How to use the MINIDEK

With the Digital Equipment Corporation PDP-8 Family Computers

PART II

HOW TO USE THE MINIDEK

PART II

Direct comments concerning this manual to

TENNECOMP SYSTEMS, INCORPORATED ● OAK RIDGE, TENNESSEE

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.... FIRST FOLD HERE ....

.... THEN FOLD HERE AND STAPLE AT BOTTOM....................

INTRODUCTION

The Tennecomp TP-1371 Digital Tape Recorder is a low-priced, easy to operate cartridge tape recorder intended mainly for use with mini-computers to enhance the loading of programs and to provide low-cost storage space for data. The tape may be divided into three main parts:

1. Tape transport
2. Read/Write amplifiers, and associated electronics for assembling and disassembling data written on tape, and the necessary circuitry to control the movement of the tape.
3. The interface between the tape recorder and the particular mini-computer to which the tape is connected.
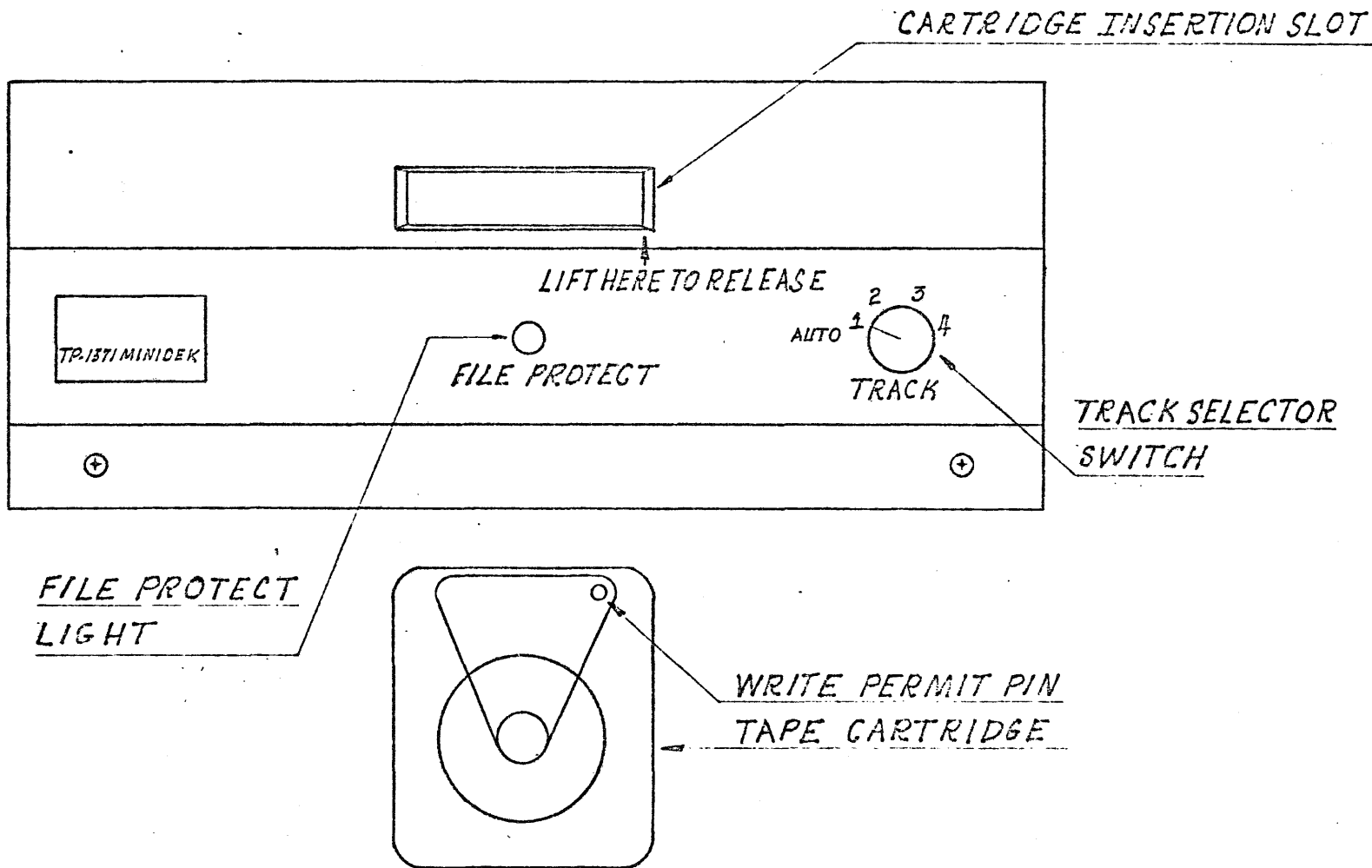
2.1 Tape Transport (Figure 1):

The tape transport is that part of the tape which includes all mechanical ports such as the motor, capstan, pinch roller, cartridge, magnetic heads, and the end/beginning of tape sensors.

Data is written on tape through a four-track magnetic head. The track may be chosen either through a rotary switch located on the front panel of the tape drive or automatically by the program when rotary switches are placed on "auto" position. The Auto Track Select reduces the average time needed for accessing any part of the tape by a factor of four. The beginning of tape (which is also the end of tape) is sensed by a head with two contacts that are shorted when the beginning of tape marker passes under the head. The BOT sensor is DC coupled all the way, enabling the user to sense the beginning of tape any time. This feature is particularly useful at the beginning of operation, since in this case there is no need for rewinding the tape if the sensing head happens to be on the BOT marker. The Read/Write mode is selected by a relay which, when activated, connects the head terminals to the write circuitry. Otherwise, the head terminals are connected to the read amplifier, which is also located inside the transport frame. The read amplifier is composed of three linear IC's which, besides amplifying the signal from the magnetic head, also rectify it for further processing by the read/write electronics.

2.2 Read/Write Electronics and Control Circuitry (Figure 2):

As the name suggests, this part of the tape may be subdivided into three parts:

a. Control Electronics
b. Write Electronics
c. Read Electronics.

CARTRIDGE INSERTION SLOT

TP-1371 MINIDEK

LIFT HERE TO RELEASE

FILE PROTECT

AUTO 1 2 3 4

TRACK

TRACK SELECTOR SWITCH

FILE PROTECT LIGHT

WRITE PERMIT PIN

TAPE CARTRIDGE

1.1

STATUS CALL

BITS PER WORD

G

MASTER CLEAR
WRITE EOR GAP

CLEAR BOT FLAG

ENAB/DISAB OUTPUT

DA LINES

I

O

INTERRUPT ENAB/DISAB
NOT USED
TRANSPORT SELECT

TRACK SELECT

$\begin{array}{c}2^1\\2^0\\2^2\end{array}$

OP CODE

OUTPUT LEVEL
LO = 0; HI = 1

CLEAR COMMAND REG
LOAD COMMAND REG
MARGIN ERROR

BOT SENSE

$\begin{array}{c}2\\1\end{array}$

GAP DETECT FLAG
WRITE FLAG
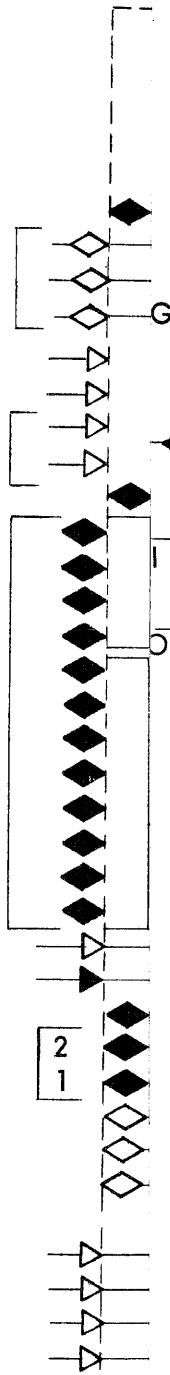READ FLAG

REWIND TRANSPORT 1
REWIND TRANSPORT 2
WRITE & CLEAR WRITE FLAG
CLEAR READ FLAG

TENNECOMP SYSTEMS, INC.

TP-1371 INTERFACE LINES

| DESIGNED W. R. B. | APPROVED | SHEET 1 OF 1 |
| DRAWN N.T. MILLER | DATE JUN 8, 1971 | DWG. NO. |

2.1 CONTROL CIRCUITRY

The complete operation of the TP-1371 tape unit is controlled through the command register in the control electronics. This register is seven bits long and is loded and cleared by the computer by 1/0 instructions and the least significant bits of the accumulator. The information from the accumulator should indicate: 1. The operation code; 2. The track to be selected; 3. The transport number (always 0 with TP-1371); 4. Whether the operation should be controlled by the interrupt bus. Figure 2 shows the bit configuration of the command register.

LSB-7	LSB-6	LSB-5	LSB-4	LSB-3	LSB-2	LSB-1	LSB
	NOT USED						

INTERRUPT   TRANSPORT   TRACK #   OPERATION CODE
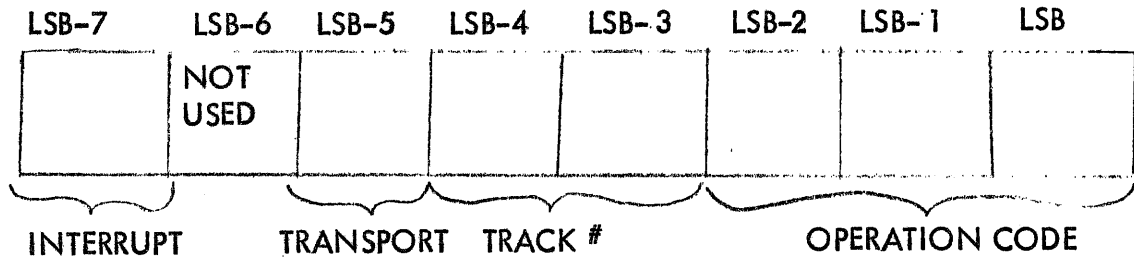
FIGURE 2.

The operation codes are as follows:

1. NOP - 000. All operation halts, the motor is stopped, and the pinch roller is disengaged.

2. Read - 001. In this mode the tape moves, the terminals of the selected track will be connected to the read amplifier, and data from the tape reach the read electronics. The read mode will hold until a gap or BOT is elected, in which case the NOP mode is entered.

3. Write - 010. In this mode the tape moves the write relay is pulled in, the terminals of the selected track are connected to the write amplifiers. After the desired data have been written (with standard Tennecomp record program), the tape unit will go into the Rewind Mode until the BOT is sensed and then into the NOP mode.

4. Rewind - 011. The tape moves until BOT is detected, then the unit enters the NOP mode. The BOT Flag must be cleared before reloading the command register.

5. Gap Count - 101. This is the same as the read mode except that the read flag is not raised. This mode is useful for searching for a block on tape. No data are read, but the gaps between blocks are detected; thus the software can count the number of gaps and select the block searched for. When a gap is detected, the NOP mode is entered and the command register must be re-loaded for the desired operation.

The tracks are selected as follows:

TRACK #	CODE (LSB's 3 & 4)
1	00
2	01
3	10
4	11

The transport is selected with LSB-5. With the TP- 1371 this Bit must always be 0 for operation since there is only one transport. With the TP-1372 option (two transports) a   in LSB 5 selects transport 1 and a 1 in this location selects transport 2.

For interrupt control to be enabled LSB-7 must be a 1. To disable the interrupt LSB-7 must be 0.

Note LSB-6 has been ignored at this time and has no function other than to stand between LSB-5 and LSB-7.

In general only one transport may be in operation at any one time with the two-transport TP-1372 option. However, while one transport is being operated in the command register, the other may be rewound by pulsing the rewind lines.

2.2 TAPE TRANSPORT (FIGURE 1.0)

The tape transport is the electro-mechanical part of the tape unit. The backbone of the transport is a much modified broadcast quality audio playback tape transport, which utilizes standard continuous loop take cartridges at 7.5 inches per second. The tape is moved across the head by a 110 V. 60 Hz synchronous motor (a 220 V. 50 Hz version is available for export models) by use of the time tested reliable capstan, pinch roller method. The capstan is attached directly to a friction free, balanced flywheel that is dual bolt driven by the motor. The pinch roller is pulled against the capstan by a relay controlled solenoid under program control.

Data are written on and read from tape through a four-track magnetic head. Track selection may be made either manually or automatically under program control by setting the switch on the front panel of the transport to the desired track or to the "auto" position. The Auto Track Select (standard with the TP-1371 Mini Deck) reduces the average access time by a factor of four.

The beginning of tape (also the end of tape) is sensed by a special head with two contacts that are shorted by the beginning of tape marker when it passes under the head. The Beginning of Tape (BOT) is D.C. coupled to the electronics, enabling the user to sense the BOT any time. This is particularly useful at the beginning of operation since there is no need for rewinding the tape if the head happens to be on the BOT marker.

The Read/Write mode is selected by a reliable hermetically sealed, dry read relay also under program control. When activated this relay connects the head terminals (selected by the rotary switch or by program control) to the write amplifiers. Unless the TP-1371 is in the write mode, the head terminals are connected to the read amplifier through the Read/Write relay in its relaxed state.

The write amplifiers are a part of a TP-21, TTL to Negative Sink Driver card, located in the bottom part of the transport chassis. The write amplifiers receive the phase encoded write pulses from the write electronics and amplify these to levels suitable for writing on magnetic tape.

The Tape Read Amplifier is a TP-014 A amplifier card and is located in the small compartment directly behind the track select switch. The read amplifier consists of three linear IC's, which amplify the signals from the read head and limit and rectify them for processing by the read electronics.

File Protect Circuitry. The TP-1371 transport is equipped with special circuitry which will prevent users from accidentally writing on tapes that they don't really want to write on. Each tape cartridge sold by Tennecomp Systems has a small pin inserted in a hole in the top front. After a program or record has been written on the cartridge and if the user does not intend to write on the cartridge for some period of time, he should remove this pin and store it for use at a later date. Should the user try to write on a tape cartridge

without a file protect pin inserted, the white light on the front panel of the transport will glow and the write pulses will be inhibited through a resistor and neither the TP-1371 nor the previous recorded data will be harmed. Thus the user, for his own protection, must make a conscious effort before writing on tape.

The transport is selected by bits in the command register. When the LSB-5 bit is "0", transport #1 is selected, and when the LSB-5 bit is "1", transport #2 is selected.

INTERRUPT ENA/DIS: This bit enables (when "1") or disables the tape controller from the interrupt bus.

For the proper operation of the tape, hardware delays are built in and are triggered whenever needed. These delays are the following:

1. RD Start Delay (200 ms): This delay is triggered whenever Read mode is selected. It is intended to allow the tape to come to speed before data is read from tape.

2. RD BOT (600 ms): This delay is triggered when the trailing edge of the BOT marker is passed over the contactor head. This delay allows the BOT marker to pass over the Read/Write head before data is read off the tape.

3. WRT BOT GAP (700 ms): This delay is triggered when the trailing edge of the BOT marker is passed over the contactor head. This delay allows the BOT marker to pass over the Read/Write head before data may be written on tape. While this delay is activated, the tape is saturated in the reference direction. Note that this delay is longer than the RD BOT delay. Thus the Read starts 100 ms (1.5" of tape at 7.5"/sec) before actual data may be found, eliminating any possibility of losing data.

4. WRT START DELAY (300 ms): This delay is triggered whenever the WRT mode is entered. Its function is to prevent writing of data on tape until the motor reaches its final speed. While this delay is activated, the tape will be saturated in the reference direction. Note that this delay is longer that the RD START delay, eliminating any possibility of losing data in the READ mode.

5. WRT EOR (600ms): This delay is triggered by an Input/output instruction (6371 for PDP-8/L). The WRT EOR instruction is initiated under program control for separating blocks of data written on tape. The gap generated by this instruction is detected when in READ mode, notifying the computer and stopping the motor. Note that the delay is longer than the sum of RD START delay and WRT START delay, thereby providing enough time for the motor to stop when the EOR gap is detected and restarted again without losing data.

Write Electronics: The write electronics consists mainly of a shift register with parallel entry and serial output, and a phase encoding circuit. The shift register is loaded with a word transmitted from the accumulator through an I/O instruction   The word length may be 8, 9 or 12

bits, and may be selected by grounding one pin on the READ/WRITE printed circuit card. The word is then right shifted at constant rate (5KHz derived from a crystal clock) and the serial output of the shift register is applied to the phase encoding circuit whose output is written on tape. When the last bit of the word is transmitted, the "WRT FLAG" is raised. The flag may be tested by the computer by reading the status register. The bit configuration in the status register is as follows:

LSB-5   LSB

MARGIN ERROR	BOT 2	BOT 1	GAP DETECT FLAG	WRITE FLAG	READ FLAG

STATUS REGISTER BIT ASSIGNMENT

Whenever the WRT FLAG is raised, the status call goes high. The STATUS CALL is usually connected to the priority interrupt bus and may be interrogated through an input/output skip instruction. When the computer recognizes the WRT flag, it will transmit the next word to the write shift register from the accumulator by an Input/Output instruction (WRT WORD & CLEAR WRT FLAG) [   ] which also clears the WRT FLAG. The computer must transmit the word to the tape in less than 2 ms following the setting of the WRT flag; otherwise, the space between the two words will be too long, causing the READ Electronics to identify it as a gap.

Read Electronics: The read electronics consists of a read amplifier, a decoder shaper, serial in/parallel out shift register, and a buffer register. When the command register is loaded with the read mode, data from the selected track is amplified and rectified in a read amplifier located inside the transport case. The amplified signal is then transmitted to the decoder shaper, which extracts the clocking information inherent in the phase encoding technique, shapes the signal and applies it, along with the recovered clock, to the shift register. When the shift register is filled up, the content is transmitted to the buffer register, the RD Flag bit in the status register is set, and the shift register is cleared. Following the setting of the READ FLAG, the STATUS CALL Flag is raised. If the interrupt is enabled, the STATUS CALL will produce a Program Interrupt. Otherwise, the computer has to skip in a loop to interrogate the STATUS CALL Flag. When the computer detects the STATUS CALL Flag, it issues a RD BUFFER instruction, [   ] which clears the accumulator, loads it with the content of the RD BUFFER, and clears the RD Flag bit in the status register.

2.3 Interfacing:

To facilitate the interface design of the tape to the particular computer, a list of the signals and levels supplied and received by the tape controller follows:

1. BRD Lines (Buffered Read):   Up to twelve lines are available – BRD0-BRD11. These are the data read serially from the tape assembled in the shift register and transferred to the buffer register. The BRD lines may be read by the computer through an input/output command.

2. STATUS REG Lines: Five lines are available and may be read by the computer through an input/output instruction. The bit configuration in the status register is as shown in the figure:

LSB-5   LSB

MARGIN ERROR	BOT 2	BOT 1	GAP DETECT FLAG	WRITE FLAG	READ FLAG

a. Read Flag: This bit is set whenever a complete word is read and assembled and is ready to be transferred to the computer. The computer should read the word in less than 2 ms; otherwise, the word is wiped out, when the next word is assembled. When the word is read, the RD FLAG is automatically cleared.

b. Write Flag: This bit is set whenever the tape is ready to receive a word from the computer for writing on tape. The bit is automatically cleared when a word is transferred to the tape.

c. Gap Detect Flag: The gap detect bit is set when the controller is either in the Read mode or in the Count Gap mode when an inter-record gap is detected. A gap is identified whenever a 0.015 of tape is saturated in the reference direction, provided at least one word has been successfuly read from tape. This feature prevents the beginning of tape gap and the START DELAY GAP from being identified as a gap.

d. BOT 1:   The BOT 1 bit of the status register is set when the Beginning of Tape Marker is under the BOT sensor. The transition of the command register bit from 0 to 1 also sets an auxilliary BOT 1 FLAG. This auxilliary flag is connected to the STATUS CALL level of the transport to inform the computer that a "rewind" operation has been completed. The auxiliary BOT 1 FLAG may be cleared with the CLR BOT 1 pulse, even though the BOT marker is still under the BOT sensor. Otherwise, it would be impossible to clear the status call without advancing the tape. Note, however, that the BOT 1 bit in the status register remains set as long as the splice marking the beginning of tape is detected.

e. BOT 2: Same as d., except refers to transport #2 (with the TP-1372 dual transport model).

f. The Margin Error Flag is set whenever the amplitude of the read signal is significantly below the normal level. The Margin Error Flag serves as a check on the quality of the tape cartridge and should normally be tested at the end of reading a block of data. If the margin error flag is set, the data which was read may still be valid, but the cartridge should be recopied onto a fresh cartridge. In this manner, incipient errors may be corrected before they cause any diffi-culties.

3. W.E.O.R. GAP: This signal may be supplied to the tape controller from the computer and is used for generating the inter-record gap.

4. CLR COMMAND REG: This signal must be presented to the tape controller for resetting the command register. Usually, it is generated by OR-ing the POWER CLEAR signal with an Input/Output instruction.

5. DA Lines: Data from the computer is transferred to the tape controller on these lines. The information on the lines is loaded in the write shift register when an I/O command (WRT WORD TRANSFER) is given. Twelve lines are available. The word length may be selected to be 8, 9, or 12 bits by a simple grounding of one pin in the controller.

6. WRT WORD TRANSFER & CLEAR WRT FLAG: This signal, when high, transfers the data present on the DA lines to the write shift register and clears the WRT FLAG bit in the status register.

7. RD BUFFER & CLEAR RD FLAG: This signal, when high, gates the information in the read buffer register (BRD LINES) to the Accumulator lines of the computer. The trailing edge of this signal also clears the RD FLAG bit in the status register.

8. LD COMMAND REG: A high level signal on this line transfers the 8 least significant bits of the DA lines to the command register.

9. STATUS CALL: This level goes high when the RD FLAG, the WRT FLAG, the GAP DET FLAG, the BOT1 FLAG or BOT2 FLAG is high. This level may be connected to the interrupt bus for real time operation, or may be interrogated by an I/O skip command.

TP-1371

CARTRIDGE TAPE UNIT

The TP-1371 evolved from the Tennecomp TP-1351 Magnetic Tape Unit. The now famous TP-1351 was the first magnetic tape unit designed for mini-computers which broke the $2,000 price barrier. The TP-1351 achieved its high performance to cost ratio by an elegantly simple design. Only a dozen integrated circuit packages were utilized in the complete electronics. However, functions such as bit timing, byte assembly, and motion delays were performed by programming.

The TP-1371 combines the best features of the older unit with a new integrated circuit control unit which performs timing, byte assembly, and motion delays by means of self-contained logic circuits. The simple field-tested, highly reliable transport mechanism is retained. In addition, automatic track select, dual transport capability and phase encoding are now standard features.

FUNCTIONAL DESCRIPTION

The Tennecomp TP-1371 is a cartridge-loaded magnetic tape unit for mini- and midi-computers and for "stand alone" applications with hardwired data devices of communications terminals.

A data input register accepts parallel binary information. Self-contained electronics provide data writing, reading, tape motion control and timing, data formatting, clocking and marginal tape checking.

For writing, a write request is made. The TP-1371 will then begin tape motion. When the tape is up to speed, a data ready signal is given. Data must be supplied to the TP-1371 within approximately 2 ms. To cease writing, the write request is cancelled.

Instructions are provided which select the transport and track of interest. A five-position switch (Track 1, 2, 3, 4, and Auto) is provided on each transport. The switch may be used to manually override the software track selection.

The TP-1371 is designed to put minimum burden on the computer, so that concurrent computer operations may be performed. Normal operation is via the "program interrupt" feature, byte at a time. A gap detect circuit allows the software to "count" gaps via the "program interrupt" so that the tape may be positioned while other computer operations are underway. A rewind operation (on either or both transports) may be initialized by the program, and it will then continue without supervision.

These features make the TP-1371 particularly suitable for real time operations where several real time devices are competing for computer time. The four tracks and the automatic gap detector give rapid access to large random files of information.

TP-1371

CARTRIDGE TAPE UNIT

TRANSPORT SPECIFICATIONS

Tape Cartridge: Continuous loop, heavy duty, 4-track.

Data Format: Bit serial in a single track, phase encoded.

Track Selection: Programmable Track Selection. Programmed track may be overridden by manual switch on transport.

Cartridge Capacity: Up to 300 ft., 0.250-inch magnetic tape. Certified tapes are available as follows:

Capacity		Maximum Access Time (sec)		
Bytes/Cart.	Bytes/Track	8-bits	9-bits	12-bits
4K	1K	5	5	6
16K	4K	11	12	15
64K	16K	40	45	55
256K	64K	150	165	210

File Protect: A write enable pin prevents accidental loss of data.

Type of Loading: Insert cartridge in slot on front panel.

Tape Head Type: 4-Track

Beginning of Tape Indication: Adhesive aluminum foil marker applied to beginning of tape.

Recording Density: 600 bits per inch.

Transfer Rate: 4.5×10^3 bits per sec.

Tape Speed: 7.5 inches per sec.

Instantaneous Tape Speed Variations: $\pm$ 0.2% (synchronous motor)

Dual Transport Operation: The software can select either transport. The rewind operation may be initiated independently.

Error Rate and Detection: The major error mechanism is tape degradation. A new certified tape cartridge is expected to read for at least 5000 passes without error.

Transport Specification (Cont'd)

A dual level playback signal discriminator is used to check for marginal playback levels. An error flag is raised if both discriminator levels do not agree, signaling the operator that the tape is marginal and should be copied onto a fresh cartridge. A software generated parity check gives another indication of the accuracy of the data.

Start Time: 500 millisec.

Stop Time: 300 millisec.

Power: *   115 V, 60 Hz, 50 W

Weight: Transport – 26 pounds
Interface – 5 pounds

Dimensions: Transport – $15\frac{1}{2}$" x 7" x 11" (with ears of 19", rack mounting)
Interface – 19" x 3" x 7"

* Also available for 220 V, 50 Hz (PDP-8/E and PDP-11 model utilize cabinet peripheral D. C. power supply).

TP-1371

CARTRIDGE TAPE UNIT

INTERFACE SPECIFICATIONS

Interfaces will soon be available for over a dozen mini- and midi-computers. The interface board determines the number of bits in a "byte". Byte length may vary from a single bit up to 60 bits, as desired. Programming is generally accomplished by means of a "data read buffer", a "data write buffer", a "command register", and a "status register".

The Command Register bits control:

> Track 1, 2, 3, or 4
> Transport 1 or 2
> Rewind, Read, Write, or Count Gap Mode
> Interrupt Enabled or Disabled

The Status Register Provides indication of:

> Beginning of Tape Marker on Transport 1 and 2
> Marginal Playback Level Flag
> Gap Detect Flag
> Read Flag
> Write Flag

Writing

For writing, the track and transport are selected. A write mode request is made. When the tape is up to speed, a data required signal will be given. Data must be supplied to the control within 2 ms. of the data ready signal. Writing continues as long as data is supplied, or until the BOT is found.

After a block of data is written, the transport may be stopped, or an end of block gap command may be issued and additional blocks written separated by an inter-block gap.

Reading

Reading is similar to writing, except that the control gives a data ready signal when the tape is up to speed and the first byte has been read. The data must be received within 2 ms of the data ready signal. Reading continues until a "gap" is encountered. At this time, a "gap detect" flag is raised. The transport may be stopped in mid-gap, or may be allowed to continue. An automatic halt will occur at the Beginning of Tape Marker, if the transport is not halted sooner under program control.

Connectors or special boards are provided to interface various model minicomputers. An extra set of connectors is always provided where "daisy chaining" is feasible.

MAINTENANCE

No periodic maintenance should be required. Generally, satisfactory performance can be obtained by observing common sense rules of cleanliness. Keep the tape cartridges stored in a protected place so that they do not pick up lint or grease.

Intermittent Operation of a Particular Cartridge

If a particular tape cartridge is giving trouble, remove the dust cover from the top of the transport so that an unobstructed view of the heads is obtained. Check to see if the tape is playing off the reel smoothly and is winding smoothly back on. Check to see if the pressure pad seems to be correctly aligned.

Intermittent Operation of all Cartridges

Remove the dust cover as above and visually inspect the transport parts. Check to see if the PINCH ROLLER is slipping. Try putting a short length of tape between the CAPSTAN and the PINCH ROLLER and see if the force is adequate to pull it from your fingers. If the CAPSTAN and HEAD are dirty or greasy, clean them with a tape head cleaning solvent. Robbins type TX-20 is adequate. Do not get solvent on the rubber PINCH ROLLER. It may be cleaned with a rag dampened with plain water or alcohol. Also give all exposed parts a good dusting if dirty or greasy.

If the transport still gives intermittent operation with a good tape, connect an oscilloscope to PIN D2 of C4 (Read Amplifier signal). The Peak to Peak signal level should be about 6 volts, while reading, and the signal should be clean and free from jitter. If the signal is appreciably less than 6 volts, the read amplifier is suspect.

Mark Sense Operation Faulty

If the mark sense circuit seems to be faulty, connect an oscilloscope to pin V of the transport connector. The signal should go from ground to at least +5 volts when the mark comes around. Check to insure that excessive amounts of oxide have not built up on the splice detect head.

Transport Inoperative

Check the MOTOR and PINCH ROLLER operation. The routine in the installation instructions will run the motor and cause the pinch roller to pull in. A ground level signal should be observed on pin C4P2..

ATTACHMENTS

ATTACHMENTS

Drawing Number	Title
TP-1371E-EO	Tape Transport (2 Sheets)
TP-1371B-EO	Control Electronics
TP-1371A-EO	Read/Write Electronics
TP-021	Driver Card
TP-014A	Read Amplifier Card

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