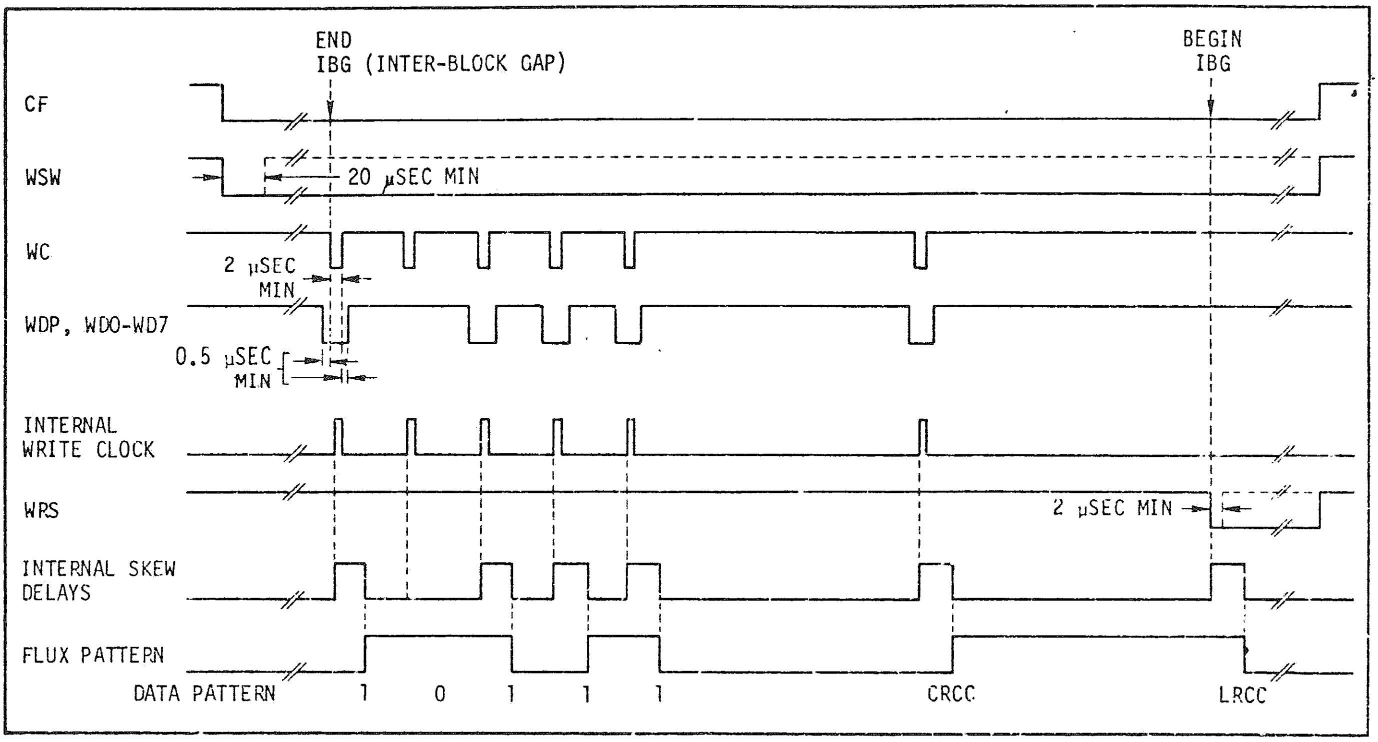


Figure 2. Write Waveforms

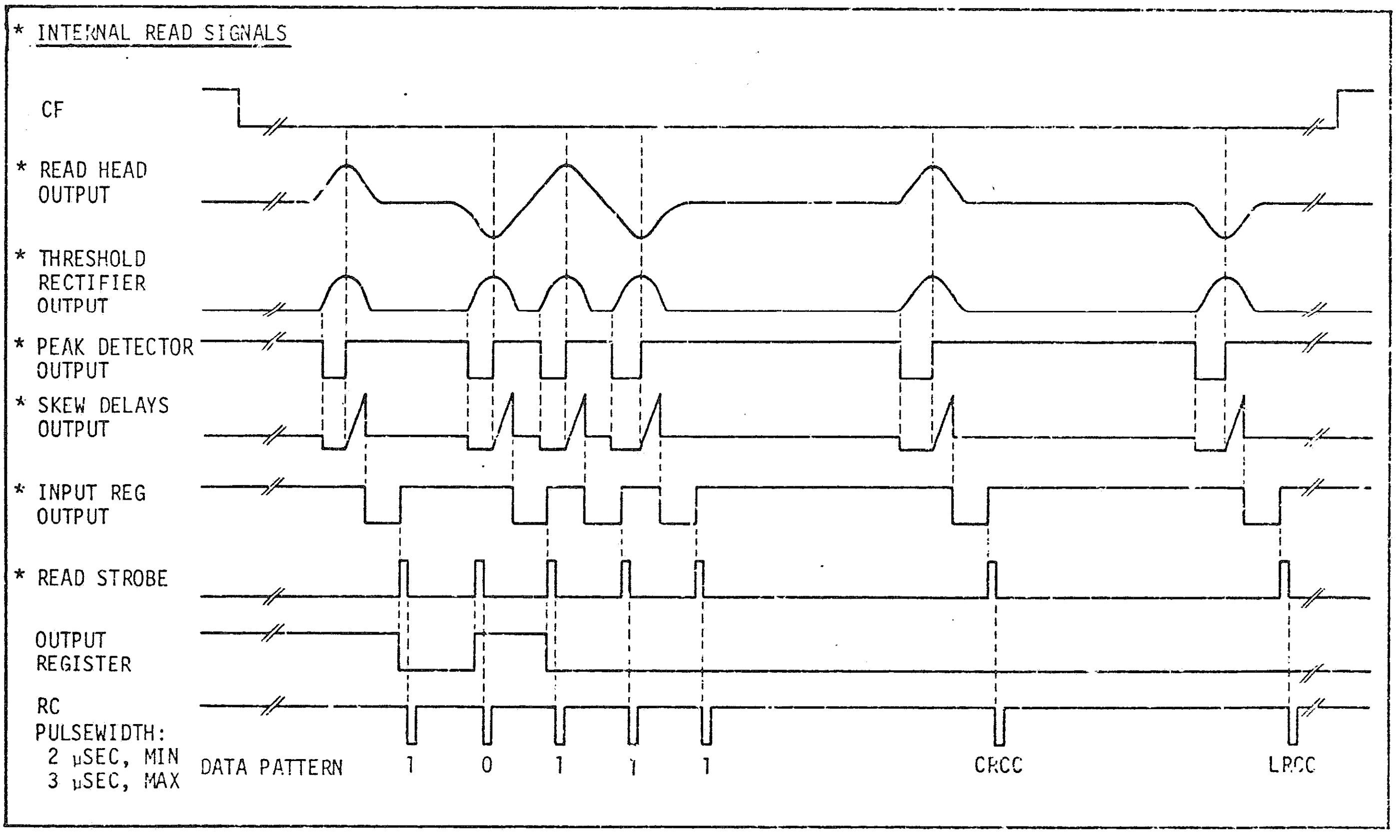


Figure 3. Read Waveforms

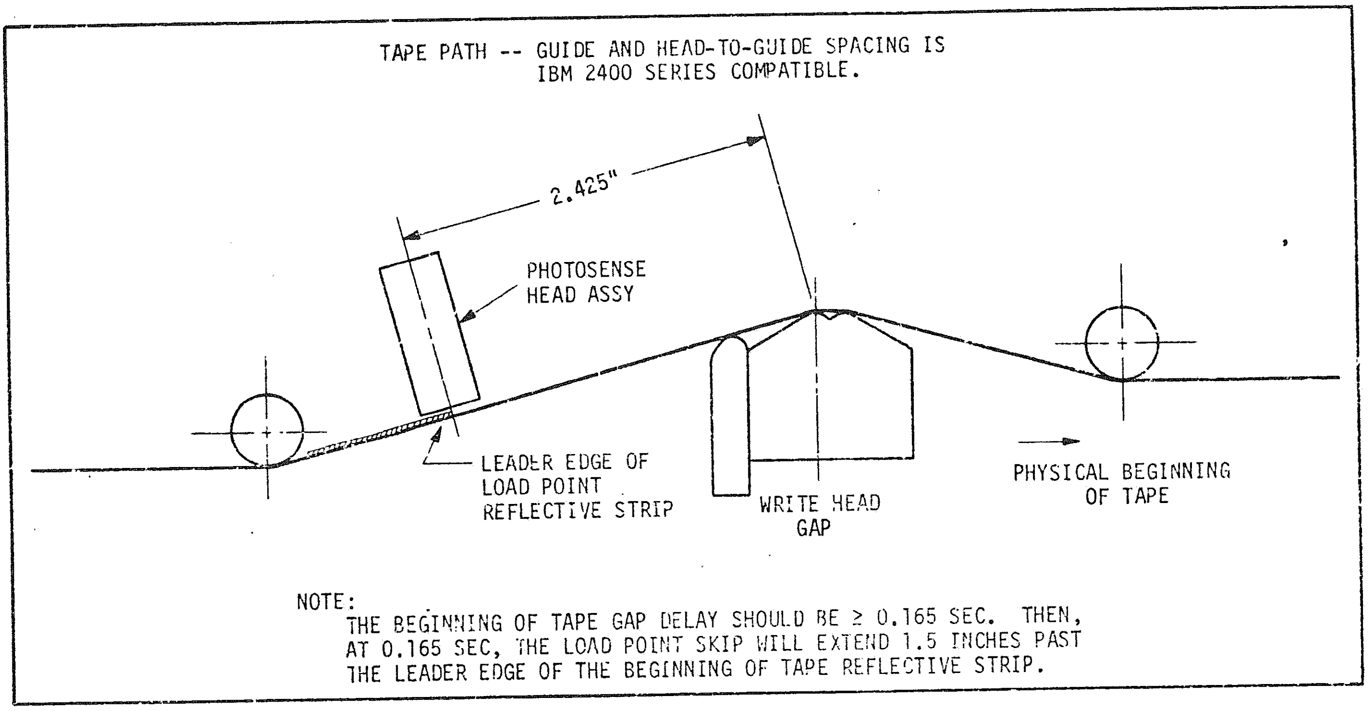


Figure 4. Location of Photosense Head Assembly

APPENDIX:

DAISY-CHAIN CABLE (13190A)

The Multi-Unit Cable, 13190A (accessory item) is available to provide daisy-chain capability (see Figure 1-17). One to three units may be added to the base unit and connected as illustrated in Figure 1-18. A multi-unit cable is required for each unit to be daisy-chained. The cable is six-feet long with female connectors on one end and male connectors on the other end (Motion Control, Read, and Write connector assemblies).

Table 2-4. Control and Status Cable (13190-60010) Pin Connections

FEMALE CONNECTOR				MNEU MONIC	DESCRIPTION	MALE CONNECTOR			
WHT-BLK	A	1	WHT	SL	ON-LINE STATUS	WHT	A	1	WHT-BLK
WHT-BRN	B	2	WHT	SLP	LOAD POINT STATUS	WHT	B	2	WHT-BRN
WHT-RED	C	3	WHT	SRW	REWIND STATUS	WHT	C	3	WHT-RED
WHT-ORN	D	4	WHT	SET	END OF TAPE STATUS	WHT	D	4	WHT-ORN
WHT-YEL	E	5	WHT	SR	READY STATUS	WHT	E	5	WHT-YEL
WHT-GRN	F	6	WHT	SFP	FILE PROTECT STATUS	WHT	F	6	WHT-GRN
WHT-BLU	H	7	WHT	SD8	DENSITY 800 STATUS	WHT	H	7	WHT-BLU
WHT-VIO	J	8	WHT	SD5	DENSITY 556 STATUS	WHT	J	8	WHT-VIO
WHT-GRA	K	9	WHT	SD2	DENSITY 200 STATUS	WHT	K	9	WHT-GRA
WHT-BLK-BLK	L	10	WHT	CS3	SELECT UNIT 3	WHT	L	10	WHT-BLK-BLK
WHT-BLK-BRN	M	11	WHT	CS2	SELECT UNIT 2	WHT	M	11	WHT-BLK-BRN
WHT-BLK-RED	N	12	WHT	CS1	SELECT UNIT 1	WHT	N	12	WHT-BLK-RED
WHT-BLK-ORN	P	13	WHT	CSØ	SELECT UNIT Ø	WHT	P	13	WHT-BLK-ORN
WHT-BLK-YEL	R	14	WHT	CRW	REWIND COMMAND	WHT	R	14	WHT-BLK-YEL
WHT-BLK-GRN	S	15	WHT	CL	OFF-LINE COMMAND	WHT	S	15	WHT-BLK-GRN
WHT-BLK-BLU	T	16	WHT	CF	FORWARD COMMAND	WHT	T	16	WHT-BLK-BLU
WHT-BLK-VIO	U	17	WHT	CR	REVERSE COMMAND	WHT	U	17	WHT-BLK-VIO
WHT-BLK-GRA	V	18	WHT	CH	HIGH SPEED COMMAND	WHT	V	18	WHT-BLK-GRA
WHT-BRN-BRN	W	19	WHT	WSW	SET WRITE COMMAND	WHT	W	19	WHT-BRN-BRN
WHT-BRN-RED	X	20	WHT		SPARES	WHT	X	20	WHT-BRN-RED

Table 2-6. Write Cable (13190-60030) Pin Connections

FEMALE CONNECTOR									MALE CONNECTOR		
	A	1		SPARES					A	1	
	B	2		↕					B	2	
	C	3							C	3	
	D	4							D	4	
	E	5		SPARES					E	5	
WHT-BLU	F	6	WHT	WRITE STATUS		SW		WHT	F	6	WHT-BLU
WHT-VIO	H	7	WHT	WRITE RESET		WRS		WHT	H	7	WHT-VIO
WHT-GRY	J	8	WHT	WRITE CLOCK		WC		WHT	J	8	WHT-GRA
				IBM CHANNEL DESIGNATIONS							
				9 TRACK	7 TRACK	9 TRACK	7 TRACK				
WHT-BLK-BRN	K	9	WHT	WRITE DATA P	WRITE DATA C	WDP	WDC	WHT	K	9	WHT-BLK-BRN
WHT BLK-RED	L	10	WHT	WRITE DATA Ø	--------------	WDØ	----	WHT	L	10	WHT-BLK-RED
WHT-BLK-ORN	M	11	WHT	WRITE DATA 1	--------------	WD1	----	WHT	M	11	WHT-BLK-ORN
WHT-BLK-YEL	N	12	WHT	WRITE DATA 2	WRITE DATA B	WD2	WDB	WHT	N	12	WHT-BLK-YEL
WHT-BLK-GRN	P	13	WHT	WRITE DATA 3	WRITE DATA A	WD3	WDA	WHT	P	13	WHT-BLK-GRN
WHT-BLK-BLU	R	14	WHT	WRITE DATA 4	WRITE DATA 8	WD4	WD8	WHT	R	14	WHT-BLK-BLU
WHT-BLK-VIO	S	15	WHT	WRITE DATA 5	WRITE DATA 4	WD5	WD4	WHT	S	15	WHT-BLK-VIO
WHT-BLK-GRA	T	16	WHT	WRITE DATA 6	WRITE DATA 2	WD6	WD2	WHT	T	16	WHT-BLK-GRA
WHT-BRN-RED	U	17	WHT	WRITE DATA 7	WRITE DATA 1	WD7	WD1	WHT	U	17	WHT-BRN-RED
	V	18			SPARES				V	18	
	W	19			↑				W	19	

Table 2-5. Read Cable (13190-60020) Pin Connections

FEMALE CONNECTOR									MALE CONNECTOR		
	A	1		SPARES					A	1	
	B	2		↕					B	2	
	C	3							C	3	
	D	4							D	4	
	E	5							E	5	
	F	6							F	6	
	H	7		SPARES					H	7	
WHT-GRY	J	8	WHT	READ CLOCK		RC		WHT	J	8	WHT-GRA
				IBM CHANNEL DESIGNATIONS							
				9 TRACK	7 TRACK	9 TRACK	7 TRACK				
WHT-BLK-BRN	K	9	WHT	READ DATA P	READ DATA C	RDP	RDC	WHT	K	9	WHT-BLK-BRN
WHT-BLK-RED	L	10	WHT	READ DATA Ø	--------------	RDØ	----	WHT	L	10	WHT-BLK-RED
WHT-BLK-ORN	M	11	WHT	READ DATA 1	--------------	RD1	----	WHT	M	11	WHT-BLK-ORN
WHT-BLK-YEL	N	12	WHT	READ DATA 2	READ DATA B	RD2	RDB	WHT	N	12	WHT-BLK-YEL
WHT-BLK-GRN	P	13	WHT	READ DATA 3	READ DATA A	RD3	RDA	WHT	P	13	WHT-BLK-GRN
WHT-BLK-BLU	R	14	WHT	READ DATA 4	READ DATA 8	RD4	RD8	WHT	R	14	WHT-BLK-BLU
WHT-BLK-VIO	S	15	WHT	READ DATA 5	READ DATA 4	RD5	RD4	WHT	S	15	WHT-BLK-VIO
WHT-BLK-GRA	T	16	WHT	READ DATA 6	READ DATA 2	RD6	RD2	WHT	T	16	WHT-BLK-GRA
WHT-BRN-RED	U	17	WHT	READ DATA 7	READ DATA 1	RD7	RD1	WHT	U	17	WHT-BRN-RED
	V	18			SPARES				V	18	
	W	19			↑				W	19	

NORSK DATA A.S.
Lørenveien 57 - Postboks 163, Økern
OSLO 1

COMMENT AND EVALUATION SHEET

ND-12.008.01 NORD-10/HP 7970 Mag. Tape Interface

In order for this manual to develop to the point where it best suits your needs, we must have your comments, corrections, suggestions for additions, etc. Please write down your comments on this pre-addressed form and post it. Please be specific wherever possible.

FROM ______________________________

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