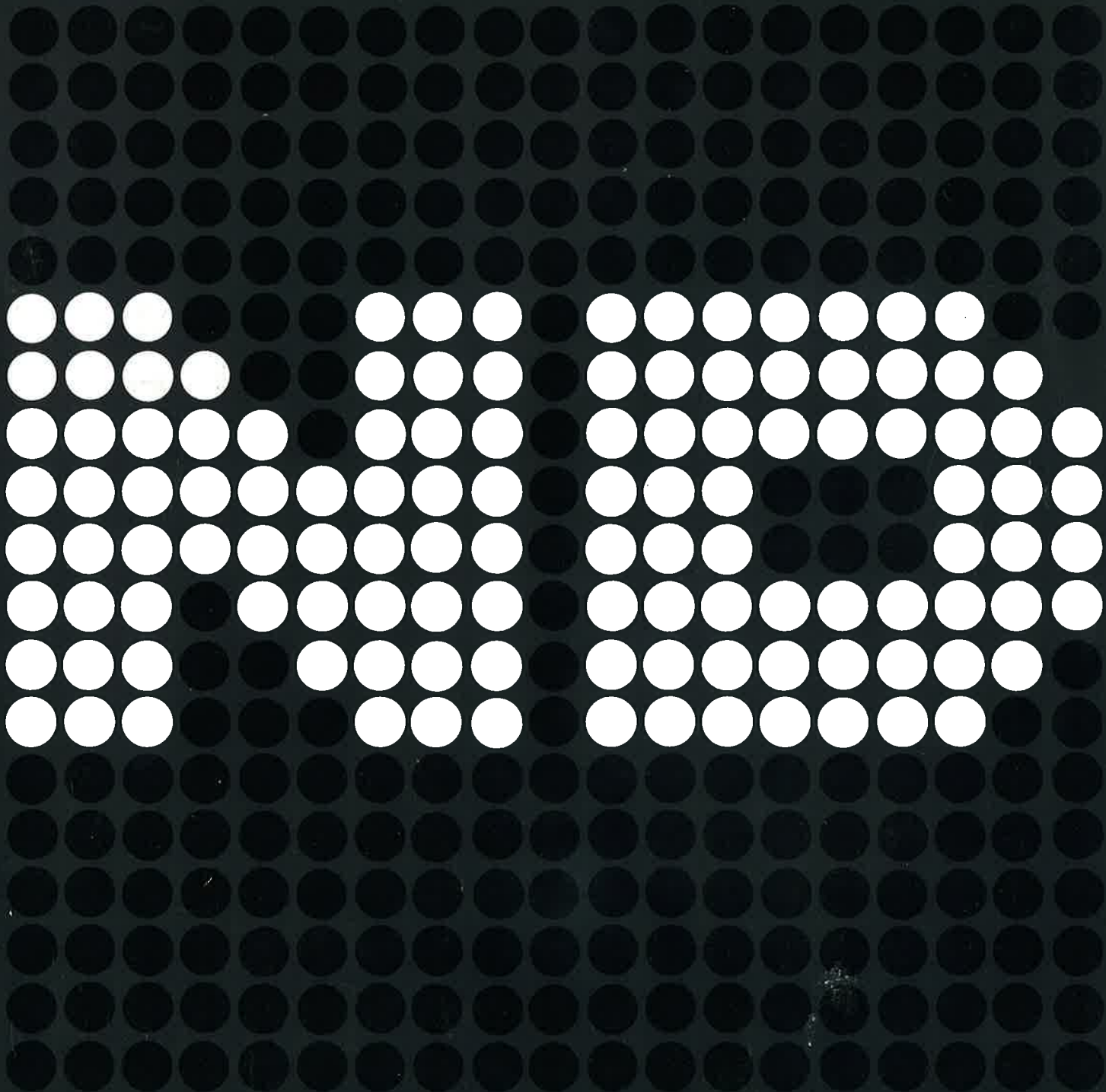


NORD-10 PROGRAMMING SPECIFICATIONS

FOR

HP MAGNETIC TAPE

NORSK DATA A.S



NORD-10 PROGRAMMING SPECIFICATIONS
FOR
HP MAGNETIC TAPE

REVISION RECORD

[illegible]

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1 MAGNETIC TAPE FUNDAMENTAL

1.1 The Recording Format

Information on tape is arranged in records. A record may consist of one or more characters which are the logical units of data. The records are separated on tape by an inter-record gap with a length of blank tape of approximately 0,75 inch for seven-track tape, and approximately 0,6 inch for nine-track tape. During writing the gap is automatically produced at the end of a record.

The densities used are as follows:

For 7 tracks	: 200 bit/inch (bpi)
	556 bit/inch (bpi)
	800 bit/inch (bpi)

For seven tracks (six data tracks + one parity track) binary records are written with odd parity (the total amount of 1 bit across the tape is an odd number) and ASCII records are written with even parity.

For 9 tracks	: One density	: 800 bpi
	Parity	: Always odd

1.2 Beginning of Tape (BOT)

To insure correct recording of the first record on the tape a tape should always start with an erased area of approximately 4". This first erased gap following the reflective load point is called beginning of tape gap (BOT).

1.3 End of File Mark (EOF)

A file mark (tape mark) is a one character record used by software to indicate the logical end of a file or group of records. One or more file marks may be written on a reel of tape.

The character for seven tracks consists of a 1-bit in the IBM track numbers 1, 2, 4 and 8, and the character for nine tracks consists of a 1-bit in tracks 3, 6 and 7. A seven-track tape mark has even parity and a nine-track tape mark has odd parity.

In general, an EOF should be written to "close" magnetic tapes before issuing a REWIND after writing.

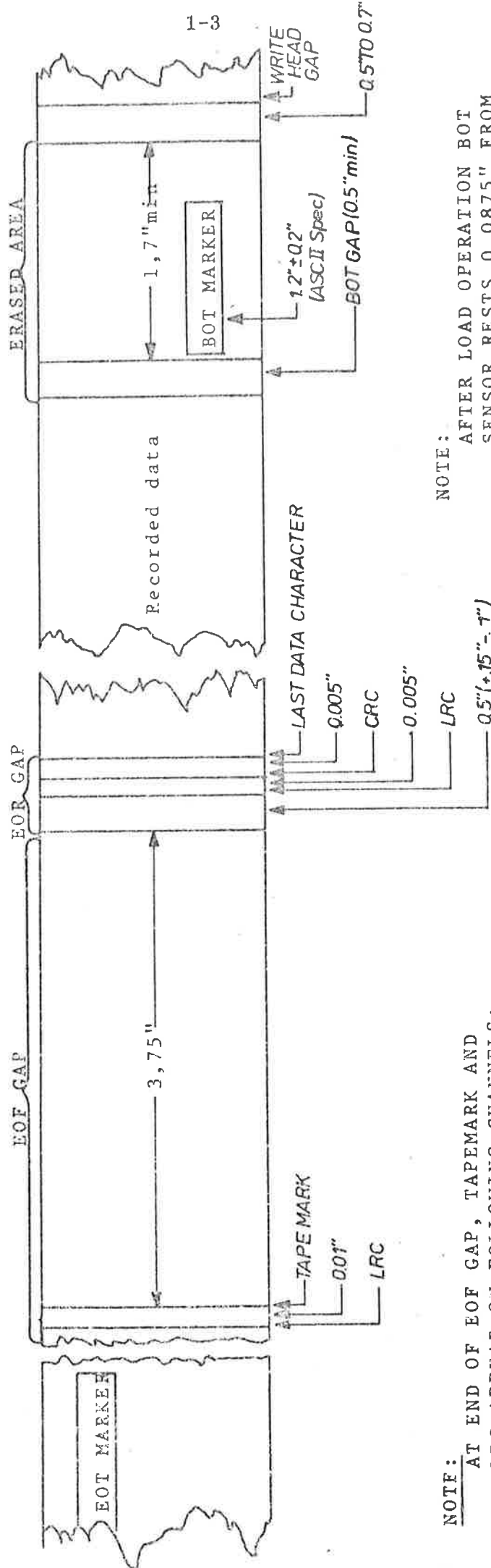
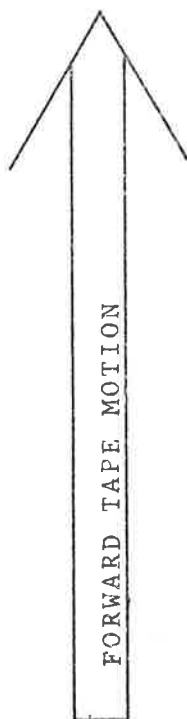
1.4 Check Characters

There are two checks in common for both seven- and nine-track tape:

- a) The longitudinal redundancy check character (LRC). This character is written at the end of each record to ensure the presence of an even number of 1-bit in each track in the record.
- b) The vertical redundancy check bit (VRC). This bit is written as the odd parity bit in nine-track tape and as either odd or even (as desired by program) in seven-tracks tape.

For nine-track tape another character - cycle redundancy check (CRC) - is written after the last data character and before the LRC character. This character is a diagonal parity check which may be used to locate and correct single track errors. This character is generated by the MT controller, but is not used for correcting purposes.

Note: When a WRITE ONE RECORD or WRITE EOF request is executed on a magnetic tape unit, all succeeding information on that magnetic tape is lost because the magnetic tape unit cannot reliably write a record on exactly the same area of the tape more than once.



NOTE:

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

NOTE:

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

Tape Format 9 track (IBM compatible 800 bpi)

2

SYSTEM ORGANIZATION

Four tape units may be connected to the NORD-10 via a tape controller, organized as one master unit and zero to three slave units. Data is transferred in variable block lengths directly between tape unit and core memory. Transfers are started by means of IOX instructions, specifying transfer and actual core and unit addresses.

The recording format is seven or nine bits NRZI (non-return to zero inverted) and with IBM compatible track and gap spacing.

3

READING MAGNETIC TAPE

If the magnetic tape has been previously written by a similar type of magnetic tape units (seven-track vs. nine-track) and the bit density has been properly selected (200, 556, or 800 bits per inch), then the MT unit should be ready to read a record.

Because the MT hardware is a record-oriented device, a READ request passes over a complete physical record of the magnetic tape (and End-OF-File is always considered to be a complete record) regardless the actual record length or number of words requested by the program. The entire record or only a part of it is transmitted to the memory buffer; this is determined by the number of words set in the word count register.

If the physical record length on the magnetic tape is unknown, a large number set in the word count register may be used to ensure reading of the entire record.

If only a part of the record is to be transmitted to the core memory, the desired number of words transmitted should be loaded into the word count register. The remainder of the record is passed over by the magnetic tape unit. The magnetic tape unit will always halt in the following inter-record gap after a READ mode has been specified.

4

TAPE SPECIFICATIONS (FOR HP 7970 TAPE UNIT)

Word format	: 6 or 8 data bits + 1 parity bit, (1 core word contains 2 tape characters)
Tape speed	: 45 ips
Recording density	: 200/556/800 bpi
Recording format	: NRZI (Non-Return to Zero IBM)
Rewind time	: <3 minutes for 2400' reel
Byte transfer rates	: 36 kHz at 800 bpi, 45 ips
Start/stop times	: 8,33 ms at 45 ips
Start/stop distance	: 0,19"

5 STARTING A TRANSFER

Before a transfer can be started, the IOX instructions to be described in the next section are used to load certain registers in the tape controller:

- a) Load the core address register (TCAR) with the first core address of the record.
- b) Load the word count register (TWCR) with the number of words to be transferred if a read or write one record operation is desired.
- c) Load the A-register with the control code of the desired operation.

The transfer will now be performed by executing the IOX LOAD CONTROL instruction with bit 3 (activate device) set.

6 IOX INSTRUCTIONS

The codes below are relevant for magnetic tape system I. Each system may take 4 magnetic tape units. For magnetic tape system II add 10_8 to the specified code.

6.1 Load Register Instructions

6.1.1 Load Core Address Register (TCAR)

$$\begin{array}{lcl} \text{IOX LTCA} & \% (A) \longrightarrow & \text{TCAR} \\ \text{LTCA} & = & 521 \end{array}$$
6.1.2 Load Word Count Register (TWCR)

$$\begin{array}{lcl} \text{IOX LTWC} & \% (A) \longrightarrow & \text{TWCR} \\ \text{LTWC} & = & 527 \end{array}$$

6.2 Read Register Instructions

6.2.1 Read Core Address Register (TCAR)

$$\begin{array}{lcl} \text{IOX RTCA} & \% (\text{TCAR}) \longrightarrow & A \\ \text{RTCA} & = & 520 \end{array}$$

This instruction is necessary to determine the length of the record. The CAR register will after the record is read or written, point to the address following the last core address used.

6.2.2 Read Status Register (TSTR)

$$\begin{array}{lcl} \text{IOX RTST} & \% (\text{TSTR}) \longrightarrow & A \\ \text{RTST} & = & 524 \end{array}$$

The status word gives information about the state of the tape controller and the selected tape unit.

Bit No.	Function	Reset by	
		IOX LOAD CONTROL with activate device = 1	MASTER CLEAR or IOX LOAD CONTROL with device clear = 1
0	Ready interrupt enabled		1
1	Error interrupt enabled		1
2	Device active		1
3	Device ready for transfer		1
4	Inclusive or of errors (bits 6, 9, 10, 11 and 12)		
5	Write Enable ring present		
6	LRC error	1	1
7	EOF detected	1	1
8	Load point		
9	EOT detected		
10	Parity error	1	1
11	DMA error	1	1
12	Overflow in read	1	1
13	Density select		
14	Mag tape unit ready		
15			

- 4 Inclusive or of error bits (6, 9, 10, 11 and 12)
- This bit will also be set if none of the above error bits are true, but if reverse command is tried when the unit is at load point.
- 5 Write Enable Ring present
- Write enable ring is present, i.e., writing is allowed.
- 6 LRC Error
- Read or Read after write electronics has detected a LRC error.
- 7 End of File Mark
- Last transfer reached end of file mark. In forward motion the tape unit will rest after the ahead of file mark, in reverse motion the tape unit will rest the file mark.
- 8 Load Point Mark
- The unit is on-line and the tape is at load point mark. This status will also remain until after the first forward command after the load point is detected.
- 9 End of Tape Mark
- End of tape reflective strip has been sensed. The tape unit does not halt automatically at end of tape mark.
- 10 Parity Error
- A vertical parity error has been detected during a read or read after write operation.
- 11 DMA Error
- A data word has been lost because the data channel has not been allowed access to the computer main memory.
- 12 Overflow in Read
- The record read was longer than the specified word count.

13 Density Select

Bit 13 = 1 tape unit has density switch set to 800 bpi

Bit 13 = 0 " " " " " " 300 or 556 bpi

14 Magnetic Tape Unit ready

Indicates that the tape unit is selected and on-line, the initial loading sequence is complete, and the tape unit is not rewinding.

6.3 The Control Instruction (TCW)

IOX TCW (A) $\longrightarrow$ TCW

TCW = 525

The content of the A-register is transferred to the control register during an IOX TCW instruction. Thus, before executing the instruction, the A-register should be loaded with the control code for the operation.

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 ASCII 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	

3 Test Mode

This mode is implementet to check the tape unit interface and the memory accesses without a physical tape unit connected. The IOX instructions have to be performed as in normal operation. Read one record (M0) and test mode will give one record of prewired data word read to core. Even words shall contain 125252 and odd words 052525 if correct.

A special register TBAR may also be loaded and read by first loading a control word with bit 3 set.

```
IOX  LTBAR
(A)  → TBAR
LTBAR = 523

IOX  RTBAR
(TBAR) → A
RTBAR = 526
```

7 Read Odd Number of Characters

This bit has to be used together with device operation code M0 if a record written with an odd number of characters is to be read. The word counter will also be decremented by the last odd character.

8 Even Parity

This bit has to be used together with device operation code M0 or M1. The meaning is as follows:

Bit 8 = 1	The record is written or checked with even parity.
Bit 8 = 0	The record is written or checked with odd parity.

9 - 10 Unit Select

These modus bits select the tape unit. The unit must be selected manually prior to initiating the select unit modus bit. A unit must also be selected after power turn-on, as the contents of the selected register are random at that time.

If the correct unit is selected, the status bit 14 (Ready) will be set.

Bit 9 and 10 are decoded as follows:

Bit 9	10	
0	0	Unit 0 selected
1	0	" 1 "
0	1	" 2 "
1	1	" 3 "

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

M0 Read One Record

This modus bit initiates forward tape motion. Two bytes are converted to a 16 bits word and transferred to core until the word counter becomes zero. The tape motion halts when an inter-record gap is detected. The CRC and LRC characters are not transferred to core.

M1 Write One Record

This modus bit initiates forward tape motion, 16 bits words are converted to bytes and written until the word counter becomes zero. The record is checked for vertical and lateral parity during read after write. The record will always contain an even number of characters.

M2 Advance to End of File

This modus bit initiates forward tape motion until a file mark is detected. Data is not transferred. The unit stops in the inter-record gap after the file mark.

M3 Reverse to End of File

This modus bit initiates backward tape motion until a file mark is detected. The unit stops in the gap before the file mark. Data is not transferred. If the unit is sensing the load point, the operation is terminated.

M4 Write End of File

This modus bit initiates forward tape motion. The tape controller will write a tape mark (1-bit on bit position 1, 2, 4 and 8 for 7-track and 3, 6 and 7 for 9-track) and the accompanying longitudinal redundancy check character (LRC).

M5 Rewind

This modus bit causes the tape unit to rewind to load point. The controller is ready to accept a new command for another tape unit as soon as this command is accepted by the selected tape unit. Thus, another tape unit may be selected and operated upon. To determine the completion of the rewinding cycle the MT unit READY bit for the rewinding unit has to return to "one".

M6 Write Skip

This modus bit initiates forward tape motion, and the tape unit erases 4 inches of tape. When the magnetic tape is positioned at load point and a write operation is required, this modus bit should be used to write Beginning Of Tape - (BOT) gap. This modus bit should also be used if a general erase is wanted.

M7 Backspace One Record

This modus bit causes the tape unit to backspace over a record and stop in the next inter-record gap. Data is not transferred. If the unit is sensing the load point, the operation is terminated.

6.4 Interrupt

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

APPENDIX A

THE CORRESPONDENCE BETWEEN A NORD-1 WORD AND THE
TRACKS ON AN IBM COMPATIBLE TAPE

NORD-1 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.

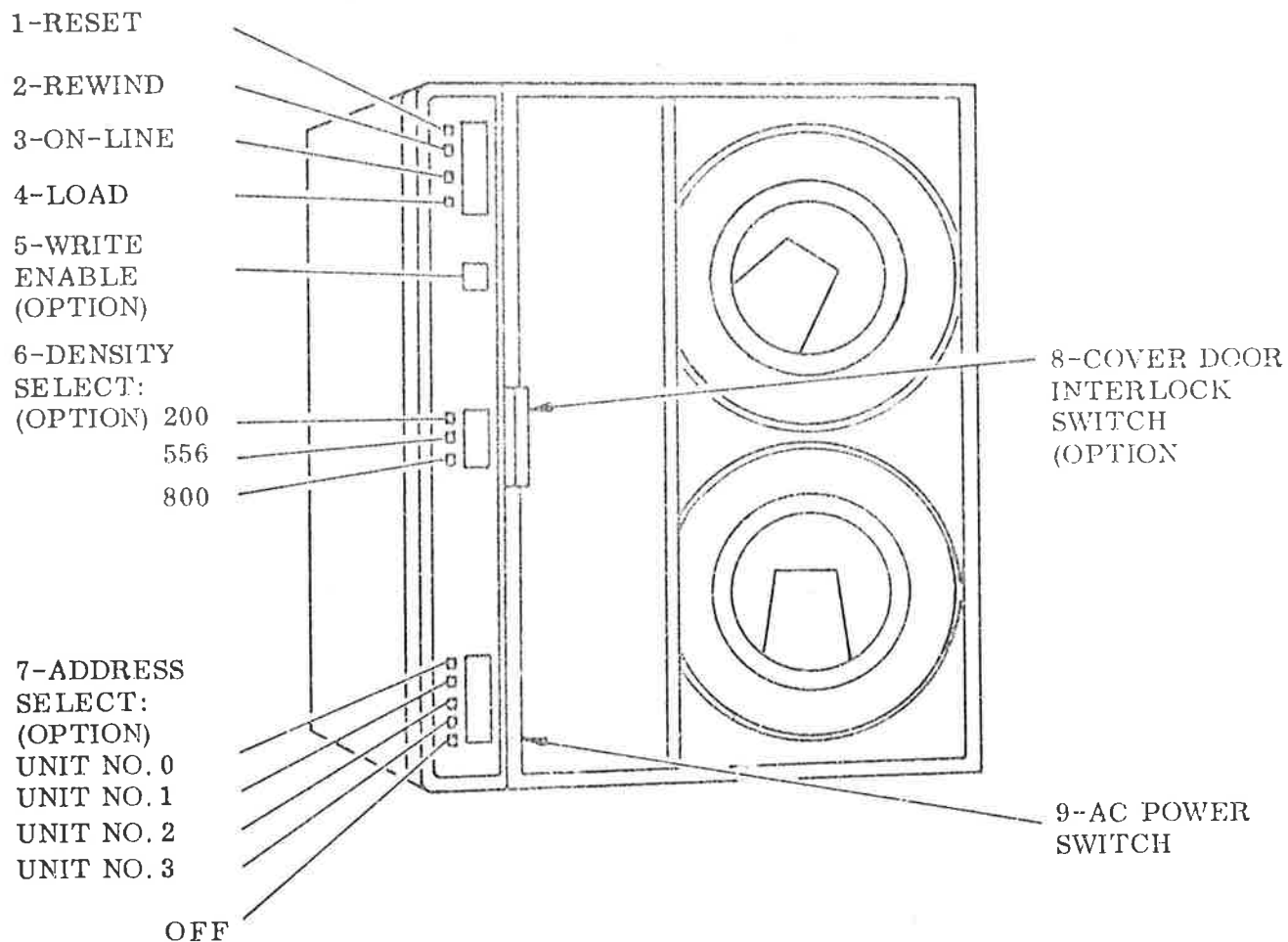
		B	A	8	4	2	1			B	A	8	4	2	1
--	--	---	---	---	---	---	---	--	--	---	---	---	---	---	---

Byte 1

Byte 2

APPENDIX B

OPERATING THE HP 7970 MAGNETIC TAPE UNIT



TAPE THREADING PROCEDURE

- a) Verify that tape path is clean.
- b) Install tape supply reel.
- c) Thread tape.
(Verify that tape is installed between guide flanges.)
- d) Work two turns of tape on take-up reel.
- e) Set power switch to ON.
- f) Press LOAD pushbutton.
- g) Close cover door.
- h) Press LOAD pushbutton and release. Motion control logic will initiate a load point search (BOT tab). Tape will stop at load point and LOAD pushbutton will illuminate.

OPERATION

The tape unit is designed for processor (computer) controlled operation. However, manual controls are provided to bring the unit to on-line status, to restart after a power failure, to position tape for addition of photosense tabs, and as a service aid during repair or check-out. The controls that the operator will normally use are located on the control panel.

Note: In multiple unit installations, do not power down more than one unit at a time. If power is removed from more than one unit, circuit loading may cause intermittent operation.

ON-LINE READ-ONLY OPERATION

To operate the unit in read-only mode, proceed as follows:

- a) Remove write enable ring from supply reel.
- b) Install supply reel.
- c) Thread tape and place tape at load point.
- d) If unit is equipped with a density select option, press density selection.
- e) If unit is equipped with an address select option, press address pushbutton.

- f) Press ON-LINE pushbutton. Unit is now in ready status under processor control.
- g) To stop unit, press RESET.
- h) Press ON-LINE to place unit under control of processor.
- i) Press address select OFF pushbutton to remove unit from processor control without disturbing unit logic. To place unit under processor control again, press unit address select pushbutton.

ON-LINE WRITE-READ OPERATION

To operate the unit in write-read mode, proceed as follows:

- a) Install write enable ring to supply reel.
- b) The rest of this procedure is identical to the read-only operation.

REWIND

High-speed rewind can be initiated during any tape function by pressing RESET and then pressing REWIND. To stop rewind at any tape position, press RESET. To resume rewind, press REWIND. Fast rewind will continue until the load point tab is sensed and passed. Unit logic will automatically go into load point search and stop at load point.

RESTART AFTER POWER FAILURE

After a power failure during a read, write, or read-after-write operation, the unit will be off-line. To resume interrupted function, proceed as follows:

- a) Open cover door.
- b) Verify that tape is on guides.
- c) Press LOAD.
- d) Close cover door.
- e) Press RESET.
- f) Press ON-LINE.

REV, FWD, AND-160 CAPSTAN SERVO TOGGLE SWITCHES

Note: These switches are for service only.

TAPE UNIT CONTROLS AND INDICATORS

CONTROLS AND INDICATORS	TYPE	FUNCTIONS
RESET	Momentary push-button switch with indicator.	a) Press to: 1) Stop tape travel from any mode. 2) Remove unit from on-line status. 3) Halt load point search if operator loads beyond load point.
		b) Lamp illuminates indicating that unit is in manual mode.
REWIND	Momentary push-button switch with indicator.	a) Rewind places unit in rewind mode. Tape rewinds at 160 ips until BOT tab is sensed. The photosense signal to motion control logic initiates a load point search; tape stops at BOT reflective strips and LOAD lamp illuminates.
		b) Lamp illuminates indicating that unit is in rewind mode.
		c) Operational only from RESET. RESET indicator stays illuminated. Will override a LOAD command.
		d) Rewind is terminated: by pressing RESET, or by logic when BOT tab is sensed.
		e) To unload tape: When tape is at load point, press REWIND pushbutton and hold momentarily until tape passed BOT tab and release.
ON-LINE	Momentary push-button switch with indicator.	a) Switches unit to on-line status when: 1) Tape has completed a BOT search or search has been stopped by a RESET command. 2) ON-LINE pushbutton is pressed.
		b) Lamp illuminates indicating that unit is available to processor.

CONT.

TAPE UNIT CONTROLS AND INDICATORS

CONT.

CONTROLS AND INDICATORS	TYPE	FUNCTIONS
LOAD	Momentary push-button switch with indicator.	a) Press pushbutton and release: 1) Establishes tape tension. 2) Logic initiates load point (BOT) search.
		b) Press RESET to terminate load point search. (Rewind will override load point search.)
		c) When transport stops at load point, unit will go to on-line status if ON-LINE pushbutton has been pressed during LOAD operation.
		d) Places reel motors under control of the tension arm photosense circuits.
		e) Lamp illuminates, indicating that tape is at load point.
		f) WRITE ENABLE indicator will also be illuminated if that operation feature is installed (and supply reel is fitted with a write enable ring).
WRITE ENABLE	Indicator	a) Available with write option package.
		b) When LOAD is pressed, indicator illuminates indicating that write enable ring is installed in supply reel.
		c) Enables power to be applied to write system.
DENSITY SELECT	Interlocked push-button switches indicators.	a) Optional feature.
		b) Allows selection of read densities: 200, 556, and 800 bpi.

CONT.

TAPE UNIT CONTROLS AND INDICATORS

CONT.

CONTROLS AND INDICATORS	TYPE	FUNCTIONS
DENSITY SELECT (Continued)	Interlocked push-button switches with indicators.	c) Indicator illuminates indicating density selected.
		d) When unit is not equipped with a density select option, logic will normally be set for 800 bpi.
ADDRESS SELECT	Interlocked push-button switches with indicators.	a) Optional feature.
		b) When one of four switches is pressed and the indicator is illuminated, the unit is assigned an address which must be selected by the processor to control the tape unit if the unit is in on-line status.
		c) When the OFF switch is pressed, all four address switches are disabled and the OFF indicator is illuminated.
		d) In OFF position unit will not respond to any incoming signal.
Cover Door Interlock Switch	Three-position switch.	a) When cover door is opened, switch is functioning to hold reset condition.
		b) Safety feature: In normal position (closed door or opened door) prevents tape motion other than tensioning of tape until door is closed.
Power	ON-OFF toggle switch.	a) Applies ac voltage to transformer primary circuit.
		b) Switches both sides of the ac line.



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COMMENT AND EVALUATION SHEET

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NORD-10 Programming Specifications
for HP Magnetic Tape

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

– we make bits for the future

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