August, 1971

How to Use the MiniDek

With the PDP 8/e Computer

Part III

Installation
Program Listings
Drawings

TENNECOMP TP-1351 MAGNETIC TAPE STORAGE UNIT

The TP-1351 "TENNETAPE" is intended for use with the PDP Family-of-Eight computers. The TENNETAPE is a high-speed I/O device capable of replacing most paper tape I/O, and operates at approximately 200 twelve-bit words per second in both read and record operations. The TENNETAPE was inspired by a less sophisticated unit constructed by J. J. H. Park of the National Research Council of Canada.

The TENNETAPE utilizes continuous-loop tape cartridges popular in the broadcasting industry for their reliability and ease of handling. Standard program cartridges have a capacity of 4096 computer words on each of their four tracks. Changing one cartridge for another is a five second operation and may be done with the tape in any position.

All functions of the TENNETAPE are software controlled except for track selection, which is by means of a four-position rotary switch. The processor is used to assemble words for writing and to disassemble words when reading. Only a single bit at a time is transferred between the processor and the tape unit. Since signals are transferred on a bit by bit basis, the FORMAT of the information is completely determined by programming. Record operations of the TENNETAPE are file-protected to prevent accidental destruction of valuable symbolic text, data, or programs.

In conjunction with the TP-1346 Automatic Loader, the TENNETAPE offers unique "one button" loading and starting of programs. The program proper is stored on the TENNETAPE; the tape reading routine is mechanically read into the computer by the Automatic Loader.

INTRODUCTION

Interface Unit

Serial information read or written by the tape unit is transferred to and from the computer by means of IOT pulses. The interface contains a 1 bit buffer (BIT FLAG) which is set when a "one" is read from tape. There are also provisions for writing a "one" on tape and sensing the Beginning-of-Tape reflective marker which is positioned at the splice in the continuous loop. The tape may be considered to have no "end" or "beginning," but one may not write over the splice without a chance of losing information.

The control contains two timing circuits which operate mechanical relays. One relay turns on the motor and engages the capstan and pinch roller (MOTOR/PINCH ROLLER RELAY) and the other relay switches the heads from a read configuration to a write configuration (WRITE MODE RELAY). The relay timing circuits hold the relays in for a specified time each time they are pulsed. The delay for the WRITE MODE relay is somewhat longer than the delay for the MOTOR/PINCH ROLLER RELAY so that the tape motion can stop before the READ/WRITE relay opens. Otherwise, some information on the tape might not be erased when starting and stopping the tape.

The device code (second and third octal digit of the instruction) is normally 37 but may be varied by clipping diodes on the device selector card in the interface. The code is denoted by XX in the following list of instructions.

Instructions

SKIP ON BIT AND PULSE MOTOR (TPSP)
Octal Code: 6XX1
(See computer manual for IOT execution time)
Operation: The BIT FLAG is sensed and if it is set (indicating a bit read from tape), the contents of the PC is incremented by one thereby skipping the next sequential instruction. The MOTOR/PINCH ROLLER RELAY of the transport is pulsed for 12 milliseconds. If a continuous loop of TPSP instructions is given, the MOTOR/PINCH ROLLER RELAY will remain engaged as long as the TPSP instruction occurs at least once every 12 milliseconds.

SKIP ON MARK AND CLEAR FLAG (TPMC)
Octal Code: 6XX2
(See computer manual for IOT execution time)
Operation: The Beginning-of-Tape photocell output is sensed and if it indicates the presence of a reflective marker, the contents of the PC is incremented by one, thereby skipping the next sequential instruction. The BIT FLAG is cleared. The output of the photocell is A.C. coupled and the mark must be in motion to be sensed. TPMC is normally combined with TPSP to search for the mark in the READ MODE or with TPWP to search for the mark in the WRITE MODE.

WRITE MODE AND PULSE MOTOR (TPWP)
Octal Code: 6XX4
(See computer manual for IOT execution time)
Operation: The READ/WRITE relay is pulsed for 55 millisec. (The relay requires about 1 millisec to pull in.) The READ/WRITE relay connects the tape head in the WRITE mode and begins to saturate the tape in the "zero" direction. When the READ/WRITE relay has pulled in, TPWP will also pulse the MOTOR AND PINCH/ROLLER RELAY for 12 millisec. Thus a continuous loop of TPWP will erase the tape.

WRITE MODE AND RECORD BIT (TPWB)
Octal Code: 6XX5
(See computer manual for IOT execution time)
Operation: The WRITE MODE RELAY is pulsed for 55 milliseconds and the MOTOR/PINCH ROLLER RELAY is pulsed for 12 milliseconds. A pulse is written on tape. If TPWB instructions are given, at least every 12 milliseconds, continuous tape motion will result.

WRITE MODE AND SKIP ON MARK (TPWM)
Octal Code: 6XX6
(See computer manual for IOT execution time)
Operation: A combination of TPWP and TPMC. Pulses the WRITE MODE RELAY for 55 milliseconds and the MOTOR/PINCH ROLLER RELAY for 12 milliseconds. The Beginning-of-Tape photocell output is sensed and if it indicates the presence of a reflective marker, the contents of the PC is incremented by one, thereby skipping the next sequential instruction. The BIT FLAG is also cleared. A continuous loop of TPWM is used to search for the Beginning-of-Tape mark erasing tape while waiting for the mark.

Operating Controls

Refer to the following sketch.

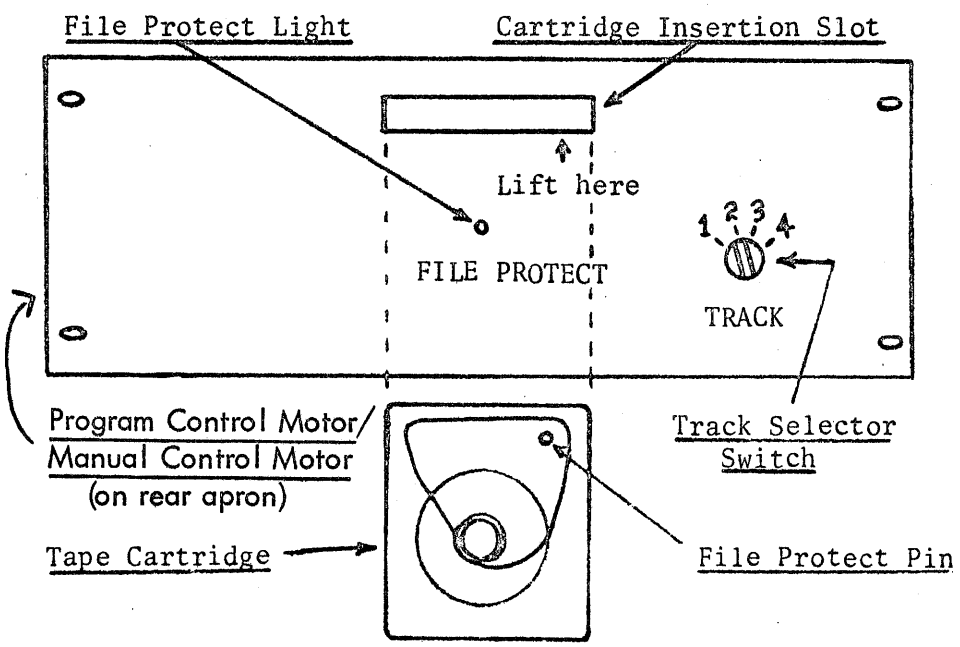


Figure 1. FRONT PANEL CONTROLS

OPERATION

Read and record operations of the TENNETAPE require short programs to be resident in the computer memory. Normally both programs are stored in the last page (200 words) of memory along with the RIM loader and are read into memory by the RIM loader.

Recording on the TENNETAPE is accomplished as follows:

(1) Read in the tape record routine from paper tape on the ASR-33 Teletype using the RIM loader;

(2) Insert a file protect pin into the hole in the cover of the tape cartridge to be used;

(3) Push the tape cartridge firmly into the front panel slot;

(4) Set the track selection switch to the desired channel;

(5) Set the computer's front panel switches to 7700_8 and press the load address switch, then the start switch;

(6) The computer will immediately halt. Set the initial octal address of the block of memory to be recorded on the computer front panel switches and press the continue switch;

(7) The computer will halt again. Set the final octal address of the block of memory to be recorded on the computer front panel switches and press the continue switch;

(8) Check the file protect light on the TENNETAPE front panel. If it is on, the record operation will not take place. If you have forgotten the file protect pin, stop the computer, remove the cartridge, and insert the file protect pin; and start the procedure over again at step (3);

(9) At the end of the record operation, the computer and the tape motion will halt. The cartridge may be removed by lifting up on its protruding end and pulling gently out of the front panel slot;

(10) Remove the file protect pin from the hole in the cover of the tape cartridge to prevent accidental destruction of the information just recorded.

Reading from the TENNETAPE is accomplished as follows:

(1) Read in the tape read routine from paper tape on the ASR-33 Teletype using the RIM loader;

(2) Push the tape cartridge firmly into the front panel slot;

(3) Set the track selection switch to the desired channel;

(4) Set the computer's front panel switches to 7600_8 and press the load address switch, then the start switch;

(5) Upon completion of the read operation, the computer and the tape motion will halt. The checksum will be displayed on the accumulator lights on the computer front panel. (Zero indicates a correct read operation, and non-zero indicates an error.)

For routine operation, it is convenient to prepare a systems cartridge which holds the record routine, a short binary loader, and a read-compare routine, rather than to obtain these routines from paper tape. Preparing a systems cartridge is facilitated by use of the system builder routine as follows:

(1) Read in the system builder routine from paper tape on the ASR-33 Teletype using the RIM loader;

(2) Insert a file protect pin into the hole in the cover of the tape cartridge to be used;

(3) Push the cartridge firmly into the front panel slot;

(4) Set the computer's front panel switches to 200_8 and press the load address switch, then the start switch;

(5) The computer will type out "Track 1 Record" and halt. Set the track selection switch to channel 1 and press the continue switch on the computer front panel. The record program will be recorded on tape;

(6) Step (5) will repeat for "Track 2 Short Binary Loader," "Track 3 Read-Compare," and "Track 4 Rim Loader." Set the track selection switch to the indicated channel at each halt and press the continue switch;

(7) Remove the cartridge from the front panel slot and remove the file protect pin from the hole in the cover of the cartridge;

(8) The teletype printout may be cut to size and used as a label for the contents of the system cartridge;

(9) The systems programs may now be read from the tape in the manner described above for reading. The "Record," "Short Binary Loader," and "Read-Compare" programs all start at 7700_8; only one of these is resident in the last page of memory at a time along with the "Read" program.

(10) The "Short Binary Loader" may be used to read binary tapes on the ASR-33 Teletype without the memory extension option;

(11) The "Read-Compare" may be used to check information recorded on tape with information resident in memory. Errors are indicated by the teletype bell, and an "O" or an "E" is typed at the end of the comparison indicating "O.K." or "Error."

PRINCIPLES OF OPERATION

Refer to the print of the Tape Unit Interface.

Write Mode

In the write mode of operation, information is recorded bit serial in the selected track by means of the WRITE ONE SHOT. The pulse width is 134 microsec. Typically, a timing pulse is recorded, followed by 12 bit pulses. Curve (1) of Figure 2 shows a timing pulse followed by bit pulses for a word containing 7253_8. The record mode of operation is selected by IOT-4, which causes closure of the WRITE MODE RELAY. The relay remains energized for 55 milliseconds each time the pulse is given. The time duration is determined by an 8 microfarad capacitor connected across the input of a W107 module. The IOT-4 pulse discharges the capacitor to zero volts, and the capacitor gradually charges up through the input circuit of the W107. The W107 is a special DEC module which consists of two inverters in tandem. The output is non-inverting. The first inverter requires only about .2 ma input for proper operation, rather than about 1 ma, as with the standard R107 inverter.

Read Mode

In the read mode of operation, the signal from the tape head appears as shown in Curve (2) of Figure 2. Two μ 709 operational amplifiers are used to amplify the head voltage. The amplified output signal goes to a Schmidt trigger circuit. The dashed line on Curve (2) of Figure 2 illustrates the Schmidt trigger threshold. When the signal goes more negative than the threshold the Schmidt trigger goes from -3 volts to ground, as shown on Curve (3) of Figure 2. The leading edge of the signal from the Schmidt trigger is used to set the BIT FLAG flip flop, as shown in Curve (4) of Figure 2. IOT-1 tests the state of this flip flop and causes a SKIP if the BIT FLAG is set. IOT-2 resets the flip flop.

In normal read operation, a series of IOT-1's is given to find the first timing pulse. Then an IOT-2 clears the BIT FLAG. Then, the processor is programmed to generate an IOT-1 in about 402 microsec, followed by 11 more IOT's every 268 microsec. These IOT-1's test the state of the BIT FLAG, which is then reset by IOT-2's. The extra delay following the timing pulse strobes the BIT FLAG half way between bit 0 and bit 1. The next IOT-1 strobes the BIT FLAG half way between bit 1 and bit 2, etc. This method of strobing gives a tolerance of approximately 125 microsec to timing errors. The cumulative timing error of the last IOT-1 which test bit 11 should be much less than 125 microsec.

On the PDP-8/S, the time delay for writing and reading is produced by the program loop which generates the write pulses and the strobe pulses. On faster computers, extra delay must be programmed in by means of delay subroutines. The processor cycle time and the memory cycle of the PDP-8/S are separately adjustable and will vary somewhat. To insure compatibility between one computer and another, the cycles times will have to be adjusted to within the timing tolerance of the transport, or else the program can be "padded" by extra dummy instructions.

In the read mode, IOT-1 also pulses the MOTOR/PINCH ROLLER RELAY and causes it to close for 12 milliseconds. In addition to resetting the BIT FLAG, IOT-2 also tests the output of the Beginning-of-Tape mark photocell, causing a skip whenever the mark passes by the photocell.

File Protect

The presence of the FILE PROTECT PIN actuates two microswitches in the transport unit. One of these is connected in series with the write mode relay so that if the FILE PROTECT PIN is absent the heads are not connected in WRITE MODE. The other switch turns on the FILE PROTECT LIGHT if an attempt is made to select WRITE MODE without the FILE PROTECT PIN.

Tape Cartridges

Standard tape cartridges are loaded with Scotch Type 282 "sandwich" tape. Sandwich tape prolongs both the life of the tape head and the life of information stored on the tape. The tape is spliced with 3/8" of splicing tape on the back side, and a 3/8" strip of reflective tape is placed on the front side, trailing the splice by 1/4". The tape has from 1" to 2" of slack in the continuous loop; less slack causes jerky oepration while more slack may cause jamming of tape after it passes the pinch roller.

The TENNETAPE is provided with three standard program cartridges of 25 sec length and one 100 sec tape. Additional cartridges, with tapes of 25, 100, or 400 sec duration may be ordered from Tennecomp. Tennecomp cartridges are covered by the TENNETAPE warranty.

Users desiring to load their own cartridges should obtain satisfactory results with the following materials:

(1) FIDELIPAC Cartridges

(2) Scotch Type 156 Digital Tape

(3) Robbins Type TST-235 Splicing Tape

(4) Scotch Type 51-7/325 Alummized Sensing Tape

These materials can be obtained from Allied Electronics, 100 N. Western Avenue, Chicago, Illinois 60680. Substitutions of other type materials are not recommended.

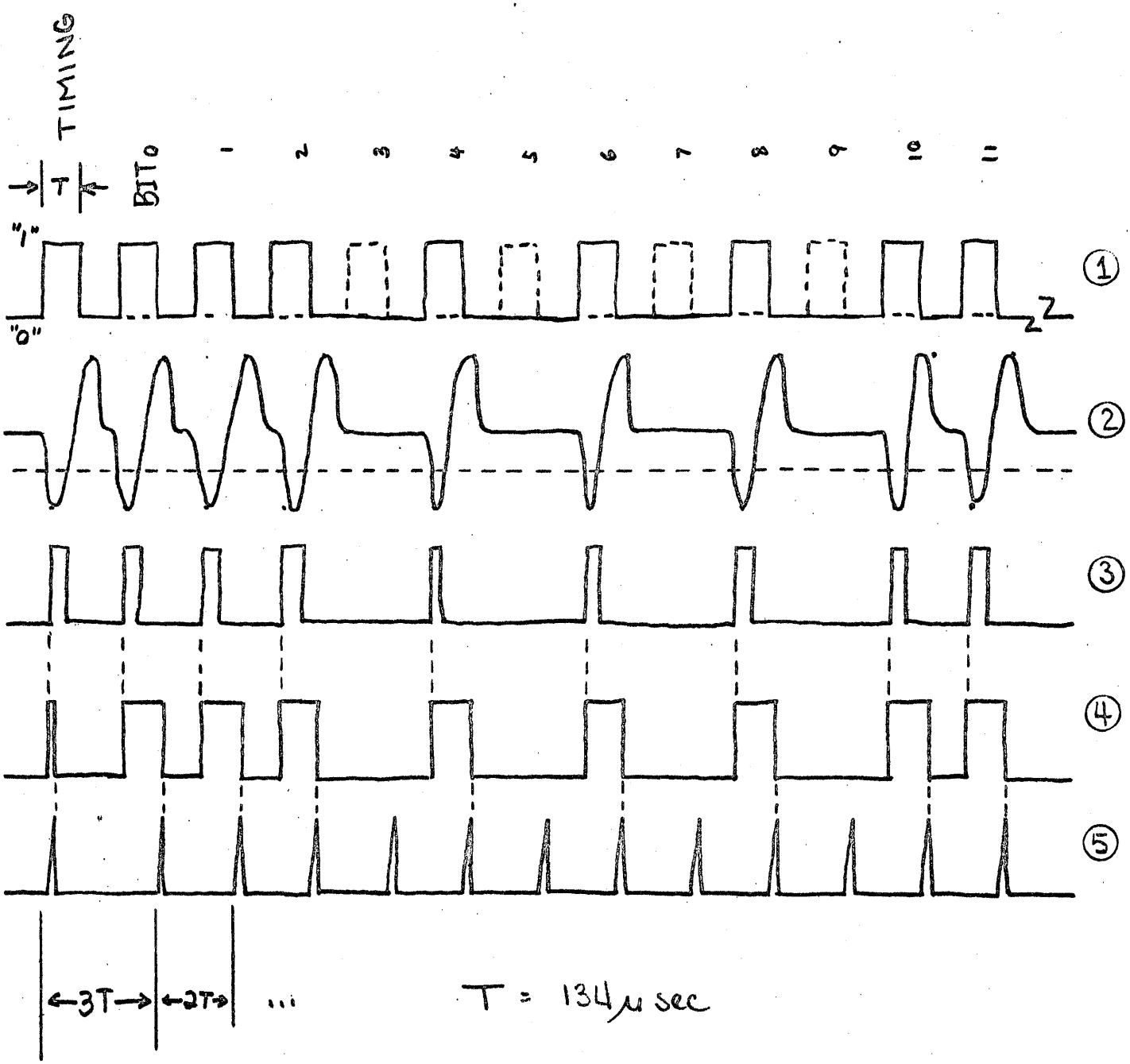


Figure 2. Tape Signals

PROGRAMMING

Recording

Refer to the listing of the TENNETAPE record routine. From the initial and final addresses, the processor calculates the negative of the number of words to be recorded. Then the write mode is selected and the tape started in motion, erasing previous information. A search for the reflective marker is started; when it is found, a three second delay of erase only is entered to insure that the tape is up to speed, and that the vicinity of the splice is past the head before actual recording begins. The first recorded word is the initial address, the second is the negative of the number of words recorded, and the rest but one are the desired information. The last word recorded is the checksum for the operation, namely the least significant 12 bits of the sum of all the recorded words.

Reading

Refer to the listing of the TENNETAPE read routine. A search loop for the reflective marker is entered, and upon exit a one second delay is entered to allow the splice to move past the head. The routine then searches for the timing mark of the first word which it takes as the initial address. The second word it takes for the negative of the number of words to read, and it then reads that number of words and deposits them in sequential memory locations starting at the initial address. The read routine keeps a checksum of all but the first two words. Upon reading all information words, the routine reads the next word as the recorded checksum and compares that checksum with the one it has calculated. The difference between the two checksums is placed in the accumulator and the routine halts.

The read program can easily be modified to do either of the following:

(1) Transfer control to some preassigned memory location when the calculated and recorded checksums agree;

(2) Compare (but not deposit) the information on tape with that in memory and ring the Teletype bell if the two do not agree. This read-compare operation is the best way to verify that record operations were successful.

Editing

Refer to the listing of EDIT-8 modifications for TENNETAPE I/O. The high speed reader options have been replaced by TENNETAPE I/O routines; otherwise editing is unchanged and operates according to the EDIT-8 manual. Text written on tape is blocked out in 574_8 word buffers for compatibility with PAL-III input; the operate/test switch must be in test position to get the tape up to speed rapidly.

The two least significant positions on the computer's front panel switches are used to denote tape input/output or Teletype input/output--one means TENNETAPE I/O, and zero means Teletype I/O.

One additional requirement is necessary for the TENNETAPE system. A dollar sign ($) must be the last character in any string of text for output; the last buffer most likely will not be exactly filled and the dollar sign is the symbol required to start output of the buffer.

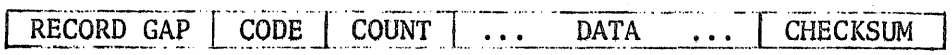
It should be noted that the space available for text in the editor has been reduced somewhat, but there remains ample storage space to handle one page of liberally annoted text.

Assembling

Refer to the listing of PAL-III modifications for TENNETAPE input. The high speed reader option has been replaced by TENNETAPE input routines; otherwise assembling is unchanged and operates according to the PAL -III manual. The operate/test switch must be in the test position to get the tape up to speed rapidly. The least significant bit on the computer front panel switches is used to denote TENNETAPE input or Teletype input; one means TENNETAPE input, and zero means Teletype input.

File Operations

Refer to the listings of the TENNETAPE file routines. The routines are quite general and require two pages of memory; more specific routines could be condensed into less space if necessary. All file operations should be done with the operate/test switch in test position unless the delays change to give more time for the tape to come up to speed. The format of files used by these routines is:



WBOT (Beginning Of Tape in Write mode) is necessary for initialization of any given track on a tape. The routine writes 1's at the end of tape and erases a short section of the tape to space the splice past the tape head. Upon return from WBOT, the tape is ready for writing files.

RBOT (Beginning Of Tape in Read mode) is used to find the beginning of tape. Upon return from RBOT, the tape is ready for reading files, and for writing files if the track has been previously initialized with WBOT.

WRITE is used to record the portion of memory from IA to FA. The file is identified with the CODE word specified by the contents of the AC when WRITE is called. The error return indicates that the end of tape was encountered during recording and the operation aborted, the tape being spaced to the beginning of tape point.

READ is used to read a file from the tape into the portion of memory from IA to FA; the code word is returned in the AC. The error return signifies one of the following errors has been made; the error flag word may be found in ERROR of the READ routine (READ + 102_8):

(a) The tape was not in an inter-record gap when READ was called (flag word = READ + 63_8). The tape was spaced to the next inter-record gap and the AC contains the code of the last record read;

(b) The size of the file on tape differs from the size called for (flag word = READ + 102_8). The tape was spaced to the inter-record gap and the code is in the AC;

(c) The checksum on tape differs from the checksum calculated during reading (flag word = READ + 51_8). The code is in the AC;

(d) The end-of-tape was encountered and the read operation was aborted (flag word = READ + 61_8). The tape was spaced to the beginning-of-tape point and the AC contains either the code word or 7777, depending on whether or not part of a record was there.

SPACE is used to skip over the number of files indicated by the contents of the AC when SPACE is called.

SEARCH is used to read a file with the code word specified by the contents of the AC when SEARCH is called. The error return indicates either that a file with the specified code was read incorrectly due to one of the error conditions discussed above with reference to READ (AC = 0) or that the end of tape was encountered without finding a file with the specified code (AC = -1). If the tape was not at the beginning of tape point when SEARCH was called, the proper file may have been on a prior portion of the tape and SEARCH should be called again to find it.

General Note

Due to the programmed delays for bit-to-bit timing in reading and writing, all tape operations should be protected from interrupts or data breaks during the inner read and write subroutines.

TP-1371 INSTALLATION INSTRUCTIONS FOR PDP-8/e

Installation of the TENNECOMP TP-1371 requires the following steps:

(0) Unpack the box and inspect all components. Make sure that none of the wire-wrap pins on the base of the control logic panel are bent or shorted and that no mechanical damage has been done in shipment. Insert the cards firmly in their sockets.

(1) Mount the transport in a standard 19-inch relay rack. The transport is normally shipped with "ears" for rack mounting. It may be specified for "table top mounting", in which case, it is shipped with "feet" instead of "ears". The feet are necessary for table top mounting to insure adequate air flow. The transport requires 7 inches of rack height.

(2) Make sure that there is adequate ventilation for the transport. It is necessary to have free air flow through the louvers on the bottom of the cabinet to avoid excessive internal temperatures. Do not mount the transport immediately above a large obstruction which blocks the air flow louvers. If the transport is "table top" mounted, make sure that the rubber feet are in place to allow an air flow gap between the transport and the table top.

(3) Turn off the 8/e and open it.

(4) Attach the transport power wires to the lugs (3) on the interface card (TP023) in the following order, starting at the green blocks (see sketch):

+5 V	RED
-15 V	BLUE
Ground	BLACK

(5) Check for loose plug-in cards, bent or broken wires, etc., then plug the interface card (attached to the green blocks and the other cards) into the rearmost slot of the omnibus. Move previously installed cards forward the appropriate number of slots. Some care is required to pass the control card (the center one) over the omnibus power wiring. Ensure that the cards do not grind together. The resulting orientation is shown in the sketch. The green blocks are upper-most; all components face forward in the computer; the power and interface cables sit near the tray on the computer power supply.

(6) Attach a 110 V line cord to the transport and plug it into the back of the PDP-8/e (or a wall receptacle). The transport AC power should be de-energized by the computer console power switch in order to prolong the motor life (the motor is rated at several years of continuous duty).

(7) Plug the red, blue, and black wires onto the similarly colored sockets on the transport rear.

(8) Plug the printed circuit paddle marked "1" into the 18-pin socket on the transport (make sure the pins mate - it can be inverted). Attach its other end to the "Molex" 9-pin socket marked "1". Repeat if a second transport is used (TP-1372).

(9) Now energize the AC power to the computer, the transport, and the control electronics. Give the system the "smoke test". Look for telltale wisps of smoke or unusual sounds or smells. If all seems well, attempt to load a memory cell from the PDP-8/e console switches to see if the computer is working normally. If not, check that the cards clear each other and the surrounding wiring. Check computer voltages.

(10) Insert a cartridge in the transport; then pull it out and look to see if the capstan is rotating (only if toggle switch on transport is in "manual motor control" position). The capstan should be slowing down to a halt. If it did not move, check the above switch, the 110 V, and the +5, -15 V ground lines.

(11) Toggle in the following short program:

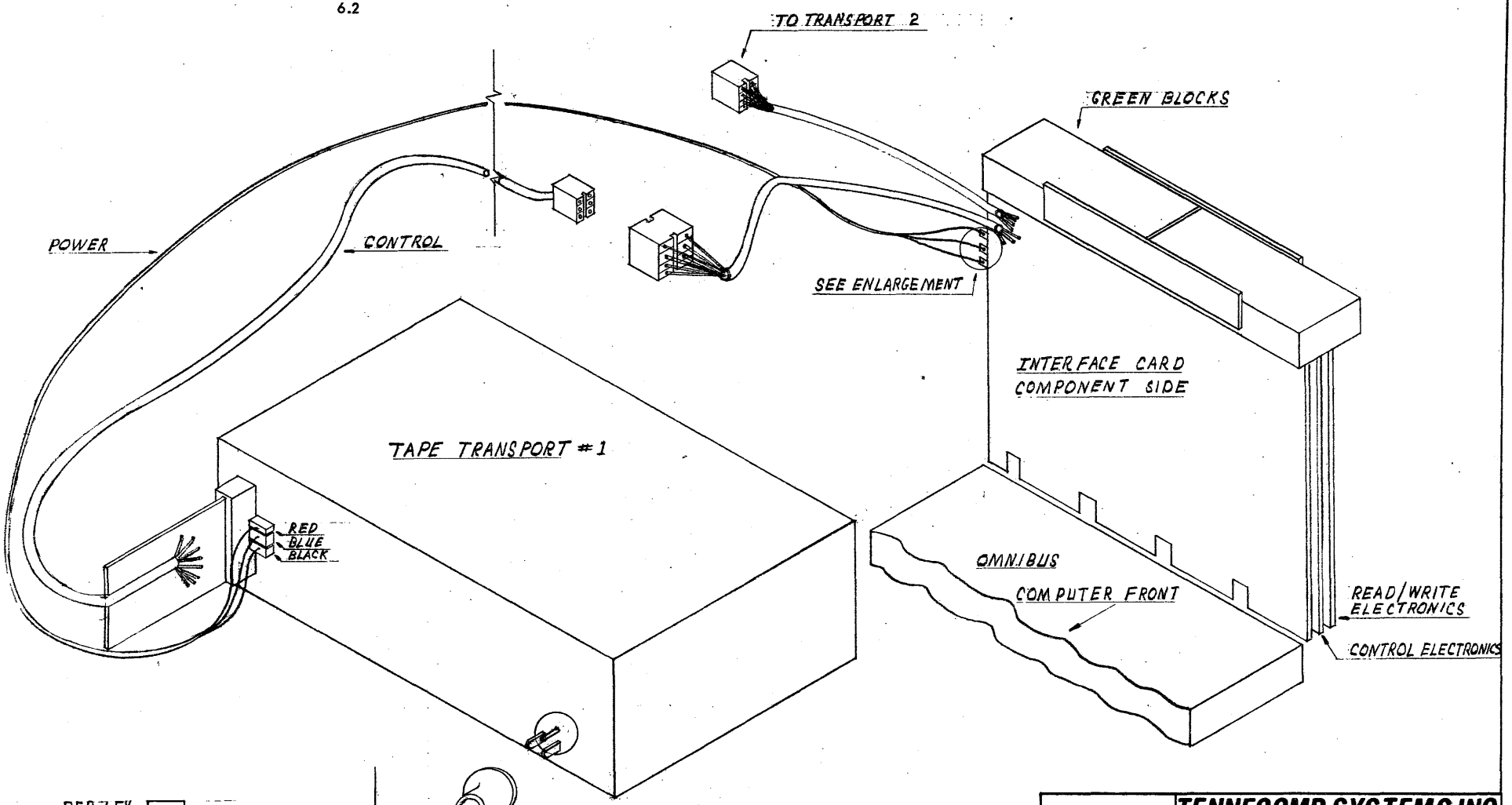
```
200    1210    TAD     210  /LOAD COMMAND REGISTER
201    6375    IOT 375      /
202    6373    IOT 373      /SKIP & READ STATUS
203    5202    JMP .-1      /
204    0211    AND     211  /
205    7450    SNA          /BEGINNING OF TAPE?
206    5202    JMP .-4      /
207    7402    HLT          /STOP

210    0002    0002         /WRITE COMMAND BITS
211    0010    0010         /MASK FOR "BOT"
```

Insert a cartridge, load address, and start at location 200. The tape reel should turn and the computer should stop when the splice comes around (about 25 seconds for a 4K cartridge). The "file protect" light on the transport should come on if the "write allow" pin is not inserted.

(12) If the simple program works correctly, try to record and read a full 31-page program (from location 0 to 7577). You can use whatever junk happens to be in memory. If you want to make sure that the program loaded all right, check a few cells and modify them after you record. Then see if they come back after the read.

(13) Now you are ready to go. Refer to the programming write-up.



REVISIONS	TENNECOMP SYSTEMS, INC.		
	TP/1371 PDP-8E INSTALLATION SUPPLEMENTARY INSTRUCTIONS		
	DESIGNED	APPROVED RMB.	SHEET OF
	DRAWN N.T. MILLER	DATE MAY, 20, 1971	DWG. NO. TP-1371/8E-8-M0

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/ TENNECOMP SYSTEMS, INC. MINIDEK FOCAL

/ 4K VERSION

/ TP-1371 DEFINITIONS

SRSR=6373       / SKIP ON STATUS AND READ STATUS
CLCR=6375       / CLEAR AND LOAD COMMAND REGISTER
RWCF=6376       / READ WORD AND CLEAR READ FLAG
TWCF=6374       / TRANSFER WORD AND CLEAR WRITE FLAG
CLB1=6365       / CLEAR BOT FLAG FOR UNIT 1
CGAP=6364       / CLEAR GAP FLAG

/ FOCAL, 1969 DEFINITIONS

SPNOR=4560      / GET NEXT NON-SPACE CHARACTER
GETC=4545       / GET NEXT CHARACTER
SORTC=4550      / SORT A CHARACTER AGAINST A LIST
TESTN=4561      / TEST A CHARACTER FOR NUMBER
SORTJ=4547      / SORT AND JUMP ROUTINE
PUSHA=4542      / PUSH AC ON PUSH-DOWN LIST
POPA=1413       / POP AC OFF PUSH-DOWN LIST
POPJ=5541       / EXIT FROM RECURSIVE ROUTINE
ERROR7=4566     / ERROR CALL
CHAR=0066       / CHARACTER STORAGE
GLIST=1377      / SORT LIST FOR TERMINATORS
SORTCN=0054     / BINARY VALUE OF CHARACTER
BUFR=0060       / STORAGE FOR LAST TEXT LOCATION
CFRS=0133       / BEGINNING OF TEXT POINTER
STARTV=BUFR     / BEGINNING OF VARIABLE STORAGE
LASTV=0031      / STORAGE FOR LAST VARIABLE LOCATION

/ OPERATE INSTRUCTION CONSTANT GENERATION DEFINITIONS

GET=CLA CLL     / BASIC CONSTANT INSTRUCTION
CNST1=IAC               / GET CNST1 = 0001 IN AC
CNST2=IAC RAL           / GET CNST2 = 0002 IN AC
CNST3=CML IAC RAL       / GET CNST3 = 0003 IN AC
CNSTM1=CMA              / GET CNSTM1 = 7777 IN AC

/ THIS PATCH IS TO BE USED ONLY WITH 4K FOCAL, 1969 AND A
/ DIFFERENT VERSION USED WITH 8K FOCAL, 1969

/ LOADING INSTRUCTIONS:
/       1.      LOAD RIM LOADER INTO COMPUTER
/       2.      LOAD BINARY LOADER INTO COMPUTER
```

```
/       3.      LOAD FOCAL, 1969 INTO COMPUTER
/       4.      LOAD MINIDEK FOCAL OVERLAY INTO COMPUTER
/ FOCAL MAY NOW BE STARTED AND INITIALIZATION QUESTIONS
/ ANSWERED ACCORDING TO THE WISHES OF THE USER.

/ OPERATING INSTRUCTIONS:       RECORDING TEXT
/       TO RECORD TEXT STORED IN MEMORY ONTO A TRACK OF
/       YOUR MINIDEK, FIRST PLACE A CARTRIDGE WITH A FILE
/       PROTECT PIN INSERTED INTO THE MINIDEK CARTRIDGE
/       SLOT.   PLACE THE TRACK SELECT SWITCH ON THE "AUTO"
/       POSITION.       IN RESPONSE TO FOCAL'S ASTERISK (*),
/       TYPE THE COMMAND "LIBRARY OUT X", WHERE "X" IS THE
/       TRACK YOU WISH USED, AND HIT RETURN.    THE TEXT WIL
/       THEN BE RECORDED AND CONTROL RETURNED TO FOCAL.
/       THE COMMAND "LIBRARY OUT X" MAY BE ABBREVIATED AS
/       ["L O X" AND MAY ALSO BE GIVEN AS AN INDIRECT COMMAD
/       IN YOUR FOCAL PROGRAM.

/ OPERATING INSTRUCTIONS:       READING TEXT
/       TO READ TEXT STORED ON A TRACK OF YOUR MINIDEK INTO
/       MEMORY, FIRST PLACE THE CARTRIDGE WITH THE DESIRED
/       FOCAL TEXT INTO THE MINIDEK CARTRIDGE SLOT.     PLAC
/       THE TRACK SELECT SWITCH ON THE "AUTO" POSITION. IN
/       RESPONSE TO FOCAL'S ASTERISK (*), TYPE THE COMMAND
/       "LIBRARY IN X", WHERE "X" IS THE TRACK THAT CONTAINS
/       THE TEXT, AND HIT RETURN. THE TEXT WILL BE READ INTO
/       MEMORY, THE VARIABLES ERASED, AND CONTROL RETURNED
/       TO FOCAL.       THE COMMAND "LIBRARY IN X" MAY BE AB
/       VIATED AS "L I X" AND MAY BE GIVEN AS AN INDIRECT
/       COMMAND IN YOUR FOCAL PROGRAM.

/ PROGRAMMING NOTES:
+       WHEN USING EITHER OF THE LIBRARY COMMANDS IN AN
/       INDIRECT CAPACITY, THE FOCAL PROGRAM WILL STOP
/       (SAME EFFECT AS THE "QUIT" COMMAND) AFTER THE
+       ACTION HAS BEEN TAKEN.  THEREFORE ANY COMMANDS
/       GIVEN AFTER THE LIBRARY COMMAND ON THE SAME LINE
/       WILL BE IGNORED.

/ SLIGHT MODIFICATIONS TO FOCAL PROPER

        *1012
1012  7000      NOP             / DELETE HIGH SPEED READER
        *1173
1173  6321      LIBRARY         / POINTER TO LIBRARY ROUTINE
        *6321
6321  4560  LIBRAR, SPNOR       / GET NEXT NON-SPACE CHARACTER
6322  1066      TAD CHAR
```

```
6323  4542          PUSHA             / SAVE KJ P@H (PUSH-DOWN LIST)
6324  4545          GETC              / GET NEXT CHARACTER
6325  4550          SORTC             / IS IT A TERMINATOR???
6326  1376                  GLIST-1   / TERMINATOR LIST POINTER
6327  7410          SKP               / YES.  GET TRACK NUMBER
6330  5324          JMP .-4           / NO. KEEP LOOKING
6331  4560          SPNOR             / GO PAST TERMINATOR (SPACE)
6332  4561          TESTN             / MAKE SURE IT'S A NUMBER
6333  4566                  ERROR7    / ?25.91 -- FOUND PERIOD
6334  4566                  ERROR7    / ?25.92 -- FOUND TERMINATOR
6335  6364          CGAP              / CLEAR THE GAP FLAG
6336  6373          SRSR              / GOOD. READ MINIDEK STATUS
6337  7000          NOP               / SKIP PROTECT
6340  0363          AND BOT1          / MASK OFF SPLICE 1 BIT
6341  7640          SZA CLA           / IS IT HERE??
6342  5347          JMP .+5           / YES. DON'T HAVE TO REWIND
6343  7325          GET CNST3         / NO. REWIND TAPE UNIT
6344  0000          CHCR              / LOAD COMMAND REGISTER
6345  6373          SRSR              [/ SKIP ON SPLICE
6346  5345          JMP .-1
6347  6365          CLB1              / CLEAR BOT FLAG (UNIT 1)
6350  7340          GET CNSTM1        / TAD MINUS1
6351  1054          TAD SORTCN        / SUBTRACT 1 FROM TRACK NUMBER
6352  0364          AND C3            / MAKE SURE NO OVERFLOW
6353  7106          CLL RTL           / ROTATE 3 LEFT
6354  7004          RAL
6355  3167          DCA TEMP1         / STORE TRACK NUMBER TEMP.
6356  1413          POPA              / GET SUB-COMMAND FROM PDL
6357  4547          SORTJ             / SORT AND JUMP
6360  6364                LLIST1-1          / SOURCE AND DESTINATION LIS
6361  0002                LLIST2-LLIST1
6362  4566                ERROR7    / ?25.;3 -- ILLEGAL SUB-COMMAND
6363  0010  BOT1,   10                / BOT 1 MASK
6364  0003  C3,     3                 / TRACK MASK
6365  0311  LLIST1, 0311              / "I" FOR "IN" FOR "READ"
6366  0317        0317                / "O" FOR "OUT" FOR "RECORD"
6367  7511  LLIST2, READ              / JUMP TO READ ON I
6370  7533        WRITE               / JUMP TO WRITE ON O

            *7503

7503  0000  UPDATE, 0                 / UPDATE POINTERS ROUTINE
7504  1567        TAD I TEMP1         / UPDATE CHECKSUM
7505  1171        TAD TEMP3
7506  3171        DCA TEMP3
7507  2167        ISZ TEMP1           / INCREMENT LOCATION POINTER
7510  5703        JMP I UPDATE
7511  7301  READ,   GET CNST1        / READ TEXT--AC = 1
```

```
7512  4351          JMS SETUP       / SET UP TAPE UNIT
7513  4357          JMS READW       / READ FIRST WORD
7514  3060          DCA BUFR        / STORE AS LAST TEXT LOCATION
7515  4367          JMS INITAL      / INITIALIZA PKINTERS
7516  4357          JMS READW       / READ DATA WORD
7517  3567          DCA I TEMP1     / STORE IN MEMORY
7520  4303          JMS UPDATE      / UPDATE POINTERS
7521  2170          ISZ TEMP2       / COUNTDOWN WORDS
7522  5316          JMP .-4         / NOT FINISHED.
7523  4357          JMS READW       / READ CHECKSUM
7524  7041          CIA             / NEGATE
7525  1171          TAD TEMP3       / ADD CALC. CHECKSUM
7526  7640          SZA CLA         / READ ERROR???
7527  4566                ERROR7    / ?30.87 -- CHECKSUM ERROR
7530  1060          TAD STARTV      / NO. ERASE VARIABLES
7531  3031          DCA LASTV
7532  5541          POPJ            / EXIT
7533  7305  WRITE,  GET CNST2       / RECORD TEXT--AC = 2
7534  4351          JMS SETUP       / SET UP TAPE UNIT
7535  4573          JMS I WAITX     / WAIT FOR FIRST TRANSFER
7536  1060          TAD BUFR        / GET LAST TEXT LOC.
7537  4363          JMS RECORD      / RECORD IT.
7540  4367          JMS INITAL      / INITIALIZE POINTERS
7541  1567          TAD I TEMP1     / GET DATA WORD
7542  4363          JMS RECORD      / RECORD IT
7543  4303          JMS UPDATE      / UPDATE POINTERS
7544  2170          ISZ TEMP2       / TRANSFER COMPLETE?
7545  5341          JMP .-4         / NO.
7546  1171          TAD TEMP3       / YES. GET CHECKSUM
7547  4363          JMS RECORD      / RECORD IT.
7550  5541          POPJ            / EXIT
7551  0000  SETUP,  0               / SET UP TAPE UNIT ROUTINE
7552  3172          DCA MASK        / STORE FUNCTION MASK
7553  1172          TAD MASK        / CALCULATE COMMAND
7554  1167          TAD TEMP1       / ADD TRACK
7555  6375          CLCR            / LOAD COMMAND REG.
7556  5751          JMP I SETUP     / RETURN
7557  0000  READW,  0               / READ A WORD ROUTINE
7560  4573          JMS I WAITX     / WAIT FOR WORD
7561  6376          RWCF            / READ WORD AND CLEAR FLAG
7562  5757          JMP I READW     / RETURN
7563  0000  RECORD, 0               / RECORD A WORD ROUTINE
7564  6374          TWCF            / TRANSFER AND CLEAR FHAG
7565  4573          JMS I WAITX     / WAIT UNIT DONE
7566  5763          JMP I RECORD    / RETURN
7567  0000  INITAL, 0               / SET UP POINTERS ROUTINE
7570  1060          TAD BUFR        / GET LAST TEXT LOCAPION
7571  7040          CMA             / SEMI-NEGATE
```

```
7572  1133          TAD CFRS          / ADD FIRST TEXT LOC.
7573  3170          DCA TEMP2         / STORE NEGATIVE WORD COUNT
7574  1133          TAD CFRS          / GET FIRST DATA LOC.
7575  3167          DCA TEMP1         / SET UP ADDR POINTER
7576  3171          DCA TEMP3         / CLEAR CHECKSUM
7577  5767          JMP I INITAL      / RETURN

              *6160

6160  0000  WAITW,   0                / WAIT FOR READY
6161  6373          SRSR              / SKIP ON STATUS
6162  5361          JMP .-1
6163  0172          AND MASK          / MASK OFF FUNCTION
6164  7650          SNA CLA           / CORRECT FUNCTION??
6165  4566                ERROR7      / ?24.;7 -- TAPE FAILURE
6166  5760          JMP I WAITW       / YES.  RETURN

              *0167

0167  0000  TEMP1,   0                / DATA ADDRESS STORAGE
0170  0000  TEMP2,   0                / WORD COUNT STORAGE
0171  0000  TEMP3,   0                / CHECKSUM STORAGE
0172  0000  MASK,    0                / FUNCTION MASK
0173  6160  WAITX,   WAITW            / INDIRECT POINTER

                    / THAT'S ALL!!!
```

```
                    /EDIT-8 MODIFICATIONS FOR TENNETAPE I/O
                    /BUFFERED INPUT-OUTPUT VERSION
                SRSR=6373           /SKIP ON STATUS CALL TRUE
                                    /AND READ STATUS REGISTER
                CLCR=6375           /CLEAR AND LOAD COMMAND REGISTER
                TWCF=6374           /TRANSFER ACCUMULATOR TO WRITE
                                    /SHIFT REGISTER AND CLEAR WRITE FLAG
                RWCF=6376           /TRANSFER READ BUFFER REGISTER
                                    /TO ACCUMULATOR AND CLEAR READ FLAG
                        WEOR=6371           /WRITE END-OF-RECORD
                *57
0057    2671    END,    BUFREG
                *115
0115    2671    BUFR,   BUFREG
                *1127
1127    7000    I750,   NOP         /WAS HIGH SPEED READER
1130    5732            JMP I S750A
1131    5727    A750,   JMP I I750
1132    2017    S750A,  S750
                *1154
1154    7000    OUTH,   NOP         /WAS HIGH SPEED PUNCH
1155    4757            JMS I PTAPE
1156    5754            JMP I OUTH
1157    1641    PTAPE,  TAPE
                *1242
1242    4644            JMS I PSRCH
1243    5634            JMP I TSTOUT
1244    1624    PSRCH,  SEARCH
                TSTOUT=1234
                *1255
1255    4657            JMS I PLOOK
1256    7410            SKP
1257    2000    PLOOK,  LOOK
1260    7000            NOP
                *1624
1624    7000    SEARCH, NOP         /FIND SPLICE FOR RECORDING
1625    6373            SRSR
1626    7000            NOP
1627    0321            AND BOTHB           /CHECK BOTH SPLICE BITS
1630    7650            SNA CLA
1631    4365            JMS REWIND
1632    1074            TAD HIGH
1633    3133            DCA OUTDEV
1634    1313            TAD M574
1635    3322            DCA SWITCH
1636    1314            TAD PROFIO
1637    3315            DCA ADDR
```

```
1640  5624          JMP I SEARCH
              HIGH=74
              OUTDEV=133
1641  7000  TAPE0,  NOP      /TENNETAPE OUTPUT
1642  3715          DCA I ADDR
1643  1715          TAD I ADDR
1644  1323          TAD NDOLAR
1645  7640          SZA CLA /IS CHARACTER A DOLLAR SIGN?
1646  5251          JMP NOTD
1647  1316          TAD M3
1650  3322          DCA SWITCH
1651  2315  NOTD,   ISZ ADDR
1652  2322          ISZ SWITCH
1653  5641          JMP I TAPE0
1654  1313          TAD M574
1655  3322          DCA SWITCH
1656  5776          JMP I SETMI
1657  3315  TAET,   DCA ADDR
1660  1715          TAD I ADDR
1661  4332          JMS RECORD
1662  2315          ISZ ADDR
1663  2322          ISZ SWITCH
1664  5263          JMP .-4
1665  1313          TAD M574
1666  3322          DCA SWITCH
1667  1314          TAD PBUFI0
1670  3315          DCA ADDR
1671  6371          WEOR
1672  7200          CLA
1673  6373          SRSR
1674  5273          JMP .-1
1675  0377          AND GAPFLG
1676  7650          SNA CLA
1677  5273          JMP .-4
1700  6364          CGAP
1701  5641          JMP I TAPE0
1702  7000  RECORD, NOP      /TAPE RECORD ROUTINE
1703  6374          TWCF     /TRANSFER 12 BIT WORD
1704  7200          CLA
1705  6373          SRSR     /SKIP ON STATUS CALL TRUE
1706  5305          JMP .-1
1707  0317          AND WRITEM      /WRITE FLAG ON?
1710  7650          SNA CLA
1711  7402          HLT
1712  5732          JMP I RECORD /YES,RETURN
1713  7234  M574,   -574
1714  2073  PBUFI0, IOBUFR
1715  0000  ADDR,   0
```

```
1716  7775  M3,      -3
1717  0002  WRITEM,  2
1720  7534  NDOLAR,  -244
1721  0010  BOTHR,   10
1722  0000  SWITCH,  0
1723  0000  KEY,     0
1724  7000  TAPEI,   NOP      /TENNETAPE INPUT
1725  2323            ISZ KEY
1726  5347            JMP INHAND
1727  1363            TAD READM
1730  6375            CLCR     /LOAD READ MODE
1731  7200            CLA      /TO START TAPE MOTION
1732  1313            TAD M574
1733  3323            DCA KEY
1734  1364            TAD PIOBUF
1735  3362            DCA POINTR
1736  4352            JMS READ
1737  3762            DCA I POINTR
1740  2362            ISZ POINTR
1741  2323            ISZ KEY
1742  5336            JMP .-4
1743  5744            JMP I SEEKGP
1744  2957  SEEKGP,  FINDGP
1745  1364  SETPNT,  TAD PIOBUF
1746  3362            DCA POINTR
1747  1762  INHAND,  TAD I POINTR
1750  2362            ISZ POINTR
1751  5724            JMP I TAPEI
1752  7000  READ,    NOP      /TAPE READ ROUTINE
1753  6373            SRSR     /SKIP ON STATUS CALL TRUE
1754  5353            JMP .-1
1755  0363            AND READM        /READ FLAG ON?
1756  7650            SNA CLA
1757  5353            JMP .-4
1760  6376            RWCF     /TRANSFER 12 BIT WORD
1761  5752            JMP I READ
1762  0000  POINTR,  0
1763  0001  READM,   1
1764  2073  PIOBUF,  IOBUFR
            IOBUFR=2073
            BUFREG=IOBUFR+576
1765  7000  REWIND,  NOP
1766  1375            TAD RWNDM
1767  6375            CLCR
1770  6373            SRSR
1771  5370            JMP .-1
1772  7200            CLA
1773  6365            CROT1
```

```
1774  5765          JMP I REWIND
1775  0003  RWNDM,   3
1776  2041  SETMI,   SETM
1777  0004  GAPFLG,  4
            CBOT1=6365
            *2000
2000  7000  LOOK,    NOP
2001  6373          SRSR
2002  7000          NOP
2003  0215          AND BOT12
2004  7650          SNA CLA
2005  4656          JMS I RWND
2006  1065          TAD CZ1
2007  3462          DCA I KEYBRD
2010  3614          DCA I SWTCH
2011  7040          CMA
2012  3616          DCA I KEYE
2013  5600          JMP I LOOK
2014  1722  SWTCH,   SWITCH
2015  0010  BOT12,   10
            KEYBRD=62
            CZ1=65
2016  1723  KEYE,    KEY
2017  4632  S750,    JMS I PTAPEI
2020  1230          TAD MDOLAR
2021  7450          SNA
2022  4234          JMS NOMORE
2023  1231          TAD PDOLAR
2024  2614          ISZ I SWTCH
2025  5627          JMP I A750A
2026  5633          JMP I PFULL
2027  1131  A750A,   A750
2030  7534  MDOLAR,  -244
2031  0244  PDOLAR,  244
2032  1724  PTAPEI,  TAPEI
2033  0576  PFULL,   576
2034  7000  NOMORE,  NOP      /END OF INPUT IN 3 CHARACTERS
2035  1240          TAD N3
2036  3614          DCA I SWTCH
2037  5634          JMP I NOMORE
2040  7775  N3,      -3
2041  1254  SETM,    TAD WRTMD
2042  6375          CLCR
2043  6373          SRSR
2044  5243          JMP .-1
2045  0255          AND WRITMD
2046  7650          SNA CLA
2047  5243          JMP .-4
```

```
2050   1252            TAD PRUF
2051   5653            JMP I TRTRN
2052   2073  PRUF,     IOBUFR
2053   1657  TRTRN,    TRET
2054   0002  WRTMD,    2
2055   0002  WAITMD,   2
2056   1765  REWD,     REWIND
2057   6373  FINDGP,   SHSR
2060   5257            JMP .-1
2061   0271            AND GPFLG
2062   7650            SNA CLA
2063   5257            JMP .-4
2064   6364            CGAP
2065   1672            TAD I NEG574
2066   3616            DCA I KEYE
2067   5670            JMP I SETPT
2070   1745  SETPT,    SETPNT
2071   0004  GPFLG,    4
2072   1713  NEG574,   M574
              CGAP=6364
```

ADDR	1715
A750	1131
A750A	2027
BOTHR	1721
BOTLP	2015
BUFFRG	2671
BUFR	0115
CBOT1	6365
CGAP	6364
CLCR	6375
CZ1	0065
END	0057
FINDGP	2057
GAPFLG	1777
GPFLG	2071
HIGH	0074
INHAND	1747
IOBUFR	2073
I751	1127
KEY	1723
KEYBRD	0062
KEYE	2116
LOOK	2000
MDOLAR	2030
M3	1716
M574	1713
NDOLAR	1720
NEG574	2072
NOMORE	2034
NOTD	1651
N3	2040
OUTDEV	0133
OUTH	1154
PBUF	2052
PBUFIO	1714
PDOLAR	2031
PFULL	2033
PIOBUF	1764
PLOOK	1257
POINTR	1762
PSRCH	1244
PTAPEI	2032
PTAPEO	1157
READ	1752
READM	1763
RECORD	1702

REWIND	1765
RWCF	6376
RAND	2056
RANDM	1775
SEARCH	1624
SEEKGP	1744
SETM	2041
SETMI	1776
SETPNT	1745
SETPT	2070
SRSR	6373
SWITCH	1722
SWTCH	2014
S750	2017
S750A	1132
TAPEI	1724
TAPEO	1641
TAET	1657
TRTRN	2053
TSTOUT	1234
TWCF	6374
WEOR	6371
WRITEM	1717
WRITMD	2055
WRTMD	2054

```
                    /PAL-III MODIFICATIONS FOR TENNETAPE INPUT
                    /BUFFERED INPUT VERSION
                SRSR=6373       /SKIP ON STATUS CALL TRUE AND
                                /READ STATUS REGISTER
                RWCF=6376       /TRANSFER READ BUFFER REGISTER
                                /TO ACCUMULATOR AND CLEAR READ FLAG
                *115
0115    3141    IAM1,   SYTA-1
                *200
0200    5620    SPAL,   JMP I STARTI
0201    7000    LOOK,   NOP     /FIND SPLICE BEFORE READING
0202    3156            DCA SWITCH
0203    5242            JMP HREAD
0204    3125    TPUNM1, DCA RBGN
0205    6364            CGAP
0206    6373            SRSR
0207    7000            NOP
0210    0217            AND BOT1
0211    7650            SNA CLA
0212    4616            JMS I RWND
0213    7200            CLA
0214    3004            DCA RFLG
0215    5601            JMP I LOOK
0216    3100    RWND,   REWIND
0217    0010    BOT1,   10
0220    3067    STARTI, START
                SWITCH=156
                HREAD=242
                LOREDI=54
                AAA=20
                TBUF=131
                RBGN=125
                *241
0241    5200            JMP SPAL
                *245
0245    5204            JMP TPUNM1
                *266
0266    4201    INITAL, JMS LOOK
                *373
0373    4201            JMS LOOK
0374    5446            JMP I A46
                A46=46
                *1441
1441    4651    READIN, JMS I PREAD
1442    1255            TAD MDOLAR
1443    7450            SNA             /IS CHARACTER A DOLLAR SIGN?
1444    4653            JMS I PNOMOR
```

```
1445  1254            TAD PDOLAR
1446  2256            ISZ FINISH
1447  5257            JMP P1457
1450  5263            JMP FULL1
1451  3111  PREAD,    READ
1452  1131            TAD TBUF
1453  3131  PNOMOR,   NOMORE
1454  0244  PDOLAR,   244
1455  7534  MDOLAR,   -244
1456  0000  FINISH,   0
            FULL1=1463
            P1457=1457
            *3067
3067  7604  START,    LAS
3070  7010            RAR
3071  7630            SZL CLA
3072  1053            TAD HIPUNI
3073  7420            SNL
3074  1052            TAD LOPUNI
3075  3021            DCA BBB
3076  5677            JMP I A223
3077  0223  A223,     AA223
            AA223=223
            LOPUNI=52
            HIPUNI=53
            BBB=21
3100  7000  REWIND,   NOP
3101  1310            TAD RWNDM
3102  6375            CLCR
3103  6373            SRSR
3104  5303            JMP .-1
3105  7200            CLA
3106  6365            CBOT1
3107  5700            JMP I REWIND
3110  0003  RWNDM,    3
            CLCR=6375
            CBOT1=6365
3111  7000  READ,     NOP             /TAPE READ ROUTINE
3112  1004            TAD RFLG
3113  7440            SZA
3114  5321            JMP CONT
3115  7040            CMA
3116  3004            DCA RFLG
3117  7001            IAC
3120  6375            CLCR
3121  7200  CONT,     CLA
3122  6373  SCHEK,    SRSR            /SKIP ON STATUS CALL TRUE
3123  5322            JMP .-1
```

```
3124  0335            AND READM       /READ FLAG ON?
3125  7650            SNA CLA
3126  5340            JMP CLEER
3127  6376            RWCF            /TRANSFER 12 BIT WORD
3130  5711            JMP I READ
                RFLG=4
3131  7000  NOMORE,   NOP             /END OF INPUT IN 3 CHARACTERS
3132  1337            TAD N3
3133  3736            DCA I PFINSH
3134  5731            JMP I NOMORE
3135  0001  READM,    1
                RKON=126
                RCNT=157
3136  1456  PFINSH,   FINISH
3137  7775  N3,       -3
3140  6364  CLEER,    CGAP
3141  5315            JMP READ + 4
                CGAP=6364
3142  0000  SYTA,     0
```

AAA	0020
AA223	0223
A223	3077
A46	0046
BBB	0021
BOT1	0217
CBOT1	6365
CGAP	6364
CLCR	6375
CLEER	3140
CONT	3121
FINISH	1456
FULL1	1463
HIPUNI	0053
HREAD	0242
IAM1	0115
INITAL	0266
LOOK	0201
LOPUNI	0052
LOREDI	0054
MDOLAR	1455
NOMORE	3131
N3	3137
PDOLAR	1454
PFINSH	3136
PNOMOR	1453
PREAD	1451
P1457	1457

```
RBGN     0125
RCNT     0157
READ     3111
READIN   1441
READM    3135
REWIND   3100
RFLG     0004
RKON     0126
RWCF     6376
RWND     0216
RWNDM    3110
SCHEK    3122
SPAL     0200
SRSR     6373
START    3067
STARTI   0220
SWITCH   0156
SYTA     3142
TBUF     0131
TPUNM1   0204
```

```
                /EDIT-8 MODIFICATIONS FOR TENNETAPE I/O
                /BUFFERED INPUT-OUTPUT VERSION
                *56
0056    2522    END,        BUFBEG
                *114
0114    2522    BUFR,       BUFBEG
                *172
0172    1522    PTAPEI,     TAPEI
0173    1720    PNOMOR,     NOMORE
0174    0565    PFULL,      565
0175    0000    SWITCH,     0
                *1126
1126    7000    I750,       NOP         /WAS HIGH SPEED READER
1127    4572                JMS I       PTAPEI
1130    1357                TAD         MDOLAR
1131    7450                SNA         /IS CHARACTER A DOLLAR SIGN?
1132    4573                JMS I       PNOMOR
1133    1360                TAD         PDOLAR
1134    2175                ISZ         SWITCH
1135    5726                JMP I       I750
1136    5574                JMP I       PFULL
                *1153
1153    7000    OUTH,       NOP         /WAS HIGH SPEED PUNCH
1154    4756                JMS I       PTAPEO
1155    5753                JMP I       OUTH
1156    1620    PTAPEO,     TAPEO
1157    7534    MDOLAR,     -244
1160    0244    PDOLAR,     244
                *1244
1244    4646                JMS I       PSRCH
1245    5636                JMP I       TSTOUT
1246    1600    PSRCH,      SEARCH
                TSTOUT=1236
                *1257
1257    4661                JMS I       PLOOK
1260    7410                SKP
1261    1500    PLOOK,      LOOK
                *1500
1500    7000    LOOK,       NOP         /FIND SPLICE FOR READING
1501    6371                TPSP
1502    0001    ONE,        0001        /EFFECTIVE "NOP"
1503    6372                TPMC
1504    5301                JMP         .-3
1505    1373                TAD         WAITR
1506    3277                DCA         COUNT
1507    6373                TPSP TPMC
1510    7000                NOP
1511    4775                JMS I       PDELAY
1512    2277                ISZ         COUNT
1513    5307                JMP         .-4
1514    1063                TAD         CZ1
1515    3460                DCA I       KEYBRD
1516    3175                DCA         SWITCH
1517    7040                CMA
1520    3274                DCA         KEY
1521    5700                JMP I LOOK
                CZ1=63
                KEYBRD=60
```

```
1522  7000  TAPEI,    NOP          /TENNETAPE INPUT
1523  2274             ISZ          KEY
1524  5345             JMP          INHAND
1525  6373             TPSP TPMC    /START TAPE MOTION
1526  2274             ISZ          KEY
1527  5325             JMP          .-2
1530  1377             TAD          N574
1531  3274             DCA          KEY
1532  1372             TAD          PIOBUF
1533  3275             DCA          POINTR
1534  4350             JMS          READ
1535  3675             DCA I        POINTR
1536  2275             ISZ          POINTR
1537  2274             ISZ          KEY
1540  5334             JMP          .-4
1541  1377             TAD          N574
1542  3274             DCA          KEY
1543  1372             TAD          PIOBUF
1544  3275             DCA          POINTR
1545  1675  INHAND,    TAD I        POINTR
1546  2275             ISZ          POINTR
1547  5722             JMP I        TAPEI
1550  7000  READ,      NOP          /NORMAL TENNETAPE READ LOOP
1551  6371             TPSP
1552  5351             JMP          .-1
1553  6372             TPMC
1554  1376             TAD          N14
1555  3277             DCA          COUNT
1556  1374             TAD          HDELAY       /"AND I 0" FOR 8/S
1557  4775             JMS I        PDELAY       /"AND 0" FOR 8/S
1560  7104  BITS,      CLL RAL
1561  3276             DCA          SAVE
1562  4775             JMS I        PDELAY       /"NOP" FOR 8/S
1563  1276             TAD          SAVE
1564  6373             TPSP TPMC
1565  7410             SKP
1566  1302             TAD          ONE
1567  2277             ISZ          COUNT
1570  5360             JMP          BITS
1571  5750             JMP I        READ
1572  1724  PIOBUF,    IOBUFR
1573  5000  WAITR,     -3000
1574  0034  HDELAY,    34
1575  1677  PDELAY,    DELAY
1576  7764  N14,       -14
1577  7204  N574,      -574
            KEY=1474
            POINTR=1475
            SAVE=1476
            COUNT=1477
```

```
                *1600
1600    7000    SEARCH,     NOP         /FIND SPLICE FOR RECORDING
1601    6376                TPWM
1602    5201                JMP         .-1
1603    1317                TAD         WAITW
1604    3312                DCA         COUNTR
1605    6374                TPWP
1606    4277                JMS         DELAY
1607    2312                ISZ         COUNTR
1610    5205                JMP         .-3
1611    1072                TAD         HIGH
1612    3132                DCA         OUTDEV
1613    1307                TAD         M574
1614    3175                DCA         SWITCH
1615    1310                TAD         PBUFIO
1616    3311                DCA         ADDR
1617    5600                JMP I       SEARCH
                HIGH=72
                OUTDEV=132
1620    7000    TAPEO,      NOP         /TENNETAPE OUTPUT
1621    3711                DCA I       ADDR
1622    1711                TAD I       ADDR
1623    1315                TAD         NDOLAR
1624    7640                SZA CLA     /IS CHARACTER A DOLLAR SIGN?
1625    5230                JMP         NOTD
1626    1314                TAD         M3
1627    3175                DCA         SWITCH
1630    2311    NOTD,       ISZ         ADDR
1631    2175                ISZ         SWITCH
1632    5620                JMP I       TAPEO
1633    1316                TAD         WAIT
1634    3175                DCA         SWITCH
1635    6374                TPWP        /GET TAPE UP TO SPEED
1636    4277                JMS         DELAY
1637    2175                ISZ         SWITCH
1640    5235                JMP         .-3
1641    1307                TAD         M574
1642    3175                DCA         SWITCH
1643    1310                TAD         PBUFIO
1644    3311                DCA         ADDR
1645    1711                TAD I       ADDR
1646    4257                JMS         RECORD
1647    2311                ISZ         ADDR
1650    2175                ISZ         SWITCH
1651    5245                JMP         .-4
1652    1307                TAD         M574
1653    3175                DCA         SWITCH
1654    1310                TAD         PBUFIO
1655    3311                DCA         ADDR
1656    5620                JMP I       TAPEO
```

```
1657  7000  RECORD,   NOP          /NORMAL TENNETAPE RECORD LOOP
1660  6375             TPWB
1661  3313             DCA          STORE
1662  1306             TAD          N16
1663  3312             DCA          COUNTR
1664  4277             JMS          DELAY        /"AND I 0" FOR 8/S
1665  1313  BIT,       TAD          STORE
1666  7500             SMA
1667  7410             SKP
1670  6375             TPWB
1671  7104             CLL RAL
1672  3313             DCA          STORE
1673  4277             JMS          DELAY        /"NOP" FOR 8/S
1674  2312             ISZ          COUNTR
1675  5265             JMP          BIT
1676  5657             JMP I        RECORD
1677  7000  DELAY,     NOP
1700  1305             TAD          MDELAY
1701  7001             IAC
1702  7440             SZA
1703  5301             JMP          .-2
1704  5677             JMP I        DELAY
1705  7710  MDELAY,    -70         /"-2" FOR 8/S
1706  7762  N16,       -16
1707  7204  M574,      -574
1710  1724  PBUFIO,    IOBUFR
1711  0000  ADDR,      0
1712  0000  COUNTR,    0
1713  0000  STORE,     0
1714  7775  M3,        -3
1715  7534  NDOLAR,    -244
1716  6400  WAIT,      -1400         /"-3000" FOR 8/S
1717  4000  WAITW,     -4000
1720  7000  NOMORE,    NOP          /END OF INPUT IN THREE CHARACTERS
1721  1314             TAD          M3
1722  3175             DCA          SWITCH
1723  5720             JMP I        NOMORE
1724  1724  IOBUFR,    .
      BUFBEG=IOBUFR+576
      TPSP=6371
      TPMC=6372
      TPWP=6374
      TPWB=6375
      TPWM=6376
```

ADDR	1711
BIT	1665
BITS	1560
BUFBEG	2522
BUFR	0114
COUNT	1477
COUNTR	1712
CZ1	0063
DELAY	1677
END	0056
HDELAY	1574
HIGH	0072
INHAND	1545
IOBUFR	1724
I750	1126
KEY	1474
KEYBRD	0060
LOOK	1500
MDELAY	1705
MDOLAR	1157
M3	1714
M574	1707
NDOLAR	1715
NOMORE	1720
NOTD	1630
N14	1576
N16	1706
N574	1577
ONE	1502
OUTDEV	0132
OUTH	1153
PBUFIO	1710
PDELAY	1575
PDOLAR	1160
PFULL	0174
PIOBUF	1572
PLOOK	1261
PNOMOR	0173
POINTR	1475
PSRCH	1246
PTAPEI	0172
PTAPEO	1156
READ	1550
RECORD	1657
SAVE	1476
SEARCH	1600
STORE	1713
SWITCH	0175
TAPEI	1522
TAPEO	1620
TPMC	6372
TPSP	6371
TPWB	6375
TPWM	6376
TPWP	6374
TSTOUT	1236
WAIT	1716
WAITR	1573
WAITW	1717

```
                /PAL-III MODIFICATIONS FOR TENNETAPE INPUT
                /BUFFERED INPUT VERSION
                *115
0115    3065    IAM1,       SYTA-1
                *200
0200    5222    SPAL,       JMP         START
0201    7000    LOOK,       NOP         /FIND SPLICE BEFORE READING
0202    3156                DCA         SWITCH
0203    7604                LAS
0204    7010                RAR
0205    7630                SZL CLA
0206    5243                JMP         HREAD
0207    1054                TAD         LOREDI
0210    3020                DCA         AAA
0211    1131                TAD         TBUF
0212    3125                DCA         RBGN
0213    5601                JMP I       LOOK
0214    3125    TPUNM1,     DCA         RBGN
0215    6371                TPSP
0216    7000                NOP
0217    6372                TPMC
0220    5215                JMP         .-3
0221    5601                JMP I       LOOK
                SWITCH=156
                HREAD=243
                START=222
                LOREDI=54
                AAA=20
                TBUF=131
                RBGN=125
                *246
0246    5214                JMP         TPUNM1
                *271
0271    4201    INITAL,     JMS         LOOK
                *1441
1441    4651    READIN,     JMS I       PREAD
1442    1255                TAD         MDOLAR
1443    7450                SNA         /IS CHARACTER A DOLLAR SIGN?
1444    4653                JMS I       PNOMOR
1445    1254                TAD         PDOLAR
1446    2256                ISZ         FINISH
1447    5257                JMP         P1457
1450    5263                JMP         FULL1
1451    3006    PREAD,      READ
1452    1131                TAD         TBUF
1453    3060    PNOMOR,     NOMORE
1454    0244    PDOLAR,     244
1455    7534    MDOLAR,     -244
1456    0000    FINISH,     0
                FULL1=1463
                P1457=1457
```

```
                *3006
3006    7000    READ,       NOP
3007    1126                TAD         RKON
3010    7041                CIA
3011    1157                TAD         RCNT
3012    7640                SZA CLA
3013    5222                JMP         NOGAP
3014    1253                TAD         WAIT
3015    3257                DCA         COUNTR
3016    6373                TPSP TPMC   /GET TAPE UP TO SPEED
3017    4243                JMS         DELAY
3020    2257                ISZ         COUNTR
3021    5216                JMP         .-3
3022    6371    NOGAP,      TPSP
3023    5222                JMP         .-1
3024    6372                TPMC
3025    1254                TAD         N14
3026    3257                DCA         COUNTR
3027    1252                TAD         HDELAY      /"AND I 0" FOR 8/S
3030    4243                JMS         DELAY       /"AND 0" FOR 8/S
3031    7104    BITS,       CLL RAL
3032    3256                DCA         STORE
3033    4243                JMS         DELAY       /"NOP" FOR 8/S
3034    1256                TAD         STORE
3035    6373                TPSP TPMC
3036    7410                SKP
3037    1255                TAD         ONE
3040    2257                ISZ         COUNTR
3041    5231                JMP         BITS
3042    5606                JMP I       READ
3043    7000    DELAY,      NOP
3044    1251                TAD         MDELAY
3045    7001                IAC
3046    7440                SZA
3047    5245                JMP         .-2
3050    5643                JMP I       DELAY
3051    7710    MDELAY,     -70         /"-2" FOR 8/S
3052    0034    HDELAY,     34
3053    7000    WAIT,       -1000
3054    7764    N14,        -14
3055    0001    ONE,        1
3056    0000    STORE,      0
3057    0000    COUNTR,     0
3060    7000    NOMORE,     NOP         /END OF INPUT IN THREE CHARACTERS
3061    1265                TAD         N3
3062    3664                DCA I       PFINSH
3063    5660                JMP I       NOMORE
3064    1456    PFINSH,     FINISH
3065    7775    N3,         -3
3066    0000    SYTA,       0
                RKON=126
                RCNT=157
                TPSP=6371
                TPMC=6372
```

```
AAA      0020
BITS     3031                    /UPDATE OF JUNE, 1969
COUNTR   3057                    /FIXES PAUSE PSEUDO-OP
DELAY    3043                    *376
FINISH   1456          0376  4201          JMS     LOOK
FULL1    1463          0377  5446          POPJ
HDELAY   3052                    LOOK=201
HREAD    0243                    POPJ=5446
IAM1     0115
INITAL   0271          LOOK    0201
LOOK     0201          POPJ    5446
LOREDI   0054
MDELAY   3051
MDOLAR   1455
NOGAP    3022
NOMORE   3060
N14      3054
N3       3065
ONE      3055
PDOLAR   1454
PFINSH   3064
PNOMOR   1453
PREAD    1451
P1457    1457
RBGN     0125
RCNT     0157
READ     3006
READIN   1441
RKON     0126
SPAL     0200
START    0222
STORE    3056
SWITCH   0156
SYTA     3066
TBUF     0131
TPMC     6372
TPSP     6371
TPUNM1   0214
WAIT     3053
```

```
/          CALLING SEQUENCE:
/
/          TAD         CODE
/          JMS         WRITE
/          IA
/          FA
/          (ERROR RETURN)
/          (NORMAL RETURN)
/
WRITE,     NOP
           DCA         CODE
           TAD I       WRITE       /PICK UP INITIAL ADDRESS
           DCA         IA
           ISZ         WRITE
           TAD I       WRITE       /PICK UP FINAL ADDRESS
           CMA
           TAD         IA
           DCA         NWORDS
           ISZ         WRITE
           TAD         WDELAY      /WRITE RECORD GAP AND
           DCA         CHKSUM      /GET TAPE UP TO SPEED
           TPWP
           JMS         DELAY
           JMS         SPLICE
           ISZ         CHKSUM
           JMP .-4
           TAD         CODE        /WRITE CODE WORD
           JMS         RECORD
           JMS         SPLICE
           TAD         NWORDS      /WRITE WORD COUNT
           JMS         RECORD
           JMS         SPLICE
DUMP,      TAD         CHKSUM      /UPDATE CHECKSUM
           TAD I       IA
           DCA         CHKSUM
           TAD I       IA          /WRITE DATA WORD
           JMS         RECORD
           JMS         SPLICE
           ISZ         IA
           ISZ         NWORDS      /WRITTEN ALL DATA?
           JMP         DUMP
           TAD         CHKSUM      /YES, WRITE CHECKSUM
           JMS         RECORD
           TAD         SDELAY      /PAUSE TO LET READ-WRITE
           DCA         CHKSUM      /RELAY SWITCH TO READ MODE
           JMS         DELAY
           JMS         SPLICE
           ISZ         CHKSUM
           JMP         .-3
           ISZ         WRITE
           JMP I       WRITE
RECORD,    NOP                     /TENNETAPE RECORD LOOP
           TPWB
           DCA         STORE
           TAD         MEXTRA
           DCA         COUNTR
           JMS         DELAY       /"AND I 0" FOR 8/S
```

```
BIT,        TAD         STORE
            SMA
            SKP
            TPWB
            CLL RAL
            DCA         STORE
            JMS         DELAY       /"NOP" FOR 8/S
            ISZ         COUNTR
            JMP         BIT
            JMP I       RECORD
DELAY,      NOP
            TAD         MDELAY
            IAC
            SZA
            JMP         .-2
            JMP I       DELAY
SPLICE,     NOP
            TPMC                    /SPLICE FOUND?
            JMP I       SPLICE
            JMS         WBOT        /YES, SPACE TO BOT
            JMP I       WRITE
WDELAY,     -1400
SDELAY,     -700
MDELAY,     -70                     /"-2" FOR 8/S
MEXTRA,     -16
CHKSUM,     0
COUNTR,     0
NWORDS,     0
STORE,      0
CODE,       0
IA,         0
/
/           CALLING SEQUENCE:
/
/           JMS         WBOT
/           (NORMAL RETURN)
/
WBOT,       NOP
            TPWP TPMC               /TEST FOR SPLICE
            JMP         .-1
            TAD         M4
            DCA         NWORDS
            CMA                     /WRITE "7777" FOUR TIMES
            JMS         RECORD
            ISZ         NWORDS
            JMP         .-3
            TAD         BDELAY      /SET INDEX FOR SPACE
            DCA         CHKSUM
            TPWP                    /SPACE SPLICE PAST HEAD
            JMS         DELAY
            ISZ         CHKSUM
            JMP         .-3
            JMP I       WBOT
BDELAY,     -4000
M4,         -4
```

```
/          CALLING SEQUENCE:
/
/          TAD         CODE
/          JMS         SEARCH
/          IA
/          FA
/          (ERROR RETURN)
/          (NORMAL RETURN)
/
SEARCH,    NOP
           DCA         CODE
           TAD I       SEARCH      /PICK UP INITIAL ADDRESS
           DCA         JREAD+1
           ISZ         SEARCH
           TAD I       SEARCH      /PICK UP FINAL ADDRESS
           DCA         JREAD+2
           ISZ         SEARCH
JREAD,     JMS I       PREAD       /READ A FILE
           NOP
           NOP
           JMP         ERROR       /IF ERROR, WHAT KIND?
           CIA
           TAD         CODE
           SZA CLA                 /RIGHT CODE?
           JMP         JREAD
           ISZ         SEARCH      /YES, INCREMENT RETURN ADDRESS
           JMP I       SEARCH
ERROR,     CIA
           TAD         CODE
           SNA CLA                 /RIGHT CODE?
           JMP I       SEARCH      /YES, RETURN WITH AC=0
           TAD I       PERROR
           TAD         NEOT
           SZA CLA                 /END OF TAPE?
           JMP         JREAD
           CMA                     /YES, SET AC=-1 FOR RETURN
           JMP I       SEARCH
PREAD,     READ
PERROR,    READ+102
NEOT,      -READ-61


READ=WRITE+200                     /ASSUME CONSECUTIVE PAGES
TPMC=6372
TPWP=6374
TPWB=6375
$
```

```
/          CALLING SEQUENCE:
/
/          JMS         READ
/          IA
/          FA
/          (ERROR RETURN)
/          (NORMAL RETURN)
/
READ,      NOP
           TAD I       READ        /PICK UP INITIAL ADDRESS
           DCA         IA
           ISZ         READ
           TAD I       READ        /PICK UP FINAL ADDRESS
           CMA
           TAD         IA
           DCA         NWORDS
           ISZ         READ
           TPMC                    /CLEAR BIT FLAG
           TAD         RDELAY
           DCA         CHKSUM
           TPSP TPMC               /TEST FOR RECORD GAP
           SKP
           JMP         JUNK
           JMS         DELAY
           ISZ         CHKSUM
           JMP         .-5
           JMS         ASSMBL      /READ CODE WORD
           DCA         CODE
           JMS         SPLICE
           JMS         ASSMBL      /READ WORD COUNT
           CIA
           TAD         NWORDS
           SZA CLA                 /SIZE ERROR?
           JMP         SIZE
           JMS         SPLICE
GET,       JMS         ASSMBL      /READ DATA WORD
           DCA I       IA
           TAD         CHKSUM      /UPDATE CHECKSUM
           TAD I       IA
           DCA         CHKSUM
           JMS         SPLICE
           ISZ         IA
           ISZ         NWORDS      /READ ALL DATA?
           JMP         GET
           JMS         ASSMBL      /YES, READ CHECKSUM
           CIA
           TAD         CHKSUM
           SZA CLA                 /CHECKSUM ERROR?
           JMS         ERROR
           ISZ         READ        /NO, INCREMENT RETURN ADDRESS
RETURN,    TAD         CODE
           JMP I       READ        /CODE IN AC UPON EXIT
```

```
SPLICE,   NOP
          TPMC                    /SPLICE FOUND?
          JMP I       SPLICE
          JMS         RBOT        /YES, SPACE TO BOT
          JMS         ERROR
JUNK,     JMS         BLANK       /SPACE TO RECORD GAP
          JMS         ERROR
BLANK,    NOP
          TAD         RDELAY      /SET INDEX FOR BLANK TAPE
          DCA         CHKSUM
          TPMC                    /TEST FOR SPLICE
          SKP
          JMP         SPLICE+3
          TPSP                    /TEST FOR BIT
          SKP
          JMP         BLANK+1     /BIT FOUND, RESET INDEX
          JMS         DELAY
          ISZ         CHKSUM
          JMP         .-5
          JMP I       BLANK
SIZE,     JMS         BLANK       /SPACE TO RECORD GAP
          JMS         ERROR
ERROR,    NOP                     /ERROR CODE LOCATION
          JMP         RETURN
ASSMBL,   NOP                     /TENNETAPE READ LOOP
          TPSP
          JMP         .-1
          TPMC
          TAD         HDELAY
          JMS         DELAY
          TAD         M14         /"AND I 0" FOR 8/S
          DCA         COUNTR      /"AND 0" FOR 8/S
BIT,      CLL RAL
          DCA         STORE
          JMS         DELAY       /"NOP" FOR 8/S
          TAD         STORE
          TPSP TPMC
          SKP
          TAD         ONE
          ISZ         COUNTR
          JMP         BIT
          JMP I       ASSMBL
DELAY,    NOP
          TAD         MDELAY
          IAC
          SZA
          JMP         .-2
          JMP I       DELAY
```

```
MDELAY,    -70                    /"-2" FOR 8/S
HDELAY,    34
M14,       -14
CHKSUM,    0
STORE,     0
IA,        0
NWORDS,    0
COUNTR,    0
RDELAY,    -100
CODE,      0
/
/          CALLING SEQUENCE:
/
/          JMS        RBOT
/          (NORMAL RETURN)
/
RBOT,      NOP
           TPSP
ONE,       1
           TPMC                   /TEST FOR SPLICE
           JMP        .-3
           TAD        BDELAY      /SET INDEX FOR SPACE
           DCA        COUNTR
           JMS        DELAY
           TPSP TPMC              /SPACE SPLICE PAST HEAD
           ISZ        COUNTR
           JMP        .-3
           JMP I      RBOT
BDELAY,    -4000
/
/          CALLING SEQUENCE:
/
/          TAD        +N
/          JMS        SPACE
/          (NORMAL RETURN)
/
SPACE,     NOP
           CIA                    /SET NEGATIVE INDEX
           DCA        SKIP
           JMS        READ        /READ A FILE
           0                      /WITH RIDICULOUS ARGUMENTS
           0                      /TO FORCE AN ERROR
           NOP
           CLA                    /IGNORE CODE WORD
           ISZ        SKIP
           JMP        SPACE+3     /SKIP ANOTHER FILE
           JMP I      SPACE       /FINISHED SKIPPING
SKIP,      0


TPSP=6371
TPMC=6372
$
```