UNIVERSITY OF CALIFORNIA

LICK OBSERVATORY TECHNICAL REPORTS

No. 22

THE LICK OBSERVATORY

FLEXIBLE ("FLOPPY") DISC SYSTEM

C. Delaney, T.P. Ricketts and L.B. Robinson

Santa Cruz, California
October 1977

THE LICK OBSERVATORY FLOPPY DISC SYSTEM

Index

THE LICK OBSERVATORY FLOPPY DISC SYSTEM

Introduction

The PDP 8I computers used at Lick Observatory have proven reliable and economical. In spite of memory limitation imposed by small core (8K) and tiny disk (32K), fairly successful systems for data taking and interactive analysis were developed between 1970 and 1976. One system, used for data taking with the image tube scanner at the 120-inch telescope, needed over 20K of machine language programs to support a chain of 50 or so FOCAL language programs, and operated on spectra of 8K words per scan. The interactive data analysis system used a similar amount of memory.

Obviously, these systems had to have constant switching of programs and data between core, disk and tape, with a resulting loss of time. Although much of this shuffling of information was handled automatically and was "transparent" to the user, some programs were difficult to write and debug and some ran more slowly than desired. Upgrading the data-taking systems to do more simultaneous data reduction seemed to be impossible.

Serious consideration was given to obtaining a completely new system, based on one of the more modern minicomputers now available, with a large enough memory and enough disc storage to meet foreseeable needs.

This approach was rejected in favor of upgrading our existing system. It was felt that the wealth of high quality, debugged software available on our present PDP 8I computers more than outweighed the advantage to be gained from a more complex processor. The 8K version of the PDP 8I handled many of its data taking and control tasks quite adequately; building a completely new system to do the same job would be an expensive and useless task. It also seemed likely that advances in microprocessors and minicomputers might require conversion to yet a third type of computer within 3 to 5 years. Such "progress" seemed undesirable.

The upgrading of the PDP 8I required larger fast memory, more disc storage, and additional software to make use of the new features. (A description of the expanded software package is given in Lick Observatory Technical Report No. 21.) This report describes the floppy disc controller which was developed to satisfy the need for added disc storage.

The Lick floppy disc system was developed with a microprocessor controller in an attempt to provide inexpensive reliable mass storage for the PDP 8I, and for stand-alone operation. Since all of our software has operated in the past using Dectape, the system was designed to look like a Dectape to the PDP 8. This allows existing software to be used for the floppy disc with no modifications.

A brief outline of the system is given in the following pages.

Fig. 1 and Fig. 2 attempt to show the interconnection of major segments of the system.

The Floppy Disc System is designed to mimic the operation of Dectape to the PDP 8, except that it runs faster than Dectape and, unlike Dectape, cannot read or write in the reverse direction. Each disc controller has selector switches reading 0*--7, so that the floppy disc unit number can be selected in the same way as a Dectape. The floppy disc controller detects all Dectape commands. If the "unit" No. requested corresponds to the floppy disc No., the microprocessor responds to the command and the Dectape controller is inhibited. This allows almost all software that runs with the Dectape system to use the floppy disc and allows Dectape drives and floppy disc drives to be mixed in the same system. The only Dectape program known to fail on the floppy disc is OS 8 "TD Copy" which tries to read and write moving the tape backwards.

*Disc Unit No. 0 corresponds to Dectape Unit. No. 8.

A MOS 6502 microprocessor plus a two-kilobyte programmable read-only memory ("PROM") is used to control the floppy disc. Input-output to the microprocessor is done using Motorola Peripheral Interface Adapters (PIA) and an Asynchronous Communication Interface Adapter (ACIA) that codes and decodes serial data for the disc.

The read-only memory also contains a program that allows formatting of the floppy disc, and loading or listing microprocessor contents with the PDP-8 by means of a debug program "DDTU".

The floppy discs are "soft-formatted", but with a special format similar to Dectape formats. There are a total of 78 tracks, each with 19 blocks, holding 129 12-bit words apiece. The total of 1482 blocks on the floppy disc compares with 1474 blocks on a standard Dectape.

Each block of data on the disc is preceded by two 8-bit numbers that identify the block number, first a track number (0--77) and then a sector number (0--18). The "block" number is given by the sector number plus 19 times the track number.

The data blocks and block numbers are separated by gaps containing only clock marks but no data. When writing successive blocks, the system is disabled for some 475 microseconds by a "trim erase" signal that follows the 7.7 millisecond interval when a block of data is written. Thus the gap between a data block and the next block number must be greater than 475 microseconds, or a whole disc revolution of 167 milliseconds would occur before the following block number could be found. (An 800 msec gap was chosen to give reasonable margins for speed and timing variations.) In order to have room for 19 blocks of data, separated by 800 microsecond gaps, the clock speed for the microprocessor and for data to the

disc was increased by 6% above nominal values. This provides good overall protection against fluctuations in speed, power supplies, and temperature. The speed increase is possible because of the high quality of the disc drives, the microprocessor and the memory elements used.

It is absolutely vital that when writing on the disk, the block number identifier never be changed. To provide adequate security, each block number is preceeded by a data-free gap, and special code words precede and follow the number. The octal numbers 221, 111, 325 precede each block number, and each block number is followed by its complement. Finally, the octal codes 231, and 165 follow each block number. Writing of a block of data can only take place after all of these codes are detected in the proper sequence.

Several additional features were included to avoid accidental writing on the disc, and to prevent accidental transmission of data into the PDP-8 memory by unintended Data Break (direct memory access - DMA) cycles:

-- Write enable to the disc requires that PIA 2-B hold a high level on bit 6 and a low level on Bit 3.

-- Writing is prevented by a Write Lock Switch.

-- Writing is stopped if the PDP-8 clock is interrupted for >10μ sec.

-- Writing is inhibited by the "disc unable" signal, "head unloaded", disc not selected, or if A(4) [tape motion] in the "A" register goes low.

-- The "Disc Unable" signal is generated for 2.5 seconds after a disc motor is started, to be sure disc is up to speed.

-- If no data is sent from the ACIA for 100μ sec, the write enable turns off.

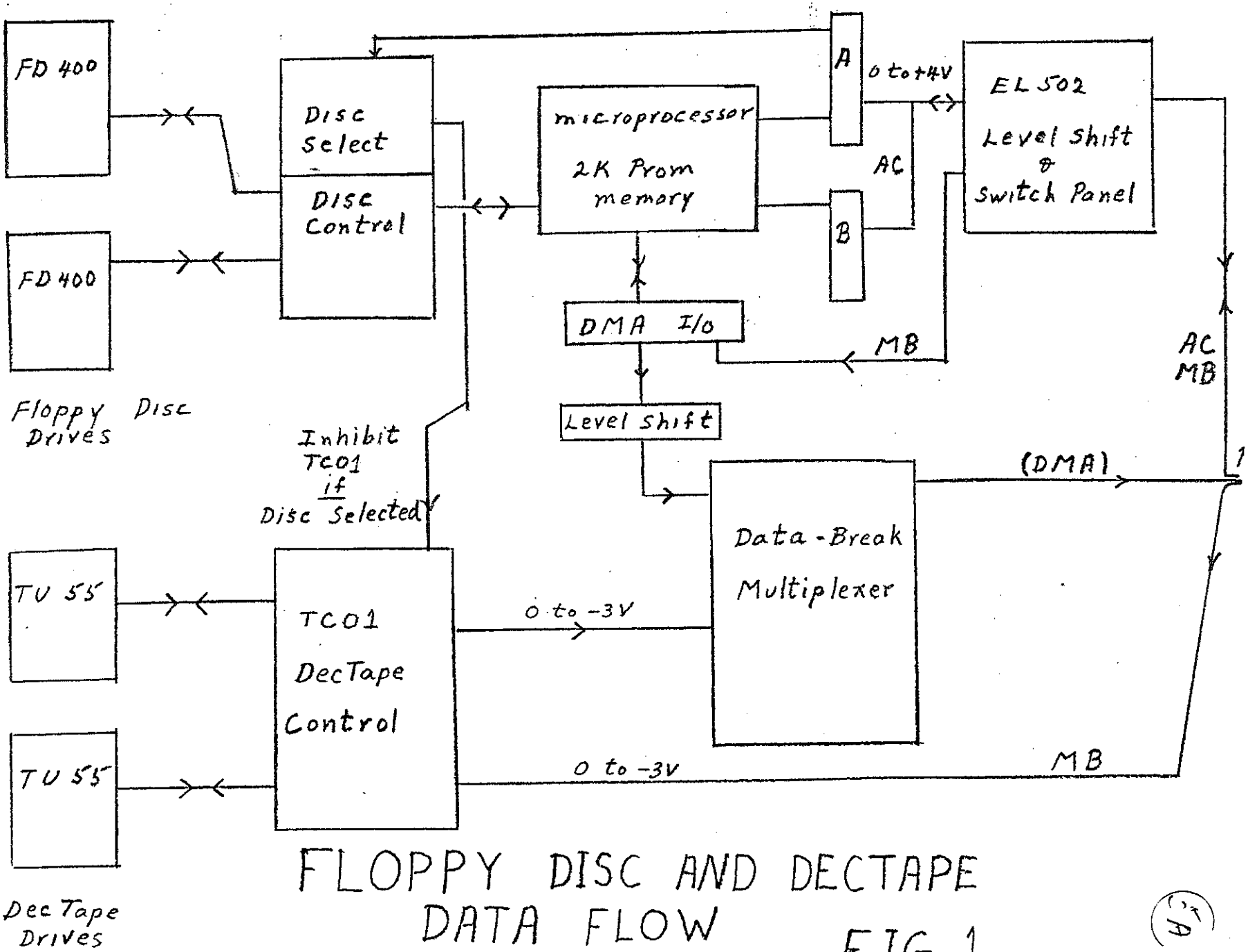
-- The "DMA enable" signal must be deliberately set by the microprocessor before DMA can occur, and is reset by power clear, word-count overflow, DTCA command, disc unable or A(4) turned off.

Error checking of data, when reading, is facilitated by a one-byte complemented check-sum written after each 129-word block of data.

The "head-load" signal is generated by a one-shot circuit and turns off after several hundred milliseconds of inactivity, or at once if a different disc unit is selected.

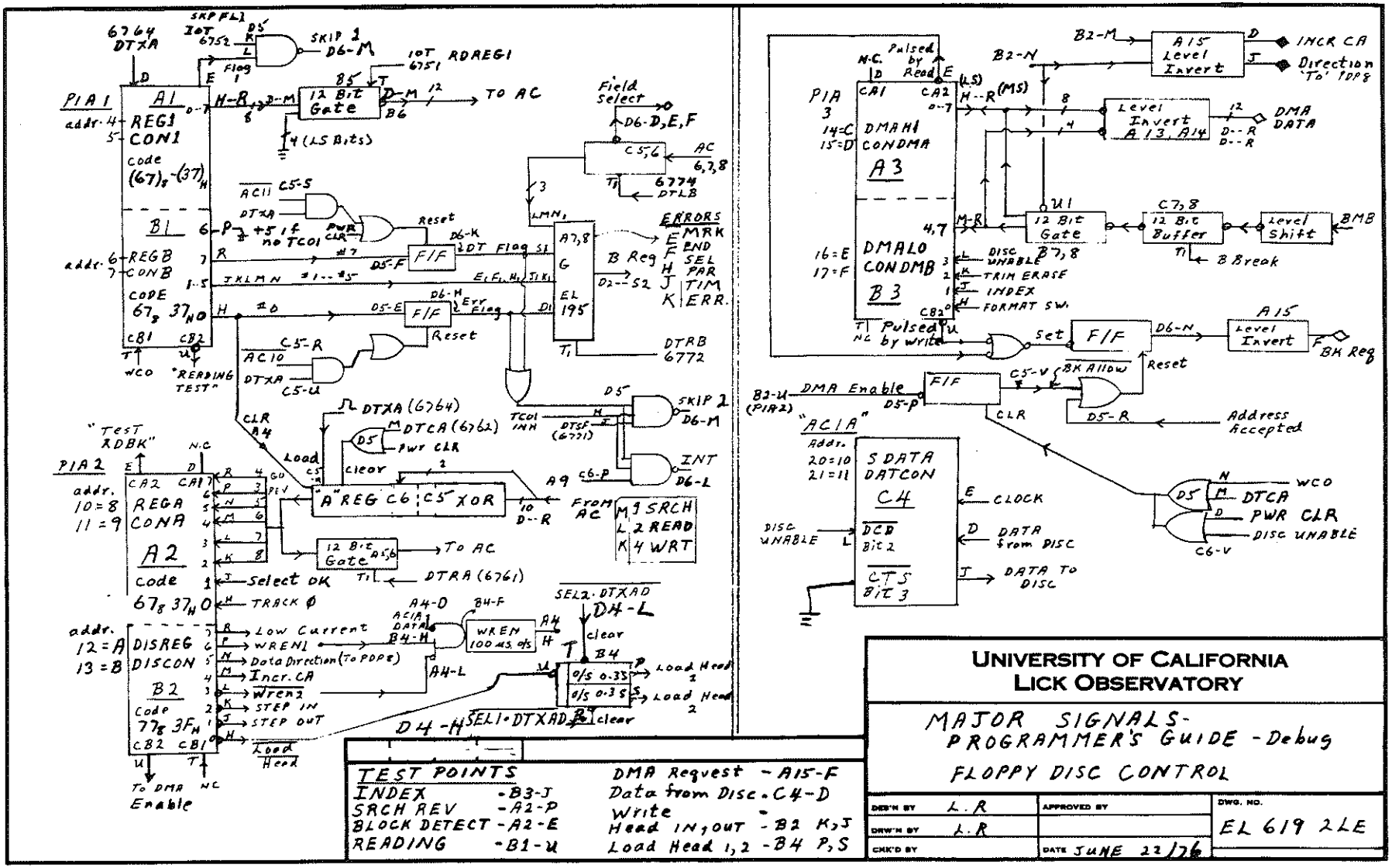
A microprocessor card identical to that used in the floppy disc is being used as a controller in other electronic equipment for the telescope. Debugging of such new equipment is facilitated since a random access memory (RAM) can be connected both to the floppy disc processor and to a processor controlling other equipment. Using program "DDTU," a test program can be loaded into the RAM, and that program allowed to run the equipment under development. This allows for rapid test and modification of new programs.

It should also be noted that the use of a microprocessor to operate the disc makes it possible for the disc system to act as a stand-alone data collector without a computer. Only fairly minor additions to the interface hardware and to the microprocessor program should be required.



FLOPPY DISC AND DECTAPE DATA FLOW

FIG 1



UNIVERSITY OF CALIFORNIA
LICK OBSERVATORY

MAJOR SIGNALS-
PROGRAMMER'S GUIDE - Debug
FLOPPY DISC CONTROL

DES'N BY L.R	APPROVED BY	DWG. NO.	EL 619 2LE
DRW'N BY L.R			
CHK'D BY	DATE JUNE 22/76		

FIG 2

57

PIA - Peripheral Interface Adapter

The following section is not a prerequisite to understanding the system operation. It should be skipped over by most readers.

The PIA and ACIA (asynchronous communication interface adapter) are used to send and receive data between the microprocessor and all the other circuits. These circuits have data registers which are labelled REGI, REGB, REGA, DISREG, DMAHI, DMALO and SDATA in both Fig. 2 and in the program listing. The corresponding control registers are labelled CONI, CONB, CONA, DISCON, CONDMA, CONDMB and DATCON. These registers appear to the microprocessor just like bytes in memory, and the addresses chosen are listed in program "CON8" and in Fig. 2.

The PIA chips can send and receive both pulses, levels, or data, depending on the control codes stored in the control registers. There is also a "hidden" register at the same address as each data register, the "Data Direction Register" (DDR). The DDR determines whether each bit of the data register acts as an input or output.

The PIA control register is 8 bits long. The most significant bits, 6 and 7, are "read only" and indicate flags, turned on by inputs to "CA1, CA2, CB1 or CB2." (See below.) The lower 6 bits, named below in octal code, determine the function of the four pins that detect and transmit levels and pulses. These pins are labelled CA1, CB1, CA2, CB2 and are wired to pins ID, IE, 2T and 2U respectively of the printed circuit card holding the PIA.

Input Control Codes for CA1, CB1.

1 ($\overline{1}$) Enable interrupt "IRQ" to microprocessor (disable* IRQ)

*Note that the floppy disc system does not use the IRQ interrupt, even if it is enable in the PIA.

2 ($\overline{2}$) Detect rising edge of input pulse by setting bits 7 or 6 of the control register. (Detect falling edge)

4 ($\overline{4}$) Close DDR (i.e., prevent DDR contents from being changed.) (Open DDR)

Output Control Codes for CA2, CB2.

10 ($\overline{10}$) Output will rise on next clock pulse (rise on transition of CA1 or CB1).

20 ($\overline{20}$) Low level out of "10" is low. [positive level if 10 is high.] (Low level for write to B or read from A.)

40 ($\overline{40}$) CA2, CB2 are outputs (CA2, CB2 are inputs)

Input Control Codes for CA2, CB2.

10 ($\overline{10}$) IRQ line goes low when control register bit 6 goes high. (IRQ line disabled.)

20 ($\overline{20}$) Set control register bit 6 on positive going signal at CA2 or CB2. (Detect signal falling from positive level to zero.)

Examples of PIA Codes.

67 DDR closed, rising edge inputs on CA1, or CB1 will set corresponding control register bits. CA2, CB2 outputs are held low. IRQ enabled.

77 Same, but CA2, CB2 are held high.

56 DDR closed, negative output pulse on CA2 for read A or on CB2 for write B.

50 DDR open. "Ones" written to data register will set Data Direction to output, zeros set it to input.

ACIA.

The ACIA converts parallel 8 bits to serial 8 bits with a clock period of 4 microseconds. It has one-word buffers for both receiving and transmitting.

Bits 0, 1 of the control register selects a clock rate divided by 1, 16 or 64. Master Reset is produced if both bits are high.

Bits 2, 3, 4 control the number of data bits and select the parity. With Bits 2, 4 high and bit 3 low, we use 8 data bits with a start and a stop bit and no parity bit.

The status register:

Bit 0	Data ready in the receive buffer.
Bit 1	Transmit data buffer free.
Bit 2	Goes high if signal to "$\overline{\text{DCD}}$" (pin L of card C4) goes high.

The other bits are not used by the floppy disc system.

These devices are very flexible, *but* very difficult to program correctly. Their use will be avoided in future.

More detailed descriptions of the PIA and ACIA are found in the Motorola M6800 Microprocessor Applications Manual.

MARK - Floppy Disc Formatting Program.

This program writes a suitable format with all necessary block numbers, and zero data in all blocks on a floppy disc.

The program measures the interval between the leading edge of index pulses and halts if outside the range 165.5-168.4 millisec. Otherwise, it then checks that FORMAT and WRITE switches are turned on, then spends about 20 sec formatting the disc. It then attempts to find and read all blocks, printing error messages if any block cannot be found or has a check sum error in the data.

The program can be restarted to repeat the process on the same or another disc by typing "R" or "G".

To use the program, bootstrap the LOEL maintenance Dectape, type "MARK", and follow instructions from the teletype.

FTOG - Trouble Shooting Program (Floppy Disc Test Programs).

Program FTOG tests most functions of the Floppy Disc interface, and prints error messages on the teletype if anything wrong is detected. The program includes subprogram FIO, which checks the DMA and PIA operations. The program should be run with a blank formatted disc in unit 7, with write lock set.

This program should be run whenever errors are reported in the operation of a disc. It should run successfully as each of the power supply voltages is varied by ±10% in turn.

CAUTION: If an error is seen, the results of later tests in the sequence are suspect, since each test assumes that the hardware already tested is working correctly.

The first tests (A--H) check that signals are transmitted properly between the PDP 8 and the floppy disc registers. Then tests I--L check that the microprocessor is running and can set Dectape flags properly. Any one of tests A--H can be made to loop continually by typing the corresponding letter. (Press the space bar to discontinue looping.) Error printouts can be inhibited by setting all the PDP 8 accumulator switches to 1.

Note: The listing in FTOG for tests A--T can be found by looking for a comment headed by the same letter.

A: Can "A" register be cleared to zero? (by DTCA)

B: Does "DTXA" leave accumulator zeroed?

C: Can "A" register be set to all 1's?

D: Does XOR operation work for A register?

E: Does DTLB clear the accumulator?

F: Can DTRB read the field register?

G: Can each field bit be set and read?

H: Can each bit in A register be set and read?

I: Does the MOVE Command cause a skip for DTSF?

J: Is error flag set by "MOVE" command?

K: Does correct "end of tape" code occur for "MOVE"?

L: Does "A" register bit 4 get cleared by error flag?

Next, the program checks the PIA and Data Break performance: the following tests use special subroutines in "FBUG" which are stored starting at location 0A00 of the PROM memory.

Error printouts are preceded by an error code to assist in finding the subprogram in FIO that is detecting the trouble.

AA DTXA didn't respond with* "FLAG 1." The microprocessor may not be running. (The core location of the program in FIO that was ignored is also printed.)

AB Does "A" register get copied to* REG1 following "DTXA"? The microprocessor does this to check the REG1 interface to the PDP 8 and to prove that the microprocessor program is running.

BB Is the "select OK" signal seen by PIA 2, Pin J?

*Note: (See Fig. 2, which is an overall flow diagram of the interface signals between the PDP 8, the disc and the microprocessor. Note that the Peripheral Interface Adaptors are named in the drawing and those names are used in the tests.)

Typical Error Printouts:

"A - DTCA: A = 0040" [Bit 6 in the A register was seen as non-zero after DTCA command.]

"G - FIELD WRONG B = 0010" [DTRB read field 1 in B register when a different field was set.]

Now a series of tests are made to be sure that data can be stored and read from each PIA and then that data can be transmitted back and forth via DMA.

This sequence works by transmitting a special code to the program FBUG in the microprocessor. FBUG transmits or accepts data, word by word, or in a prearranged sequence, and puts the result in "REG1" where it can be read directly by the PDP 8.

The following detailed description may be of interest but isn't needed to run or use the tests.

[For example, to test DMA transmission from the PDP 8 for the high 8 bits, a series of numbers is placed in a PDP 8 core buffer, field Ø, words 4000 to 4400. The octal code 7610 is transmitted to FBUG by a DTXA command, which starts a microprocessor subroutine that reads one 8 bit byte from the PDP 8 via DMA, stores the result in REG1 and sets the "FLAG1" signal in PIA 1. The PDP 8 then reads the number in REG1 to see that it is the same as the number sent via DMA. The relevant code for this operation is found at 2322 in FIO and at B08 in FBUG.

Since the FBUG routine must remain invisible during ordinary operation of the system, an elaborate hand shaking routine (see 2251 in FIO) is used to get FBUG and it will switch back to the normal program if anything unexpected, like a start pulse occurs.]

An error diagnostic printed here would be of the form:

"I-O ERROR, A, RCOUNT, REG1, EXPECT: 7610, R, 1260, 1240"

A (=7610) defines the specific test, R is the octal word number (1--370), 1260 is an 8 bit octal number read from REG1, and 1240 is the 8 bit octal number transmitted by DMA. In this case one would look for an error on the data bit going to Pin H of PIA 3 in location A3.

Note: A hardware failure may cause several hundred lines of error messages to be printed. Any one of the tests can be terminated by typing "G" to go on to the next one.

The codes used for various tests are as folows:

A = 110: Can all codes be loaded and read from REG 1 (PIA 1-A)

A = 40: Can all codes be loaded and read from DISREG (PIA 2-B)

A = 50: Can all codes be loaded and read from REGB (PIA1-B)

A = 7600: Can all codes be transferred from PDP 8 via DMA (testing low 8 bits)

A = 7610: Can all codes be transferred from PDP 8 via DMA (testing high 8 bits)

A = 7200: Can all codes be loaded and read back from PIA3-A (DMAHI)

Next a check is made that all codes are properly transferred to the PDP 8 via DMA, and that word count overflow works properly.

The disc period is measured and printed, and then tests of operational capability are performed. These check that the disc in the transport can be read correctly:

M - Does a search command produce a DTSF skip?

N - Do we get Block No.'s sent to PDP 8 when searching in any field?

O - Do we get an END TAPE signal if search forward is left on?

P - Does interrupt control work as expected?

Q - Does search send block No.'s in correct sequence for both forward and reverse?

R - Can all blocks on disc be read?

S - Can all blocks be found?

T - Does each block transmit exactly 129 words?

"TEST DONE" is typed, and the test cycle is started again.

No test of writing or formatting capability is made by FTOG. Those tests are best done with a FOCAL test program and with the MARK program respectively, and in that order.

An Over-All Test

Experience has shown that using program "DUPL" to copy one disc to another, or use of O/s 8 to copy one disc to another tends to show up any hardware problems, even those that would not be detected by other tests.

Use the following O/s 8 sequence to copy a full disc to a second one.

.R PIR (Both discs write enabled)

*DTA7: <SYS:(YZ)

*DTA7: <SYS:/s

ARE YOU SURE? (Printed by PDP 8)

Y (es)

If this completes successfully, and the copy has no errors detectable with FTOG, there are probably no hardware problems.

Error Exits in Microprocessor Program.

If an error occurs on floppy disc it may be useful to know exactly where in the microprocessor program the error was detected.

By setting a Halt position on the tester unit,* one can determine if the program ever gets to certain error conditions. The locations of these errors are as follows:

48D - Illegal Code in "A" REGISTER

572 - Disc unable during SRCH

BC2 - Gap, Guard words and Block No. found, but complement of Block wrong

680 - Couldn't find a Block No. (SEEK)

59F - Parity error during read.

763 - Block No. found without the following guard No.

767 - Attempt to read or write in reverse direction

By far the most probable error is 59F or 680 If error 680 occurs, a system design error is indicated and should be reported. Please save any disc that causes trouble so that the cause can be determined. The parity error seems to occur from time to time on a single read but not be seen on the next trial. Since certain blocks appear temporarily error prone, it is suspected that dirt particles may stick to the disc at times.

*A "tester" unit is held in the Lick electronics shop that can be plugged into the microprocessor card, and allows the program to be trapped (halted) at a switch selected address, single stepped, or started at a switch selected.

Testing and Debugging.

In general, errors should be fixed by replacing circuit cards one by one until the offending circuit is found. Marginal failures can sometimes be found by varying the power supply voltage ±10%.

In case of stubborn problems where signals must be looked at on the oscilloscope, several test points have been placed in the microprocessor program that indicate exactly when certain events occur. The following test points allow scope sync and analysis of problems:

B3-J One pulse per disc revolution, at the Index.

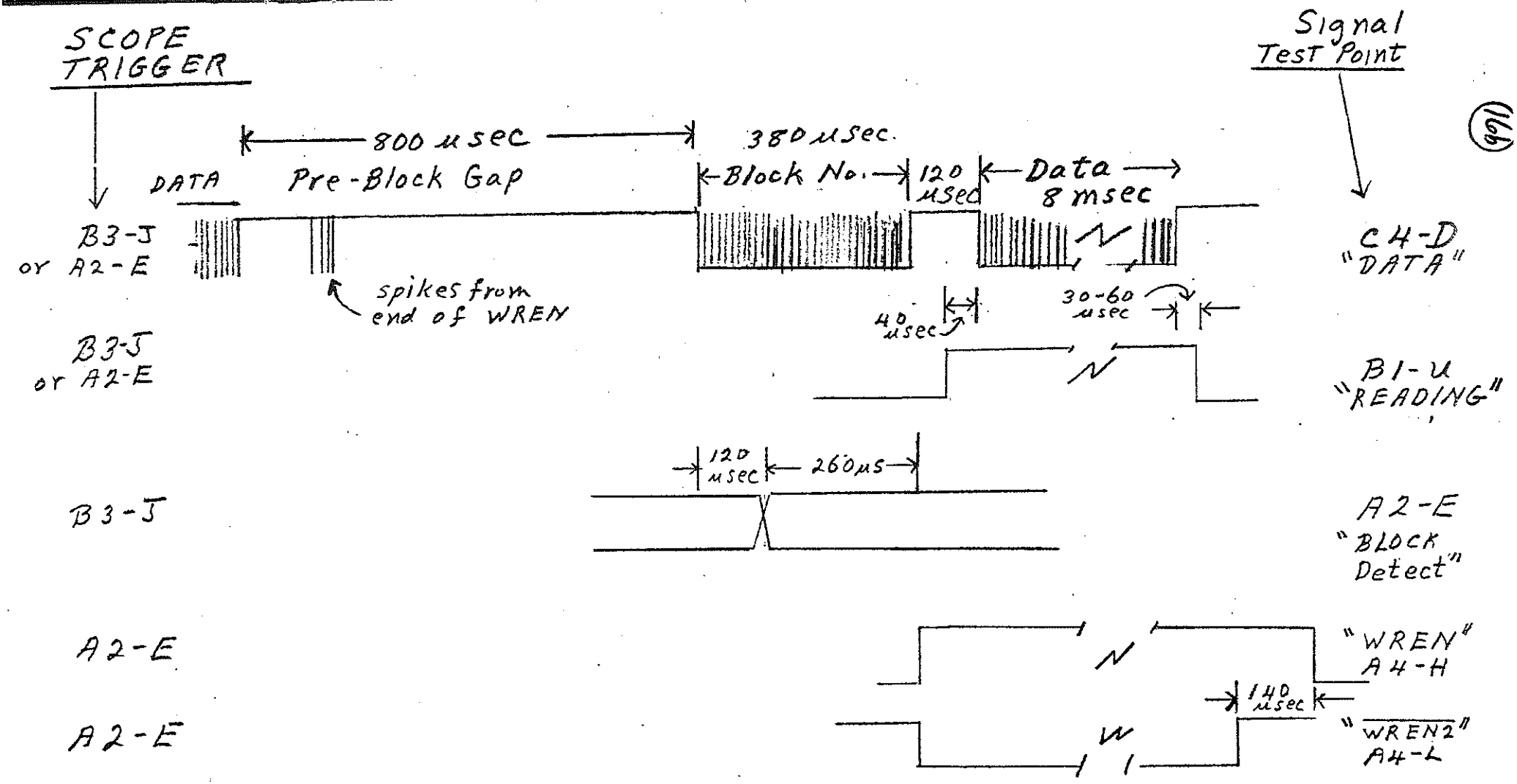
A2-P Search reverse command from PDP-8.

A2-E Level changes when a block mark is detected.

B1-U High when actually reading a 129 word block of data.

Many more useful test points are shown in Fig. 2.

Fig 3 indicates the timing of some waveforms. Use a FOCAL program to read or write a desired block number.



Some Track-Timing Relations

FIG 3

Critical Timing.

1. There are several time intervals and one-shots whose period-length is critical.

a) the write enable one-shot must have a period >140μ sec. If period is too short, the disc write signal will have a notch near the beginning of blocks where zero is written. This would make the data in that block totally unreadable.

b) The RESET one-shot must be at least 10μ sec, but if much longer, the bootstrap will hang up when START is pressed to initialize the PDP-8.

c) the PDP 8 Halt-detect o/s period should be about 10μ sec as there are breaks of several μ sec in the T1 clock.

d) the two clock generating one-shots on card EL612 must have periods of 2.65 ± 0.05μ sec.

2. The disc period must be between 166.0 and 168 m sec when formatting a disc with program "MARK". If the period is too short, blocks may overlap. [It is assumed that the microprocessor clock period is 0.945 micro sec ± 1%.] The speed margins are much less critical (±4%) when reading or writing a previously formatted disc.

3. The pre-block gap is set at about 800μ sec when formatting. Writing of data will eat into this interval, but in worse case condition, the gap should never be reduced below 600μ sec. (The microprocessor block reader insists upon a gap of at least 50μ sec.)

DDTU - Microprocessor Debug Program.

This program uses a program FBUG at location 0A00 to 0B46 in the floppy-disc-controller PROM program. It allows listing of all memory accessible to the floppy disc microprocessor card, and allows modification to contents of any writable memory location in that memory.

Since external RAM memory can be connected to the floppy disc microprocessor, and this RAM in turn can be used by a second microprocessor, the DDTU program allows the PDP 8 to be used for loading and debugging of test programs in new microprocessor-controlled systems.

DDTU uses the floppy disc DMA system to communicate with the microprocessor. Since DMA is inhibited unless a disc unit is actually selected, DDTU selects disc unit 7. It is necessary to have a disc unit switched to 7 when using DDTU.

DDTU Commands (All addresses and data are in Hexadecimal code.)

XXXXL — List memory contents starting at XXXX. Stops for any teletype keyboard stroke.

XXXXG — Make the microprocessor program jump to location XXXX.

XXXXI — Will copy code in field 1 of the PDP-8 to addresses in RAM starting at XXXX.

*XXXXM — Allow modification of contents of byte location XXXX. Prints current contents, replaces by new content if given. Next byte is accessed by hitting Line Feed. Exit by Return, or any illegal character.

XXXXS — AB CD 12 etc store codes AB, CD, 12 etc in bytes starting at XXXX. Press space to merely print the current contents of next byte. Exit with Return. A new line will start every 16 bytes, and every 4 bytes are marked by a comma. Each byte is stored when SPACE is pressed.

*Note that absolute 12 bit addresses produced by assembler PALH will be rearranged by DDTU before transmission to the RAM.

Programming Microprocessors with the PDP 8.

Since no really satisfactory system exists to assemble program code for the microprocessors, we have developed a procedure to use the PDP-8I to assemble machine language code for the MOS 6502 microprocessor and to load the resultant binary code into either a PROM (programable read-only memory) or RAM, (random access memory). All the PDP 8I disc monitor programs can then be used in preparing programs for the microprocessor.

Program:
- PALH assembles symbolic code, byte by byte.
- PROM copies code from PDP 8 core into a PROM memory.

PALH (Assembler) A version of the PDP 8 assembler "PALD" was modified to assemble microprocessor symbolic code. Code is written one line per byte, with an equality list preceding each program, that gives the octal code for each symbol used. The output listing will be typed in hexadecimal if the letter 'H' is typed when the listing starts. The computer pauses when H is typed; press "space" to continue.

Output can be sent to either the 613 memory scope, or the teletype. In order to switch from teletype to CRT output, or back, press ALT MODE or ESCAPE key. This also erases the CRT, when switching to CRT output. Pressing CTRL-T will change the size of the lettering on the CRT, allowing a choice between large or small print on the screen.

The PALH assembler includes all the features of disc monitor PALD with some extra options so that a short important part of a long listing can be typed, without having to type out the whole listing.

When any key is pressed, the assembler will pause waiting for a second key. If a number from 1 to 9 is pressed, it will print only that number of lines before pausing again. If the RUBOUT or DELETE key is pressed, the screen will be erased before restarting. Of course, if ALT MODE or ESCAPE is pressed the following lines will be typed on the teletype.

PALH also includes modifications to store long symbol tables in field I of core instead of in ".SYM" of the disc. A paging routine that numbers each page has also been added.

PROM (Summary)

1. Call PROM, load microprocessor program to PDP 8 core buffer, call PROM again.
2. Type L to List errors, Q to Quit listing.
3. Microprocessor programs start at 2000 or 4000 in field I; the core buffer addresses should be the same as the microprocessor addresses used.

Operation: A "Prom Programmer" unit couples to the PDP 8 via cables 7 (in) and 18 (out) from serial Multiplexer Unit 3.

Microprocessor code in PDP 8 field I, words 2000-2777 or 4000 to 4777 can be written into a PROM 2704. Code in words 2000 to 3777 or 4000 to 5777 can be written into a PROM 2708.

Procedure:

Type PROM (Return). Mount a 2708 in Prom Programmer. (PROM stores NOP [Octal 352 = HEX EA] in PDP 8 core area.)

Load microprocessor code into core as requested by PROM .

Type PROM (Return).

Type 2 or 4 to select start of core buffer: 2000 or 4000.

Type 4 or 8 for a 2704 or 2708 PROM.

Any 12 bit absolute addresses in the code are converted to two byte addresses by PROM.

The program repeatedly copies the code from the PDP 8 core buffer into the PROM, then reads it back to see if the PROM remembers correctly yet. The number of remaining errors is displayed in the PDP 8's MQ register. After this procedure is repeated for about 30 seconds, the count in the MQ register should drop to 10 or so and then will probably not go any lower. This appears to be because a few seconds must elapse after writing, before correct readback can be achieved, but it is not really understood at present. When the error count seems to have stabilized, set the PROM programmer "Program Inhibit" switch ON. The error count should drop to zero. Then allow the program to run with Program Inhibit off for 2 Min after zero errors are seen, to avoid marginally written bytes.

The residual errors can be printed out at any point by pressing "L" on the teletype. Press "Q" to inhibit typing.

Notes:

1. If the PROM is not initially erased, the program will tell you so and print the contents of any non-erased words. This also allows you to print the contents of the PROM after programming it. (Call PROM but set Write Inhibit switch.) In case you wish to repeat the storage procedure (if an error persists after the first funning of the program) press Q on the teletype to bypass the printout.

2. The PROM erases to all "ONES". A ZERO can be written over a "ONE", but a "ONE" cannot be written over a "ZERO". If a program is changed, erase the PROM with UV light and start again.

3. The 2708 can be destroyed by static electricity. Be sure to be grounded before touching one.

PROM LOADING SEQUENCE

```
.PROM
LOAD PROM PROGRAMS INTO PIPS
.LOAD
*IN-S:REST,S:SRCH,S:RCD:
*
*
*
ST=
```

CTRL-P

```
.LOAD
*IN-S:ROFR,S:GO-JR,S:SEEK
*
*
*
ST=
```

```
.LOAD
*IN-S:W129,S:R129,S:XOR
*
*
*
ST=
```

```
.LOAD
*IN-S:WRIT,S:SOR
*
*
ST=
```

```
.SAVE FLOP:1<000-7777,
.PROM
1ST CORE 2(000) OR 4(000)?,
FROM (270)4 OR (270)5 ??
.
```

→ {Prom program loads the PROM 12 for Microprocessor Card

```
.LOAD
*IN-S:FORM,S:IBUG,S:BOOT
*
*
*
ST=
```

```
.SAVE FORM:14000-17777,
.PROM
LOAD PROM PROGRAMS INTO PIPS
.FORM
.PROM
1ST CORE 2(000) OR 4(000)?4
FROM (270)4 OR (270)5 ??
```

load PROM 13

Appendix A. Floppy Disc Control Program & Listings (Subroutine List).

The floppy disc is operated by a program in read-only memory. (See REST, etc.) Flow charts of the program preceed the listings. In general, the program is divided into a number of short single-function subroutines.

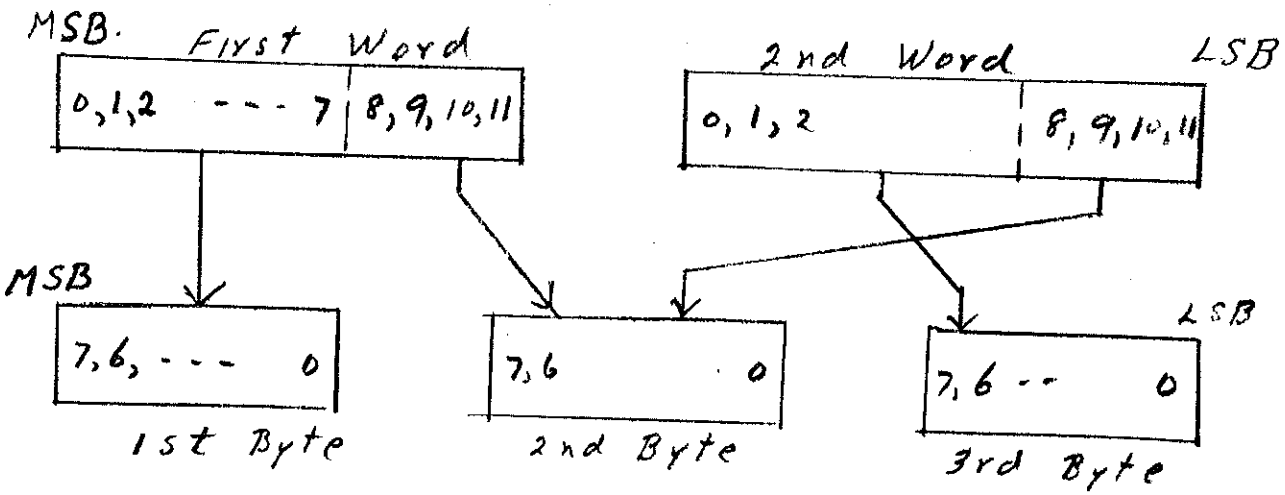
REST	Initialize microprocessor, watch for DTXA, dispatch to SRCH, READ, WRITE, FORM, FBUG.
SRCH	Transmit block numbers to PDP-8 with 500 μsec period until told to stop.
SEEK	Move the head to selected track, then hunt for selected block No.
RDBK	Detect and read a block No.
ADVB	Advance block No., check for word count overflow at end of operation.
W129	Write 129 12 bit words from PDP-8 to the disc.
R129	Read 129 12 bit words from disc to PDP-8.
REDS	Control multi-block read sequence, test the check-sums.
XSUP	Read-write initializing subroutine.
WRIT	Control multi-block write sequence, store check-sums.
FORM	Format a disc for 129 word data blocks.
FBUG	Microprocessor testing routines.

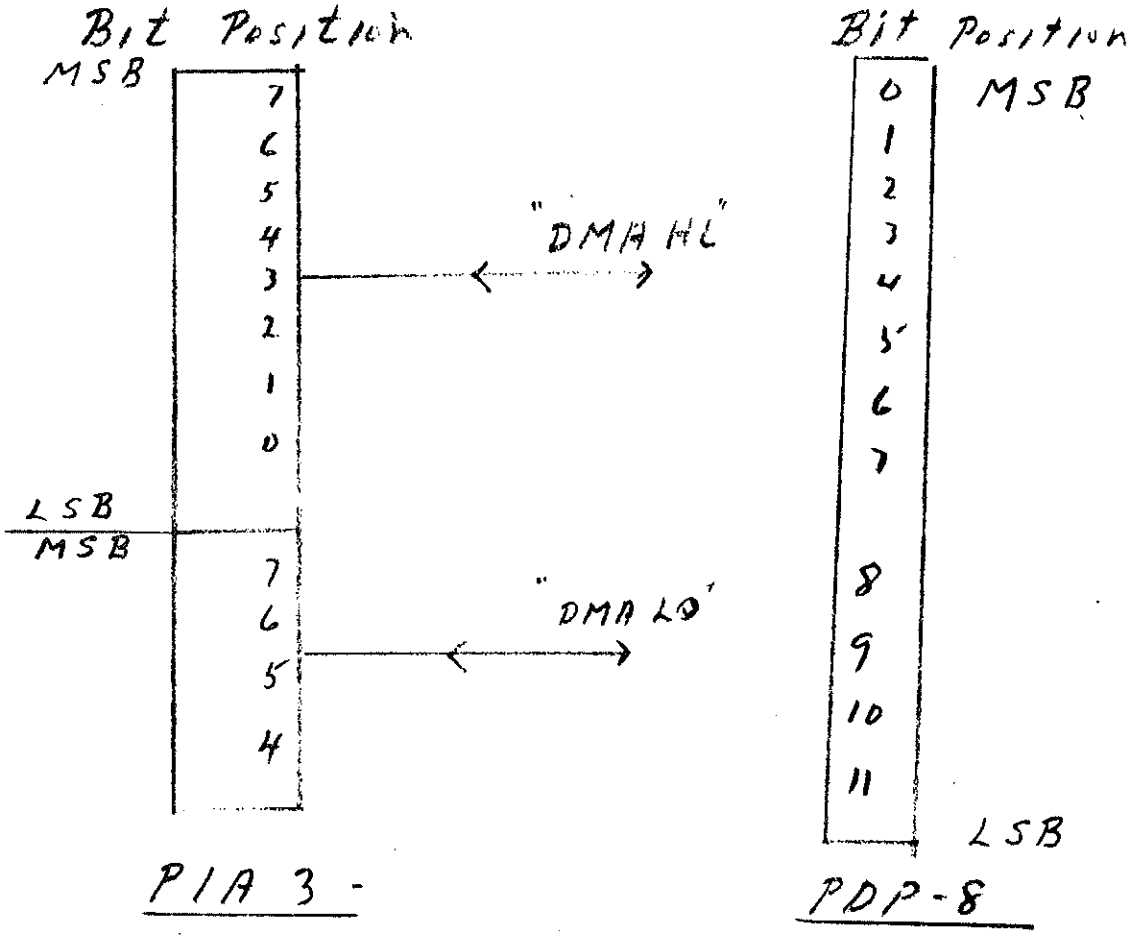
MEMORY UTILIZATION

	EMPTY ↓	PROGRAM ↓		Page Listing	Page Logic
400-4A4			Rest	36	25
4A5-573			SRCH	40	26
----	8				
57C-5A6			REDS	44	32
----	1				
5A8-5C1			RDBK	45	27
----	24				

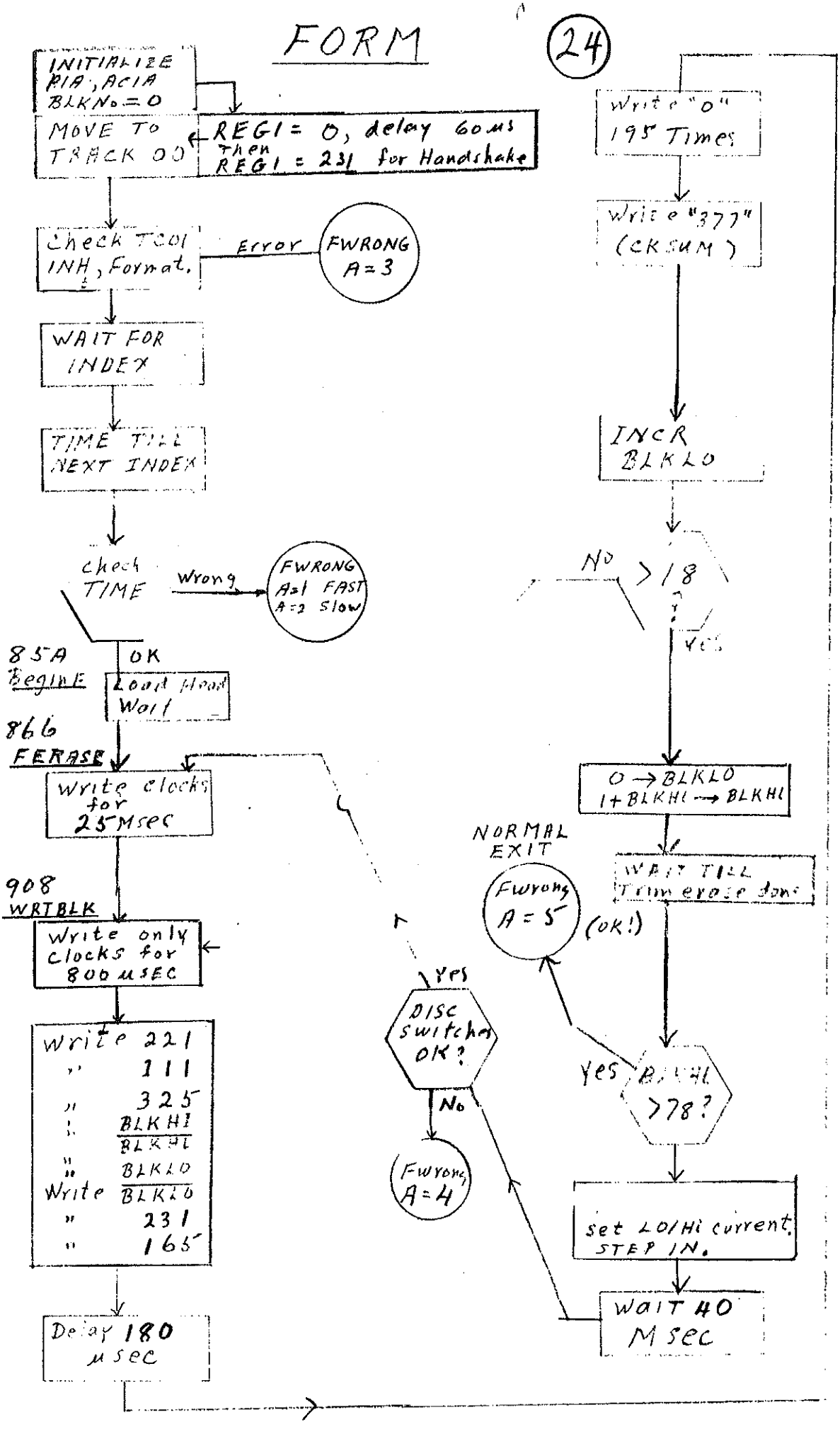
5DA-606			ADVD	48	28
----	1				
608-695			SEEK	50	29
----	12				
698-6D9			W129	53	30
----	9				
6E0-73D			R129	55	31
----	6				
745-768			XSUP	57	33
769-795			WRIT	58	34
797-7FF	1		SUBR	60	
800-8A1			FORM	63	24
8A6-9BE	4		TRAK00 etc.	66	
----	10				
9C8-9FD			ERRCLR, ENDMOV, PERIOD. DELAYS	71	
----	8				
A00-A28			FBUG	73	
----	24				
A40-B58			FBUG		
----	8				
B60-BDA			RDBK	45	
----	33				
BFC-BFD			"Reset entry to Loc 400"	80	

Data Word Format



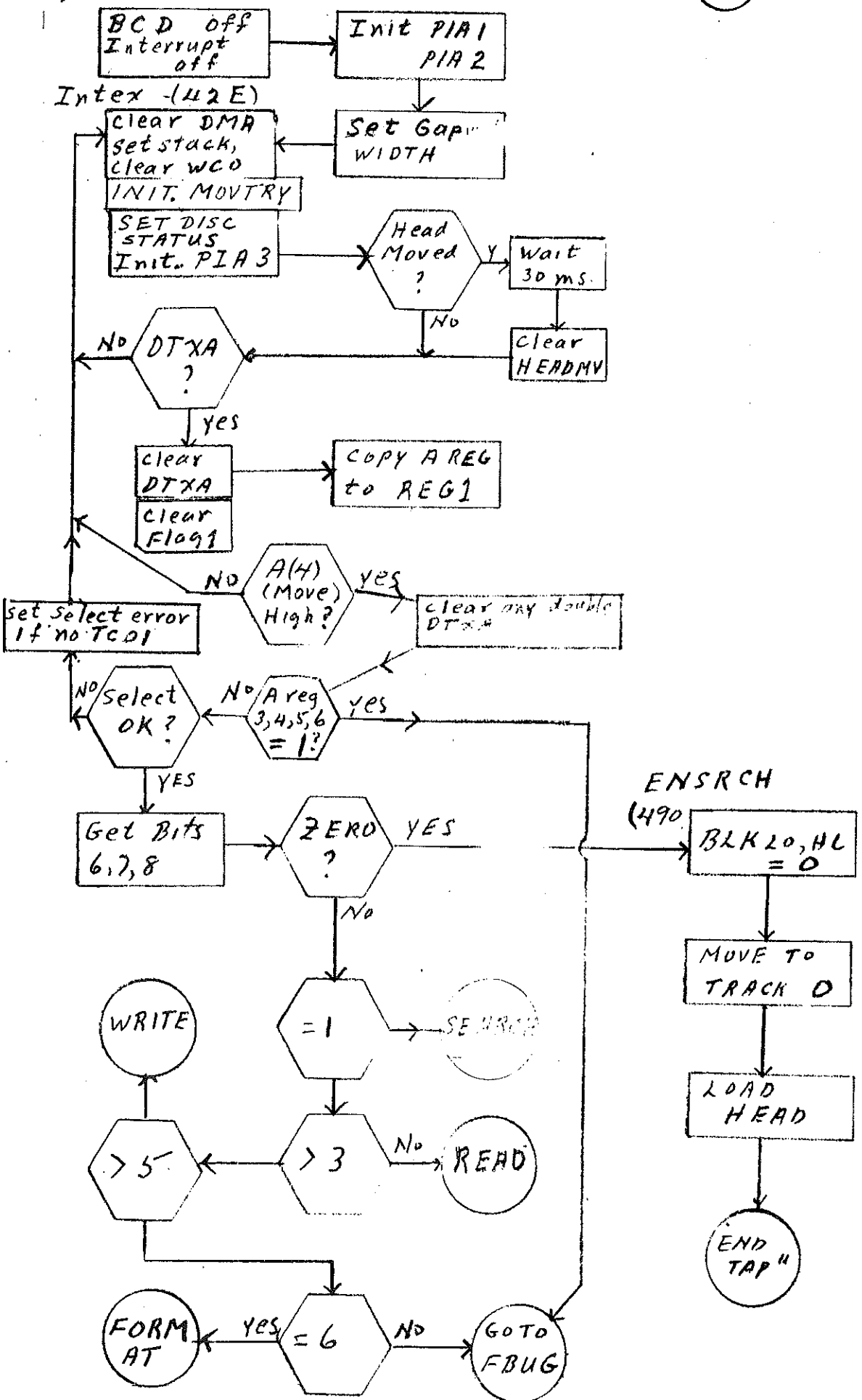


FORM

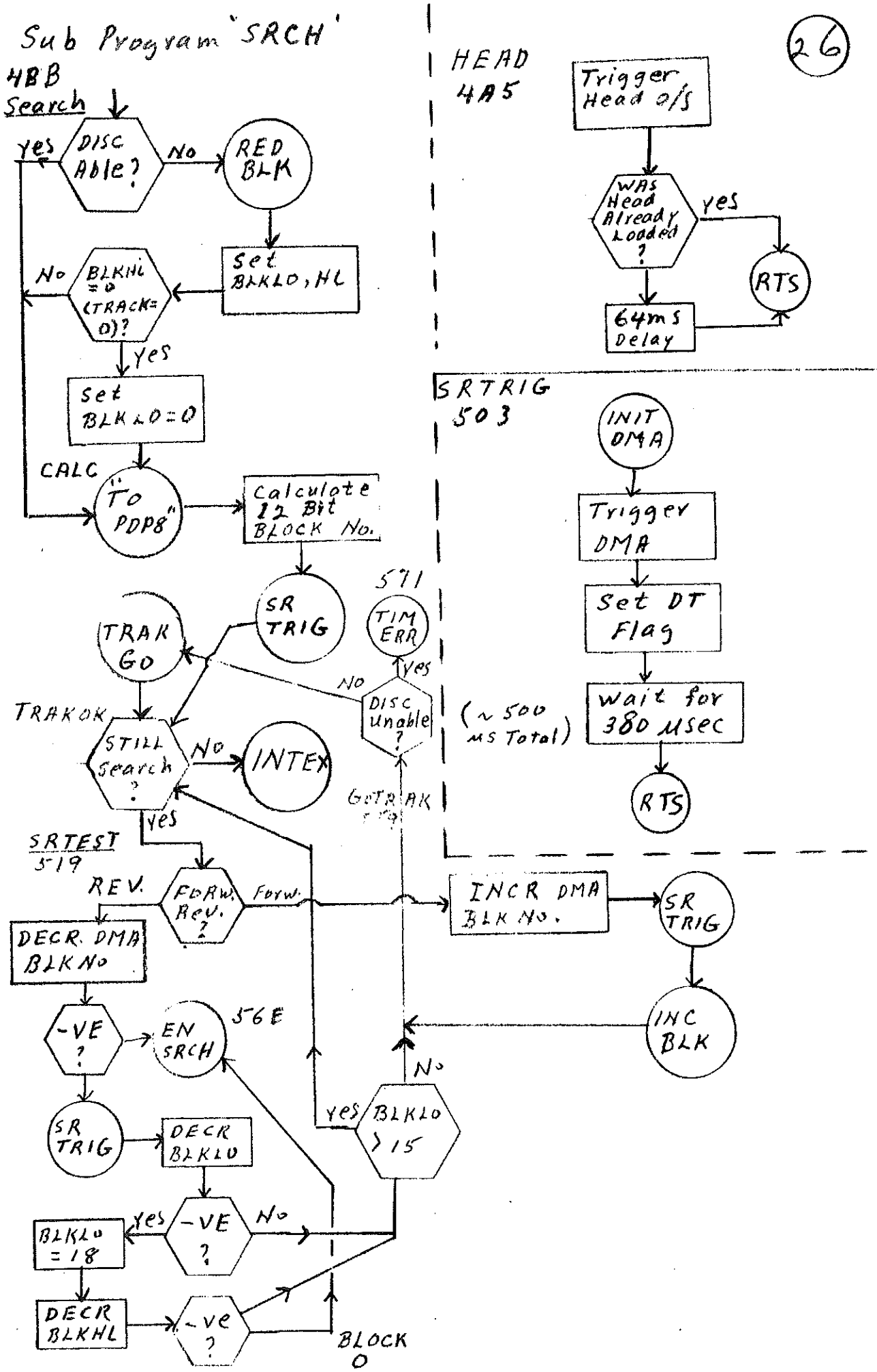

INITIALIZE PIA, ACIA BLKNo=0
MOVE TO TRACK 00
REG1 = 0, delay 60ms then REG1 = 231 for Handshake
Check TEST INH, Format.
Error
FWRONG A=3
WAIT FOR INDEX
TIME TILL NEXT INDEX
check TIME
Wrong
FWRONG A=1 FAST A=2 Slow
OK
85A Begine
Load Head Wait
86 ERASE
Write clocks for 25 Msec
908 WRTBLK
Write only clocks for 800 uSEC
Write 221
" 111
" 325
" BLKHI
" BLKHI
" BLKLO
Write BLKLO
" 231
" 165
Delay 180 usec
Write "0" 195 Times
Write "377" (CKSUM)
INCR BLKLO
No
>18 ?
Yes
0 → BLKLO
1+BLKHI → BLKHI
NORMAL EXIT
Fwrong A=5
(OK!)
WAIT TILL Trim erase done
Yes
BLKHI >78?
DISC switched OK?
Yes
No
Fwrong A=4
set LO/Hi current. STEP IN.
WAIT 40 MSec

Sub. Program "REST"

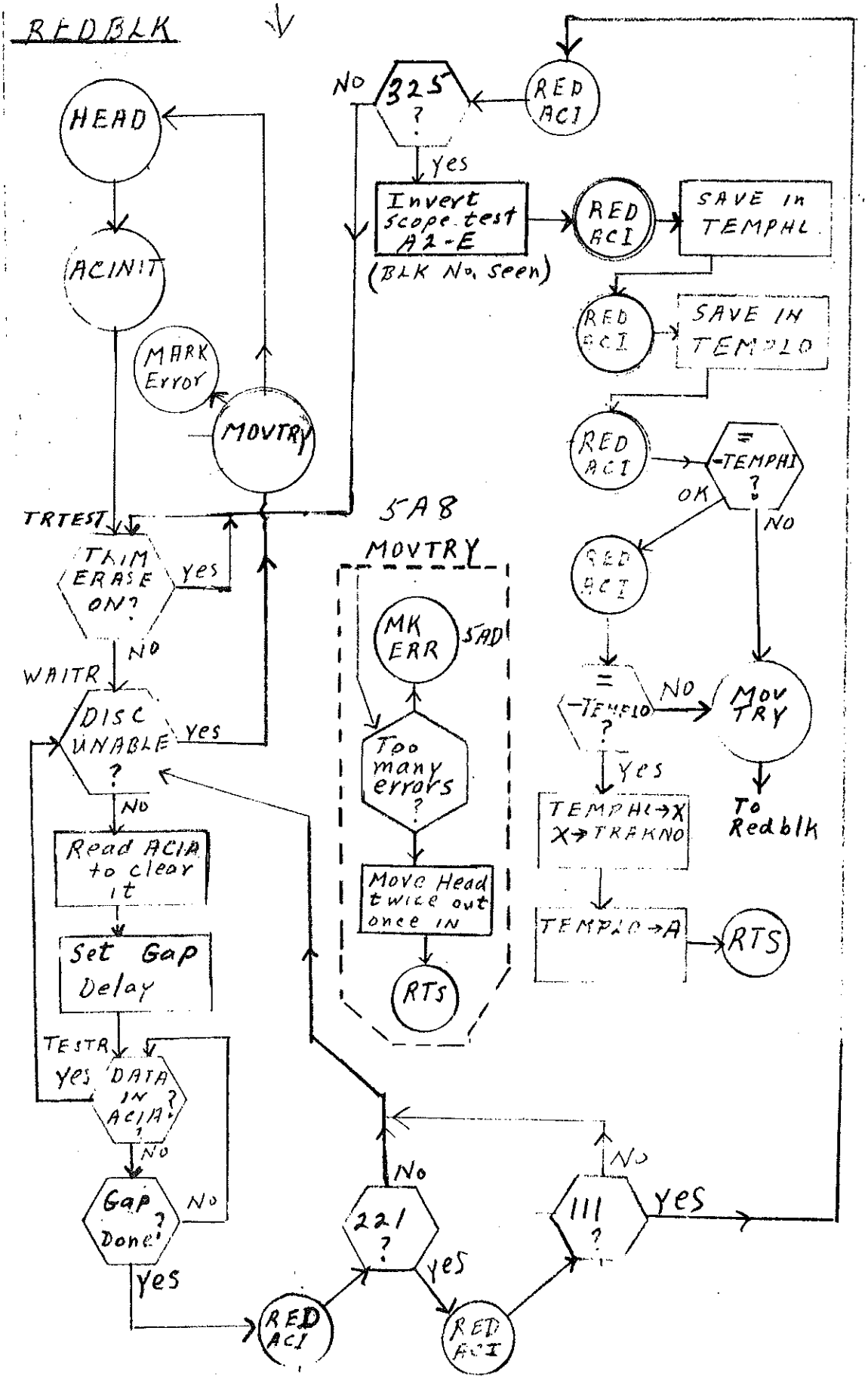
400



Sub Program 'SRCH'



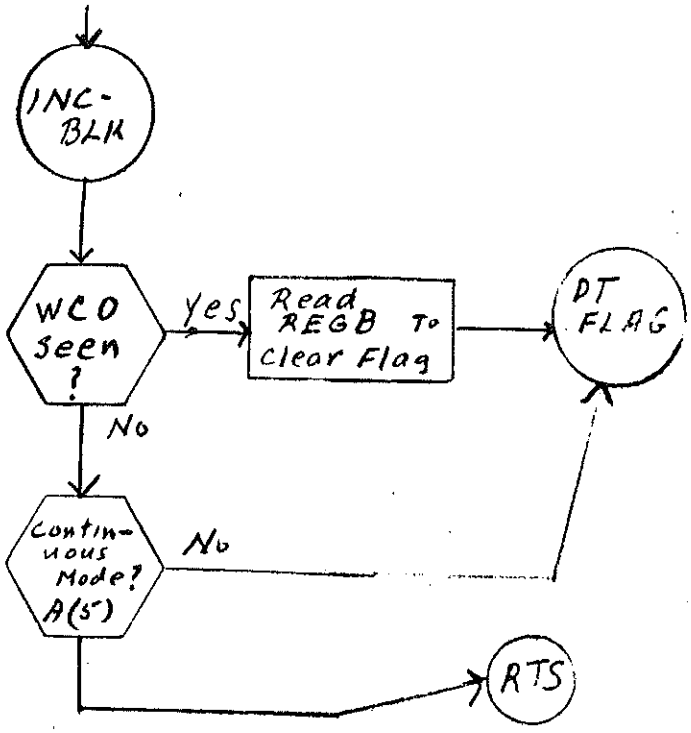
Sub-Program RDBK
B60 and 5A8



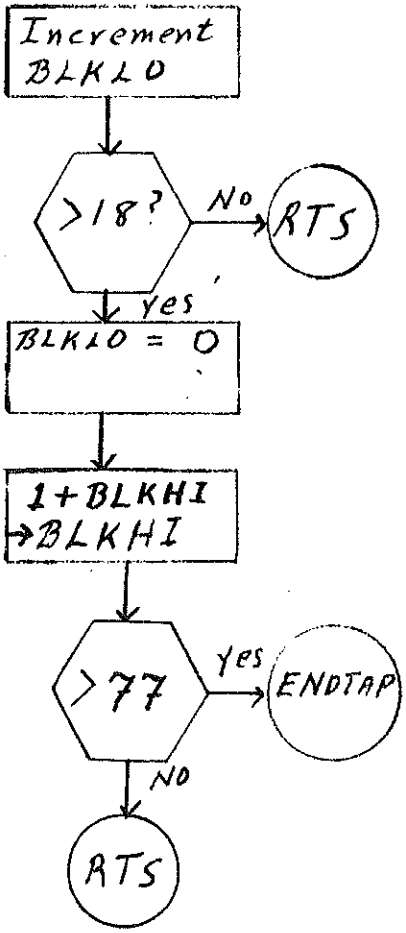
ADVB "BLKADV", "INCBLK"

5"DA

BLKADV

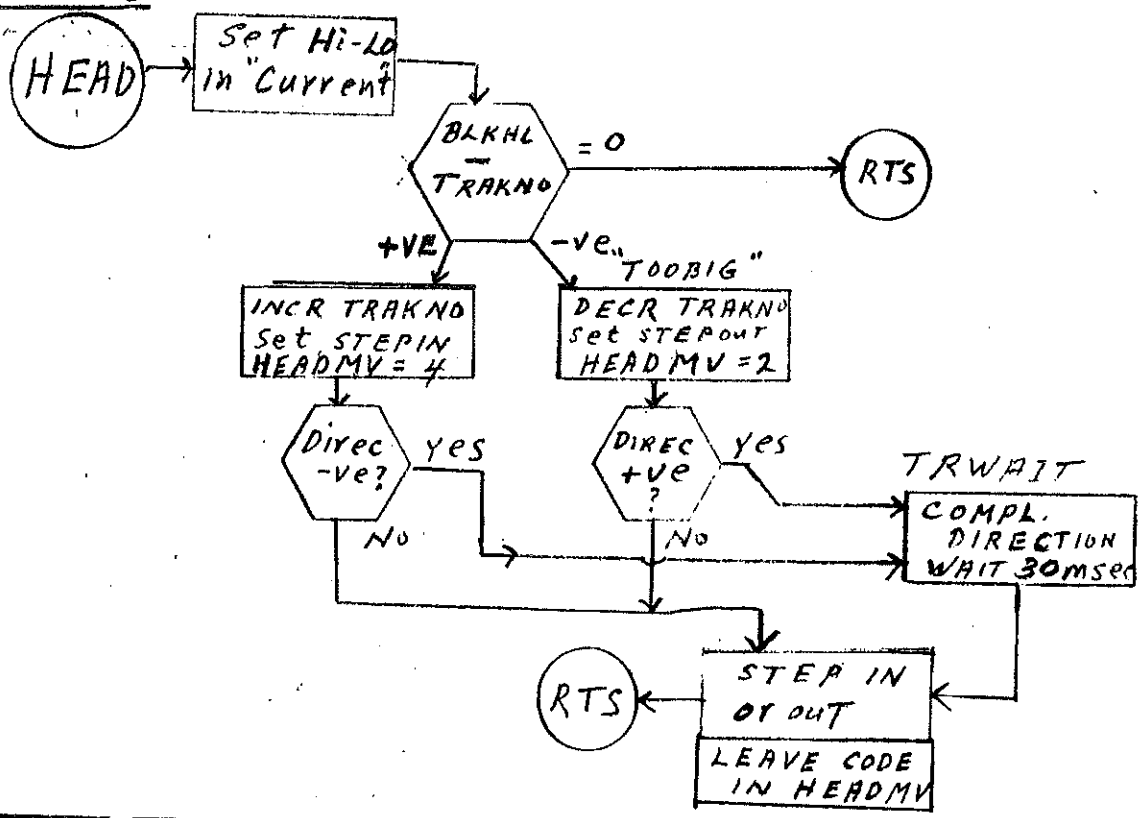


INCBLK 5"ED

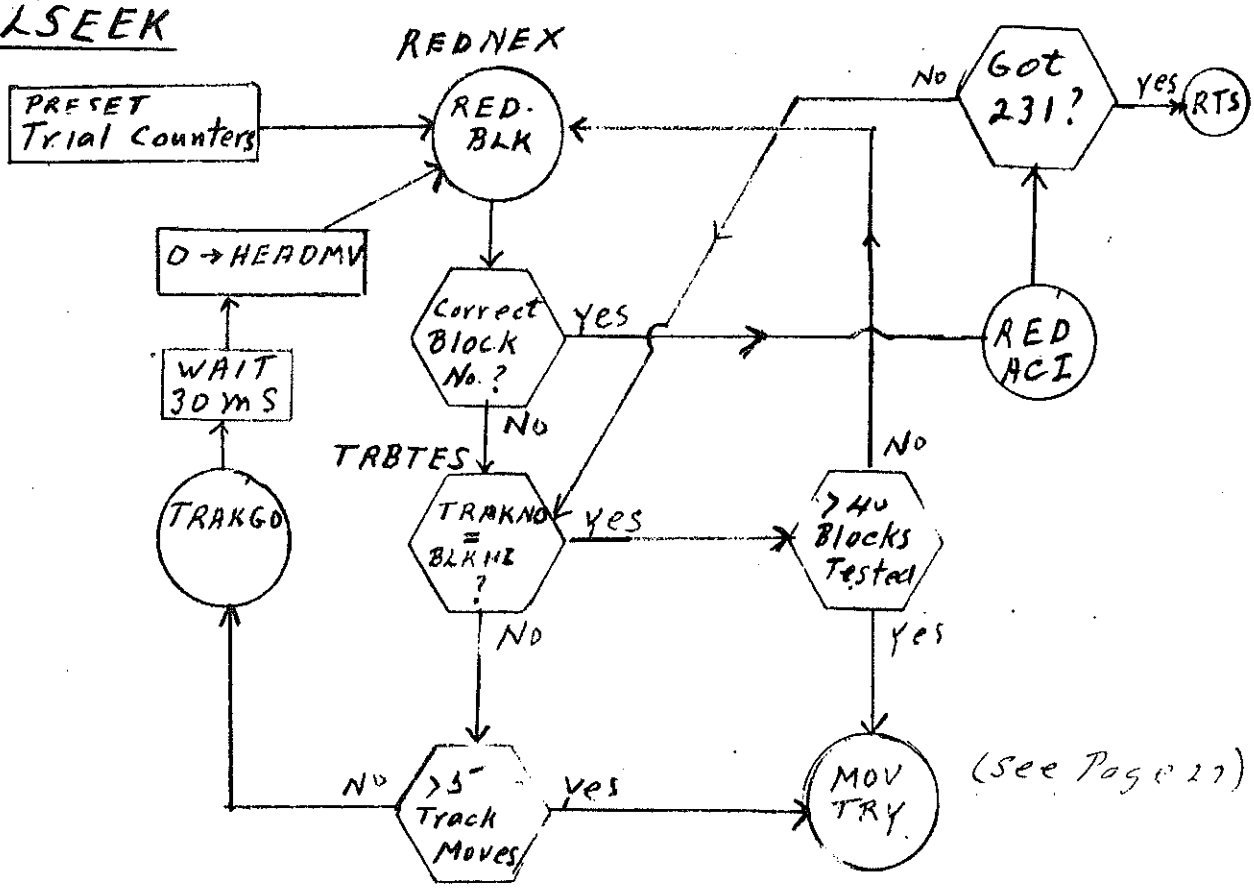


608 SEEK "TRAKGO" + "BLSEEK"

TRAKGO



64B BLSEEK

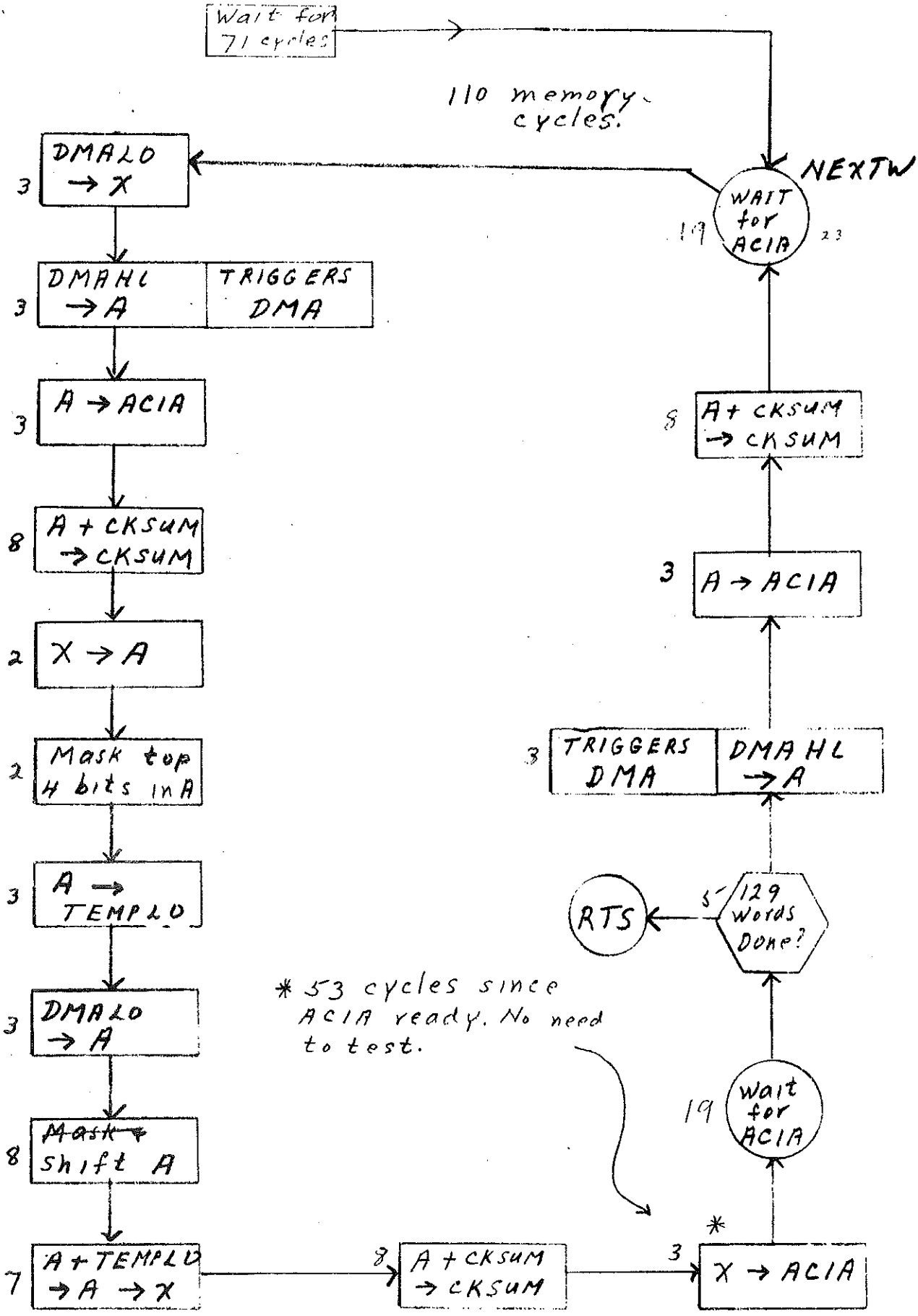


(See Page 27)

WRT 129 "W129"

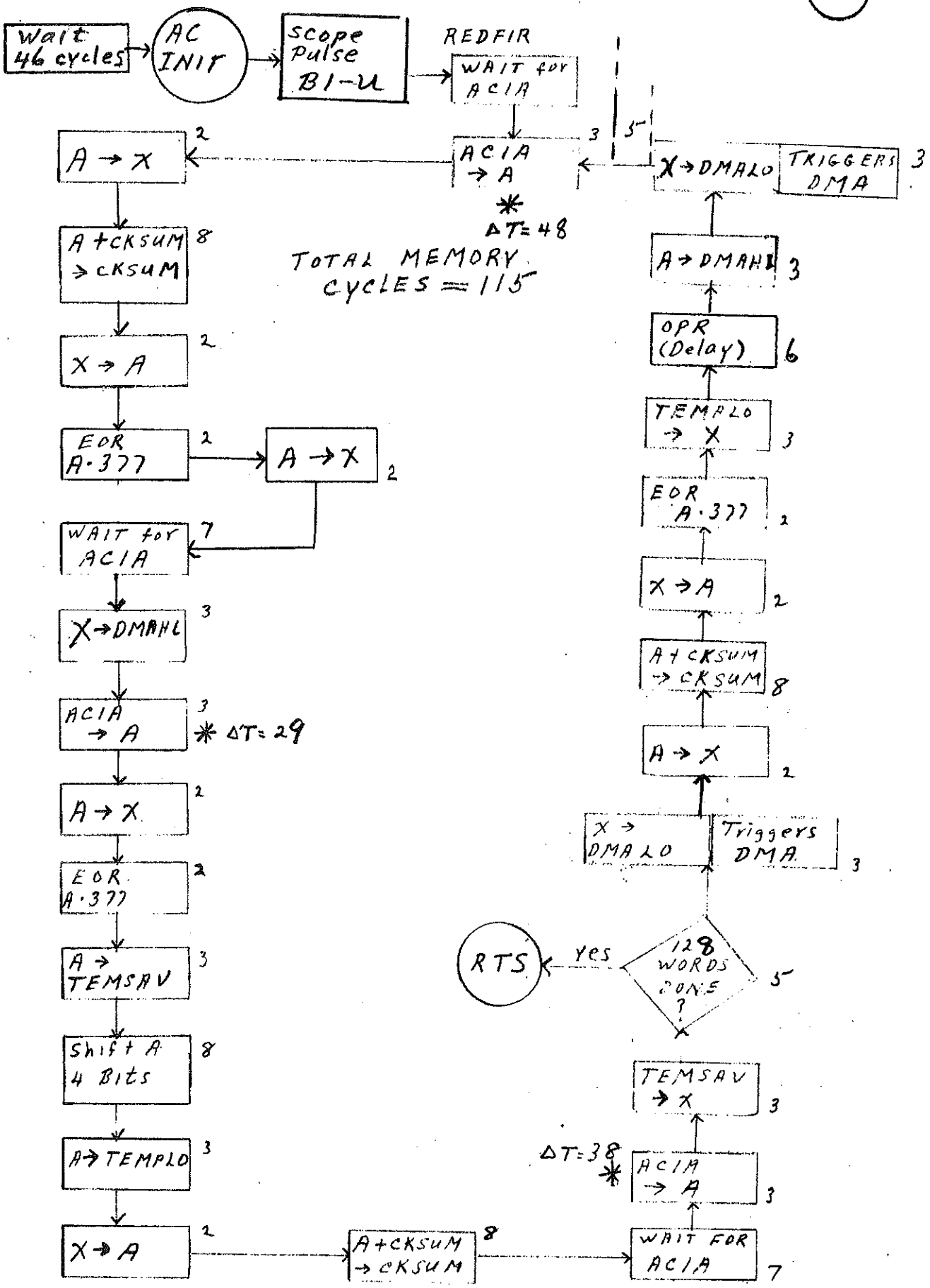
698

WRT129



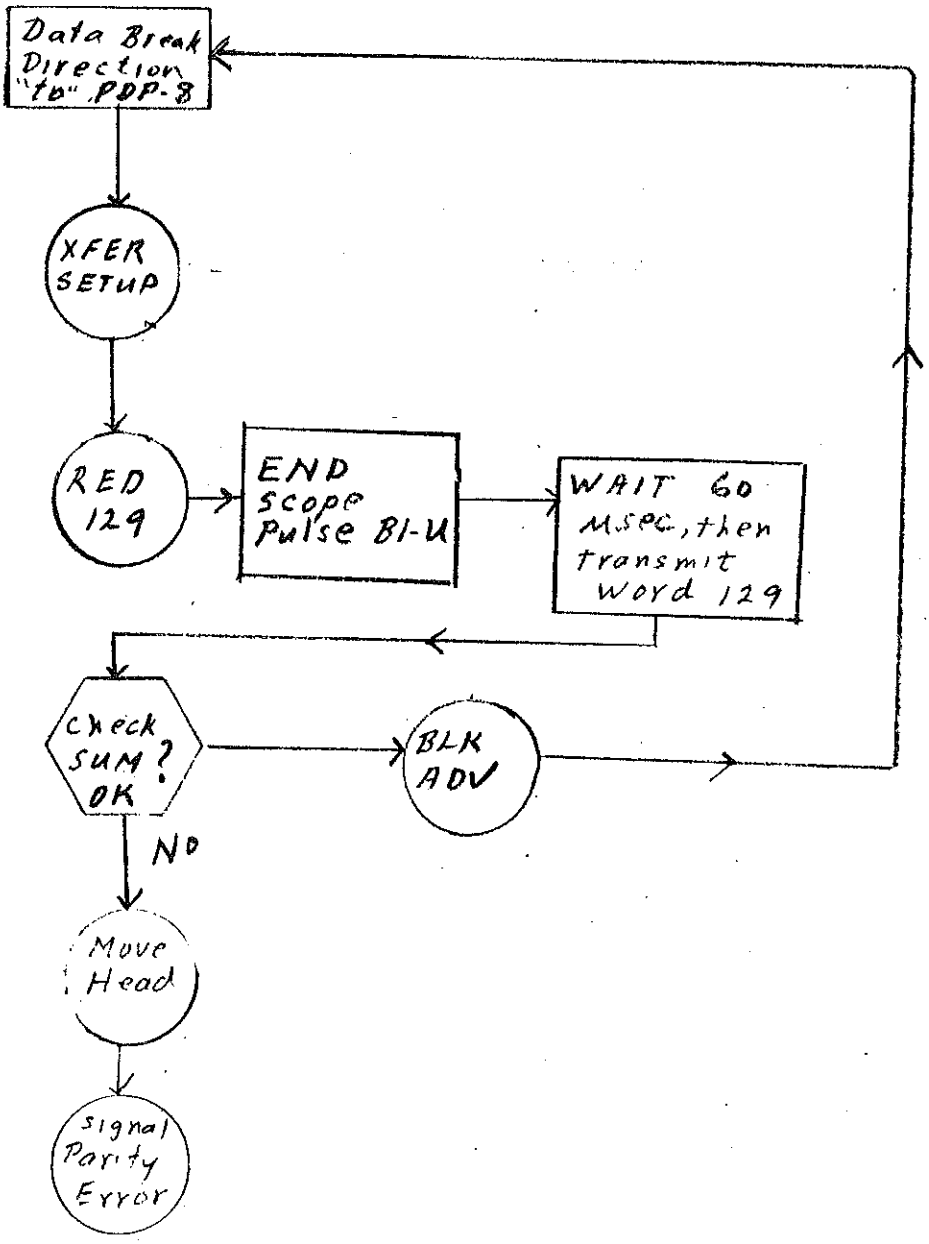
R129

6E0


Wait 46 cycles
AC INIT
Scope Pulse B1-U
REDFIR
WAIT for ACIA
ACIA → A
3
5
* ΔT=48
TOTAL MEMORY CYCLES = 115
A → X
2
A + CKSUM → CKSUM
8
X → A
2
EOR A·377
2
A → X
2
WAIT for ACIA
7
X → DMAHL
3
ACIA → A
3
* ΔT=29
A → X
2
EOR A·377
2
A → TEMSAV
3
Shift A 4 Bits
8
A → TEMPLO
3
X → A
2
A + CKSUM → CKSUM
8
WAIT FOR ACIA
7
ACIA → A
3
* ΔT=38
TEMSAV → X
3
128 WORDS DONE ?
5
Yes
RTS
X → DMALO
Triggers DMA
3
A → X
2
A + CKSUM → CKSUM
8
EOR A·377
2
X → A
2
TEMPLO → X
3
OPR (Delay)
6
A → DMAHL
3
X → DMALO
TRIGGERS DMA
3

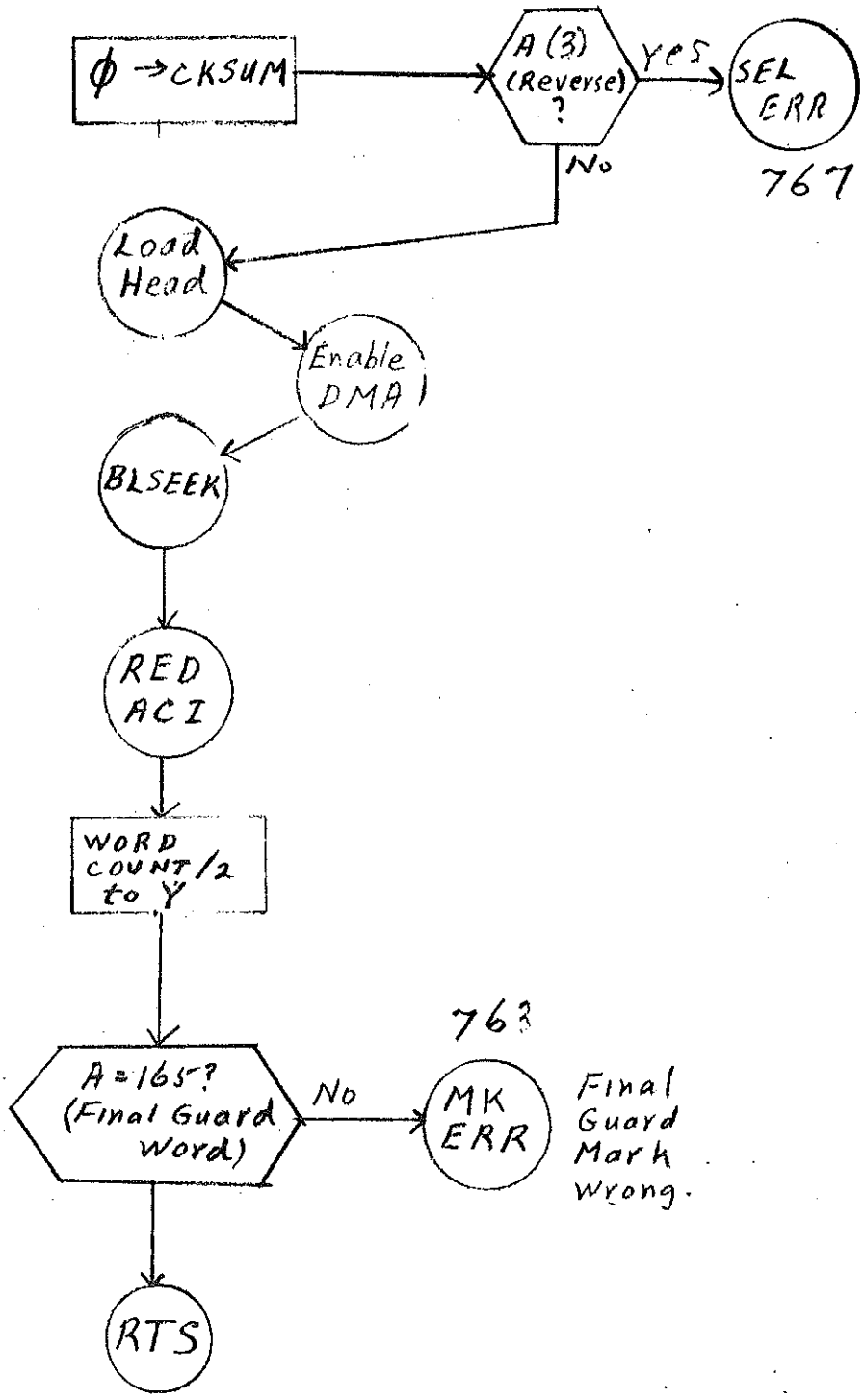
READER "REDS"

5 7C



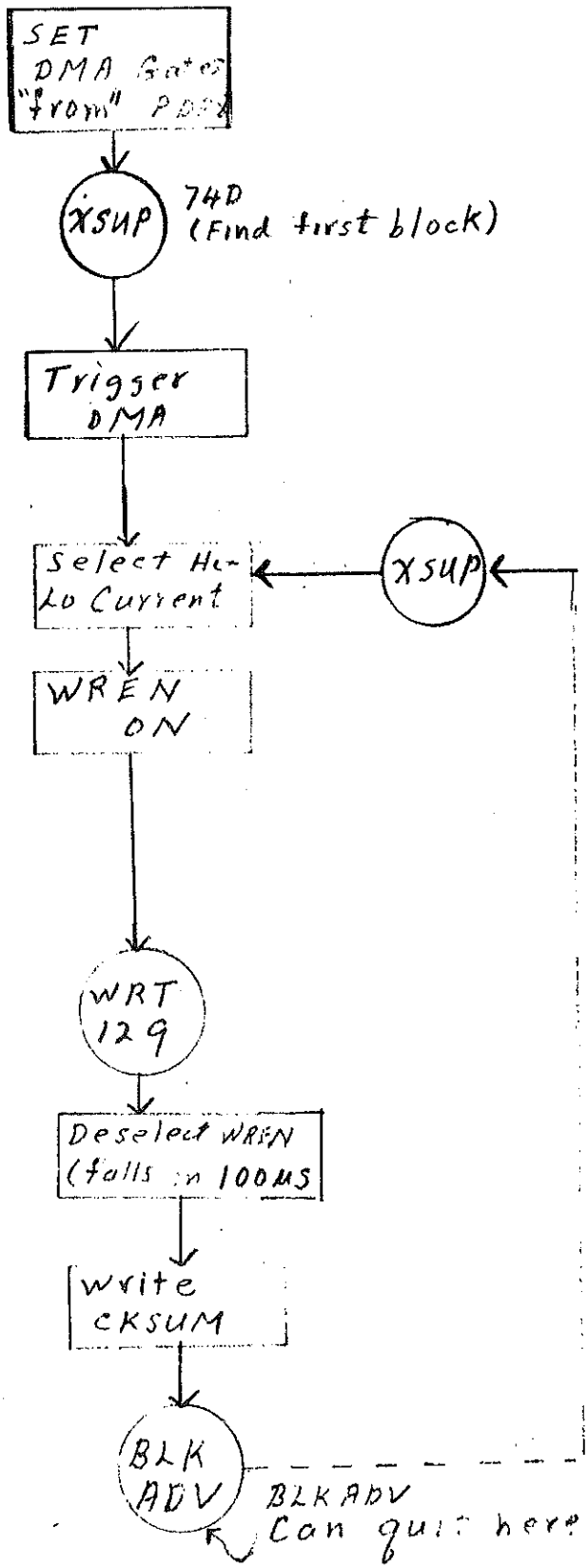
Sub Routine "XSUP"

745
XSETUP



Sub. Routine WRIT

769
WRITER



FR 12 · JUNE 9/77

```
L
/
/CON8
FIELD 1
XLIST
/NOTE THAT FOR EXTENDED ADDRESSES,"PROM" TAKES
/12 BIT ADDRESSES,AND LOADS LOW PART INTO PRECEEDING
/CONTENT 0 WORD.
/ASSEMBLER CODES FOR MOS 6502
/
ADCZ=145
ADCI=151
ANDZ=45
ANDI=51
ASL=12
BCC=220
BCS=260
BEQ=360
BITZ=44
BMI=60
BNE=320
BPL=20
BVC=120
BVS=160
CLC=30
CLD=330
CLI=130
CLV=270
CMPZ=305
CMPI=311
CPXZ=344
CPXI=340
CPYZ=304
CPYI=300
DEX=312
DECZ=306
DEY=210
EORI=111
EORZ=105
INCZ=346
INX=350
INY=310
JMP=114
JMPI=154
JSR=40
LDAZ=245
LDAI=251
LDAX=265
LDAXI=241
LDXI=242
LDXZ=246
LDYI=240
LDYZ=244
LSR=112
OPR=352
NOP=352
ORAI=11
ORAZ=5
PLA=150
ROL=52
RTS=140
/
/
/
SBCI=351
SBCZ=345
SEC=70
STAA=215
STAYI=221
STAXI=201
SEI=170 /78
STAZ=205
STXZ=206
STYZ=204
TAX=252
TAY=250
TXA=212
TYA=230
TXS=232
/
/
INTEX=2056
ENSRCH=2210
TOPDP8=3627
CLOSDM=3652
OPENDM=CLOSDM+7
INITDM=OPENDM+7
DELAY=INITDM+11
ACINIT=DELAY+12
READCI=ACINIT+11
MKERR=READCI+11
ENDTAP=MKERR+17
TIMERR=ENDTAP+4
DTFLAG=TIMERR+4
PARERR=DTFLAG+4
SELERR=PARERR+4
/
HEAD=2245
SEARCH=HEAD+26
MOVTRY=2650
MOVOUT=MOVTRY+7
DEL60=MOVTRY+40
READER=2574
READBLK=5540
BLKADV=2732
INCBLK=BLKADV+23
TRAK00=3010
BLSEEK=TRAK00+103
WRT129=3230
RED129=3340
XSETUP=3505  Aug 20
WRITER=3558
FORMAT=4000
TRAK00=4246
ERRCLR=4710
ENDMOV=4730
PERIOD=4750
FBUGX=5100
/PIA1
REG1=4
CON1=5
REGB=6
CONB=7
/
/PIA2
REGA=10 /8
CONA=11 /9
DISREG=12        /A
DISCON=13        /B
/
/
/
/
/
/PIA3
DMALO=16         /E
CONDMA=15        /D
CONDMB=17        /F
DMAHI=14         /C
/
/ACIA
SDATA=21         /11
DATCON=20        /10
/
/
/
/VARIABLES
BLKLO=201
BLKHI=202
DSTATE=203
TRAKNO=204
TEMPLO=205
TEMPHI=206
TEST1=207
TEST2=210
CKSUM=211
TIME=212
DIREC=213
HEADMV=214
CURENT=215
TEMSAV=216
GAPWID=217
ADDRLO=220       /TEMPORARY ADDRESS
ADDRHI=221       /MUST BE IN THIS ORDE
ERRCNT=222
XLIST
PAUSE
```

(36)

AUG 20/77

FR 12 (FAST)

```
.
.PALH
*OUT-S:REST
*
*IN-S:CON8,S:REST
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /REST-START OF FLOPPY PROGRAM-MOS 6502
                /
                /
                /NOTE!!!!!!!
                /**********CHANGE GAPWID WHEN ALL DISCS ARE 1.06 MHZ!!*****
                *2000
400     D8    RESET,CLD
401     78     SEI
402     A2     LDXI
403     BF      277     /BIT 6 IS AN INPUT
404     86     STXZ     /1ST CLOSE PIA 1B DDR,AND
405      7      CONB
406     86     STXZ     /SET OUTPUT REG. HIGH TO
407      6      REGB     /AVOID SETTING FLAGS DURING RESET
408     A9     LDAI
409     30      60
40A     85     STAZ     /NEXT MUST SET DDR AS OUTPUTS
40B      7      CONB     /OPEN PIA1-B
40C     86     STXZ     /THIS IS NEEDED BEFORE BOOTSTRAP DMA FINISHES.
40D      6      REGB
40E     A2     LDXI
40F     FF      377
410     86     STXZ     /CLOSE PIA 2B
411      B      DISCON
412     A0     LDYI     /.....NOTE THAT PIA 1A,2A,2B DDR'S
413      9      11       / ARE LEFT OPEN BY RESET PULSE
414     84     STYZ              /SET FLAG CONTROL BITS HIGH.
415      A      DISREG           /THIS AVOIDS HEAD LOAD FOR RESET,WHEN
416     86     STXZ              /DISREG GETS SET TO OUTPUTS
417      4      REG1   /PIA1-A SET FOR OUTPUTS
418     A0     LDYI
419     38      70
41A     84     STYZ
41B      B      DISCON           /RE-OPEN PIA2-B;WITH NO DMA ENABLE
41C     86     STXZ
41D      A      DISREG           /PIA2-B SET FOR OUTPUTS
41E     A9     LDAI
41F             0
420     85     STAZ
421      8       REGA /DATA DIRECTION IN (PIA2-A)
422     A9     LDAI
423     37      67      /SET CB2 LOW
424     85     STAZ
```

```
P2
425    7     CONB   /CLOSE DDRB (PIA1-B)
426   85    STAZ
427    9     CONA   /CLOSE PIA2-A
428   85    STAZ
429    5     CON1   /CLOSE PIA1-A
               /
               /
42A   A9    LDAI
42B  FFC     -4     /CHANGE TO -16 WHEN 1.06 MHZ IS ESTABLISHED!!!
42C   85    STAZ
42D   8F     GAPWID          /PRE-BLOCK GAP WIDTH(SEE RDBK)
               /
               /
               /
               *INTEX
42E   A9    LDAI
42F  FF9     -7
430   85    STAZ
431   92     ERRCNT          /INITIALIZE MOVTRY COUNTER
432   A9    LDAI
433   3F     77
434   85    STAZ
435    B     DISCON          /CLEAR ANY DMA ENABLE
436   A2    LDXI
437   DF     337
438   A5    LDAZ
439    6     REGB   /CLEAR ANY WCO FLAG
43A   9A    TXS    /TOP OF RAM FOR STACK,(BELOW TIM'S STACK)
43B   A9    LDAI
43C    9     11
43D   85    STAZ
43E    A     DISREG          /DISC STATUS
43F   20    JSR
440            0
441  7B1     OPENDM
442   A9    LDAI
443            0
444   85    STAZ
445    C     DMAHI /PIA3 RECEIVE DIRECTION
446   85    STAZ
447    E     DMALO /SET RECEIVE DIRECTION FOR PIA3-B
448   20    JSR
449            0
44A  7AA     CLOSDM          /PIA 3 INITIALIZED
44B   A5    LDAZ
44C   8C     HEADMV          /WAIT IF HEAD HAS MOVED.
44D   F0    BEQ
44E    7     MOVDON-1-.
44F   A9    LDAI
450   1E     36     /30 MSEC SETTLING TIME
451   20    JSR
452            0
453  7C1     DELAY
454   86    STXZ            /X IS ZEROED BY 'DELAY'
455   8C     HEADMV          /CLEAR THE MOVE INDICATOR
456   A5   MOVDON,LDAZ
457    5     CON1
458   10    BPL
459  FD4     INTEX-.-1       /WAIT FOR PDP-8
45A   A5    LDAZ
```

```
P3
45B     4     REG1   /CLEAR FLAG FROM DTXA
              /
45C    A9   DTXAS,LDAI
45D    37     67
45E    85    STAZ
45F     5     CON1   /CLEAR PDP 8 SKIP 1
460    A5    LDAZ
461     8     REGA
462    85    STAZ
463     4     REG1
464    10    BPL     /TEST FOR A(4) LOW;I.E...
465   FC8     INTEX-1-.      /'A' CLEARED BY DTXA AT END OF I/O
466    A6    LDXZ
467     4     REG1   /BE SURE ANY DOUBLE DTXA IS CLEARED
468    29    ANDI
469    3C     74
46A    38    SEC
46B    E9    SBCI
46C    3C     74
46D    F0    BEQ     /GO TO FBUG IF CODE 70(EVEN WITHOUT SELECT-OK)
46E    1D     SETERR-1-.
46F    A5    LDAZ
470     8     REGA
471    29    ANDI
472     2     2      /TEST FOR SELECT OK(=TC01 INHIBIT)
473    F0    BEQ
474    1E     SETBAD-1-.
475    A5    LDAZ
476     8     REGA
477    29    ANDI
478    1C     34
479    F0    BEQ
47A    15     ENSRCH-1-.     /'MOVE' COMMAND
47B    38    SEC
47C    E9    SBCI
47D     4     4      /TEST WHAT CODE
47E    F0    BEQ
47F    3B     SEARCH-1-.
480    38    SEC
481    E9    SBCI
482     C     14     /TEST WRITE
483    30    BMI
484    1A     READ-1-.
485    38    SEC
486    E9    SBCI
487     8     10
488    30    BMI
489    18     WRITE-1-.
48A    F0    BEQ
48B    10     FORM-1-.
48C    20   SETERR,JSR
48D           0
48E   A40     FBUGX /GO TO DEBUG ROUTINE FOR ILLEGAL CODE
              /
              *ENSRCH
490    20    JSR
491           0
492   9D8     ENDMOV
              /
493    A5   SETBAD,LDAZ
```

```
P4
494     6     REGB
495    29    ANDI
496    40     100    /TEST IF TC01 IN SYSTEM
497    F0    BEQ
498   F95     INTEX-1-,      /YES IF BIT 6 IS GROUNDED
499    20    JSR
49A           0
49B   7FC     SELERR         /NO TC01,SO GENERATE OUR OWN SELECT ERROR
              /
              /
              /
49C    20   FORM,JSR
49D           0
49E   800     FORMAT
              /
49F    20   READ,JSR
4A0           0
4A1   57C     READER
              /
4A2    20   WRITE,JSR
4A3           0
4A4   769     WRITER
              /
              /

.
```

(39)

```
 FLOP
.LOAD
*IN-S:WRIT,S:SUBR,S:REST
*
*
*
ST=
^^^^
.SAVE FLOP!12000-3777$
.
```

```
.PAL H
*OUT-S:SRCH
*
*IN-S:CON8,S:SRCH
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /SRCH-SENDS SUCCESSIVE BLOCK NO.S TO PDP-8
                /READS CURRENT LOCATION ONLY IF HEAD FOUND UP.
                /
                *HEAD
4A5    A4     LDYZ
4A6     E      DMALO /SAVE STATUS
4A7    A6     LDXZ
4A8     A      DISREG
4A9    8A     TXA
4AA    29     ANDI
4AB    F6      366
4AC    85     STAZ
4AD     A      DISREG
4AE    86     STXZ
4AF     A      DISREG          /PULSE HEAD ONE SHOT
4B0    98     TYA
4B1    29     ANDI
4B2     8      10     /WAS HEAD DOWN ALREADY?
4B3    F0     BEQ
4B4     5      HDOWN-.-1
4B5    A9     LDAI
4B6    40      100   /NO
4B7    20     JSR
4B8             0
4B9   7C1      DELAY /HEAD DOWN DELAY
4BA    60    HDOWN,RTS
                /
                *SEARCH
4BB    A5     LDAZ
4BC     E      DMALO
4BD    29     ANDI
4BE     8      10
4BF    F0     BEQ     /TEST FOR DISC UNABLE
4C0     E      CALC-1-.        /IF NOT,ASSUME HEAD POSITION IS KNOWN
4C1    20     JSR
4C2             0
4C3   B60      REDBLK          /ALSO SETS TRAKNO,HEAD DOWN,ACINIT
4C4    85     STAZ
4C5    81      BLKLO /RETURNS WITH CURRENT BLOCK IN A,B
4C6    86     STXZ
4C7    82      BLKHI
4C8    A6     LDXZ
4C9    82      BLKHI /TEST FOR TRACK 0
```

```
P2
4CA   D0    BNE
4CB    3     CALC-1-.
4CC   8A    TXA
4CD   86    STXZ    / START AT BLOCK 0
4CE   81     BLKLO /...IF ON TRACK 0
             /
             /CALCULATE BLOCK NO.
4CF   20   CALC,JSR          /CONVERT TRACK NO AND 19 BLKS/TRACK TO BINARY
4D0          0
4D1  797     TOPDP8          /SET DIRECTIONS 'TO' PDP-8
4D2   A2    LDXI
4D3          0
4D4   A5    LDAZ
4D5   81     BLKLO
4D6   A4    LDYZ
4D7   82     BLKHI /=TRACK NO
4D8   F0    BEQ
4D9    9     DONE-1-.
4DA   18   MUL19,CLC
4DB   69    ADCI    /ADD 19 BLOCKS TO A
4DC   13     23
4DD   90    BCC
4DE    1     OVRNOT-1-.
4DF   E8    INX     /ADD CARRY TO X
4E0   88   OVRNOT,DEY        /SUB 19 BLOCKS FROM Y
4E1   D0    BNE
4E2  FF7     MUL19-1-.
4E3   2A   DONE,ROL          /SHIFT 'A' LEFT 4 TIMES
4E4   2A     ROL
4E5   2A    ROL
4E6   2A    ROL
4E7   A8    TAY     /SAVE LS 4 BITS
4E8   2A    ROL
4E9   29    ANDI
4EA    F     17     /MIDDLE 4 BITS
4EB   85    STAZ
4EC   85     TEMPLO          /IN LOW 4 OF TEMPLO
4ED   8A    TXA     /HIGH 4 BITS FROM LOW X
4EE   2A    ROL
4EF   2A    ROL
4F0   2A    ROL
4F1   2A    ROL     /HI PART TO TOP OF A
4F2   29    ANDI
4F3   F0     360
4F4   18    CLC
4F5   65    ADCZ
4F6   85     TEMPLO
4F7   49    EORI
4F8   FF     377    /HARDWARE REQUIRES COMPLEMENT
4F9   AA    TAX
4FA   98    TYA
4FB   49    EORI
4FC   FF     377
4FD   20    JSR
4FE          0
4FF  503     SRTRIG
500   4C    JMP
501          0
502  562     TRAKOK
             /
```

```
F3
503   A8   SRTRIG,TAY        /STORE COMPLEMENT OF BLOCKNO, FOR PDP-8
504   20    JSR
505         0
506  7B8    INITDM           /ALLOW DMA-GETS CLEARED BY DTXA,DTCA
507   86    STXZ
508    C     DMAHI           /HI IN'X',LO IN 'Y'
509   84    STYZ
50A    E     DMALO /TRIGGERS DMA,XFERS BLOCK NO.
50B   A2    LDXI
50C    1     1
50D   86    STXZ
50E    6     REGB
50F   A2    LDXI
510   81     201
511   86    STXZ
512    6     REGB  /SET DTFLAG
513   A2   WAIT,LDXI
514  FB3     -115  /DELAY FOR 1.06 MHZ CLOCK
515   E8   WAT800,INX        /CONTROLS STEP-HEAD PERIOD
516   D0    BNE
517  FFD     WAT800-1-.      /WAIT FOR 300 USEC
518   60    RTS
            /
519   A5   SRTEST,LDAZ
51A    8     REGA  /TEST SEARCH DIRECTION
51B   29    ANDI
51C   40     100   /TEST BIT3
51D   D0    BNE
51E   13     REVRS-1-.       /A(3)=1
51F   A5    LDAZ
520    E     DMALO
521   A6    LDXZ
522    C     DMAHI /TRIGGERS DMA,NOT USED
523   38    SEC
524   E9    SBCI    /ADD 1 TO BLKNO(COMPLEMENTED)
525   10     20
526   B0    BCS
527    1     ISET-1-.
528   CA    DEX     /CARRY TO DMAHI
529   20   ISET,JSR
52A         0
52B  503     SRTRIG          /BLKNO TO PDP-8
52C   20    JSR
52D         0
52E  5ED     INCBLK
52F   4C    JMP
530         0
531  559     GOTRAK
532   A2   REVRS,LDXI
533  FF9     -7
534   E8   BAKWRD,INX
535   D0    BNE
536  FFD     BAKWRD-1-.      /ADJUST HEAD STEP TIME FOR REVERSE
537   A5    LDAZ
538    E     DMALO
539   A6    LDXZ
53A    C     DMAHI /TRIGGERS DMA BUT NO MATTER
53B   18    CLC
53C   69    ADCI
53D   10     20     /SUB 1 FROM BLKNO (COMPLEMENTED)
```

```
P4
53E   90    BCC
53F    3     LSET-1-,
540   E8    INX     /CARRY TO DMAHI
541   F0    BEQ
542   2B     ENSRCX-1-,     /DON'T SEND  -1.
543   20   LSET,JSR
544          0
545  503     SRTRIG
546   C6    DECZ
547   81     BLKLO
548   10    BPL             /FIXUP IF IT GOES -VE
549    8     GOCHEK-1-,
54A   A9    LDAI
54B   12     22
54C   85    STAZ
54D   81     BLKLO
54E   C6    DECZ
54F   82     BLKHI
550   30    BMI
551   1C     ENSRCX-1-,     /SET FRONT END OF TAPE SIGNAL
             /
552   A5   GOCHEK,LDAZ      /DON'T STEP BACK TILL SURE
553   81     BLKLO
554   38    SEC
555   E9    SBCI
556    F     17     /SEARCH GOES 2 BLOCKS BELOW REQUIRED BLOCK
557   10    BPL     / FOR DECTAPE DELAYS
558    9     TRAKOK-1-,
559   A5   GOTRAK,LDAZ
55A    E     DMALO
55B   29    ANDI
55C    8     10
55D   D0    BNE
55E   12     TIMBAD-1-,.    /QUIT IF DISC UNABLE
55F   20    JSR
560          0
561  608     TRAKGO
562   A5   TRAKOK,LDAZ      /SEARC STILL ON?
563    8     REGA
564   29    ANDI
565   1C     34
566   38    SEC
567   E9    SBCI
568    4     4
569   F0    BEQ
56A  FAE     SRTEST-1-,     /SEARCH BIT STILL ON
56B   4C   SRQUIT,JMP
56C          0      /SEARCH DONE
56D  42E     INTEX
             /
56E   4C   ENSRCX,JMP
56F          0
570  490     ENSRCH         /IT HIT BLOCK 0
             /
571   20   TIMBAD,JSR
572          0
573  7F0     TIMERR
```

```
.
.
.PALH
*OUT-S:REDS
*
*IN-S:CON8,S:REDS
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /REDS-READS DATA FROM FLOPPY DISC
                /
                *READER
57C    20   NEXRED,JSR
57D           0
57E   797    TOPDP8
57F    A5    LDAZ
580     A     DISREG
581     9    ORAI
582    38     70              /CONTROLS CORE ADDRESS INCREMENT
583    85    STAZ
584     A     DISREG          /DIRECTION TO PDP-8 IS SET ALREADY
585    20     JSR
586           0
587   745      XSETUP         /PREPARE DATA TRANSFER
588    20    JSR
589           0
58A   6E0     RED129         /READ 129 WORD BLOCK
58B    A0    LDYI
58C    37     67
58D    84    STYZ
58E     7     CONB  /SIGNAL END OF BLOCK (PIN B1-U)
58F    A0    LDYI   /DECTAPE MONITOR NEEDS 150 USEC DELAY } Perhaps!
590     C     14     /AFTER 128TH WORD                     } not proven!
591    88   DLAY,DEY
592    10    BPL
593   FFD     DLAY-1-.
594    86    STXZ
595     E     DMALO /XMIT 129TH DMA WORD
596    38    SEC
597    65    ADCZ   /CHECKSUM FROM DISC IS IN A
598    89     CKSUM /COMPUTED CHECKSUM FROM RED129
599    F0    BEQ
59A     6     BLKNEX-.-1
59B    20    JSR
59C           0
59D   5AF     MOVOUT         /MOVE THE TRACK BEFORE ANY RETRY
59E    20    JSR
59F           0
5A0   7F8     PARERR         /CHECKSUM WRONG
5A1    20   BLKNEX,JSR
5A2           0                    5A4   4C    JMP
5A3   5DA     BLKADV               5A5          0
                                   5A6   57C     NEXRED
```

```
.PAL H
*OUT-S:RDBK
*
*IN-S:CON8,S:RDBK
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /RDBK=READ BLOCK NO.
                /
                /******NEXT LOCATION IS AT 5A8-(-B60 IS AN INSERT)
                /
                *REDBLK
B60    20   REDBL1,JSR
B61         0
B62   4A5    HEAD
B63    20   JSR
B64         0
B65   7CB    ACINIT
B66    A5   TRTEST,LDAZ
B67     E    DMALO
B68    29   ANDI
B69     4    4      /TEST IF TRIM ERASE ON
B6A    D0   BNE
B6B   FFA    TRTEST-1-.
B6C    A5   WAITR,LDAZ
B6D     E    DMALO
B6E    29   ANDI
B6F     8    10
B70    D0   BNE
B71    4F    MKERRA-1-.     /HEAD UP? PROBABLY A BAD TRACK
B72    A5   LDAZ
B73    11    SDATA /CLEAR ACIA DATA
B74    A6   LDXZ    /SET DELAY
B75    8F    GAPWID         /USUALLY SET  TO -16 FOR 170 USEC
B76    A5   TESTR,LDAZ
B77    10    DATCON
B78    29   ANDI
B79     1    1
B7A    D0   BNE
B7B   FF0    WAITR-.-1
B7C    E8   INX     /NO DATA SEEN
B7D    30   BMI
B7E   FF7    TESTR-.-1      /12 USEC PER CYCLE
B7F    20   JSR
B80         0
B81   7D4    REDACI
B82    AA   TAX
B83    8A   BAD1,TXA
B84    18   CLC
B85    69   ADCI
```

```
P2
B86  F6F    -221  /TEST FOR BLOCK GUARD MARK
B87   D0    BNE
B88  FE3     WAITR-1-.      /GAP WASN'T FOLLOWED BY '221'
B89   20    JSR
B8A          0
B8B  7D4     REDACI
B8C   AA    TAX
B8D   18    CLC
B8E   69    ADCI
B8F  FB7     -111
B90   D0    BNE
B91  FDA     WAITR-1-.      /IF 111 NOT AFTER 221,IGNORE
B92   20    JSR
B93          0
B94  7D4     REDACI
B95   18    CLC
B96   69    ADCI
B97  F2B     -325
B98   D0    BNE
B99  FCC     TRTEST-1-.     /NOT A BLOCK IF WRONG
B9A   A5    LDAZ
B9B    9     CONA
B9C   49    EORI
B9D    8     10     /CHANGE 67--77
B9E   85    STAZ
B9F    9     CONA  /PROVIDES SCOPE TEST SIGNAL FOR EACH BLOCK SEEN
BA0   20    JSR
BA1          0
BA2  7D4     REDACI
BA3   85    STAZ   /RETURNS WITH ACIA OUTPUT IN A
BA4   86     TEMPHI
BA5   20    JSR
BA6          0
BA7  7D4     REDACI
BA8   85    STAZ
BA9   85     TEMPLO
BAA   20    JSR
BAB          0
BAC  7D4     REDACI
BAD   38    SEC
BAE   65    ADCZ   /BLOCKNO+(-BLOCKNO)=0
BAF   86     TEMPHI
BB0   D0    BNE
BB1    F     MKERRA-.-1     /NOT A BLOCK NO.
BB2   20    JSR
BB3          0
BB4  7D4     REDACI
BB5   38    SEC
BB6   65     ADCZ  /COMPARE LOW PART OF BLOCKNO.
BB7   85     TEMPLO
BB8   D0    BNE    /PASSED 5 TESTS,COMPLAIN IF WRONG!
BB9    7     MKERRA-.-1
BBA   A6    LDXZ
BBB   86     TEMPHI
BBC   86    STXZ
BBD   84     TRAKNO         /STORE CURRENT TRACK NO.
BBE   A5    LDAZ
BBF   85     TEMPLO         /EXIT WITH NO.S IN X,A
BC0   60    RTS
             /
```

```
P3
BC1    20   MKERRA,JSR
BC2           0
BC3   5A8     MOVTRY          /MOVE HEAD AND TRY AGAIN
BC4    4C    JMP
BC5           0
BC6   B60     REDBLK
              /
BC7    85   PULSE,STAZ
BC8    8C    HEADMV
BC9    A9   LDAI
BCA    1E    36
BCB    20   JSR
BCC           0
BCD   7C1     DELAY
BCE    A5   LDAZ
BCF    8C    HEADMV
BD0    45   EORZ
BD1     A    DISREG
BD2    A4   LDYZ
BD3     A    DISREG
BD4    85   STAZ
BD5     A    DISREG          /PULSE(IN OR OUT,HEAD LOAD)
BD6    84   STYZ
BD7     A    DISREG          /RESTORE DISREG
BD8    A5   LDAZ
BD9    8C    HEADMV
BDA    60   RTS
              /
              /
              *MOVTRY /ROUTINE MOVES HEAD BACK AND FORTH
5A8    E6   INCZ
5A9    92    ERRCNT
5AA    30   BMI
5AB     3    MOVOUT-1-,
5AC    20   JSR
5AD           0
5AE   7DD     MKERR /TOO MANY ERRORS
              /
              *MOVOUT
5AF    A9   LDAI
5B0     3    3               /1 FOR LOAD,2 FOR STEP OUT
5B1    20   JSR
5B2           0
5B3   BC7     PULSE
5B4    20   JSR
5B5           0
5B6   BC7     PULSE
5B7    A9   LDAI
5B8     4    4               /MOVE BACK IN,1 STEP ONLY.
5B9    20   JSR
5BA           0
5BB   BC7     PULSE
5BC    A9   LDAI
5BD    1E    36
5BE    20   JSR
5BF           0
5C0   7C1     DELAY
5C1    60   RTS
              /
```

```
.PALH
*OUT-S:ADVB
*
*IN-S:CON8,S:ADVB
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /ADVB-BLOCK NO. ADVANCE
                /
                *BLKADV
5DA    20       JSR
5DB             0
5DC    5ED      INCBLK
5DD    A5    WCTEST,LDAZ       /TEST WORD COUNT OVERFLOW
5DE     7       CON8
5DF    30       BMI
5E0     7       FLAG-.-1        /WCO FOUND?
5E1    A9       LDAI
5E2    20       40
5E3    25       ANDZ
5E4     8       REGA   /TEST REG. A,BIT 5(CONTINUOUS?)
5E5    F0       BEQ    /A5 HIGH FOR CONTINUOUS(AS IN FOCAL)
5E6     1       FLAG-.-1
5E7    60       RTS
5E8    A5    FLAG,LDAZ
5E9     6       REGB   /CLEAR WCO FLAG
5EA    20       JSR
5EB             0
5EC    7F4      DTFLAG
                /
                /INCREMENTS BLOCK NO.
                *INCBLK
5ED    E6       INCZ
5EE    81       BLKLO
5EF    A5       LDAZ
5F0    81       BLKLO
5F1    38       SEC
5F2    E9       SBCI
5F3    13       23     /-19 TO TEST >18
5F4    30       BMI
5F5     6       TESTH-.-1
5F6    A9       LDAI
5F7             0
5F8    85       STAZ
5F9    81       BLKLO
5FA    E6       INCZ
5FB    82       BLKHI
5FC    A5    TESTH,LDAZ
5FD    82       BLKHI
5FE    38       SEC
```

(#9)

```
P2
5FF    E9    SBCI
600    4E     116    /TEST TRACK>77
601    30    BMI
602     3     EXIT-.-1
603    20    JSR
604           0
605   7EC     ENDTAP          /TRACK 78 WOULD BE NEXT
            /
606    60   EXIT,RTS

.
```

```
.PALH
*OUT-S:SEEK
*
*IN-S:CON8,S:SEEK
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /SEEK=TRACK SETTING,AND BLOCK SETTING
                *TRAKGO
608    20      JSR
609             0
60A   4A5       HEAD  /KEEP HEAD DOWN
60B    A5     TESTI,LDAZ       /NOW SET LO OR HI CURRENT
60C    84       TRAKNO
60D    A2      LDXI
60E             0
60F    38      SEC
610    E9      SBCI
611    2B       53     /> OR < 43?
612    30      BMI
613     2       IHIGH-1-.       /IF >43 SET LO CURRENT (DISREG=200)
614    A2      LDXI
615    80       200
616    86     IHIGH,STXZ
617    8D       CURENT          /200 IN DISREG GIVES LOW CURRENT
618    A5     TRAKG1,LDAZ
619    82       BLKHI
61A    38      SEC
61B    E5      SBCZ
61C    84       TRAKNO          /TEST TRACK NO.
61D    D0      BNE
61E     1       TRTEST-1-.
61F    60      RTS     /EXIT WHEN TRACK IS CORRECT
620    30     TRTEST,BMI
621    1D       TOOBIG-1-.     /TRAKNO TOO BIG
622    E6      INCZ
623    84       TRAKNO
624    A9      LDAI
625     4       4       /TOO SMALL,STEP IN
626    85      STAZ
627    8C       HEADMV
628    A5      LDAZ
629    8B       DIREC
62A    10      BPL
62B     9       SETRAK-1-.
62C    49     TRWAIT,EORI
62D    FF       377    /COMPLEMENT DIREC
62E    85      STAZ
62F    8B       DIREC
630    A9      LDAI
```

```
P2
631   1E     36
632   20    JSR
633          0
634   7C1    DELAY /MUST DELAY 30 MSEC IF REVERSING
635   A5   SETRAK,LDAZ
636    A     DISREG
637   AA    TAX
638    5    ORAZ    /2=OUT,4=STEP IN
639   8C     HEADMV
63A   85    STAZ
63B    A     DISREG          /STEPS IN OR OUT
63C   86    STXZ    /NOW CLEAR THE PULSE
63D    A     DISREG
63E   60    RTS
             /
63F   C6   TOOBIG,DECZ
640   84     TRAKNO
641   A9    LDAI
642    2     2       /STEP HEAD OUT
643   85    STAZ
644   8C     HEADMV
645   A5    LDAZ
646   8B     DIREC
647   30    BMI
648   FEC    SETRAK-1-.
649   10    BPL
64A   FE1    TRWAIT-1-.
             /
             *BLSEEK
64B   A9   BLSEK1,LDAI       /SET TRIAL COUNTER
64C   FD8    -50
64D   85    STAZ
64E   87     TEST1
64F   A9    LDAI
650   FF0    -20    /ALLOW 16 TRIES IN CASE OF BAD STEPPER MOTER
651   85    STAZ
652   88     TEST2
653   A5    LDAZ
654   82     BLKHI
655   38    SEC
656   E9    SBCI
657   4E     116    /TRACK >77
658   30    BMI
659    3     REDNEX-1-.
65A   20    JSR
65B          0
65C   7EC    ENDTAP          /END OF DISC ERROR
65D   20   REDNEX,JSR
65E          0
65F   B60    REDBLK          /READ CURRENT BLOCK NO.
660   38    SEC
661   E5    SBCZ
662   81     BLKLO /RETURNED WITH BLK IN A,X
663   D0    BNE
664    F     TRBTES-1-.
665   8A    TXA
666   38    SEC
667   E5    SBCZ
668   82     BLKHI
669   D0    BNE
```

```
P3
66A     9     TRBTES-1-,
66B    20    JSR
66C           0       /NOW CHECK THE GUARD WORD(2ND LAST)
66D   7D4     REDACI
66E    38    SEC
66F    E9    SBCI
670    99     231
671    D0    BNE
672     1     TRBTES-1-,
673    60    RTS     /EXIT,BLOCK FOUND
              /
674    A5   TRBTES,LDAZ
675    84     TRAKNO
676    38    SEC
677    E5    SBCZ
678    82     BLKHI
679    D0    BNE
67A     A     NEXTRK-1-,      /NOT THIS TRACK NO.
67B    E6    INCZ
67C    87     TEST1
67D    30    BMI
67E   FDE     REDNEX-1-,
67F    20   GIVEUP,JSR
680           0
681   5A8     MOVTRY
682    4C    JMP
683           0
684   64B     BLSEEK          /MOVE HEAD ONCE AND TRY AGAIN
              /
685    E6   NEXTRK,INCZ
686    88     TEST2
687    10    BPL
688   FF6     GIVEUP-1-,      /TOO MANY WRONG TRACKS SEEN
689    20    JSR
68A           0
68B   608     TRAK00
68C    A9    LDAI
68D    1E     36
68E    20    JSR
68F           0
690   7C1     DELAY /WAIT 30 MSEC FOR HEAD SETTLING AND STEPPING TIME
691    86    STXZ
692    8C     HEADMV          /ZERO TO MOVE INDICATOR
693    4C    JMP
694           0
695   65D     REDNEX
```

```
.PALH
*OUT-S:W129
*
*IN-S:CON8,S:W129
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /W129
                /WRITES 129 PDP-8 WORDS ON FLOPPY DISC
                /ENTER WITH Y=-101 OCTAL
                /
                *WRT129
698    A2     LDXI
699   FF2      -16
69A    E8    WWAIT9,INX        /LEAVE GAP FOR READ TO GET READY
69B    30     BMI
69C   FFD      WWAIT9-1-.
69D    20    NEXTW,JSR
69E           0
69F   6D3      WWAIT /WAIT FOR ACIA
6A0    A6    WREAD,LDXZ
6A1     E      DMALO
6A2    A5     LDAZ
6A3     C      DMAHI /ALSO TRIGGERS DMA
6A4    85     STAZ    /DATA WRITE STARTS 63 USEC AFTER XSETUP
6A5    11      SDATA /DATA TO ACIA
6A6    18     CLC
6A7    65     ADCZ
6A8    89      CKSUM
6A9    85     STAZ
6AA    89      CKSUM
6AB    8A     TXA
6AC    29     ANDI
6AD    F0      360
6AE    85     STAZ
6AF    85      TEMPLO          /FIRST HALF BYTE
6B0    A5     LDAZ
6B1     E      DMALO /2ND HALF BYTE
6B2    4A     LSR
6B3    4A     LSR
6B4    4A     LSR
6B5    4A     LSR
6B6    18     CLC
6B7    65     ADCZ
6B8    85      TEMPLO          /BUILD FULL BYTE
6B9    AA     TAX
6BA    65     ADCZ
6BB    89      CKSUM
6BC    85     STAZ
6BD    89      CKSUM
```

```
P2
6BE   86    STXZ
6BF   11     SDATA
6C0   20    JSR
6C1          0
6C2  6D3     WWAIT
6C3   C8    INY
6C4   30    BMI
6C5    1     DMA2-1-.
6C6   60   WDONE,RTS        /EXIT
           /
6C7   A5   DMA2,LDAZ
6C8    C     DMAHI /TRIGGER 2ND DMA
6C9   85    STAZ
6CA   11     SDATA
6CB   18    CLC
6CC   65    ADCZ
6CD   89     CKSUM
6CE   85    STAZ
6CF   89     CKSUM
6D0   4C    JMP
6D1          0
6D2  69D     NEXTW
           /
6D3   A9   WWAIT,LDAI
6D4    6     6      /2 FOR DATA READY,4 FOR DISC UNABLE(=DTD NOT)
6D5   24   WWAIT2,BITZ
6D6   10     DATCON         /TEST IF DATA IN ACIA
6D7   F0    BEQ
6D8  FFC     WWAIT2-1-.
6D9   60    RTS

.
```

```
.PALH
*OUT-S:R129
*
*IN-S:CON8,S:R129
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /R129
                /READS 129 PDP-8 WORDS FROM FLOPPY DISC
                /ENTER WITH Y=-65,CKSUM=0
                /
                *RED129
6E0    A2     LDXI
6E1   FF7       -11
6E2    E8   RWAIT9,INX        /WAIT TILL WREN TRANSIENT IS WELL PAST
6E3    30     BMI
6E4   FFD       RWAIT9-1-.
6E5    20     JSR
6E6             0
6E7   7CB       ACINIT         /CLEARS ACIA AFTER 16 CYCLES
6E8    A9     LDAI
6E9    3F       77
6EA    85     STAZ
6EB     7       CONB  /SIGNAL THE START OF BLOCK READ (PIN B1-U)
6EC    A5   REDFIR,LDAZ       /READY FOR FIRST BYTE
6ED    10       DATCON
6EE    29     ANDI            /TEST FOR ACIA READY
6EF     5       5
6F0    F0     BEQ
6F1   FFA       REDFIR-1-.     /NOT READY
6F2    A5   REDONE,LDAZ
6F3    11       SDATA          /GOT IT
6F4    AA     TAX             /SAVE BYTE
6F5    18     CLC
6F6    65     ADCZ            /ADD FIRST CHECKSUM
6F7    89       CKSUM
6F8    85     STAZ
6F9    89       CKSUM
6FA    8A     TXA
6FB    49     EORI
6FC    FF       377           /COMPLEMENT 'A' FOR PDP 8 HARDWARE
6FD    AA     TAX
6FE    A5   RED2,LDAZ
6FF    10       DATCON
700    29     ANDI
701     5       5
702    F0     BEQ
703   FFA       RED2-1-.
704    86     STXZ
705     C       DMAHI
```

```
P2
706    A5    LDAZ
707    11     SDATA
708    AA    TAX
709    49    EORI
70A    FF     377
70B    85    STAZ
70C    8E     TEMSAV          /SAVE FOR DMALO
70D    2A    ROL
70E    2A    ROL
70F    2A    ROL              /GET LOW 4 BITS FOR NEXT WORD
710    2A    ROL
711    85    STAZ
712    85     TEMPLO          /SAVE FOR NOW
713    8A    TXA
714    18    CLC
715    65    ADCZ    /DO 2ND CHECKSUM
716    89     CKSUM
717    85    STAZ
718    89     CKSUM
719    A5   RED3,LDAZ
71A    10     DATCON
71B    29    ANDI
71C     5     5
71D    F0    BEQ
71E   FFA     RED3-1-.
71F    A5    LDAZ
720    11     SDATA           /GET BYTE 3
721    A6    LDXZ
722    8E     TEMSAV          /READY FOR DMALO
723    C8    INY              /TEST END OF BLOCK
724    D0    BNE
725     1     RDMA2-1-.
726    60    RTS              /EXIT AFTER 129 WORDS
727    86   RDMA2,STXZ
728     E     DMALO /FIRST DMA TRIGGER
729    AA    TAX
72A    18    CLC
72B    65    ADCZ             /3RD CHECKSUM
72C    89     CKSUM
72D    85    STAZ
72E    89     CKSUM
72F    8A    TXA
730    49    EORI
731    FF     377             /COMPLEMENT 3RD BYTE
732    A6    LDXZ
733    85     TEMPLO
734    EA    OPR              /40 USEC DELAY BETWEEN THE 2 ACIA READS
735    EA    OPR
736    EA    OPR              /SO NO WAIT FOR ACIA IS NEEDED.
737    85    STAZ
738     C     DMAHI
739    86    STXZ
73A     E     DMALO           /TRIGGER 2ND PDP-8 WORD
73B    4C    JMP
73C           0
73D   6F2     REDONE
```

```
.PALH
*OUT-S:XSUP
*
*IN-S:CON8,S:XSUP
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /XSUP-PREPARE TO READ OR WRITE 129 PDP-8 WORDS
                /
                *XSETUP
745    A9     LDAI
746           0
747    85     STAZ
748    89      CKSUM /INIT. TO ZERO
749    A5     LDAZ
74A     8      REGA
74B    29     ANDI
74C    40      100    /TEST FOR REVERSE MOTION DEMAND
74D    D0     BNE
74E    17      SELER-1-.      /NOT ALLOWED FOR F-DISK
74F    20     JSR
750           0
751   4A5      HEAD  /OR INITDM MAY NOT WORK!
752    20     JSR
753           0
754   788      INITDM         /ALLOW DMA
755    20     JSR
756           0
757   64B      BLSEEK         /MOVE TO CORRECT BLOCK
758    20     JSR
759           0
75A   7D4      REDACI
75B    A0     LDYI
75C   FBF      -101   /65 DECIMAL
75D    38     SEC
75E    E9     SBCI
75F    75      165    /TEST FINAL GUARD MARK
760    F0     BEQ
761     3      EXIT-1-.
762    20     JSR
763           0
764   7DD      MKERR /GUARD NOT FOUND
765    60    EXIT,RTS
                /
766    4C    SELER,JMP
767           0
768   7FC      SELERR         /TRIED TO READ OR WRITE REVERSE

.
```

```
.PALH
*OUT-S:WRIT
*
*IN-S:CON8,S:WRIT
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /WRIT
                /WRITES SEVERAL BLOCKS TO DISC
                /EXIT IS VIA BLKADV WHEN WCO IS SEEN
                /
                *WRITER
769    A9     LDAI
76A    19      31
76B    85     STAZ
76C     A      DISREG          /SET DMA FOR INCR.ADDRESS;DATA'FROM' PDP-8
76D    20     JSR
76E            0
76F   745      XSETUP          /FIND THE FIRST BLOCK
770    A5     LDAZ
771     C      DMAHI /TRIGGER FIRST DMA WORD
772    A9   NEXBLK,LDAI
773    51      121
774     5     ORAZ
775    8D      CURENT
776    85     STAZ
777     A      DISREG          /WREN TO ENABLE WRITING(8 USEC AFTER XSETUP)
778    20     JSR
779            0
77A   698      WRT129
77B    A5     LDAZ
77C    8D      CURENT
77D     9     ORAI
77E    19      31
77F    85     STAZ    /WREN FALLS IN 100 USEC
780     A      DISREG          /FORMAT FAILS FOR INSTANT WREN-OFF
781    A5     LDAZ
782    89      CKSUM
783    49     EORI    /COMPLEMENT CHECKSUM
784    FF      377
785    85     STAZ
786    11      SDATA /SAVE ON DISC
787    A5     LDAZ
788     E      DMALO /IS DISC STILL ABLE?
789    29     ANDI
78A     8      10
78B    D0     BNE     /SHOULD BE JSR BUT NO ROOM
78C    63      TIMERR-1-.      /BE SURE DISTANCE LESS THAN 80!!!!!
78D    20     JSR
78E            0
```

```
F2
78F   5DA     BLKADV        /EXITS IF WCO WAS SEEN
790    20     JSR
791           0
792   745     XSETUP        /FIND SUCCEEDING BLOCKS FOR CONTINUOUS
793    4C     JMP
794           0
795   772     NEXBLK
```

```
.PALH
*OUT-S:SUBR
*
*IN-S:CON8,S:SUBR
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /SUBR-SUBROUTINES FOR FLOPPY DISC
                /
                *TOPDP8
 797    A9     LDAI
 798    29      51
 799    85     STAZ
 79A     A      DISREG          /GATES TO PDP 8 DMA
 79B    20     JSR
 79C            0
 79D   7B1      OPENDM
 79E    A9     LDAI
 79F    FF      377
 7A0    85     STAZ
 7A1     C      DMAHI /PIA 'OUT' SELECT
 7A2    A9     LDAI
 7A3    F0      360
 7A4    85     STAZ
 7A5     E      DMALO
 7A6    20     JSR
 7A7            0
 7A8   7AA      CLOSDM
 7A9    60     RTS
                /
                *CLOSDM
 7AA    A9   CLOSM1,LDAI       /CLOSE DDR FOR DMA
 7AB    2E     56     /PULSE FOR WRITE
 7AC    85    STAZ
 7AD     D     CONDMA
 7AE    85    STAZ
 7AF     F     CONDMB          /PULSE FOR READ?
 7B0    60    RTS
                /
                *OPENDM
 7B1    A9   OPEND1,LDAI       /OPEN DDR FOR DMA
 7B2    28     50
 7B3    85    STAZ
 7B4     D     CONDMA
 7B5    85    STAZ
 7B6     F     CONDMB
 7B7    60    RTS
                /
                *INITDM
 7B8    A9   INITD1,LDAI
```

```
P2
7B9    37     67     /ENABLE DMA FLAG
7BA    85    STAZ
7BB     B     DISCON
7BC    A9    LDAI
7BD    3F     77
7BE    85    STAZ
7BF     B     DISCON          /END THE -VE PULSE
7C0    60    RTS
              /
              *DELAY
7C1    AA   DELAY1,TAX        /NO. OF MSEC. IN A
7C2    A0   STIME,LDYI
7C3    C4     304    /1 MSEC AT 1.06 MHZ.
7C4    88   WAIT1,DEY
7C5    D0    BNE
7C6   FFD     WAIT1-.-1
7C7    CA    DEX
7C8    D0    BNE
7C9   FF8     STIME-.-1
7CA    60    RTS
              /
              *ACINIT
7CB    A9    LDAI
7CC     3     3
7CD    85    STAZ
7CE    10     DATCON
7CF    A9    LDAI
7D0    34     64
7D1    85    STAZ
7D2    10     DATCON
7D3    60    RTS
              /
              *REDACI           /USES 16 USEC WITH RTS
7D4    A9   REDAC1,LDAI       /WAIT FOR ACIA
7D5     5     5       /BIT0=DATA;BIT2=DTD(NOT)=DISC UNABLE
7D6    24    BITZ    /TEST IF DATA THERE
7D7    10     DATCON
7D8    F0    BEQ
7D9   FFA     REDAC1-.-1
7DA    A5    LDAZ
7DB    11     SDATA /READ THE BYTE
7DC    60    RTS     /EXIT,BYTE IN A
              /
              *MKERR
7DD    A9   MKERR1,LDAI
7DE     2     2
7DF    AA   DTERR1,TAX        /SAVE ERROR CODE
7E0    85    STAZ
7E1     6     REGB   /LEVELS CLEARED,THEN SET TO SET FLAGS
7E2     9    ORAI
7E3    81     201    /PULSE BITS 0,11 TO SET FLAG FLIP-FLOPS
7E4    85    STAZ
7E5     6     REGB   /ERROR TO PDP-8
7E6    EA    OPR     /REPLACED AN ERRONEOUS TEST
7E7    EA    OPR
7E8    8A    TXA
7E9    4C   ALDONE,JMP
7EA           0
7EB  9C8      ERRCLR          /GO CLEAR DTXA,THEN NORMAL LOOP
              *ENDTAP
```

```
F3
7EC    A9    LDAI
7ED     4     4
7EE    D0    BNE
7EF   FEF     DTERR1-1-.
              *TIMERR
7F0    A9    LDAI
7F1    20     40
7F2    D0    BNE
7F3   FEB     DTERR1-1-.
              *DTFLAG
7F4    A9    LDAI
7F5     1     1
7F6    D0    BNE
7F7   FE7     DTERR1-1-.
              *PARERR
7F8    A9    LDAI
7F9    10     20
7FA    D0    BNE
7FB   FE3     DTERR1-1-.      /VARIOUS B REG FLAGS TO PDP-8
              *SELERR
7FC    A9    LDAI
7FD     8     10
7FE    D0    BNE
7FF   FDF     DTERR1-1-.
              /
```

```
 PALH
*OUT-S:FORM
*
*IN-S:CON8,S:FORM,S:FOR2,S:FOR3,S:FOR4
*
*
*
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /FORM--------***LOAD FORM,RDBK,FBUG;SAVE FORM!14000-5777;
                /-WRITES DECTAPE BLOCK NO.S ON FLOPPY DISC
                /SENDS 0,THEN 99 TO REG1 UPON ENTRY
                /1-DISC TOO SLOW;;2-TOO FAST;;3-FORMAT SWITCH OFF
                /4-DISC UNABLE;;5-SUCCESSFUL COMPLETION
                /
                /
                *FORMAT
800     A2      LDXI
801     DF       337    /SET STACK AT 01DF
802     9A      TXS     /TO KEEP IT BELOW 'TIM' STACK
803     D8      CLD     /NO DECIMAL
804     78      SEI     /NO INTERRUPT
805     A9      LDAI
806              0
807     85      STAZ
808     8D       CURENT         /HIGH CURRENT TO START
809     85      STAZ
80A      4       REG1  /CLEAR REG1 FOR HANDSHAKE WITH "MARK"
80B     85      STAZ
80C      9       CONA  /OPEN PIA2-A
80D     85      STAZ
80E      B       DISCON         /OPEN PIA2-B
80F     85      STAZ
810      F       CONDMB         /OPEN PIA3
811     85      STAZ
812      8       REGA  /SET PIA2-A FOR INPUTS
813     85      STAZ
814      E       DMALO /PIA3-B SET FOR INPUTS
815     A9      LDAI
816     FF       377
817     85      STAZ
818      A       DISREG         /OUTPUTS FOR PIA2-B
819     A9      LDAI
81A     37       67
81B     85      STAZ
81C      9       CONA  /CLOSE PIA2-A
81D     85      STAZ
81E      5       CON1  /FLAG1 OFF TO START
81F     85      STAZ
820      B       DISCON         /CLOSE PIA2-B
821     A9      LDAI
822     2E       56
```

(63)

Aug 20/77

FR 12 (FAST)

```
P2
823   85   STAZ
824    D    CONDMA
825   85   STAZ
826    F    CONDMB          /CLOSE PIA3-B
827   A9   LDAI
828    3    3               /INIT ACIA
829   85   STAZ
82A   10    DATCON
82B   A9   LDAI
82C   34    64
82D   85   STAZ
82E   10    DATCON          /10 BIT BYTES
82F   A9   LDAI            /INITIALIZE BLOCKNO.
830         0
831   85   STAZ
832   82    BLKHI
833   85   STAZ
834   81    BLKLO
835   A9   LDAI
836   99    231
837   85   STAZ
838    4    REG1   /HANDSHAKE CODE FOR "MARK"
            //NOW MOVE TO TRACK 0
839   20   JSR
83A         0
83B  8A6    TRAK00
83C   20   JSR
83D         0
83E  8D7    GOTEST
            /
83F   20  WAIT1,JSR
840         0
841  87C    INWAIT          /WAIT TILL INDEX PASSES
842   20   JSR
843         0
844  87C    INWAIT          /CHECK TIME TO NEXT ONE
            /
845   98  IFOUND,TYA        /TIME=(Y*256+X)*12 USEC
846   38   SEC
847   E9   SBCI    /CHECK FOR A REASONABLE PERIOD
848   39    71     /57*3077/1.06=165.46 MSEC
849   10   BPL
84A    5    OK0-1-.
84B   A9   LDAI
84C    1    1      /ERROR CODE-TOO FAST
84D   20  SPEED,JSR
84E         0
84F  8EE    FWRONG          /DISC SPEED WRONG
850   38  OK0,SEC
851   E9   SBCI
852    2    2      /LET PROGRAM "MARK" TIGHTEN SPEED LIMITS
853   30   BMI
854    5    BEGINF-1-.
855   A9   LDAI
856    2    2
857   4C   JMP
858         0
859  8EE    FWRONG          /TOO SLOW(>168.3 MSEC
            /
85A   A9  BEGINF,LDAI
```

```
P3
85B    9     11
85C   85    STAZ
85D   83     DSTATE
85E   20    JSR
85F          0
860  8CE     WPULSE          /LOADS THE HEAD
861   A9    LDAI
862   28     50
863   20    JSR
864          0
865  9F0     DELAY2          /ALLOW HEAD TO SETTLE
             /
             /ERASE AT START OF NEW TRACK
866   A2   FERASE,LDXI
867  FFC     -4     /SET 4*6.6 MSEC ERASE INTERVAL
868   A0    LDYI
869          0
86A   A5    LDAZ
86B   8D     CURENT
86C    9    ORAI
86D    9     11
86E   85    STAZ
86F   83     DSTATE          /READY FOR WPULSE!!
870   20   DERASE,JSR
871          0
872  8CE     WPULSE          /CONTINUOUS CLOCKS,NO DATA
873   C8    INY
874   D0    BNE
875  FFA     DERASE-1-.
876   E8    INX     /26*256=6.6 MSEC
877   30    BMI
878  FF7     DERASE-1-.
             /
879   4C    JMP
87A          0
87B  908     WRTBLK
             PAUSE/
             /
             /
             /
             /
             /
             /FOR2
             /
             /FORMAT SUBROUTINES
             /
87C   20   INWAIT,JSR        /TIME TILL INDEX PASSES
87D          0
87E  885     INDEX
87F   20    JSR
880          0
881  896     INDEND          /ADD TIME TILL INDEX PASSES
882   86    STXZ
883   85     TEMPLO          /SAVE 'TIMER' FOR DEBUGGING
884   60    RTS
             /
885   A2   INDEX,LDXI        /TIME TILL INDEX
886          0
887   A0    LDYI
888          0
```

```
P4
889    A5  TESTF,LDAZ
88A     E    DMALO
88B    29   ANDI
88C     2    2
88D    D0   BNE
88E     6    INEXIT-1-.      /INDEX FOUND
88F    E8   INX
890    D0   BNE
891   FF7    TESTF-1-.
892    C8   INY
893    D0   BNE     /NEVER 0 UNLESS INDEX FAILED.
894   FF4    TESTF-1-.
895    60  INEXIT,RTS        /TIME=(Y*256+X)*12 USEC
           /
896    24  INDEND,BITZ       /ASSUMES A=2 FROM 'INDEX'
897     E    DMALO
898    EA   NOP
899    F0   BEQ
89A     6    IDONE-1-.       /INDEX DONE
89B    E8   INX
89C    D0   BNE
89D   FF8    INDEND-1-.      /KEEP ON TIMING
89E    C8   INY
89F    D0   BNE     /NEVER 0
8A0   FF5    INDEND-1-.      /WAIT TILL INDEX PAST
8A1    60  IDONE,RTS
           /
           *TRAK00
8A6    A9   LDAI    /MOVE TO TRACK 00
8A7         0
8A8    85   STAZ
8A9    84    TRAKNO
8AA    A5  BEGIN,LDAZ
8AB     8    REGA
8AC    29   ANDI
8AD     1    1
8AE    D0   BNE
8AF    12    LEAVE-1-.       /TRACK 00 FOUND
8B0    A9   LDAI
8B1     B    13
8B2    85   STAZ
8B3     A    DISREG          /STEP OUT TO TRACK 00
8B4    85   STAZ
8B5    8C    HEADMV          /INDICATOR FOR HEAD MOTION
8B6    A9   LDAI
8B7     9    11
8B8    85   STAZ
8B9     A    DISREG          /END PULSE
8BA    A9   LDAI
8BB     A    12
8BC    20   JSR
8BD         0
8BE   9F0    DELAY2          /10 MSEC DELAY
8BF    4C   JMP
8C0         0
8C1   8AA    BEGIN
8C2    A9  LEAVE,LDAI
8C3    70    160
8C4    20   JSR
8C5         0
```

```
P5
8C6   9F0     DELAY2
8C7    A5    LDAZ
8C8     8     REGA
8C9    29     ANDI
8CA     1     1
8CB    F0    BEQ
8CC   FDD     BEGIN-1-.       /BE SURE IT HAS SETTLED DOWN
8CD    60    RTS
              /
8CE    A5   WPULSE,LDAZ
8CF    83     DSTATE          /TIME IS CRITICAL AND EXACT!!
8D0    85    STAZ
8D1     A     DISREG
8D2    49    EORI
8D3    49     111             /ENABLE WREN,LOAD HEAD
8D4    85    STAZ
8D5     A     DISREG
8D6    60    RTS              /23 USEC,INCLUDING JSR,RTS
              /
8D7    A5   GOTEST,LDAZ       /TEST TC01 INH.
8D8     8     REGA
8D9    29    ANDI
8DA    12     22
8DB    49    EORI
8DC    12     22      /TEST A(6),TC01 INH. TRUE
8DD    F0    BEQ
8DE     3    OK2-1-.
8DF    20    JSR
8E0           0
8E1   8EE     FWRONG          /TC01 INH. NOT ON
8E2    A5   OK2,LDAZ
8E3     E     DMALO
8E4    29    ANDI
8E5     1     1
8E6    D0    BNE     /TEST FORMAT SWITCH UP
8E7     5     OK3-1-.
8E8    A9    LDAI
8E9     3     3       /ERROR CODE
8EA    20    JSR
8EB           0
8EC   8EE     FWRONG          /FORMAT SWITCH OFF
8ED    60   OK3,RTS
              PAUSE/
              /
              /FOR3-CONTINUE FORMAT PROGRAM
              /
8EE    85   FWRONG,STAZ
8EF     4     REG1   /SEND ERROR CODE
8F0    A9    LDAI
8F1    3F     77
8F2    85    STAZ
8F3     5     CON1   /SET PDP8 "SKIP"
8F4    A9    LDAI
8F5           0       /SET FLAGS
8F6    85    STAZ
8F7     6     REGB
8F8     9    ORAI
8F9    81     201
8FA    85    STAZ
8FB     6     REGB
```

```
P6
8FC   4C    JMP
8FD         0
8FE   42E   INTEX
            /
8FF   A5    WRTACI,LDAZ      /SUBR. TO WRITE X TO ACIA
900   10    DATCON
901   29    ANDI
902    2    2
903   F0    BEQ     /WAIT TILL ACIA IS FREE
904   FFA   WRTACI-1-.
905   86    STXZ
906   11    SDATA
907   60    RTS     /USES 22 USEC MINIMUM,WITH RTS AND JSR
            /
            /WRITING BLOCK NO.S NOW
908   A9    WRTBLK,LDAI
909         0
90A   85    STAZ
90B   8B    DIREC
90C   A2    WRTNEX,LDXI
90D   1E    36      /30*26.3=800 USEC GAP
90E   20    WRTING,JSR
90F         0
910   8CE   WPULSE          /WRITE BLANK BYTES BEFORE BLOCK NO.
911   CA    DEX
912   D0    BNE
913   FFA   WRTING-1-.      /28 USEC PER STEP
914   A2    LDXI
915   91    221     /GUARD WORD PRECEDES BLOCK NO.
916   20    JSR
917         0
918   8FF   WRTACI
919   A2    LDXI
91A   49    111
91B   20    JSR
91C         0
91D   8FF   WRTACI
91E   A2    LDXI
91F   D5    325
920   20    JSR
921         0
922   8FF   WRTACI
923   A6    LDXZ
924   82    BLKHI
925   20    JSR
926         0
927   8FF   WRTACI          /WRITE THE BLOCK NO
928   A6    LDXZ
929   81    BLKLO
92A   20    JSR
92B         0
92C   8FF   WRTACI
92D   A5    LDAZ
92E   82    BLKHI
92F   49    EORI
930   FF    377     /COMPLEMENT A
931   AA    TAX               /WILL WRITE CONTENTS OF X
932   20    JSR
933         0
934   8FF   WRTACI          / WRITE -(BLKNO)
```

```
F7
935   A5   LDAZ
936   81    BLKLO
937   49   EORI
938   FF    377
939   AA   TAX
93A   20   JSR
93B         0
93C   8FF   WRTACI
93D   A2   LDXI
93E   99    231
93F   20   JSR
940         0
941   8FF   WRTACI
942   A2   LDXI
943   75    165             /WRITING GUARD CODES AFTER BLOCK NO.
944   20   JSR
945         0
946   8FF   WRTACI
947   20   JSR
948         0
949   8CE   WPULSE          /START PRE DATA GAP
94A   20   JSR
94B         0
94C   8CE   WPULSE
94D   20   JSR
94E         0
94F   8FF   WRTACI          /BREAK IT UP WITH A GARBAGE WORD
950   A2   LDXI
951   FFA   -6     /A TOTAL OF ABOUT 180 USEC PRE-DATA GAP
952   20   BDELAY,JSR
953         0
954   8CE   WPULSE
955   E8   INX
956   D0   BNE
957   FFA   BDELAY-1-.
958   A0   LDYI
959   F3E   -302  /NOW WRITE 194 ZERO'S
95A   A2   LDXI
95B         0
95C   20   DATWRT,JSR
95D         0
95E   8FF   WRTACI          /WRITE ONE BYTE
95F   C8   INY
960   D0   BNE
961   FFA   DATWRT-1-.      /NOT DONE YET
962   A5   LDAZ
963   8D    CURENT
964    9   ORAI
965    9    11
966   85   STAZ
967    A    DISREG          /TURN OFF WREN(IN 100 USEC,IF TRACK DONE)
968   A2   LDXI
969   FF    377
96A   20   JSR
96B         0
96C   8FF   WRTACI /WRITE CHECKSUM(*-1)
96D   A5   LDAZ
96E   81    BLKLO
96F   18   CLC
970   69   ADCI
```

```
P8
971    1     1
972   85    STAZ
973   81     BLKLO
974   38    SEC
975   E9    SBCI
976   13     23     /TEST END OF TRACK(BLOCK 19)
977   10    BPL
978    3     NEXTAC-1-.
979   4C    JMP
97A          0
97B  90C     WRTNEX
97C   E6   NEXTAC,INCZ
97D   82     BLKHI /PREPARE FOR NEXT TRACK
97E   EA    OPR
97F   A9    LDAI    /TRIM ERASE LASTS FOR 450 USEC
980    1     1
981   20    JSR
982          0
983  9F0     DELAY2          /WAIT 1 MSEC TILL IT IS OVER
984   A9    LDAI
985          0
986   85    STAZ
987   81     BLKLO
988   A5    LDAZ
989   82     BLKHI
98A   38    SEC
98B   E9    SBCI
98C   4E     116    /TRACK 78?
98D   10    BPL
98E   26     FDONE-1-.
98F   A5    LDAZ
990   82     BLKHI
991   38    SEC
992   E9    SBCI
993   2B     53
994   30    BMI
995    4     CURROK-1-.     /STARTS WITH CURENT=0 FOR BLK<43
996   A2    LDXI
997   80     200    /SET LOW CURRENT
998   86    STXZ
999   8D     CURENT
99A   A5   CURROK,LDAZ
99B   8D     CURENT
99C    9    ORAI
99D    D     15
99E   85    STAZ    /STEP IN
99F    A     DISREG
9A0   49    EORI
9A1    4     4
9A2   85    STAZ
9A3    A     DISREG          /END OF PULSE
9A4   A9    LDAI
9A5   28     50
9A6   20    JSR
9A7          0
9A8  9F0     DELAY2          /WAIT FOR 40 MSEC.
9A9   A5    LDAZ
9AA    E     DMALO
9AB   29    ANDI
9AC    9     11     /TEST DISC ABLE,FORMAT SWITCH ON
```

```
P9
9AD   38    SEC
9AE   E9    SBCI
9AF    1     1
9B0   D0    BNE     /DISC UNABLE=10;FORMAT SW.=1
9B1    8     FQUIT-1-.
9B2   4C    JMP
9B3         0
9B4  866     FERASE          /START NEXT TRACK
             /
9B5   A9   FDONE,LDAI
9B6    5     5       /HANDSHAKE FOR COMPLETION
9B7   20    JSR
9B8         0
9B9  8EE     FWRONG          /JOB COMPLETED
             /
9BA   A9   FQUIT,LDAI
9BB    4     4       /DISC UNABLE
9BC   20    JSR
9BD         0
9BE  8EE     FWRONG
             /
             *ERRCLR
9C8   29    ANDI
9C9    8     10      /WAIT IF SELERR
9CA   F0    BEQ
9CB    6     OUT-1-.
9CC   A5   DXWAIT,LDAZ
9CD    5     CON1
9CE   10    BPL
9CF  FFC     DXWAIT-1-.
9D0   A5    LDAZ
9D1    4     REG1  /CLEAR DTXA AFTER SELECT ERROR
9D2   4C   OUT,JMP
9D3         0
9D4  42E     INTEX
             /
             *ENDMOV
9D8   A9    LDAI
9D9         0
9DA   85    STAZ
9DB   81     BLKLO
9DC   85    STAZ
9DD   82     BLKHI /WE HIT FRONT OF TAPE
9DE   20    JSR
9DF         0
9E0  8A6     TRAK00
9E1   20    JSR
9E2         0
9E3  4A5     HEAD
9E4   20    JSR
9E5         0
9E6  7EC     ENDTAP          /READY FOR BOOTSTRAP READ
             /
             *PERIOD
9E8   20    JSR
9E9         0
9EA  87C     INWAIT
9EB   20    JSR
9EC         0
9ED  87C     INWAIT
```

```
F:
9EE   60    RTS     /ALLOWS FBUG TO MEASURE DISC PERIOD
              /
              *4760    /AVOID ANY PAGE CROSSING
9F0   AA   DELAY2,TAX       /DUPLICATE SUBR. SO FORMAT STANDS ALONE
9F1   A0   STIME,LDYI
9F2   C4     304    /1 MSEC AT 1.06 MHZ.
9F3   88   WAITD2,DEY
9F4   D0    BNE
9F5  FFD     WAITD2-1-.
9F6   CA    DEX
9F7   D0    BNE
9F8  FF8     STIME-1-.
9F9   60    RTS
              /
              *4774    /RESET AUTO START ADDRESS
9FC           00
9FD    4      4      /START AT 400 HEX =2000 OCTAL
              PAUSE/
              /
              /FOR4-COMMENTS
              /
              /ERRCLR WAITS FOR DTXA FOLLOWING SELERR,AND THEN CLEARS IT.
              /THIS IS NEEDED FOR BOOTSTRAP WITH WRITE LOCK,AND NO TC01.
              /OTHERWISE,THE DOUBLE ERROR WHEN BOOTSTRAP TRIES TO SAVE
              /7200-7577 CAUSES HEAD TO TRACK BACK AND FORTH BEFORE
              /BOOTSTRAP IS DONE.
              /
              /AUG 18/77--PUT EXTRA  DTXA CLEAR IN INTEX.
              /THIS MAY MAKE ERRCLR UNNEEDED. NEVER TESTED.
```

FBUG: DEBUGGING PROGRAM FOR FLOPPY DISC MICROPROCESSOR PERIPHERAL INTERFACE ADAPTERS

A subprogram in the FD microprocessor is triggered by FTOG and by DDTU. The program resides in the high address 1K PROM. It tests various signals available to it and transmits the results to the PDP-8. The PDP-8 program FTOG compares received information with what is expected.

FTOG initializes the test by sending 7770 (illegal for Dectape) to the FD processor. FBUG sets "FLAG 1" and FTOG transmits codes 70, 50 to assure the FD system that the test made is really wanted. After this initializing procedure, the FD processor carries out the specific sequences depending on the code sent to the "A" register. FBUG exits to the initial disc reset loop if a zero is sent to the "A" register.

Program DDTU also uses FBUG to allow listing of all memory accessible to the microprocessor, and modification of the contents of writable memory. (See DDTU - MICROPROCESSOR DEBUG PROGRAM).

FR 2
May 8/77

FR 12 - JUNE 9/77

```
 PALH
*OUT-S:FBUG
*
*IN-S:CON8,S:FBUG,S:FBG2
*
*
*
*OPT-T

ACINIT 3713

                /
                /CON8
                FIELD 1
                XLIST
                PAUSE/
                /
                /FBUG
                /-U-PROCESSOR ROUTINE TO TEST
                /I/O WITH PDP-8--CONTROLLED BY 'FTOG'..AND "DDTU"
                /
                *5000
                /
A00    85   FLAG2,STAZ
A01     4     REG1
A02    20    JSR
A03           0
A04   A0A     FLAG
A05    D0    BNE
A06    56     BUGOK-1-.
A07    4C   QUIT,JMP
A08           0
A09     4     04      /RESET TO 0400 IN CASE SETUP WRONG
              /
A0A    A9   FLAG,LDAI
A0B    3F     77
A0C    85    STAZ
A0D     5     CON1   /SET FLAG1
A0E    A9    LDAI
A0F     1     1       /SET DT FLAG,NO ERROR FLAG
A10    85    STAZ
A11     6     REGB
A12    A9    LDAI
A13    81     201
A14    85    STAZ
A15     6     REGB
A16    A5   PDWAIT,LDAZ
A17     5     CON1   /WAIT FOR DTXA
A18    10    BPL
A19   FFC     PDWAIT-1-.
A1A    A9    LDAI
A1B    37     67
A1C    85    STAZ
A1D     5     CON1   /CLEAR FLAG1
A1E    A5    LDAZ
A1F     4     REG1   /CLEAR FLAG1
A20    C8    INY     /INCREMENT TEST NO.
A21    A5    LDAZ
A22     8     REGA
A23    29    ANDI    /FOR USE BY FBUGIN
```

```
P2
A24   FC     374
A25   38    SEC     /READY TO SUBTRACT
A26   F0    BEQ
A27  FDF     QUIT-1-.
A28   60    RTS
             /
             /FBUG STARTS HERE
             /
             *FBUGX
A40   A5   FBUGIN,LDAZ      /ENTRY FROM 'INTEX'
A41    8     REGA
A42   85    STAZ
A43    4     REG1
A44   20    JSR
A45          0
A46  A0A     FLAG
A47   38    SEC
A48   E9    SBCI
A49   38     70     /HANDSHAKE TO BE SURE PDP WANTS US
A4A   D0    BNE
A4B  FBB     QUIT-1-.
A4C   20    JSR
A4D          0
A4E  A0A     FLAG
A4F   38    SEC
A50   E9    SBCI
A51   28     50
A52   D0    BNE
A53  FB3     QUIT-1-.       /PDP SENDS 70,THEN 50
A54   A5    LDAZ
A55    8     REGA
A56   85    STAZ
A57    4     REG1   /ALLOW TEST OF SELECT-OK
A58   20   GET0,JSR
A59          0
A5A  A0A     FLAG
A5B   A0    LDYI
A5C          0      /INITIALIZE Y
             /
A5D   A2   BUGOK,LDXI
A5E   DF     337
A5F   9A     TXS    /RESET STACK
A60   38    SEC
A61   E9    SBCI    /NOW TEST REGA FOR 374
A62   FC     374
A63   F0    BEQ
A64  FF3     GET0-1-.       /INITIALIZE Y IF 'A'=374
A65   A5   BUGNEX,LDAZ
A66    8     REGA
A67   29    ANDI
A68   FC     374
A69   AA    TAX
A6A   38    SEC
A6B   E9    SBCI
A6C   AC     254    /DISC PERIOD ASKED?
A6D   F0    BEQ
A6E   20     SPTEST-1-.
A6F   8A    TXA
A70   38    SEC
A71   E9    SBCI
```

```
P3
A72   E4    344
A73   F0   BEQ
A74   10   P344-1-.
A75   8A   TXA
A76   38   SEC
A77   E9   SBCI
A78   80    200
A79   D0   BNE
A7A   31    NOT200-1-.
A7B   20  P200,JSR
A7C         0
A7D  A9C    SETOUT
A7E   84   STYZ    /TEST DMAHI 'TO' PDP8
A7F    C    DMAHI
A80   A5   LDAZ
A81    C    DMAHI /TRIGGER DMA
A82   4C   JMP
A83         0
A84  A00    FLAG2
            /
A85   20  P344,JSR
A86         0
A87  A9C    SETOUT
A88   84   STYZ    /TEST DMALO 'TO' PDP8 IF P344
A89    E    DMALO
A8A   A5   LDAZ
A8B    E    DMALO
A8C   4C   JMP
A8D         0
A8E  A00    FLAG2
            /
A8F   20  SPTEST,JSR       /FOR P254
A90         0              /GET DISC PERIOD
A91  9E8    PERIOD
A92   20   JSR
A93         0
A94  A9C    SETOUT
A95   84   STYZ
A96    C    DMAHI
A97   86   STXZ
A98    E    DMALO /SEND IT
A99   4C   JMP
A9A         0
A9B  A0A    FLAG
            /
A9C   20  SETOUT,JSR
A9D         0
A9E  797    TOPDP8
A9F   20   JSR
AA0         0
AA1  B11    LHEAD
AA2   20   JSR
AA3         0
AA4  7B8    INITDM
AA5   A5   LDAZ
AA6    A    DISREG
AA7    9   ORAI
AA8   10    20     /FOR CA INCR.
AA9   85   STAZ
AAA    A    DISREG
```

```
P4
AAB   60    RTS
             /
AAC   18   NOT200,CLC
AAD   29    ANDI
AAE   7F     177    /ALL CODES MAY INCLUDE 200
AAF   2A    ROL
AB0   2A    ROL
AB1   B0    BCS
AB2   2B     P100-1-.
AB3   2A    ROL
AB4   B0    BCS
AB5   1C     P40-1-.
AB6   2A    ROL
AB7   B0    BCS
AB8    9     P20-1-.
AB9   2A    ROL
ABA   B0    BCS
ABB   69     P10-1-.
ABC   2A    ROL
ABD   B0    BCS
ABE   74     P4-1-.
ABF   4C    JMP
AC0          0
AC1   A07    QUIT
             /
AC2   D0   P20,BNE
AC3    7     P24-1-.
AC4   84    STYZ
AC5    A     DISREG
AC6   A5    LDAZ
AC7    A     DISREG          /TEST DISREG
AC8   4C    JMP
AC9          0
ACA   A00    FLAG2
             /
ACB   84   P24,STYZ
ACC    6     REGB
ACD   A5    LDAZ
ACE    6     REGB   /TEST REGDT
ACF   4C    JMP
AD0          0
AD1   A00    FLAG2
             /
             /
AD2   D0   P40,BNE
AD3   39     P44-1-.
AD4   A9    LDAI    /START UPROC AT LOC FROM P4
AD5   3F     77
AD6   85    STAZ
AD7    5     CON1   /SET 'FLAG1'
AD8   6C     JMPI
AD9   90   ADDRLO
ADA          00
             /
ADB   4C   QUITTER,JMP
ADC          0
ADD   A07    QUIT
             /
ADE   AA   P100,TAX
ADF   20    JSR
```

```
P5
AE0          0
AE1   B11    LHEAD /NEEDED BEFORE INITDM
AE2    20    JSR
AE3          0
AE4   788    INITDM
AE5    A9    LDAI
AE6    19     31
AE7    85    STAZ
AE8     A     DISREG          /DATA 'FROM' PDP-8
AE9    98    TYA     /TEST FOR THE FIRST    IN LOOP
AEA    D0    BNE
AEB     5     NOTFRS-1-.
AEC    A5    LDAZ
AED     C     DMAHI /PRETRIGGER DMA
AEE    20    JSR
AEF          0
AF0   B11    LHEAD /TO KILL 30 USEC
AF1    8A   NOTFRS,TXA
AF2    D0    BNE
AF3    14     P104-1-.
              /
AF4    A5    LDAZ    /TEST DMALO 'FROM' PDP8
AF5     E     DMALO
AF6    2A    ROL     /TOP BIT OF LOW 4 TO C
AF7    29    ANDI
AF8    E0     340    /ONLY WANT 3 BITS MORE
AF9    85    STAZ
AFA    85     TEMPLO
AFB    A5    LDAZ
AFC     C     DMAHI /TRIGGER DMA,AND GET MIDDLE 4 BITS
AFD    29    ANDI
AFE     F     17
AFF     5    ORAZ
B00    85     TEMPLO
B01    2A    ROL
B02    2A    ROL
B03    2A    ROL
B04    2A    ROL     /LOW 8 BITS IN A
B05    4C    JMP
B06          0
B07   A00     FLAG2
              /
B08    A5   P104,LDAZ         /TEST DMAHI 'FROM' PDP8
B09     C     DMAHI
B0A    4C    JMP
B0B          0
B0C   A00     FLAG2
              /
B0D    98    P44,TYA          /TEST REG1 XFER TO PDP8
B0E    4C     JMP
B0F          0
B10   A00     FLAG2
              /
              /
B11    A5   LHEAD,LDAZ
B12     A     DISREG          /SAVE STATE
B13    85    STAZ
B14    85     TEMPLO
B15    A9    LDAI
B16     8     10     /LOAD THE HEAD
```

```
P6
B17   85    STAZ
B18    A     DISREG
B19   A5    LDAZ
B1A   85     TEMPLO
B1B   85    STAZ
B1C    A     DISREG          /RESTORE STATE
B1D   60    RTS
             PAUSE/
             /
             /FBG2
             /
B1E   A2   P14,LDXI          /DATA FROM RAM TO PDP
B1F         0
B20   A1    LDAXI
B21   90     ADDRLO          /LOAD INDIRECT
B22   4C    JMP
B23         0
B24  A00     FLAG2 /SEND VIA REG1
             /
B25   D0   P10,BNE
B26  FF7     P14-1-,
B27   20    JSR     /DATA "TO" RAM FROM PDP8
B28         0
B29  B49     SETIN
B2A   A2    LDXI
B2B         0
B2C   A5    LDAZ
B2D    C     DMAHI
B2E   81    STAXI   /STORE INDIRECT
B2F   90     ADDRLO
B30   4C    JMP
B31         0
B32  A00     FLAG2
             /
B33   20   P4,JSR
B34         0       /GET AN ADDRES FROM PDP
B35  B49     SETIN
B36   A5    LDAZ
B37    C     DMAHI /HI PART OF ADDRES
B38   85    STAZ
B39   91     ADDRHI          /SAVE FOR USE BY OTHER ROUTINES
B3A   85    STAZ    /ALLOW COPY TEST
B3B    4     REG1
B3C   20    JSR
B3D         0
B3E  A0A     FLAG
B3F   20    JSR
B40         0
B41  B49     SETIN
B42   A5    LDAZ
B43    C     DMAHI
B44   85    STAZ
B45   90     ADDRLO          /LO PART OF ADDRESS
B46   4C    JMP
B47         0
B48  A00     FLAG2
             /
B49   20   SETIN,JSR         /PREPARE DMA FOR XFER "FROM" PDP8
B4A         0
B4B  B11     LHEAD
```

```
P7
B4C    20    JSR
B4D           0
B4E   7B8     INITDM
B4F    A9    LDAI
B50     9     11
B51    85    STAZ
B52     A     DISREG
B53    A5    LDAZ
B54     C     DMAHI /PRETRIGGER DMA
B55    20    JSR
B56           0
B57   B11     LHEAD /WAIT FOR IT
B58    60    RTS
              /
              /NOTE THAT RDBK USES B60 TO BE3
              /
              *5774
BFC           00
BFD     4      4     /START AT 400 HEX(=2000 OCTAL)
```

(81) (82) (83)

See Pages 45, 46, 47 "RDBK"
which uses locations B60-BDA.

```
 PALH
*OUT-S:FTOG
*
*IN-S:TOGO,S:TELY,S:FTOG,S:TOG1,S:TOG2
*
*
*
*
*
*OPT-T

ACCUM     74

                    /
                    /
                    /TOGO-ROUTINES FOR FTOG
                    /LOAD FIO,FTOG,,,SAVE FTOG!0-2700;200
                    /
                    /
                    MQL=7421
                    MQA=7501
                    RDREG1=6751
                    DTRA=6761
                    DTCA=6762
                    DTXA=6764
                    DTSF=6771
                    DTRB=6772
                    DTLB=6774
                    CDF=6201
                    CIF=6202
                    /
                    FTOGX=4
                    UTOGX=5
                    MASK=6
                    PCOUNT=7
                    /
                    MESAGX=20
                    CRLFX=21
                    TYPEX=22
                    POCTLX=23
                    OCTALX=24
                    /
                    *30
    30              TIME,0
    31    7775      M3,-3
    32    7774      M4,-4
    33    7730      M50,-50
    34    7634      M144,-144
    35    7401      M377,-377
                    /
    36      17      P17,17
    37      44      P44,44
    40      20      P20,20
    41     100      P100,100
    42     104      P104,104
    43     200      P200,200
    44     240      P240,240
    45     260      P260,260
    46     301      P301,301
    47     370      P370,370
    50     374      P374,374
    51     400      P400,400
```

(84)

FR 12
JUNE 10/70

```
P2
   52   4000   P4000,4000
   53   4004   P4004,4004
   54   4016   P4016,4016
   55   4200   P4200,4200
   56   4201   P4201,4201
   57   7040   P7040,7040
   60   7050   P7050,7050
   61   7654   P7654,7654
   62   7674   P7674,7674
   63   7760   P7760,7760
   64   7770   P7770,7770
   65   7774   P7774,7774
   66   7777   P7777,7777
   67     70   P70,70
   70     10   P10,10
   71   7770   M10,-10
   72          COUNT,0
   73          KTEST,0
   74          ACCUM,0
   75          TEST,0
   76          TEMP,0
   77          TEMP2,0
  100   7600   P7600,7600
  101   5001   P5001,5001
  102   7210   P7210,7210
  103   7220   P7220,7220
  104   7755   P7755,7755
  105   7754   P7754,7754
  106   7410   P7410,7410
  107    222   M7556,-7556
  110          TESTQ,0
  111          TSAVE,0
  112   5070   M2710,-2710
  113     76   TEMPNT,TEMP
  114   7776   M2,-2
  115   7766   M12,-12
  116   7530   M250,-250
  117          HTEMP,0
  120          COUNTF,0
  121          FCOUNT,0
  122   5402   JMPI2,JMP I 2
  123          RCOUNT,0
  124          REGTEM,0
  125          COMPAR,0
  126          PRELOD,0
  127          ADDRES,0
  130          BYTE,0
  131    130   BYTPNT,BYTE
  132          AREG,0
               /
               /TSLOOP RETURNS TO CALL+2,UNLESS KEY
               /CORRESPONDING TO 'TEST' IS PRESSED
               *1600
 1600          TSLOOP,0          /TEST FOR SCOPE LOOP
 1601   3074     DCA ACCUM       /SAVE AC
 1602   2073     ISZ KTEST
 1603   6034     KRS
 1604   7041     CIA
 1605   1073     TAD KTEST
 1606   7650     SNA CLA
```

```
P3
1607   5213     JMP LOOP
1610   2200     ISZ TSLOOP
1611   1074     TAD ACCUM
1612   5600     JMP I TSLOOP   /NO LOOP
1613   7240   LOOP,CLA CMA
1614   1073     TAD KTEST
1615   3073     DCA KTEST      /REPEAT
1616   5600     JMP I TSLOOP
               /
               /
1617           WAITER,0         /START I/O OPERATION AND WAIT FOR FLAG
1620   6766     DTCA!DTXA        /EXITS TO CALL+2 IF NO RESPONSE
1621   1033     TAD M50
1622   3030     DCA TIME
1623   6771   WAIT,DTSF          /WAIT 1 SEC
1624   7410     SKP
1625   5233     JMP OKOUT        /FLAG SEEN
1626   2072     ISZ COUNT
1627   5223     JMP WAIT
1630   2030     ISZ TIME
1631   5223     JMP WAIT
1632   5235     JMP WERR         /NO RESPONSE
1633   6772   OKOUT,DTRB         /TEST ERR. FLAG
1634   7710     SPA CLA
1635   2217   WERR,ISZ WAITER  /ERROR
1636   5617     JMP I WAITER
               PAUSE/
               /
               /TELY
               /MESAGE PACKAGE WHEN FOCAL NOT USED
               /CALL;JMS MESAG
               /   ...TEXT /..../
               /
               SHL=7413
               /
               /
1637           POCTAL,0
1640   7421     MQL
1641   1032     TAD M4
1642   3121     DCA FCOUNT
1643   1044     TAD P240
1644   4422     JMS I TYPEX
1645   7413   PRN,SHL
1646      2     2
1647   1045     TAD P260
1650   4422     JMS I TYPEX
1651   2121     ISZ FCOUNT
1652   5245     JMP PRN
1653   5637     JMP I POCTAL
               HERE=.
               /
               *POCTLX
  23   1740     PRINTA
               /
               *OCTALX
  24   1637     POCTAL
               /
               *MESAGX
  20   1654   MESAG
               *CRLFX
```

```
P4
   21   1701   CRLF
               *TYPEX
   22   1711   TYPE
               /
               *HERE
1654           MESAG,0
1655   4301      JMS CRLF
1656   1654   PRINT,TAD I MESAG
1657   2254      ISZ MESAG
1660   7421      MQL
1661   4264      JMS CHARP
1662   4264      JMS CHARP
1663   5256      JMP PRINT
               /
1664           CHARP,0
1665   7413      SHL
1666      5       5
1667   7450      SNA
1670   5654      JMP I MESAG
1671   1277      TAD M40
1672   7500      SMA
1673   1041      TAD P100
1674   1300      TAD P140
1675   4311      JMS TYPE
1676   5664      JMP I CHARP
               /
1677   7740   M40,-40
1700    140   P140,140
               /
1701           CRLF,0  /PRINT A LINE FEED
1702   1310      TAD P215
1703   4311      JMS TYPE
1704   1307      TAD P212
1705   4311      JMS TYPE
1706   5701      JMP I CRLF
               /
1707    212   P212,212
1710    215   P215,215
               /
1711           TYPE,0  /PRINT A CHARACTER FROM AC
1712   3344      DCA TTEMP      /IF SW.0 SET,:NO TYPING
1713   7604      LAS
1714   7001      IAC    /TEST SW. REG. ALL 1'S
1715   7650      SNA CLA
1716   5324      JMP TRY
1717   1344      TAD TTEMP
1720   6046      TLS
1721   6041      TSF
1722   5321      JMP .-1
1723   7200      CLA
1724   6031   TRY,KSF
1725   5711      JMP I TYPE     /NORMAL EXIT
1726   6034      KRS
1727   1337      TAD M203       /TEST CTRL-C
1730   7640      SZA CLA
1731   5711      JMP I TYPE
1732   6032   QUITIT,KCC
1733   6203      CDF!CIF
1734   6766      DTCA!DTXA      /BE SURE UPROC IS IN NORMAL PLACE
1735   5736      JMP I .+1
```

```
P5
1736  7600      7600
                /
1737  7575      M203,-203
                /
1740              PRINTA,0
1741  1074        TAD ACCUM
1742  4237        JMS POCTAL
1743  5740        JMP I PRINTA
                /
1744              TTEMP,0
                  PAUSE/
                  /
                  /FTOG-
                  /TESTS FLOPY DISC INTERFACE
                  /SELECT FD UNIT 7,WRITE LOCK
                  /TYPE A,B,C ETC. TO SCOPE LOOP ON TEST A,B,C ETC.
                  /
                  /LOAD FTOG,FIO$SAVE FTOG!O-2577$200
                  /
                  *200
 200  7200        FTOG,CLA
 201  7200          CLA
 202  4420          JMS I MESAGX
 203  2305        TEXT /SE
 204  2440        T
 205   604        FD
 206  4025         U
 207  1611        NI
 210  2440        T
 211  6755        7-
 212  5527        -W
 213  2211        RI
 214  2405        TE
 215  4014         L
 216  1703        OC
 217  1300        K/
 220  4420          JMS I MESAGX
 221  2022        TEXT /PR
 222   523        ES
 223  2340        S
 224  1417        LO
 225  1720        OP
 226  4003         C
 227  1001        HA
 230  2256        R.
 231  5017        (O
 232  2240        R
 233  2320        SP
 234   103        AC
 235   551        E)
 236              /
 237  6036          KRB
 240  6031          KSF
 241  5240          JMP .-1
 242  7300        GO,CLA CLL
 243  1046          TAD P301
 244  3073          DCA KTEST      /POINTER FOR SCOPE LOOP
 245  7240        TESTA,CLA CMA
 246  6766          DTCA!DTXA
 247  6762          DTCA  /TEST CLEAR A BY DTCA
```

```
P6
 250  6761   DTRA
 251  4777    JMS TSLOOP     /TEST-A
 252  5245    JMP TESTA      /SCOPE LOOP FOR A
 253  7650    SNA CLA
 254  5264    JMP TESTB
 255  4420    JMS I MESAGX
 256   155   TEXT /A-
 257   424   DT
 260   301   CA
 261  7201   ↑A
 262  7500   =/
 263  4423    JMS I POCTLX   /PRINT A
 264  6762   TESTB,DTCA
 265  7240    CLA CMA
 266  6764    DTXA
 267  4777    JMS TSLOOP     /TEST B..DOES DTXA CLEAR AC?
 270  5264    JMP TESTB      /LOOP TEST B
 271  7650    SNA CLA
 272  5312    JMP TESTC
 273  4420    JMS I MESAGX
 274   255   TEXT /B-
 275   424   DT
 276  3001   XA
 277  4004    D
 300  1104   ID
 301  1647   N'
 302  2440   T
 303   314   CL
 304   501   EA
 305  2240   R
 306   103   AC
 307  7375   ↑=
 310         /
 311  4423    JMS I POCTLX
 312  6761   TESTC,DTRA
 313  7040    CMA
 314    65    AND P7774
 315  4777    JMS TSLOOP     /TEST-C..LOAD AND READ 'A'
 316  5312    JMP TESTC
 317  7650    SNA CLA
 320  5340    JMP TESTD
 321  4420    JMS I MESAGX
 322   355   TEXT /C-
 323   424   DT
 324  2201   RA
 325  7206   ↑F
 326  1722   OR
 327  4067    7
 330  6767   77
 331  6454   4,
 332   103   AC
 333  7500   =/
 334  1074    TAD ACCUM
 335  7040    CMA
 336  3074    DCA ACCUM
 337  4423    JMS I POCTLX
             /
 340  7240   TESTD,CLA CMA
 341  6766    DTCA!DTXA
 342  7240    CLA CMA
```

```
P7
 343   6764     DTXA
 344   6761     DTRA
 345   4777     JMS TSLOOP      /TEST-D,,CHECK XOR TO 'A'
 346   5340     JMP TESTD
 347   7650     SNA CLA
 350   5365     JMP TESTE
 351   4420     JMS I MESAGX
 352    455    TEXT /D-
 353   3017    XO
 354   2240    R
 355    201    BA
 356    440    D
 357   1116    IN
 360   4004     D
 361   2430    TX
 362    172    A;
 363           /
 364   4423     JMS I POCTLX
 365   7200    TESTE,CLA
 366   1067     TAD P70         /SET FIELD 7
 367   6774     DTLB
 370   4777     JMS TSLOOP      /TEST-E,,DOES DTLB CLEAR AC?
 371   5365     JMP TESTE
 372   7650     SNA CLA
 373   5776     JMP TESTF
 374   5775     JMP EPRINT
               /
 375    400
 376    417
 377   1600
               PAGE
 400   4420    EPRINT,JMS I MESAGX
 401    555    TEXT /E-
 402    424    DT
 403   1402    LB
 404   4004     D
 405   1104    ID
 406   1647    N'
 407   2440    T
 410    314    CL
 411    501    EA
 412   2240    R
 413    103    AC
 414   7375    ;=
 415           /
 416   4423     JMS I POCTLX
               /
 417   6772    TESTF,DTRB
 420   7040     CMA
 421     67     AND P70
 422   4777     JMS TSLOOP      /TEST-F,,CAN DTRB READ THE FIELD?
 423   5217     JMP TESTF
 424   7650     SNA CLA
 425   5244     JMP TESTG
 426   4420     JMS I MESAGX
 427    655    TEXT /F-
 430    424    DT
 431   2202    RB
 432   7206    ;F
 433   1722    OR
```

```
 434   4067    7
 435   6054   0,
 436    705   GE
 437   2440   T
 440          /
 441   6772     DTRB
 442     67     AND P70
 443   4776     JMS POCTAL
 444   1031   TESTG,TAD M3
 445   3072     DCA COUNT
 446   1070     TAD P10          /CHECK EACH FIELD  IS SETTABLE
 447     67   NEXTH,AND P70
 450   3117     DCA HTEMP
 451   1117     TAD HTEMP
 452   6774     DTLB
 453   6772     DTRB
 454     67     AND P70
 455   7041     CIA
 456   1117     TAD HTEMP
 457   7650     SNA CLA
 460   5275     JMP G2
 461   4420     JMS I MESAGX
 462    755   TEXT /G-
 463    611   FI
 464    514   EL
 465    440   D
 466   2722   WR
 467   1716   ON
 470    756   G.
 471    275   B=
 472          /
 473   6772     DTRB
 474   4776     JMS POCTAL
 475   6772   G2,DTRB
 476   7004     RAL
 477   2072     ISZ COUNT
 500   5247     JMP NEXTH
 501   4777     JMS TSLOOP      /TEST-G
 502   5244     JMP TESTG
 503   7200   TESTH,CLA
 504   1115     TAD M12
 505   3072     DCA COUNT
 506   7330     CLL CLA CML RAR          /CHECK FOR 'A' CROSS WIRES
 507   3076     DCA TEMP
 510   1076   LOOPER,TAD TEMP
 511   6766     DTCA!DTXA
 512   6761     DTRA
 513   3077     DCA TEMP2
 514   1076     TAD TEMP
 515   7041     CIA
 516   1077     TAD TEMP2
 517   3074     DCA ACCUM
 520   1074     TAD ACCUM
 521   7650     SNA CLA
 522   5341     JMP OK
 523   4420     JMS I MESAGX
 524   1055   TEXT /H-
 525    211   BI
 526   2440   T
 527    322   CR
```

(92)

```
 530   1723   OS
 531   2305   SE
 532    440   D
 533   1116   IN
 534   4001    A
 535   4000    /
 536   4423      JMS I POCTLX
 537   4777      JMS TSLOOP      /TEST-H
 540   5310      JMP LOOPER
 541   1076   OK,TAD TEMP
 542   7010      RAR
 543   3076      DCA TEMP
 544   2072      ISZ COUNT
 545   5310      JMP LOOPER
               /
 546   4775   TESTI,JMS BDELAY          /GET BACK TO INTEX
 547   1100      TAD P7600       /MOVE BACK,UNIT 7..CHECK DTSF
 550   4774      JMS WAITER
 551   5773      JMP JPRINT      /ERROR MISSED BY 'WAITER'
 552   6771      DTSF   /TEST SKIP FLAG
 553   7410      SKP
 554   5366      JMP MOVED
 555   4420      JMS I MESAGX   /NO DTSF FLAG
 556   1155   TEXT /I-
 557   1517   MO
 560   2605   VE
 561   5502   -B
 562    103   AC
 563   1340   K
 564    522   ER
 565   2200   R/
 566   6772   MOVED,DTRB        /...CHECK ERROR FLAG
 567   7710      SPA CLA
 570   5772      JMP FLAGGED
 571   5773      JMP JPRINT
               /
 572    612
 573    601
 574   1617
 575   1000
 576   1637
 577   1600
               PAGE
 600   2777   P2777,2777
 601   4420   JPRINT,JMS I MESAGX
 602   1255   TEXT /J-
 603   1617   NO
 604   4005    E
 605   2222   RR
 606   1722   OR
 607   4006    F
 610   1401   LA
 611    700   G/
 612   6772   FLAGGED,DTRB
 613   3076      DCA TEMP
 614   1076      TAD TEMP
 615    101      AND P5001
 616   1200      TAD P2777
 617   7650      SNA CLA
 620   5234      JMP EOTOK       /CHECKED ERR.,EOT, AND DT FLAGS
```

```
P:
 621  4420    JMS I MESAGX
 622  1355  TEXT /K=
 623   517  EO
 624  2440  T
 625   614  FL
 626   107  AG
 627  5607  ,G
 630  1724  OT
 631  7200  :/
 632  1076    TAD TEMP
 633  4777    JMS POCTAL
 634  6761  EOTOK,DTRA
 635    43    AND P200
 636  7650    SNA CLA
 637  5253    JMP HLTOK
 640  4420    JMS I MESAGX
 641  1455  TEXT /L=
 642   150  A(
 643  6451  4)
 644  4016   N
 645  1724  OT
 646  4003   C
 647  1405  LE
 650   122  AR
 651   504  ED
 652        /
            /
 653  4776  HLTOK,JMS BDELAY          /MAY NEED TIME TO RESTORE ITSELF
 654  4404    JMS I FTOGX    /RUN FIO TESTS
 655  4776    JMS BDELAY
 656  1311    TAD CDFP       /CDF
 657  3302    DCA FIELDR
 660  1071    TAD M10
 661  3120    DCA COUNTF
 662  1113    TAD TEMPNT
 663  3504    DCA I P7755    /SET FOR SEARCH
 664  1302  SERTES,TAD FIELDR
 665  6774    DTLB
 666  1102    TAD P7210      /SEARCH FORWARD
 667  4775    JMS WAITER
 670  5301    JMP FOUNF
 671  4420    JMS I MESAGX
 672  1555  TEXT /M=
 673  2322  SR
 674   310  CH
 675  4005   E
 676  2222  RR
 677  5600  ,/
 700  5264    JMP SERTES     /TRY AGAIN
            /
 701  6764  FOUNF,DTXA       /CLEAR FLAG
 702  6201  FIELDR,CDF       /GETS CHANGED TO CDF 10,20 ETC.
 703  3513    DCA I TEMPNT   /SET FOR TEST
 704  6771    DTSF
 705  5304    JMP .-1
 706  1513    TAD I TEMPNT   /READ BLKNO FROM SEARCH
 707  7421    MQL
 710  1513    TAD I TEMPNT
 711  6201  CDFP,CDF
 712  7640    SZA CLA        /2ND BLOCKNO CAN'T BE ZERO
```

```
P;
  713   5337     JMP SRCHN
  714   4420   JMS I MESAGX
  715   1655   TEXT /N-
  716   1617   NO
  717   4002    B
  720   1413   LK
  721   1617   NO
  722   5423   ,S
  723    501   EA
  724   2203   RC
  725   1040   H
  726    611   FI
  727    514   EL
  730    440   D
  731          /
               PAUSE/
               /
               /TOG1
  732   1302     TAD FIELDR
  733     67     AND P70
  734   7110     CLL RAR
  735   7012     RTR
  736   4777     JMS POCTAL
  737   1302   SRCHN,TAD FIELDR          /SET UP NEXT FIELD
  740   1070     TAD P10
  741   3302     DCA FIELDR
  742   2120     ISZ COUNTF
  743   5264     JMP SERTES
  744   1033     TAD M50
  745   1033     TAD M50
  746   3030     DCA TIME
  747   2072   WAITDF,ISZ COUNT
  750   5347     JMP .-1          /WAIT TILL HEAD REACHES END
  751   2030     ISZ TIME
  752   5347     JMP WAITDF
  753   7200   SRDONE,CLA         /CHECK END OF DISC FLAG
  754   6772     DTRB
  755    101     AND P5001
  756   1200     TAD P2777        /TEST FOR EOT CODE
  757   7650     SNA CLA
  760   5774     JMP ENDFND
  761   5773     JMP NOEND
               /
  773   1015
  774   1031
  775   1617
  776   1000
  777   1637
               PAGE
               /
 1000          BDELAY,0
 1001   7346     CLA CMA CLL RTL
 1002   3213     DCA TEMPT        /54 MSEC DELAY
 1003   1214     TAD P7000        /DESELCT UNIT 7 ,KEEP HEAD LOADED
 1004   6766     DTCA!DTXA
 1005   3120     DCA COUNTF
 1006   2120   BDWAIT,ISZ COUNTF
 1007   5206     JMP .-1
 1010   2213     ISZ TEMPT
 1011   5206     JMP BDWAIT
```

```
P<
1012  5600    JMP I BDELAY
              /
1013          TEMPT,0
1014  7000    P7000,7000
              /
1015  4420      NOEND,JMS I MESAGX
1016  1755    TEXT /O-
1017  1011    HI
1020  4005     E
1021  1604    ND
1022  4016     N
1023  1724    OT
1024  4022     R
1025   501    EA
1026   310    CH
1027   504    ED
1030          /
              /
1031  1777    ENDFND,TAD IONPX          /BADION
1032  3002      DCA 2           /NOW TEST INTERRUPT
1033  1122      TAD JMPI2
1034  3001      DCA 1
1035  6032      KCC
1036  6042      TCF
1037  6001      ION    /NO INTERRUPT EXPECTED HERE
1040  7000      OPR
1041  6002      IOF
1042  1266      TAD P7614
              /
1043  4776      JMS WAITER
1044  7000      OPR
1045  7000      OPR
1046  1775      TAD IONOK       /IDONE
1047  3002      DCA 2
1050  6001      ION
1051  7000      OPR
1052  6002      IOF             /SHOULDN'T EVER GET HERE
              /
1053  4420    BADION,JMS I MESAGX
1054  2055    TEXT /P-
1055  1116    IN
1056  2405    TE
1057  2222    RR
1060  2520    UP
1061  2440    T
1062   522    ER
1063  2217    RO
1064  2200    R/
1065  5267      JMP IDONE
1066  7614    P7614,7614
              PAUSE/
              /
              /TOG2-CONTINUE'S FTOG
              /
              /
1067  7200    IDONE,CLA
1070  3110      DCA TESTQ
1071  6774      DTLB
1072  1100      TAD P7600       /MOVE TO BLOCK 0
1073  4776      JMS WAITER
```

```
P=
1074   7000     OPR
1075   7000     OPR
1076   4774     JMS SETUP
1077   7001     IAC
1100   3773     DCA STEPQ
1101   1102   SNEXT,TAD P7210
1102   4304     JMS SERSUB
1103   5772     JMP GOODF
                /
1104           SERSUB,0
1105   6762     DTCA
1106   6764   REPEAT,DTXA       /NOW TEST SEARCH
1107   6771     DTSF
1110   5307     JMP .-1
1111   6772     DTRB
1112   7700     SMA CLA
1113   5316     JMP FLAGOK
1114   4771     JMS SYSERR      /"SS" ERROR
1115   5704     JMP I SERSUB   /ERROR FLAG FOR SLEW
1116   1513   FLAGOK,TAD I TEMPNT
1117   7421     MQL
1120   7501     MQA
1121   3527     DCA I ADDRES
1122   2127     ISZ ADDRES
1123   2123     ISZ RCOUNT
1124   5306     JMP REPEAT
1125   1214     TAD P7000
1126   6766     DTCA!DTXA       /STOP BUT DONT DESELECT
1127   4774     JMS SETUP
1130   1527   TESTIT,TAD I ADDRES
1131   7041     CIA
1132   1110     TAD TESTQ
1133   7640     SZA CLA
1134   4770     JMS SERBAD
1135   2127     ISZ ADDRES
1136   2123     ISZ RCOUNT
1137   7410     SKP
1140   5704   SEREXT,JMP I SERSUB
1141   1110     TAD TESTQ
1142   1773     TAD STEPQ
1143   3110     DCA TESTQ
1144   5330     JMP TESTIT
                /
1170   1200
1171   1333
1172   1230
1173   1250
1174   1237
1175   1331
1176   1617
1177   1332
                PAGE
                /
1200           SERBAD,0
1201   4420     JMS I MESAGX   /TEST Q
1202   2155   TEXT /Q-
1203   2322   SR
1204    310   CH
1205   4002    B
1206   1413   LK
```

```
P>
1207  7206  ;F
1210  1722  OR
1211  5407  ,G
1212  1724  OT
1213  7300  ;/
1214  1110     TAD TESTQ
1215  4777     JMS POCTAL
1216  1527     TAD I ADDRES
1217  4777     JMS POCTAL
1220  6031     KSF
1221  5600     JMP I SERBAD
1222  6036     KRB
1223  1227     TAD M307
1224  7650     SNA CLA        /TEST FOR KEYBOARD 'G'
1225  5776     JMP SEREXT     /QUIT FOR G
1226  5600     JMP I SERBAD
              /
1227  7471  M307,-307
              /
              /
1230  4775  GOODF,JMS BDELAY
1231  7240     CLA CMA        /NOW SEARCH REVERSE
1232  3250     DCA STEPQ
1233  4237     JMS SETUP
1234  1251     TAD P7610
1235  4774     JMS SERSUB
1236  5252     JMP SEARCH
              /
1237        SETUP,0
1240  1052     TAD P4000
1241  3127     DCA ADDRES
1242  7000     NOP
1243  1113     TAD TEMPNT     /(ADDRES)
1244  3504     DCA I P7755    /SETS DMA ADDRESS POINTER
1245  1112     TAD M2710
1246  3123     DCA RCOUNT
1247  5637     JMP I SETUP
              /
1250        STEPQ,0
1251  7610  P7610,7610
              /
              /
1252  7200  SEARCH,CLA       /NOW READ EACH BLOCK
1253  3110     DCA TESTQ
1254  1113  SRCHON,TAD TEMPNT
1255  3504     DCA I P7755
1256  1102     TAD P7210      /SEARCH FORWARD
1257  4773     JMS WAITER
1260  7410     SKP
1261  5772     JMP SERROR     /NO RESPONSE
1262  6772     DTRB
1263  7710     SPA CLA
1264  5772     JMP SERROR     /ERROR FLAG
1265  1513     TAD I TEMPNT
1266  7421     MQL
1267  7501     MQA    /BLOCK NO TO MQ
1270  7041     CIA
1271  1110     TAD TESTQ
1272  7640     SZA CLA
1273  5254     JMP SRCHON
```

```
P?
1274   7240   GOREAD,CLA CMA
1275   1052     TAD P4000
1276   3504     DCA I P7755
1277   1110     TAD TESTQ
1300   7421     MQL
1301   1116     TAD M250        /ALLOW EXTRA WORDS
1302   3505     DCA I P7754
1303   1105     TAD P7754
1304   3456     DCA I P4201     /1 WORD PAST BUFFER
1305   1105     TAD P7754
1306   3455     DCA I P4200
1307   1103     TAD P7220
1310   4773     JMS WAITER      /NOW READ THE BLOCK
1311   7410     SKP
1312   5772     JMP SERROR      /NO RESPONSE
1313   6772     DTRB
1314   7710     SPA CLA
1315   5771     JMP RERROR
1316   1456     TAD I P4201
1317   7041     CIA
1320   1105     TAD P7754
1321   7640     SZA CLA
1322   5770     JMP WCOWNG      /TOO MANY WORDS
1323   1455     TAD I P4200
1324   7041     CIA
1325   1105     TAD P7754
1326   7650     SNA CLA         /DON'T EXPECT 7754 FROM DISC
1327   5770     JMP WCOWNG      /TOO FEW WORDS
1330   5767     JMP REDONE
                /
1331   1067   IONOK,IDONE
1332   1053   IONPX,BADION
                /
1333           SYSERR,0
1334   4420     JMS I MESAGX
1335   2323   TEXT /SS
1336   5523   -S
1337   1405   LE
1340   2740   W
1341    522   ER
1342   2273   R;
1343    154   A,
1344    275   B=
1345           /
1346   6761     DTRA
1347   4777     JMS POCTAL
1350   6772     DTRB
1351   4777     JMS POCTAL
1352   5733     JMP I SYSERR
                /
1367   1400
1370   1472
1371   1417
1372   1436
1373   1617
1374   1104
1375   1000
1376   1140
1377   1637
                PAGE
```

```
P@
1400  2110  REDONE,ISZ TESTQ
1401  1110    TAD TESTQ
1402  1112    TAD M2710
1403  7710    SPA CLA
1404  5777    JMP GOREAD     /READ ALL BLOCKS
1405  4420    JMS I MESAGX
1406  2405  TEXT /TE
1407  2324  ST
1410  4004   D
1411  1716  ON
1412   500  E/
1413  4421    JMS I CRLFX
1414  4421    JMS I CRLFX
1415  5616    JMP I .+1
1416   242    GO
             /
1417  4420  RERROR,JMS I MESAGX      /R-
1420  2255  TEXT /R-
1421  2205  RE
1422   104  AD
1423  4005   E
1424  2222  RR
1425  1722  OR
1426  7302  ;B
1427  1417  LO
1430   313  CK
1431  5401  ,A
1432  5402  ,B
1433  7272  ;;
1434        /
1435  5255    JMP ADVANC
1436  4420  SERROR,JMS I MESAGX      /S
1437  2355  TEXT /S-
1440  2305  SE
1441   122  AR
1442   310  CH
1443  4005   E
1444  2222  RR
1445  1722  OR
1446  7202  ;B
1447  1417  LO
1450   313  CK
1451  5401  ,A
1452  5402  ,B
1453  7240  ;
1454        /
1455  1110  ADVANC,TAD TESTQ
1456  4776    JMS POCTAL
1457  6761    DTRA
1460  4776    JMS POCTAL
1461  6772    DTRB
1462  4776    JMS POCTAL
1463  2110    ISZ TESTQ
1464  1110    TAD TESTQ
1465  1112    TAD M2710
1466  7710    SPA CLA
1467  5305    JMP SERMOV
1470  5671    JMP I .+1
1471   242    GO     /REPEAT THE TEST SEQUENCE
             /
```

```
PA
1472   4420   WCOWNG,JMS I MESAGX      /T-
1473   2455   TEXT /T-
1474   2717   WO
1475   2204   RD
1476   4003    C
1477   1725   OU
1500   1624   NT
1501   4027    W
1502   2217   RO
1503   1607   NG
1504          /
1505   1110   SERMOV,TAD TESTQ
1506   7001     IAC    /SEARCH FOR THE NEXT BLOCK
1507   3110     DCA TESTQ
1510   1100     TAD P7600
1511   4775     JMS WAITER
1512   7000     OPR
1513   7000     OPR
1514   5774     JMP SRCHON
1574   1254
1575   1617
1576   1637
1577   1274

.
```

```
.PALH
*OUT-S:FIO
*
*IN-S:TOGO,S:TELY,S:FIO,S:FIO2
*
*
*
*
*OPT-T

ACCUM     74

                  /
                  /
                  /TOGO-ROUTINES FOR FTOG
                  /LOAD FIO,FTOG...SAVE FTOG!O-2700$200
                  /
                  /
                  MQL=7421
                  MQA=7501
                  RDREG1=6751
                  DTRA=6761
                  DTCA=6762
                  DTXA=6764
                  DTSF=6771
                  DTRB=6772
                  DTLB=6774
                  CDF=6201
                  CIF=6202
                  /
                  FTOGX=4
                  UTOGX=5
                  MASK=6
                  PCOUNT=7
                  /
                  MESAGX=20
                  CRLFX=21
                  TYPEX=22
                  POCTLX=23
                  OCTALX=24
                  /
                  *30
30                TIME,0
31      7775      M3,-3
32      7774      M4,-4
33      7730      M50,-50
34      7634      M144,-144
35      7401      M377,-377
                  /
36        17      P17,17
37        44      P44,44
40        20      P20,20
41       100      P100,100
42       104      P104,104
43       200      P200,200
44       240      P240,240
45       260      P260,260
46       301      P301,301
47       370      P370,370
50       374      P374,374
51       400      P400,400
```

SEE FTOG FOR LISTING OF 0-1777.

```
P5
1736  7600    7600
              /
1737  7575    M203,-203
              /
1740          PRINTA,0
1741  1074      TAD ACCUM
1742  4237      JMS POCTAL
1743  5740      JMP I PRINTA
              /
1744          TTEMP,0
              PAUSE/
              /
              /FIO
              /PDP-8 ROUTINE TO TEST THE FLOPPY DISC I/O PROCESSOR.
              /
              SKPFL1=6752
              /
              *FTOGX
   4  2200    FIO
              /
              *2000
2000          SEQUEN,0
2001  3132      DCA AREG        /SAVE CONTROL CODE FOR FBUG
2002  3125      DCA COMPAR
2003  1273      TAD M370
2004  3123      DCA RCOUNT      /COUNTER FOR DMA-IF USED ON THIS CALL
2005  7240      CLA CMA
2006  1052      TAD P4000
2007  3504      DCA I P7755     /INITIALIZE DMA POINTERS,IN CASE NEEDED
2010  1273      TAD M370
2011  3505      DCA I P7754     /ONLY ALLOW 370 WORDS DMA
2012  1504      TAD I P7755
2013  3010      DCA 10
2014  1274      TAD M400
2015  3011      DCA 11
2016  1126    FILL,TAD PRELOD /FILL DMA BUFFER
2017  3410      DCA I 10
2020  1126     TAD PRELOD
2021  1366      TAD BFSTEP
2022  3126      DCA PRELOD
2023  2011      ISZ 11
2024  5216      JMP FILL
2025  1064      TAD P7770       /374 TO U-PROC,
2026  4262      JMS WAITIO      /INITIALIZE U-PROC, Y REG,
2027  1132    SEQNEX,TAD AREG
2030  4262      JMS WAITIO      /ASKING FOR A SPECIFIC FUNCTION
2031  6751      RDREG1
2032  3124      DCA REGTEM
2033  1124      TAD REGTEM
2034  7041      CIA
2035  1125      TAD COMPAR
2036     6      AND MASK
2037  7640      SZA CLA
2040  4307      JMS ERRP
2041  1125      TAD COMPAR
2042  1040      TAD P20
2043  3125      DCA COMPAR      /COMPARING UPPER 8 BITS
2044  4276      JMS KEYTES      /EXIT FOR LETTER G(0)
2045  7650      SNA CLA
2046  5252      JMP SEQEND
```

```
P6
2047  2123    ISZ RCOUNT
2050  5227    JMP SEQNEX
2051  5255    JMP PASTIT
2052  4421  SEQEND,JMS I CRLFX
2053  1132    TAD AREG
2054  4777    JMS POCTAL
2055  1052  PASTIT,TAD P4000
2056  3127    DCA ADDRES
2057  1273    TAD M370
2060  3123    DCA RCOUNT      /READY TO CHECK DMA IF USED
2061  5600    JMP I SEQUEN
              /
2062          WAITIO,0
2063  6766    DTCA!DTXA       /XMIT A FUNCTION TO FBUG
2064  1274    TAD M400
2065  3011    DCA 11
2066  2011    ISZ 11
2067  5266    JMP .-1         /GIVE IT LOTS OF TIME
2070  6752    SKPFL1
2071  5344    JMP ERB         /NO RESPONSE
2072  5662    JMP I WAITIO
              /
2073  7410  M370,-370
2074  7400  M400,-400
2075  7471  M307,-307        /TEST FOR 'G'
              /
2076          KEYTES,0        /LOOK FOR LETTER G TYPED
2077  7200    CLA
2100  6031    KSF
2101  5305    JMP NOKEY
2102  6036    KRB
2103  1275    TAD M307
2104  5676    JMP I KEYTES
2105  7001  NOKEY,IAC
2106  5676    JMP I KEYTES  /EXIT WITH ZERO IF G SEEN
              /
2107          ERRP,0
2110  4420    JMS I MESAGX
2111  1155  TEXT /I-
2112  1740  O
2113   522  ER
2114  2217  RO
2115  2254  R,
2116   154  A,
2117  2203  RC
2120  1725  OU
2121  1624  NT
2122  5422  ,R
2123   507  EG
2124  6154  1,
2125   530  EX
2126  2005  PE
2127   324  CT
2130  7200  !/
2131  1132    TAD AREG
2132  4777    JMS POCTAL
2133  1047    TAD P370
2134  1123    TAD RCOUNT
2135  4777    JMS POCTAL
2136  1124    TAD REGTEM
```

```
P7
2137   4777     JMS POCTAL
2140   1125     TAD COMPAR
2141      6     AND MASK
2142   4777     JMS POCTAL
2143   5707     JMP I ERRP
                /
2144            ERB,0
2145   4420     JMS I MESAGX
2146    101     TEXT /AA
2147   5516     -N
2150   1740     O
2151    614     FL
2152    107     AG
2153   6154     1,
2154   1417     LO
2155    356     C.
2156            /
2157   7240     CLA CMA
2160   1262     TAD WAITIO
2161   4777     JMS POCTAL
2162   1776     TAD FIO
2163   3365     DCA TEMPEX
2164   5765     JMP I TEMPEX
                /
2165            TEMPEX,0
2166            BFSTEP,0
                /
2176   2200
2177   1637
                PAGE
2200            FIO,0   /**********TEST STARTS HERE**************
2201   7200     CLA
2202   6766     DTCA!DTXA      /BACK TO INTEX
2203   3076     TESTAA,DCA TEMP
2204   2076     ISZ TEMP
2205   5204     JMP .-1        /WAIT TILL INTEX  OK
2206   7240     CLA CMA
2207   6774     DTLB  /SET FIELD 7
2210   1065     TAD P7774      /CALL FBUG IN U-PROC,
2211   4777     JMS WAITIO
2212   6751     RDREG1
2213    351     AND P7700      /IGNORE TC01 INH,TRAK00
2214   3124     DCA REGTEM
2215   1124     TAD REGTEM
2216   1041     TAD P100
2217   7650     SNA CLA
2220   5251     JMP TESTBB
2221   4420     JMS I MESAGX
2222    102     TEXT /AB
2223   5542     -"
2224    142     A"
2225   4024      T
2226   1740     O
2227   2205     RE
2230    761     G1
2231   4027      W
2232   2217     RO
2233   1607     NG
2234   5672     .:
2235   7211     :I
```

```
P8
2236  1654  N,
2237   154  A,
2240  2205  RE
2241   761  G1
2242  7500  =/
2243  1065    TAD P7774
2244  4776    JMS POCTAL
2245  6761    DTRA
2246  4776    JMS POCTAL
2247  1124    TAD REGTEM
2250  4776    JMS POCTAL
              /
2251  1337  TESTBB,TAD P160 /70 TO FBUG FOR HANDSHAKE
2252  4777    JMS WAITIO
2253  1340    TAD P7120     /50 TO FBUG(7 TO SELECT FDISC FOR SELECT OK)
2254  4777    JMS WAITIO
2255  6751  TESTCC,RDREG1
2256   343    AND P40       /TEST 'SELECT OK'
2257  7640    SZA CLA
2260  5272    JMP TESTDD
2261  4420    JMS I MESAGX
2262   202  TEXT /BB
2263  5516  -N
2264  1740  O
2265  2403  TC
2266  1761  O1
2267  4011   I
2270  1610  NH
2271        /
            /
            /NOW SEND A SEQUENCE OF TESTS
2272  7200  TESTDD,CLA
2273  6774    DTLB
2274  1066    TAD P7777
2275  3006    DCA MASK
2276  3126    DCA PRELOD
2277  1342    TAD P110      /44 FOR U-P::TEST REG1
2300  4775    JMS SEQUEN
2301  7200    CLA
2302  1066    TAD P7777
2303  3006    DCA MASK
2304  1343    TAD P40       /20 FOR U-P:TEST DISREG
2305  4775    JMS SEQUEN
2306  7200    CLA
2307  1346    TAD P5777
2310  3006    DCA MASK      /BIT 6 IS AN INPUT
2311  1344    TAD P50       /24 FOR U-P:TEST REGDT
2312  4775    JMS SEQUEN
2313  7201    CLA IAC
2314  3774    DCA BFSTEP
2315  3126    DCA PRELOD
2316  1066    TAD P7777
2317  3006    DCA MASK
2320  1350    TAD PP7600    /100 FOR U-P;LOW 8 BITS OF DMA
2321  4775    JMS SEQUEN
2322  7200    CLA
2323  1040    TAD P20
2324  3774    DCA BFSTEP
2325  3126    DCA PRELOD
2326  1352    TAD PP7610    /104 FOR U-P;; DMAHI FROM PDP 8
```

```
P9
2327   4775     JMS SEQUEN
2330   7201     CLA IAC
2331   3774     DCA BFSTEP
2332   1046     TAD P301
2333   3126     DCA PRELOD     /INITIALIZE DMA BUFFER TO RANDOM
2334   1347     TAD P7200      /CHECK DMAHI TO PDP8
2335   4775     JMS SEQUEN     /200 FOR U-PROC.
2336   5773     JMP CHK200
                /
2337    160   P160,160
2340   7120   P7120,7120
2341    120   P120,120
2342    110   P110,110
2343     40   P40,40
2344     50   P50,50
2345      2   P2,2
                /
2346   5777   P5777,5777
2347   7200   P7200,7200
2350   7600   PP7600,7600
2351   7700   P7700,7700
2352   7610   PP7610,7610
                /
                PAUSE/
                /
                /FIO2
                /
2373   2400
2374   2166
2375   2000
2376   1637
2377   2062
                PAGE
                /
2400   1040   CHK200,TAD P20  /NOW CHECK DMA BUFFER
2401   3125     DCA COMPAR
2402   1527   NEX200,TAD I ADDRES
2403     63     AND P7760
2404   3111     DCA TSAVE
2405   1111     TAD TSAVE
2406   1125     TAD COMPAR
2407   7640     SZA CLA
2410   4256     JMS ERRDBK     /RECEIVED WRONG CODE
2411   6031     KSF
2412   5217     JMP NOTGEE
2413   6036     KRB
2414   1777     TAD M307
2415   7650     SNA CLA
2416   5231     JMP TESTWC     /EXIT IF G IS TYPED
2417   1125   NOTGEE,TAD COMPAR
2420   1040     TAD P20
2421   3125     DCA COMPAR     /READY FOR NEXT NUMBER
2422   4776     JMS KEYTES
2423   7650     SNA CLA
2424   5231     JMP TESTWC
2425   2127     ISZ ADDRES     /EXPECT A SERIES 7770,7760,7750,ETC.
2426   2123     ISZ RCOUNT
2427   5202     JMP NEX200
2430   5231     JMP TESTWC
                /
```

```
P:
2431  1046  TESTWC,TAD P301 /CHECK WORD 371 UNTOUCHED
2432  1047    TAD P370
2433  7041    CIA
2434  1640    TAD I P4370
2435  7650    SNA CLA
2436  5306    JMP TESTFF
2437  5241   JMP WCBAD
              /
2440  4370  P4370,4370
2441  4420  WCBAD,JMS I MESAGX
2442  2703  TEXT /WC
2443  1740  0
2444   411  DI
2445   416  DN
2446  4724  'T
2447  4023   S
2450  2417  TO
2451  2040  P
2452   415  DM
2453   141  A!
2454        /
2455  5306    JMP TESTFF
              /
2456        ERRDBK,0
2457  4420    JMS I MESAGX
2460   401  TEXT /DA
2461  2401  TA
2462  4002   B
2463  2205  RE
2464   113  AK
2465  4005   E
2466  2222  RR
2467  1722  OR
2470  7305  $E
2471  3020  XP
2472   503  EC
2473  2454  T,
2474   717  GO
2475  2400  T/
2476  1125    TAD COMPAR
2477  7041    CIA
2500     6    AND MASK
2501  4775    JMS POCTAL
2502  1111    TAD TSAVE
2503     6    AND MASK
2504  4775    JMS POCTAL
2505  5656    JMP I ERRDBK
              /
              /
2506  1046  TESTFF,TAD P301 /CHECK DMA-LOW 4 BITS
2507  3126    DCA PRELOD
2510  1036    TAD P17
2511  3006    DCA MASK
2512  1335    TAD P7710      /=344 FOR U-PROC,
2513  4774    JMS SEQUEN
2514  1063    TAD P7760
2515  3125    DCA COMPAR
2516  1527  FFNEXT,TAD I ADDRES
2517  3111    DCA TSAVE
2520  1111    TAD TSAVE
```

```
P$
2521   1125     TAD COMPAR
2522   7001     IAC
2523      6     AND MASK
2524   7640     SZA CLA
2525   4256     JMS ERRDBK
2526   7000     OPR
2527   1127     TAD ADDRES
2530   1040     TAD P20
2531   3127     DCA ADDRES
2532   2125     ISZ COMPAR
2533   5316     JMP FFNEXT
2534   5773     JMP TSPEED
2535   7710   P7710,7710
              /
2573   2600
2574   2000
2575   1637
2576   2076
2577   2075
              PAGE
              /
              MUY=7405
              MQL=7421
              DVI=7407
              /
2600   7240   TSPEED,CLA CMA   /NOW MEASURE DISC PERIOD
2601   1052     TAD P4000
2602   3504     DCA I P7755
2603   1064     TAD P7770
2604   4777     JMS WAITIO
2605   1276     TAD P7330      /=254 FOR U-PROC.
2606   6766     DTCA!DTXA
2607   1033     TAD M50
2610   1033     TAD M50
2611   3030     DCA TIME
2612   3076     DCA TEMP
2613   2076     ISZ TEMP
2614   5213     JMP .-1
2615   2030     ISZ TIME
2616   5213     JMP .-3        /WAIT FOR DISC PERIODS
              /
2617   4420   JMS I MESAGX
2620    411   TEXT /DI
2621   2303   SC
2622   4020    P
2623    522   ER
2624   1117   IO
2625    440   D
2626   2310   SH
2627   1725   OU
2630   1404   LD
2631   4002    B
2632    540   E
2633   6166   16
2634   6656   6.
2635   6055   0-
2636   5561   -1
2637   6670   68
2640   5660   .0
2641   4015    M
```

Sept 7/77

```
P<
2642  2373  S$
2643  1123  IS
2644  4000   /
2645  1452    TAD I P4000    /PERIOD IS N*3077/16
2646  7040    CMA    /DMA GIVES COMPLEMENT OF NO. HERE
2647  7425    MQL!MUY
2650  1323    1323   /3077/4 (/1.06 FOR 1.06 MHZ CLOCK)
2651  7407    DVI
2652   620    620    /DIV. BY 400 TO GET ANS.*10MSEC.
2653  7300    CLA CLL
2654  7407    DVI
2655  1750    1750   /1000'S
2656  4277    JMS PRIN       /PRINTING IN DECIMAL
2657  7407    DVI
2660   144    144    /100'S
2661  4277    JMS PRIN
2662  7407    DVI
2663    12    12     /10'S
2664  4277    JMS PRIN
2665  1275    TAD P256
2666  4422    JMS I TYPEX
2667  1307    TAD REMAIN
2670  7421    MQL
2671  4277    JMS PRIN
2672  1776  EXITF,TAD FIO
2673  3076    DCA TEMP
2674  5476    JMP I TEMP
              /
2675   256  P256,256
2676  7330  P7330,7330
              /
2677        PRIN,0
2700  3307    DCA REMAIN
2701  7501    MQA
2702  1045    TAD P260
2703  4422    JMS I TYPEX
2704  1307    TAD REMAIN
2705  7421    MQL
2706  5677    JMP I PRIN
              /
2707        REMAIN,0
2776  2200
2777  2062
```

(110)

FR 3
May 13/77

```
.PALH
*OUT-S:FTES
*
*IN-S:TOGO,S:TELY,S:FTES
*
*
*
*OPT-T
```

This holds the head down and moves to any track, no matter what disc format is used.

```
ACCUM    74
                /
                /
                /TOGO-ROUTINES FOR FTOG
                /
                MQL=7421
                MQA=7501
                RDREG1=6751
                DTRA=6761
                DTCA=6762
                DTXA=6764
                DTSF=6771
                DTRB=6772
                DTLB=6774
                CDF=6201
                CIF=6202
                /
                FTOGX=4
                UTOGX=5
                MASK=6
                PCOUNT=7
                /
                MESAGX=20
                CRLFX=21
                TYPEX=22
                POCTLX=23
                OCTALX=24
                /
                *30
  30            TIME,0
  31   7775     M3,-3
  32   7774     M4,-4
  33   7730     M50,-50
  34   7634     M144,-144
  35   7401     M377,-377
                /
  36     17     P17,17
  37     44     P44,44
  40     20     P20,20
  41    100     P100,100
  42    104     P104,104
  43    200     P200,200
  44    240     P240,240
  45    260     P260,260
  46    301     P301,301
  47    370     P370,370
  50    374     P374,374
  51    400     P400,400
  52   4000     P4000,4000
  53   4004     P4004,4004
```

```
P2
   54   4016   P4016,4016
   55   4200   P4200,4200
   56   4201   P4201,4201
   57   7040   P7040,7040
   60   7050   P7050,7050
   61   7654   P7654,7654
   62   7674   P7674,7674
   63   7760   P7760,7760
   64   7770   P7770,7770
   65   7774   P7774,7774
   66   7777   P7777,7777
   67     70   P70,70
   70     10   P10,10
   71   7770   M10,-10
   72          COUNT,0
   73          KTEST,0
   74          ACCUM,0
   75          TEST,0
   76          TEMP,0
   77          TEMP2,0
  100   7600   P7600,7600
  101   5001   P5001,5001
  102   7210   P7210,7210
  103   7220   P7220,7220
  104   7755   P7755,7755
  105   7754   P7754,7754
  106   7410   P7410,7410
  107    222   M7556,-7556
  110          TESTQ,0
  111          TSAVE,0
  112   5070   M2710,-2710
  113     76   TEMPNT,TEMP
  114   7776   M2,-2
  115   7766   M12,-12
  116   7530   M250,-250
  117          HTEMP,0
  120          COUNTF,0
  121          FCOUNT,0
  122   5402   JMPI2,JMP I 2
  123          RCOUNT,0
  124          REGTEM,0
  125          COMPAR,0
  126          PRELOD,0
  127          ADDRES,0
  130          BYTE,0
  131    130   BYTPNT,BYTE
  132          AREG,0
               /
               /TSLOOP RETURNS TO CALL+2,UNLESS KEY
               /CORRESPONDING TO 'TEST' IS PRESSED
               *1600
 1600          TSLOOP,0          /TEST FOR SCOPE LOOP
 1601   3074     DCA ACCUM       /SAVE AC
 1602   2073     ISZ KTEST
 1603   6034     KRS
 1604   7041     CIA
 1605   1073     TAD KTEST
 1606   7650     SNA CLA
 1607   5213     JMP LOOP
 1610   2200     ISZ TSLOOP
```

```
P3
1611  1074    TAD ACCUM
1612  5600    JMP I TSLOOP  /NO LOOP
1613  7240  LOOP,CLA CMA
1614  1073    TAD KTEST
1615  3073    DCA KTEST     /REPEAT
1616  5600    JMP I TSLOOP
              /
              /
1617          WAITER,0        /START I/O OPERATION AND WAIT FOR FLAG
1620  6766    DTCA!DTXA       /EXITS TO CALL+2 IF NO RESPONSE
1621  1033    TAD M50
1622  3030    DCA TIME
1623  6771  WAIT,DTSF        /WAIT 1 SEC
1624  7410    SKP
1625  5233    JMP OKOUT       /FLAG SEEN
1626  2072    ISZ COUNT
1627  5223    JMP WAIT
1630  2030    ISZ TIME
1631  5223    JMP WAIT
1632  5235    JMP WERR        /NO RESPONSE
1633  6772  OKOUT,DTRB        /TEST ERR. FLAG
1634  7710    SPA CLA
1635  2217  WERR,ISZ WAITER /ERROR
1636  5617    JMP I WAITER
              PAUSE/
              /
              /TELY
              /MESAGE PACKAGE WHEN FOCAL NOT USED
              /CALL:JMS MESAG
              /   ...TEXT /..../
              /
              SHL=7413
              /
              /
1637          POCTAL,0
1640  7421    MQL
1641  1032    TAD M4
1642  3121    DCA FCOUNT
1643  1044    TAD P240
1644  4422    JMS I TYPEX
1645  7413  PRN,SHL
1646     2    2
1647  1045    TAD P260
1650  4422    JMS I TYPEX
1651  2121    ISZ FCOUNT
1652  5245    JMP PRN
1653  5637    JMP I POCTAL
              HERE=.
              /
              *POCTLX
  23  1740    PRINTA
              /
              *OCTALX
  24  1637    POCTAL
              /
              *MESAGX
  20  1654  MESAG
              *CRLFX
  21  1701  CRLF
              *TYPEX
```

```
P4
  22  1711  TYPE
            /
            *HERE
1654        MESAG,0
1655  4301    JMS CRLF
1656  1654  PRINT,TAD I MESAG
1657  2254    ISZ MESAG
1660  7421    MQL
1661  4264    JMS CHARP
1662  4264    JMS CHARP
1663  5256    JMP PRINT
            /
1664        CHARP,0
1665  7413    SHL
1666     5     5
1667  7450    SNA
1670  5654    JMP I MESAG
1671  1277    TAD M40
1672  7500    SMA
1673  1041    TAD P100
1674  1300    TAD P140
1675  4311    JMS TYPE
1676  5664    JMP I CHARP
            /
1677  7740  M40,-40
1700   140  P140,140
            /
1701        CRLF,0  /PRINT A LINE FEED
1702  1310    TAD P215
1703  4311    JMS TYPE
1704  1307    TAD P212
1705  4311    JMS TYPE
1706  5701    JMP I CRLF
            /
1707   212  P212,212
1710   215  P215,215
            /
1711        TYPE,0  /PRINT A CHARACTER FROM AC
1712  3344    DCA TTEMP      /IF SW.0 SET,:NO TYPING
1713  7604    LAS
1714  7001    IAC   /TEST SW. REG. ALL 1'S
1715  7650    SNA CLA
1716  5324    JMP TRY
1717  1344    TAD TTEMP
1720  6046    TLS
1721  6041    TSF
1722  5321    JMP .-1
1723  7200    CLA
1724  6031  TRY,KSF
1725  5711    JMP I TYPE     /NORMAL EXIT
1726  6034    KRS
1727  1337    TAD M203       /TEST CTRL-C
1730  7640    SZA CLA
1731  5711    JMP I TYPE
1732  6032  QUITIT,KCC
1733  6203    CDF!CIF
1734  6766    DTCA!DTXA      /BE SURE UPROC IS IN NORMAL PLACE
1735  5736    JMP I .+1
1736  7600    7600
            /
```

```
F5
1737  7575  M203,-203
            /
1740        PRINTA,0
1741  1074    TAD ACCUM
1742  4237    JMS POCTAL
1743  5740    JMP I PRINTA
            /
1744        TTEMP,0
            PAUSE/
            /
            /FTES
            /ALLOWS FLOPPY DISC HEAD TO BE LOADED AND STEPPED ON
            /AN UNFORMATTED DISC.
            /USE PDP 8 SWITCH REGISTERS TO SELECT TRACK NO.
            /
            MQL=7421
            MQA=7501
            MUY=7405
            *200
 200  7300  CLA CLL
 201  4420    JMS I MESAGX
 202  2205  TEXT /RE
 203   104  AD
 204  4017   O
 205  1614  NL
 206  3141  Y!
 207  4120  !P
 210  2524  UT
 211  4024   T
 212   523  ES
 213  2440  T
 214   411  DI
 215  2303  SC
 216  4011   I
 217  1640  N
 220  2516  UN
 221  1124  IT
 222  4060   0
 223        /
 224  4420  JMS I MESAGX
 225  2305  TEXT /SE
 226  2440  T
 227  2422  TR
 230   103  AC
 231  1340  K
 232  1617  NO
 233  5640  .
 234   617  FO
 235  2240  R
 236  2405  TE
 237  2324  ST
 240  4004   D
 241  1123  IS
 242   340  C
 243  1116  IN
 244  4023   S
 245  2711  WI
 246  2403  TC
 247  1040  H
 250  2205  RE
```

```
 251   711   OI
 252  2324   ST
 253   522   ER
 254  2300   S/
 255  4421     JMS I CRLFX
 256  4420     JMS I MESAGX
 257  2022   TEXT /PR
 260   523   ES
 261  2340   S
 262  1305   KE
 263  3140   Y
 264  2710   WH
 265   516   EN
 266  4022    R
 267   501   EA
 270   431   DY
 271         /
 272  6036     KRB
 273  6031     KSF
 274  5273     JMP .-1          /WAIT FOR KEY
 275  5777    JMP NEXPAG
             /
 377   400
             PAGE
 400  7200   NEXPAG,CLA
 401  1113     TAD TEMPNT
 402  3504     DCA I P7755     /SET DMA ADDRESS FOR SEARCH
 403  6774     DTLB  /FIELD 0
 404  1043     TAD P200
 405  6766     DTCA!DTXA       /MOVE TEST DISC TO TRACK 0
 406  6772     DTRB  /WAIT FOR ERROR CODE
 407  7700     SMA CLA
 410  5206     JMP .-2
 411  4247     JMS DELAY
 412  1260   FORW,TAD P210     /SEARCH FORWARD ON DISC 0--NO ACTUAL READ TEST
 413  6766     DTCA!DTXA       /SINCE DISC WILL BE FOUND ENABLED.
 414  7604   TESTF,LAS         /READ SWITCH REG.
 415  1262     TAD M116
 416  7700     SMA CLA
 417  5244     JMP TOP          /MOVE ONLY TO TOP OF DISC(TRACK 78)
 420  7604     LAS
 421  7425   CALCUL,MQL!MUY    /CALCULATE CENTER BLOCK OF  DESIRED TRACK
 422    23     23
 423  7701     CLA!MQA
 424  7041     CIA
 425  1071     TAD M10          /GO TO CENTER OF TRACK
 426  3263     DCA TARGET
 427  1513     TAD I TEMPNT
 430  7421     MQL
 431  1264     TAD MM100
 432  3010     DCA 10           /SET  300 U SEC. DELAY
 433  2010     ISZ 10           /DISPLAY BLOCK NO.
 434  5233     JMP .-1
 435  1513     TAD I TEMPNT
 436  1263     TAD TARGET
 437  7710     SPA CLA
 440  5212     JMP FORW         /BLOCK NO. TOO SMALL
 441  1261   BAKWAR,TAD P610 /SEARCH BACKWARD
 442  6766     DTCA!DTXA
 443  5214     JMP TESTF
```

```
P7
 444   1262   TOP,TAD M116
 445   7041     CIA
 446   5221     JMP CALCUL
                /
 447          DELAY,0
 450   1032     TAD M4
 451   3076     DCA TEMP
 452   3010     DCA 10
 453   2010     ISZ 10
 454   5253     JMP .-1
 455   2076     ISZ TEMP
 456   5253     JMP .-3
 457   5647     JMP I DELAY
                /
 460    210   P210,210
 461    610   P610,610
 462   7662   M116,-116
 463          TARGET,0
 464   7700   MM100,-100

.


 LOAD         $

.LOAD
*IN-S:FTES
*
ST=
^C
.SAVE FTES!0-577,1600;200
.FTES
READ ONLY!!PUT TEST DISC IN UNIT 0
SET TRACK NO. FOR TEST DISC IN SWITCH REGISTERS

PRESS KEY WHEN READY
.FTVE
.FTES
READ ONLY!!PUT TEST DISC IN UNIT 0
SET TRACK NO. FOR TEST DISC IN SWITCH REGISTERS

PRESS KEY WHEN READY
.PIR
*OPT-S

*OUT-D7:FTES
*
*IN-S:FTES
*^
*OPT-
.
```

(117)

FR 12 · JUNE 10/77
1.06 MHZ

```
 PALH
*OUT-S:MARK
*
*IN-S:CON4,S:TELY,S:MAKE,S:MAK2
*
*
*
*
*OPT-T

ACCUM     41

                  /
                  /**********************SAVE MARK!0-1577;200
                  /CON4-MINIMUM SET OF CONSTANTS
                  /
                  MESAGX=20
                  CRLFX=21
                  TYPEX=22
                  POCTLX=23
                  OCTALX=24
                  /
                  SHL=7413
                  MQL=7421
                  MQA=7501
                  SKPFL1=6752
                  RDREG1=6751
                  DTRA=6761
                  DTCA=6762
                  DTXA=6764
                  DTSF=6771
                  DTRB=6772
                  DTLB=6774
                  /
                  CDF=6201
                  CIF=6202
                  /
                  *30
   30             CHAR,0
   31             HEXBFL,0
   32             HEXBFH,0
   33             ADDLO,0
   34             ADDHI,0
   35             BYTE,0
   36      35     BYTPNT,BYTE
   37             TEMP,0
   40             COUNT,0
   41             ACCUM,0
   42             TIME,0
   43    7754     P7754,7754
   44             FCOUNT,0
   45    7755     P7755,7755
   46    7774     M4,-4
   47    7772     M6,-6
   50    7730     M50,-50
   51      17     P17,17
   52     240     P240,240
   53     260     P260,260
   54     100     P100,100
                  /
                  PAUSE/
```

```
                /
                /TELY
                /MESAGE PACKAGE WHEN FOCAL NOT USED
                /CALL:JMS MESAG
                /   ...TEXT /..../
                /
                SHL=7413
                /
                /
   55           POCTAL,0
   56   7421      MQL
   57   1046      TAD M4
   60   3044      DCA FCOUNT
   61   1052      TAD P240
   62   4422      JMS I TYPEX
   63   7413   PRN,SHL
   64      2      2
   65   1053      TAD P260
   66   4422      JMS I TYPEX
   67   2044      ISZ FCOUNT
   70   5063      JMP PRN
   71   5455      JMP I POCTAL
                HERE=.
                /
                *POCTLX
   23    156      PRINTA
                /
                *OCTALX
   24     55      POCTAL
                /
                *MESAGX
   20     72   MESAG
                *CRLFX
   21    117   CRLF
                *TYPEX
   22    127   TYPE
                /
                *HERE
   72           MESAG,0
   73   4117      JMS CRLF
   74   1472   PRINT,TAD I MESAG
   75   2072      ISZ MESAG
   76   7421      MQL
   77   4102      JMS CHARP
  100   4102      JMS CHARP
  101   5074      JMP PRINT
                /
  102           CHARP,0
  103   7413      SHL
  104      5       5
  105   7450      SNA
  106   5472      JMP I MESAG
  107   1115      TAD M40
  110   7500      SMA
  111   1054      TAD P100
  112   1116      TAD P140
  113   4127      JMS TYPE
  114   5502      JMP I CHARP
                /
  115   7740   M40,-40
```

```
P3
 116    140   P140,140
              /
 117          CRLF,0  /PRINT A LINE FEED
 120   1126     TAD P215
 121   4127     JMS TYPE
 122   1125     TAD P212
 123   4127     JMS TYPE
 124   5517     JMP I CRLF
              /
 125    212   P212,212
 126    215   P215,215
              /
 127          TYPE,0  /PRINT A CHARACTER FROM AC
 130   3162     DCA TTEMP      /IF SW.0 SET,:NO TYPING
 131   7604     LAS
 132   7001     IAC    /TEST SW. REG. ALL 1'S
 133   7650     SNA CLA
 134   5142     JMP TRY
 135   1162     TAD TTEMP
 136   6046     TLS
 137   6041     TSF
 140   5137     JMP .-1
 141   7200     CLA
 142   6031   TRY,KSF
 143   5527     JMP I TYPE     /NORMAL EXIT
 144   6034     KRS
 145   1155     TAD M203       /TEST CTRL-C
 146   7640     SZA CLA
 147   5527     JMP I TYPE
 150   6032   QUITIT,KCC
 151   6203     CDF!CIF
 152   6766     DTCA!DTXA      /BE SURE UPROC IS IN NORMAL PLACE
 153   5554     JMP I .+1
 154   7600     7600
              /
 155   7575   M203,-203
              /
 156          PRINTA,0
 157   1041     TAD ACCUM
 160   4055     JMS POCTAL
 161   5556     JMP I PRINTA
              /
 162          TTEMP,0
              PAUSE/
              /
              /MAKE
              /WRITES FORMAT ON FLOPY DISC,
              /TESTS THAT ALL BLOCKS CAN BE READ
              /
              *200
 200   7200   MAKE,CLA
 201   4420     JMS I MESAGX
 202   2025   TEXT /PU
 203   2440   T
 204    214   BL
 205    116   AN
 206   1340   K
 207    411   DI
 210   2303   SC
 211   4011    I
```

```
P4
 212  1640  N
 213  2516  UN
 214  1124  IT
 215  4067   7
 216        /
 217  4420    JMS I MESAGX
 220  2305  TEXT /SE
 221  2440  T
 222  2722  WR
 223  1124  IT
 224   540  E
 225   116  AN
 226   440  D
 227   617  FO
 230  2215  RM
 231   124  AT
 232  4023   S
 233  2711  WI
 234  2403  TC
 235  1005  HE
 236  2300  S/
            /
 237  4777  STARTP,JMS SPEEDT        /CHECK DISC SPEED
 240  7300    CLA CLL
 241  6774    DTLB
 242  4421  G02,JMS I CRLFX
 243  1371    TAD P7260       /FORMATTING CODE
 244  6766    DTCA!DTXA
 245  3042    DCA TIME
            /
 246  6751  WAIT,RDREG1       /FORM CLEARS REG1 TO START
 247  7650    SNA CLA
 250  5254    JMP ZEROED
 251  2042    ISZ TIME
 252  5246    JMP WAIT
 253  5265    JMP NOTHIN
 254  3042  ZEROED,DCA TIME
 255  6751  WAIT9,RDREG1
 256  1264    TAD P3160       /TEST'99' IN FORM
 257  7650    SNA CLA
 260  5307    JMP OK
 261  2042    ISZ TIME
 262  5255    JMP WAIT9
 263  5265    JMP NOTHIN
            /
 264  3160  P3160,3160
            /
 265  4420  NOTHIN,JMS I MESAGX
 266  1617  TEXT /NO
 267  4022   R
 270   523  ES
 271  2017  PO
 272  1623  NS
 273   556  E.
 274  5623  .S
 275   524  ET
 276  2520  UP
 277  7727  'W
 300  2211  RI
 301  2405  TE
```

```
P5
 302   4014    L
 303   1703   OC
 304   1377   K?
 305          /
 306   5200     JMP MAKE
              /
 307   4420   OK,JMS I MESAGX
 310    617   TEXT /FO
 311   2215   RM
 312    124   AT
 313   2411   TI
 314   1607   NG
 315   4100   !/
 316   1372     TAD M1200      /SET 20 SEC DELAY
 317   3042     DCA TIME
 320   6752   WAIT2,SKPFL1
 321   7410     SKP
 322   5776     JMP ERTEST
 323   2037     ISZ TEMP
 324   5320     JMP WAIT2
 325   1042     TAD TIME
 326   7421     MQL   /KEEP OPERATOR HAPPY
 327   2042     ISZ TIME
 330   5320     JMP WAIT2
 331   4072     JMS MESAG
 332   1025   TEXT /HU
 333   1607   NG
 334   4025    U
 335   2077   P?
 336          /
 337   4421     JMS I CRLFX
 340   4421     JMS I CRLFX
 341   6031   EXIT,KSF
 342   5341     JMP .-1
 343   6036     KRB
 344   1775     TAD M322       /REPEAT FOR R
 345   7650     SNA CLA
 346   5200     JMP MAKE
 347   5750   EXIT2,JMP I .+1
 350   7600     7600
              /
 351          WAITER,0
 352   6766   DTCA!DTXA
 353   1050     TAD M50
 354   3042     DCA TIME
 355   6771   WAITIN,DTSF      /WAIT FOR RESPONSE FROM UPROC
 356   7410     SKP
 357   5365     JMP OKOUT
 360   2040     ISZ COUNT
 361   5355     JMP WAITIN
 362   2042     ISZ TIME
 363   5355     JMP WAITIN
 364   5367     JMP WERR       /TIMED OUT
 365   6772   OKOUT,DTRB
 366   7710     SPA CLA
 367   2351   WERR,ISZ WAITER /ERROR RETURN
 370   5751     JMP I WAITER
              /
 371   7260   P7260,7260
 372   6600   M1200,-1200
```

```
P6
 375  1362
 376  1322
 377   400
                PAGE
                /
                DVI=7407
                MUY=7405
                /
 400            SPEEDT,0
 401  6036        KRB
 402  7200        CLA
 403  4420        JMS I MESAGX
 404  2431      TEXT /TY
 405  2005      PE
 406  4007       G
 407  4024       T
 410  1740      O
 411   717      GO
 412            /
 413  6031        KSF
 414  5213        JMP .-1
 415  6036        KRB
 416  1155        TAD M203        /TEST CTRL-C
 417  7650        SNA CLA
 420  5777        JMP EXIT2
 421  1334      RESTAR,TAD P7770
 422  4353        JMS WAITIO
 423  1335        TAD P7160       /HANDSHAKING WITH FBUG IN UPROC.
 424  4353        JMS WAITIO
 425  1336        TAD P7120
 426  4353        JMS WAITIO
 427  7240        CLA CMA
 430  1331        TAD PP4000
 431  3445        DCA I P7755     /PREPARE DMA XFER OF SPEED
 432  1337        TAD P7330       /=254 FOR UPROC "FBUG"
 433  6766        DTCA!DTXA       /NEEDS 1/2 SEC.
 434  1352        TAD M100
 435  3042        DCA TIME
 436  2037        ISZ TEMP
 437  5236        JMP .-1
 440  2042        ISZ TIME
 441  5236        JMP .-3         /WAIT TILL PERIOD HAS BEEN MEASURED
 442  4420        JMS I MESAGX
 443   411      TEXT /DI
 444  2303      SC
 445  4020       P
 446   522      ER
 447  1117      IO
 450   440      D
 451  2310      SH
 452  1725      OU
 453  1404      LD
 454  4002       B
 455   540      E
 456  6166      16
 457  6656      6.
 460  6055      0-
 461  5561      -1
 462  6670      68
 463  5660      .0
```

```
F7
 464   7311   $I
 465   2340   S
 466          /
 467   7300     CLA CLL
 470   6766     DTCA!DTXA       /RESET UPROC
 471   1731     TAD I PP4000    /PERIOD IS N*3077/16
 472   7040     CMA    /DMA INVERTS N
 473   7425     MQL!MUY
 474   1323     1323   /3077/4 (/1.06 FOR 1.06 MHZ)..1401 WFOR 1 MHZ
 475   7407     DVI
 476    620     620    /400
 477   7200     CLA
 500   7407     DVI
 501   1750     1750   /1000
 502   4341   PRINDC,JMS PRIN
 503   7407     DVI
 504    144     144    /100
 505   4341     JMS PRIN
 506   7407     DVI
 507     12     12     /10
 510   4341     JMS PRIN
 511   1340     TAD P256        /TYPE "."
 512   4422     JMS I TYPEX
 513   1351     TAD REMAIN
 514   7421     MQL
 515   4341     JMS PRIN
 516   7100     CLL
 517   1731     TAD I PP4000    /CHECK SPEED BEFORE STARTING
 520   1332     TAD P1543
 521   7630     SZL CLA         /TOO FAST?
 522   5330     JMP QUIT        /YES
 523   7100     CLL
 524   1731     TAD I PP4000
 525   1333     TAD P1560       /TOO SLOW?
 526   7630     SZL CLA
 527   5600     JMP I SPEEDT
 530   5776   QUIT,JMP MAKE     /WRONG SPEED
              /
 531   4000   PP4000,4000
 532   1627   P1543,1627        /1.06 MHZ
 533   1642   P1560,1642        /1.06 MHZ
 534   7770   P7770,7770
 535   7160   P7160,7160
 536   7120   P7120,7120
 537   7330   P7330,7330
 540    256   P256,256
              /
 541          PRIN,0
 542   3351     DCA REMAIN
 543   7501     MQA
 544   1053     TAD P260
 545   4422     JMS I TYPEX
 546   1351     TAD REMAIN
 547   7421     MQL
 550   5741     JMP I PRIN
              /
 551          REMAIN,0
 552   7700   M100,-100
              /
              /
```

```
P8
 553          WAITIO,0
 554  6766      DTCA!DTXA
 555  1364      TAD M400
 556  3042      DCA TIME
 557  2042      ISZ TIME
 560  5357      JMP .-1
 561  6752      SKPFL1
 562  5775      JMP NOTHIN
 563  5753      JMP I WAITIO
               /
 564  7400    M400,-400
               PAUSE/
               /
               /MAK2-CONTINUE'S MAKE
               /
 575   265
 576   200
 577   347
               PAGE
               /
 600  7200    FDONE,CLA
 601  3777      DCA TESTQ
 602  6774      DTLB
 603  1323      TAD P7600       /MOVE TO BLOCK 0
 604  4776      JMS WAITER
 605  7000      OPR
 606  7000      OPR
 607  4311      JMS SETUP
 610  7001      IAC
 611  3327      DCA STEPQ
 612  1321    SNEXT,TAD P7210
 613  4215      JMS SERSUB
 614  5300      JMP GOODF
               /
 615          SERSUB,0
 616  6762      DTCA
 617  6764    REPEAT,DTXA       /NOW TEST SEARCH
 620  6771      DTSF
 621  5220      JMP .-1
 622  1725      TAD I TEMPNT
 623  7421      MQL
 624  7501      MQA
 625  3726      DCA I ADDRES
 626  2326      ISZ ADDRES
 627  2324      ISZ RCOUNT
 630  5217      JMP REPEAT
 631  6762      DTCA  /STOP TAPE
 632  4311      JMS SETUP
 633  7000      OPR   /FTOG NEEDS "ISZ RCOUNT" HERE????
 634  1726    TESTIT,TAD I ADDRES
 635  7041      CIA
 636  1777      TAD TESTQ
 637  7640      SZA CLA
 640  4250      JMS SERBAD      /TESTING DMA
 641  2326      ISZ ADDRES
 642  1777      TAD TESTQ
 643  1327      TAD STEPQ
 644  3777      DCA TESTQ
 645  2324      ISZ RCOUNT
 646  5234      JMP TESTIT
```

```
P9
 647  5615     JMP I SERSUB
               /
               /
 650           SERBAD,0
 651  4420     JMS I MESAGX   /TEST Q
 652  2155     TEXT /Q-
 653  2322     SR
 654   310     CH
 655  4002      B
 656  1413     LK
 657  7206     :F
 660  1722     OR
 661  5407     ,G
 662  1724     OT
 663  7300     $/
 664  1777       TAD TESTQ
 665  4055       JMS POCTAL
 666  1726       TAD I ADDRES
 667  4055       JMS POCTAL
 670  6031       KSF
 671  5650       JMP I SERBAD
 672  6036       KRB
 673  1277       TAD M307
 674  7650       SNA CLA        /TEST FOR KEYBOARD 'G'
 675  5615       JMP I SERSUB
 676  5650       JMP I SERBAD
               /
 677  7471     M307,-307
               /
 700  7240     GOODF,CLA CMA    /NOW SEARCH REVERSE
 701  3327       DCA STEPQ
 702  7240       CLA CMA
 703  1777       TAD TESTQ
 704  3777       DCA TESTQ
 705  4311       JMS SETUP
 706  1322       TAD P7610
 707  4215       JMS SERSUB
 710  5330       JMP SEARCH
               /
 711           SETUP,0
 712  1775       TAD P4000
 713  3326       DCA ADDRES
 714  1774       TAD M2710
 715  3324       DCA RCOUNT
 716  1325       TAD TEMPNT
 717  3445       DCA I P7755
 720  5711       JMP I SETUP
               /
 721  7210     P7210,7210
 722  7610     P7610,7610
 723  7600     P7600,7600
 724           RCOUNT,0
 725    37     TEMPNT,TEMP
 726           ADDRES,0
               /
 727           STEPQ,0
               /
               /
 730  7200     SEARCH,CLA       /NOW READ EACH BLOCK
 731  3354       DCA ERCNT
```

```
P:
  732   3777     DCA TESTQ
  733   1325   SRCHON, TAD TEMPNT
  734   3445     DCA I P7755
  735   1321     TAD P7210       /SEARCH FORWARD
  736   4776     JMS WAITER
  737   7410     SKP
  740   5773     JMP SERROR      /NO RESPONSE
  741   6772     DTRB
  742   7710     SPA CLA
  743   5773     JMP SERROR      /ERROR FLAG
  744   1725     TAD I TEMPNT
  745   7421     MQL
  746   7501     MQA    /BLOCK NO TO MQ
  747   7041     CIA
  750   1777     TAD TESTQ
  751   7640     SZA CLA
  752   5333     JMP SRCHON
  753   5772     JMP GOREAD
                 /
  754            ERCNT, 0
  772   1000
  773   1214
  774   1060
  775   1054
  776    351
  777   1064
                 PAGE
 1000   7240   GOREAD, CLA CMA
 1001   1254     TAD P4000
 1002   3445     DCA I P7755
 1003   1264     TAD TESTQ
 1004   7421     MQL
 1005   1263     TAD M250        /ALLOW EXTRA WORDS
 1006   3443     DCA I P7754
 1007   1043     TAD P7754
 1010   3656     DCA I P4201     /1 WORD PAST BUFFER
 1011   1043     TAD P7754
 1012   3655     DCA I P4200
 1013   1257     TAD P7220
 1014   4777     JMS WAITER      /NOW READ THE BLOCK
 1015   7410     SKP
 1016   5776     JMP SERROR      /NO RESPONSE
 1017   6772     DTRB
 1020   7710     SPA CLA
 1021   5775     JMP RERROR
 1022   1656     TAD I P4201
 1023   7041     CIA
 1024   1043     TAD P7754
 1025   7640     SZA CLA
 1026   5774     JMP WCOWNG      /TOO MANY WORDS
 1027   1655     TAD I P4200
 1030   7041     CIA
 1031   1043     TAD P7754
 1032   7650     SNA CLA         /DON'T EXPECT 7754 FROM DISC
 1033   5774     JMP WCOWNG      /TOO FEW WORDS
 1034   5235     JMP REDONE
                 /
                 /
 1035   2264   REDONE, ISZ TESTQ
 1036   1264     TAD TESTQ
```

```
P↓
1037  1260    TAD M2710
1040  7710    SPA CLA
1041  5200    JMP GOREAD     /READ ALL BLOCKS
1042  4420    JMS I MESAGX
1043  2405  TEXT /TE
1044  2324  ST
1045  4004   D
1046  1716  ON
1047   500  E/
1050  4421    JMS I CRLFX
1051  4421    JMS I CRLFX
1052  5653    JMP I .+1
1053  1265    MAKNEX
              /
              /
1054  4000  P4000,4000
1055  4200  P4200,4200
1056  4201  P4201,4201
1057  7220  P7220,7220
1060  5070  M2710,-2710
1061  2777  M5001,-5001
1062  7100  M700,-700
1063  7530  M250,-250
              /
1064        TESTQ,0
              /
1174  1242
1175  1200
1176  1214
1177   351
              PAGE
              /
1200  4420  RERROR,JMS I MESAGX      /R-
1201  2255  TEXT /R-
1202  2205  RE
1203   104  AD
1204  4005   E
1205  2222  RR
1206  1722  OR
1207  7302  ↑B
1210  1417  LO
1211   313  CK
1212  7200  ↑/
1213  5230    JMP TESEND
1214  4420  SERROR,JMS I MESAGX      /S
1215  2355  TEXT /S-
1216  2305  SE
1217   122  AR
1220   310  CH
1221  4005   E
1222  2222  RR
1223  1722  OR
1224  7202  ↑B
1225  1417  LO
1226   313  CK
1227  4000   /
1230  1777  TESEND,TAD TESTQ
1231  4055    JMS POCTAL
1232  2776    ISZ ERCNT
1233  7000    NOP
```

```
P<
1234   1777     TAD TESTQ
1235   1775     TAD M2710
1236   7710     SPA CLA
1237   5255     JMP SERMOV
1240   5641     JMP I .+1
1241   1265   MAKNEX
              /
1242   4420   WCOWNG,JMS I MESAGX      /T-
1243   2455   TEXT /T-
1244   2717   WO
1245   2204   RD
1246   4003    C
1247   1725   OU
1250   1624   NT
1251   4027    W
1252   2217   RO
1253   1607   NG
1254          /
1255   1777   SERMOV,TAD TESTQ
1256   7001     IAC   /SEARCH FOR THE NEXT BLOCK
1257   3777     DCA TESTQ
1260   1774     TAD F7600
1261   4773     JMS WAITER
1262   7000     OPR
1263   7000     OPR
1264   5772     JMP SRCHON
              /
1265   7200   MAKNEX,CLA
1266   1776     TAD ERCNT
1267   7640     SZA CLA
1270   5771     JMP BADISK
1271   4072     JMS MESAG
1272    411   TEXT /DI
1273   2303   SC
1274   4017    O
1275   1354   K,
1276   2431   TY
1277   2005   PE
1300   4022    R
1301   4024    T
1302   1740   O
1303   2205   RE
1304   2005   PE
1305    124   AT
1306          /
1307   6031     KSF
1310   5307     JMP .-1
1311   6036     KRB
1312   1362     TAD M322       /R
1313   7650     SNA CLA
1314   5770     JMP GO2
1315   6036     KRB
1316   1767     TAD M307       /O
1317   7650     SNA CLA
1320   5766     JMP RESTAR
1321   5765     JMP EXIT2
              /
1322   7300   ERTEST,CLA CLL
1323   6751     RDREG1
1324   7112     CLL RTR
```

```
P=
1325   7012     RTR
1326    334     AND P7
1327   1335     TAD LIST
1330   3037     DCA TEMP
1331   1437     TAD I TEMP
1332   3037     DCA TEMP
1333   5437     JMP I TEMP
                /
1334      7     P7,7
                /
1335   1336     LIST,.+1
1336    265     NOTHIN
1337   1346     TOOFAS
1340   1400     TOOSLO
1341   1414     FSWITH
1342   1430     UNABLE
1343   1440     ALLDON
1344    265     NOTHIN
1345    265     NOTHIN
                /
1346   4420     TOOFAS,JMS I MESAGX
1347    411     TEXT /DI
1350   2303     SC
1351   4020      P
1352    522     ER
1353   1117     IO
1354    474     D<
1355   6166     16
1356   6640     6
1357   1523     MS
1360   5600     ./
1361   5764       JMP MAKE
                /
1362   7456     M322,-322
                /
1364    200
1365    347
1366    421
1367    677
1370    242
1371   1453
1372    733
1373    351
1374    723
1375   1060
1376    754
1377   1064
                PAGE
1400   4420     TOOSLO,JMS I MESAGX
1401    411     TEXT /DI
1402   2303     SC
1403   4020      P
1404    522     ER
1405   1117     IO
1406    476     D>
1407   6166     16
1410   7040     8
1411   1523     MS
1412   5600     ./
1413   5777       JMP MAKE
```

```
F>
                    /
1414    4420        FSWITH,JMS I MESAGX
1415     617        TEXT /FO
1416    2215        RM
1417     124        AT
1420    4023         S
1421    2711        WI
1422    2403        TC
1423    1040        H
1424    1706        OF
1425     677        F?
1426                /
1427    5777        JMP MAKE
                    /
1430    4420        UNABLE,JMS I MESAGX
1431     411        TEXT /DI
1432    2303        SC
1433    4025         U
1434    1601        NA
1435     214        BL
1436     500        E/
1437    5777          JMP MAKE
                    /
1440    4420        ALLDON,JMS I MESAGX
1441     417        TEXT /DO
1442    1605        NE
1443    5424        ,T
1444     523        ES
1445    2411        TI
1446    1607        NG
1447    4016         N
1450    1727        OW
1451                /
1452    5776          JMP FDONE
                    /
1453    4072        BADISK,JMS MESAG
1454     411        TEXT /DI
1455    2303        SC
1456    4005         E
1457    2222        RR
1460    1722        OR
1461    5424        ,T
1462    2231        RY
1463    4001         A
1464     701        GA
1465    1116        IN
1466    7700        ?/
1467    5775          JMP STARTP
1575     237
1576     600
1577     200


LOAD
*IN-S:MARK

T=
^
SAVE MARK!0-1577;200
```

```
.PALH
*OUT-S:DDTU
*
*IN-S:CON4,S:TELY,S:DDTU,S:DTU2,S:DTU3
*
*
*
*
*
*OPT-T

ABDONE 1325

                /
                /
                /CON4-MINIMUM SET OF CONSTANTS
                /
                MESAGX=20
                CRLFX=21
                TYPEX=22
                POCTLX=23
                OCTALX=24
                /
                SHL=7413
                MQL=7421
                MQA=7501
                SKPFL1=6752
                RDREG1=6751
                DTRA=6761
                DTCA=6762
                DTXA=6764
                DTSF=6771
                DTRB=6772
                DTLB=6774
                /
                CDF=6201
                CIF=6202
                /
                *30
 30             CHAR,0
 31             HEXBFL,0
 32             HEXBFH,0
 33             ADDLO,0
 34             ADDHI,0
 35             BYTE,0
 36     35      BYTPNT,BYTE
 37             TEMP,0
 40             COUNT,0
 41             ACCUM,0
 42             TIME,0
 43    7754     P7754,7754
 44             FCOUNT,0
 45    7755     P7755,7755
 46    7774     M4,-4
 47    7772     M6,-6
 50    7730     M50,-50
 51      17     P17,17
 52     240     P240,240
 53     260     P260,260
 54     100     P100,100
                /
                PAUSE/
```

P2

```
                /
                /TELY
                /MESAGE PACKAGE WHEN FOCAL NOT USED
                /CALL:JMS MESAG
                /   ...TEXT /..../
                /
                SHL=7413
                /
                /
   55           FOCTAL,0
   56   7421      MQL
   57   1046      TAD M4
   60   3044      DCA FCOUNT
   61   1052      TAD P240
   62   4422      JMS I TYPEX
   63   7413   PRN,SHL
   64      2      2
   65   1053      TAD P260
   66   4422      JMS I TYPEX
   67   2044      ISZ FCOUNT
   70   5063      JMP PRN
   71   5455      JMP I FOCTAL
                HERE=.
                /
                *POCTLX
   23    156      PRINTA
                /
                *OCTALX
   24     55      FOCTAL
                /
                *MESAGX
   20     72   MESAG
                *CRLFX
   21    117   CRLF
                *TYPEX
   22    127   TYPE
                /
                *HERE
   72           MESAG,0
   73   4117      JMS CRLF
   74   1472   PRINT,TAD I MESAG
   75   2072      ISZ MESAG
   76   7421      MQL
   77   4102      JMS CHARP
  100   4102      JMS CHARP
  101   5074      JMP PRINT
                /
  102           CHARP,0
  103   7413      SHL
  104      5       5
  105   7450      SNA
  106   5472      JMP I MESAG
  107   1115      TAD M40
  110   7500      SMA
  111   1054      TAD P100
  112   1116      TAD P140
  113   4127      JMS TYPE
  114   5502      JMP I CHARP
                /
  115   7740   M40,-40
```

```
P3
 116    140   P140,140
               /
 117          CRLF,0  /PRINT A LINE FEED
 120   1126     TAD P215
 121   4127     JMS TYPE
 122   1125     TAD P212
 123   4127     JMS TYPE
 124   5517     JMP I CRLF
               /
 125    212   P212,212
 126    215   P215,215
               /
 127          TYPE,0  /PRINT A CHARACTER FROM AC
 130   3162     DCA TTEMP      /IF SW.0 SET,:NO TYPING
 131   7604     LAS
 132   7001     IAC   /TEST SW. REG. ALL 1'S
 133   7650     SNA CLA
 134   5142     JMP TRY
 135   1162     TAD TTEMP
 136   6046     TLS
 137   6041     TSF
 140   5137     JMP .-1
 141   7200     CLA
 142   6031   TRY,KSF
 143   5527     JMP I TYPE     /NORMAL EXIT
 144   6034     KRS
 145   1155     TAD M203       /TEST CTRL-C
 146   7640     SZA CLA
 147   5527     JMP I TYPE
 150   6032   QUITIT,KCC
 151   6203     CDF!CIF
 152   6766     DTCA!DTXA      /BE SURE UPROC IS IN NORMAL PLACE
 153   5554     JMP I .+1
 154   7600     7600
               /
 155   7575   M203,-203
               /
 156          PRINTA,0
 157   1041     TAD ACCUM
 160   4055     JMS POCTAL
 161   5556     JMP I PRINTA
               /
 162          TTEMP,0
              PAUSE/
               /
              /DDTU
              /TYPE XXXX M TO MODIFY CONTENTS OF XXXX
              /XXXXI TO INSERT FROM PDP8 FIELD 1 TO RAM
              /(NOTE THAT CORE AND RAM ADDRESSES ARE THE SAME
              /XXXX G TO START A PROGRAM AT XXXX IN RAM OR PROM
              /XXXX L TO LIST PROM OR RAM
               /
              *200
 200   4777     JMS WARN       /USE FD 7
 201   5255     JMP BEGIN
               /
 202          GETHEX,0
 203   7300     CLA CLL
 204   3032     DCA HEXBFH
 205   3031     DCA HEXBFL
```

```
F4
 206   3352     DCA GETEST
 207   4776   GETNEX,JMS GETCHR
 210   1030     TAD CHAR        /GETTING A HEX CHAR,OR COMMAND
 211   1362     TAD M260
 212   7710     SPA CLA
 213   5236     JMP SPAC        /<0
 214   1030     TAD CHAR
 215   1364     TAD M272
 216   7710     SPA CLA
 217   5322     JMP HEXO
 220   1030     TAD CHAR
 221   1365     TAD M301
 222   7710     SPA CLA
 223   5232     JMP BAD         /ILLEGAL CHAR
 224   1030     TAD CHAR
 225   1366     TAD M307        /G?
 226   7510     SPA
 227   5346     JMP HEXA
 230   7421     MQL
 231   5602     JMP I GETHEX
               /
 232   1354   BAD,TAD P277
 233   4422     JMS I TYPEX     /?
 234   4421   OUTHEX,JMS I CRLFX
 235   5255     JMP BEGIN
               /
 236   1030   SPAC,TAD CHAR
 237   1361     TAD M240
 240   7650     SNA CLA
 241   5602     JMP I GETHEX    /SPACE FOUND
 242   1030     TAD CHAR
 243   1775     TAD M212
 244   7640     SZA CLA
 245   5250     JMP CRTEST
 246   4421     JMS I CRLFX     /ADD CR FOR LF
 247   5602     JMP I GETHEX    /LF FOUND
 250   1030   CRTEST,TAD CHAR
 251   1360     TAD M215
 252   7640     SZA CLA
 253   5232     JMP BAD         /ILLEGAL CHAR
 254   5261     JMP BEG2        /CR FOUND
               /
               /
 255   6036   BEGIN,KRB         /CLEAR KEYBOARD
 256   6031     KSF
 257   5256     JMP .-1
 260   4774     JMS UTOG        /INITIALIZE FBUG IN UPROC.
 261   7300   BEG2,CLA CLL      /RESTART HERE TO AVOID  RESET OF UPROC.
 262   4421     JMS I CRLFX     /THIS LETS FLOPPY SETUP BE CHANGED
 263   1353     TAD P272        /AND THE FLOPPY TESTED WITH NEW SETUP
 264   4422     JMS I TYPEX
 265   4202     JMS GETHEX
 266   1031     TAD HEXBFL
 267   3033     DCA ADDLO
 270   1032     TAD HEXBFH
 271   3034     DCA ADDHI
 272   1052     TAD P240
 273   4422     JMS I TYPEX
 274   1030     TAD CHAR
 275   1366     TAD M307
```

```
P5
 276  7450     SNA
 277  5717     JMP I GOX        /G
 300  1356     TAD M2           /I ?
 301  7450     SNA
 302  5716     JMP I INSERX
 303  1357     TAD M3           /L?
 304  7450     SNA
 305  5715     JMP I LISTEX
 306  1355     TAD M1           /M?
 307  7450     SNA
 310  5720     JMP I MODIFX
 311  1047     TAD M6
 312  7650     SNA CLA          /S?
 313  5721     JMP I STOREX
 314  5232     JMP BAD
              /
              /
 315   503   LISTEX,LISTER
 316   412   INSERX,INSERT
 317  1106   GOX,GOSTAR
 320  1000   MODIFX,MODIFY
 321   707   STOREX,STORE
              /
 322  1030   HEXO,TAD CHAR
 323  1362     TAD M260
 324  7421   SAVHEX,MQL
 325  7413    SHL
 326     7     7
 327  1031     TAD HEXBFL
 330  7413     SHL
 331     3     3
 332  3031     DCA HEXBFL
 333  1031     TAD HEXBFL      /MOVE UPPER 4 BITS ALSO TO HEXBFH
 334  7421     MQL
 335  1032     TAD HEXBFH
 336  7413     SHL
 337     3     3
 340  3032     DCA HEXBFH
 341  7001     IAC
 342  3352     DCA GETEST      /MARK THAT HEX WAS RECEIVED
 343  1030     TAD CHAR
 344  4422     JMS I TYPEX     /ECHO HEX CHARACTER
 345  5207     JMP GETNEX
 346  7200   HEXA,CLA
 347  1030     TAD CHAR
 350  1363     TAD M267
 351  5324     JMP SAVHEX
              /
 352         GETEST,0
 353   272   P272,272
 354   277   P277,277
 355  7777   M1,-1
 356  7776   M2,-2
 357  7775   M3,-3
 360  7563   M215,-215
 361  7540   M240,-240
 362  7520   M260,-260
 363  7511   M267,-267
 364  7506   M272,-272
 365  7477   M301,-301
```

```
P6
 366  7471  M307,-307
             /
 374  1031
 375  1054
 376   400
 377  1200
             PAGE
             /
 400         GETCHR,0
 401  6031     KSF
 402  5201     JMP .-1
 403  6036     KRB
 404  3030     DCA CHAR
 405  1030     TAD CHAR
 406  1155     TAD M203
 407  7650     SNA CLA        /TEST CTRL-C
 410  5150     JMP QUITIT
 411  5600     JMP I GETCHR
             /
             /
 412  7200  INSERT,CLA
 413  1267     TAD P311       /"I"
 414  4422     JMS I TYPEX
 415  4777     JMS ABSET      /FIX CORE DATA
 416  4334  INSER2,JMS SENDAD        /SEND THE RAM ADDRESS
 417  6211     CDF 10
 420  1651  GOGET,TAD I ADCORE
 421  6201     CDF
 422  3035     DCA BYTE       /READYING BYTE FOR DMA XFER
 423  1035     TAD BYTE
 424  4351     JMS DMAGO      /PREPARE DMA
 425  1253     TAD P7220      /P10 IN FBUG
 426  4776     JMS WAITIO     /SEND THE BYTE
 427  1251     TAD ADCORE
 430  7040     CMA   /TEST FOR END OF CODE
 431  7100     CLL
 432  1775     TAD LASTAD
 433  7420     SNL
 434  5255     JMP DONEIT
 435  7200     CLA
 436  1252     TAD P7230      /P14
 437  4776     JMS WAITIO     /READ BYTE BACK
 440  6751     RDREG1
 441  7041     CIA
 442  1035     TAD BYTE
 443   331     AND P7760
 444  7640     SZA CLA
 445  4774     JMS RAMBAD
 446  4773  GOTOIT,JMS ADRINC        /INCR ADDRESS
 447  2251     ISZ ADCORE
 450  5216     JMP INSER2
             /
 451         ADCORE,0
 452  7230  P7230,7230
 453  7220  P7220,7220
 454   377  P377,377
             /
 455  7200  DONEIT,CLA
 456  4420     JMS I MESAGX
 457  1116  TEXT /IN
```

```
P7
 460   2305   SE
 461   2224   RT
 462   4004    D
 463   1716   ON
 464    500   E/
 465   4421     JMS I CRLFX
 466   5772     JMP BEGIN
               PAUSE/
               /
               /DTU2
               /
 467    311   P311,311
 470          GETBYT,0
 471   4334     JMS SENDAD      /SEND ADDRESS TO U PROC.
 472   1252     TAD P7230       /P14
 473   4776     JMS WAITIO      /ASK FOR DATA BYTE
 474   6751     RDREG1
 475   7112     CLL RTR
 476   7012     RTR
 477   4771     JMS HEXPRN
 500   1052     TAD P240
 501   4422     JMS I TYPEX
 502   5670     JMP I GETBYT
               /
 503   7200   LISTER,CLA
 504   1330     TAD P314        /L
 505   4422     JMS I TYPEX
 506   1046   LIST2,TAD M4
 507   3044     DCA FCOUNT
 510   4421     JMS I CRLFX
 511   4770     JMS ADPRIN      /PRINT ADDRESS
 512   1046   NEXT4,TAD M4
 513   3040     DCA COUNT
 514   4270   NEXHEX,JMS GETBYT        /GET AND PRINT A BYTE
 515   4773     JMS ADRINC
 516   6031     KSF
 517   7410     SKP
 520   5767     JMP BEG2        /STOP FOR ANY KEY
 521   2040     ISZ COUNT
 522   5314     JMP NEXHEX
 523   1052     TAD P240
 524   4422     JMS I TYPEX     /SPACE AFTER EACH 4
 525   2044     ISZ FCOUNT
 526   5312     JMP NEXT4
 527   5306     JMP LIST2
               /
 530    314   P314,314
 531   7760   P7760,7760
 532   7760   M20,-20
 533   7210   P7210,7210
               /
 534          SENDAD,0
 535   7300     CLA CLL
 536   1034     TAD ADDHI
 537   4351     JMS DMAGO       /PREPARE IT FOR DMA
 540   1333     TAD P7210       /P4 IN FBUG
 541   4776     JMS WAITIO      /SEND HI PART OF ADDRESS
 542   4766     JMS COPTES
 543   1033     TAD ADDLO
 544   4351     JMS DMAGO
```

```
P8
 545   1333     TAD P7210
 546   4776     JMS WAITIO      /SEND 2ND HALF OF ADDRESS
 547   4766     JMS COPTES
 550   5734     JMP I SENDAD
                /
                /
                DMAGO,
 551    254       AND P377
 552   7106       CLL RTL        /SET UP FOR DMA XFER
 553   7006       RTL
 554   3035       DCA BYTE
 555   1036       TAD BYTPNT
 556   3445       DCA I P7755
 557   3443       DCA I P7754
 560   5751       JMP I DMAGO
                /
 566    600
 567    261
 570    643
 571    653
 572    255
 573    634
 574   1115
 575   1327
 576   1073
 577   1223
                PAGE
                /
 600            COPTES,0
 601   6751       RDREG1
 602   7041       CIA
 603   1035       TAD BYTE
 604    777       AND P7760
 605   7650       SNA CLA
 606   5600       JMP I COPTES
 607   4420       JMS I MESAGX
 610    201     TEXT /BA
 611    440     D
 612    317     CO
 613   2031     PY
 614   4024      T
 615   1740     O
 616   2540     U
 617   2022     PR
 620   1703     OC
 621   5623     .S
 622    516     EN
 623   2454     T,
 624   2205     RE
 625    104     AD
 626   7300     $/
 627   1035       TAD BYTE
 630   4055       JMS POCTAL
 631   6751       RDREG1
 632   4055       JMS POCTAL
 633   5776       JMP BEGIN
                /
 634            ADRINC,0        /INCREMENT ADDRESS
 635   2033       ISZ ADDLO
 636   1033       TAD ADDLO
```

```
F9
 637   775     AND P377
 640  7650     SNA CLA
 641  2034     ISZ ADDHI      /8 BIT CARRY
 642  5634     JMP I ADRINC
              /
 643           ADPRIN,0
 644  1034     TAD ADDHI
 645  4253     JMS HEXPRN
 646  1033     TAD ADDLO
 647  4253     JMS HEXPRN
 650  1052     TAD P240
 651  4422     JMS I TYPEX
 652  5643     JMP I ADPRIN
              /
 653           HEXPRN,0
 654   775     AND P377
 655  7421     MQL   /PRINT AN 8 BIT BYTE
 656  1774     TAD M3
 657  7001     HEXL,IAC          /OPR FOR OCTAL
 660  3306     DCA TBCONT
 661  1306     TAD TBCONT
 662  1304     TAD P5
 663  3267     DCA HEX1
 664  1267     TAD HEX1
 665  3271     DCA HEX2
 666  7413     SHL   /ONLY PRINT LOWER 8 BITS
 667     2     HEX1,2
 670  7413     NEXTC,SHL
 671     2     HEX2,2  /MOVE 3 FOR OCTAL,4 FOR HEX
 672  1302     TAD AMINUS
 673  7500     SMA
 674  1305     TAD P7
 675  1303     TAD NUMFIX
 676  4422     JMS I TYPEX
 677  2306     ISZ TBCONT
 700  5270     JMP NEXTC
 701  5653     JMP I HEXPRN
              /
 702  7766     AMINUS,-12
 703   272     NUMFIX,272
 704     5     P5,5
 705     7     P7,7
 706           TBCONT,0
              /
              PAUSE/
              /
              /DTU3
              /
 707  7300     STORE,CLA CLL
 710  1362     TAD P323
 711  4422     JMS I TYPEX   /TYPE "S"
 712  4421     ENDLIN,JMS I CRLFX
 713  4243     JMS ADPRIN
 714  1052     TAD P240
 715  4422     JMS I TYPEX
 716  4773     SAVAD,JMS SENDAD
 717  4772     JMS GETHEX     /GET BYTE FROM KEYBOARD
 720  1771     TAD GETEST
 721  7650     SNA CLA
 722  5350     JMP NODAT      /NO NEW DATA
```

```
F:
 723   1052     TAD P240
 724   4422     JMS I TYPEX
 725   1052     TAD P240
 726   4422     JMS I TYPEX
 727   1031     TAD HEXBFL
 730   4770     JMS DMAGO
 731   1767     TAD P7220
 732   4766     JMS WAITIO      /SEND NEW DATA
 733   4234   ISAV,JMS ADRINC
 734   1033     TAD ADDLO
 735    360     AND P3
 736   7640     SZA CLA
 737   5316     JMP SAVAD
 740   1033     TAD ADDLO
 741     51     AND P17
 742   7650     SNA CLA
 743   5312     JMP ENDLIN
 744   1361     TAD P254
 745   4422     JMS I TYPEX
 746   5316     JMP SAVAD
 747   5312     JMP ENDLIN      /NEW LINE
 750   1030   NODAT,TAD CHAR
 751   1765     TAD M240        /TEST FOR SPACE
 752   7640     SZA CLA
 753   5764     JMP BEG2
 754   4763     JMS GETBYT      /GET AND PRINT BYTE
 755   1052     TAD P240
 756   4422     JMS I TYPEX
 757   5333     JMP ISAV
               /
 760      3   P3,3
 761    254   P254,254          /COMMA
 762    323   P323,323
               /
 763    470
 764    261
 765    361
 766   1073
 767    453
 770    551
 771    352
 772    202
 773    534
 774    357
 775    454
 776    255
 777    531
               PAGE
               /
1000   1252   MODIFY,TAD P315 /TYPE M
1001   4422     JMS I TYPEX
1002   4421     JMS I CRLFX
1003   4777   MODNEX,JMS ADPRIN
1004   4776     JMS SENDAD      /SEND ADDRESS
1005   4775     JMS GETBYT      /GET AND PRINT DATA BYTE
1006   4774     JMS GETHEX      /GET REPLACEMENT BYTE,LF OR CR
1007   1773     TAD GETEST
1010   7640     SZA CLA         /DATA GIVEN?
1011   5217     JMP YES
1012   1030   NO,TAD CHAR
```

```
P$
1013  1254    TAD M212        /TEST LF
1014  7650    SNA CLA
1015  5227    JMP SETNEX      /LF SENT
1016  5772    JMP BEG2        /DON'T INVOKE "RESET" AFTER MODIFY
              /
1017  1031    YES,TAD MEXBFL
1020  4771    JMS DMAGO
1021  1770    TAD P7220       /P10 IN FBUG
1022  4273    JMS WAITIO      /SEND NEW DATA
1023  1030    TAD CHAR
1024  1254    TAD M212        /LF SEEN?
1025  7640    SZA CLA
1026  5772    JMP BEG2
              /
1027  4767    SETNEX,JMS ADRINC       /INCR ADDRESS
1030  5203    JMP MODNEX
              /
              /
1031          UTOG,0  /INITIALIZE FBUG
1032  7300    CLA CLL
1033  1036    TAD BYTPNT
1034  3445    DCA I P7755
1035  6766    DTCA!DTXA       /BE SURE WE ARE IN NORMAL MODE
1036  3037    DCA TEMP
1037  2037    ISZ TEMP
1040  5237    JMP .-1
1041  1253    TAD P7770
1042  4273    JMS WAITIO
1043  1251    TAD P160        /HANDSHAKE FOR FBUG
1044  4273    JMS WAITIO
1045  1250    TAD P7120
1046  4273    JMS WAITIO
1047  5631    JMP I UTOG
              /
1050  7120    P7120,7120
1051   160    P160,160
1052   315    P315,315
1053  7770    P7770,7770
1054  7566    M212,-212
              /
              /
1055  4420    ERROR,JMS I MESAGX
1056  2555    TEXT /U-
1057  2022    PR
1060  1703    OC
1061  5640    .
1062   522    ER
1063  2217    RO
1064  2273    R$
1065  1417    LO
1066   356    C.
1067          /
1070  1273    TAD WAITIO
1071  4424    JMS I OCTALX
1072  5766    JMP BEGIN
              /
1073          WAITIO,0
1074  6766    DTCA!DTXA
1075  1304    TAD M400
1076  3037    DCA TEMP
```

```
P<
1077  2037    ISZ TEMP
1100  5277    JMP .-1
1101  6752    SKPFL1
1102  5255    JMP ERROR       /NO RESPONSE FROM UPROC
1103  5673    JMP I WAITIO
              /
1104  7400    M400,-400
1105   307    P307,307
              /
1106          GOSTAR,0        /START UPROC PROGRAM
1107  1305    TAD P307        /"G"
1110  4422    JMS I TYPEX
1111  4776    JMS SENDAD      /SEND ADDRESS FROM ADDHI,ADDLO
1112  1054    TAD P100        /P40 IN FBUG
1113  4273    JMS WAITIO
1114  5772    JMP BEG2        /DON'T INVOKE RESET AFTER "START"
              /
1115          RAMBAD,0
1116  4420    JMS I MESAGX
1117  2201    TEXT /RA
1120  1540    M
1121   201    BA
1122   477    D?
1123  1417    LO
1124   356    C.
1125  5423    ,S
1126   516    EN
1127  2454    T,
1130  2205    RE
1131   104    AD
1132  7200    ;/
1133  1034      TAD ADDHI
1134  4765      JMS HEXPRN
1135  1033      TAD ADDLO
1136  4765      JMS HEXPRN
1137  1035      TAD BYTE
1140  7112      CLL RTR
1141  7012      RTR
1142  4055      JMS POCTAL
1143  6751      RDREG1
1144  7112      CLL RTR
1145  7012      RTR
1146  4055      JMS POCTAL
1147  4421      JMS I CRLFX
1150  5766      JMP BEGIN
              /
1165   653
1166   255
1167   634
1170   453
1171   551
1172   261
1173   352
1174   202
1175   470
1176   534
1177   643
              PAGE
              /
1200          WARN,0
```

```
P=
1201   7300     CLA CLL
1202   4421     JMS I CRLFX
1203   4420     JMS I MESAGX
1204   2305   TEXT /SE
1205   1405   LE
1206    324   CT
1207   4006    F
1210    440   D
1211   6740   7
1212   2417   TO
1213   4005    E
1214   1601   NA
1215    214   BL
1216    540   E
1217    404   DD
1220   2425   TU
1221   4100   !/
1222   5600   JMP I WARN
               /
               /MODIFY 12 BIT ABSOLUTE ADDRESSES TO TWO BYTE ADDRESSES
               /FOR MOS 6502
               /
1223           ABSET,0
1224   4420     JMS I MESAGX
1225   2004   TEXT /PD
1226   2070   P8
1227   4006    F
1230   1105   IE
1231   1404   LD
1232   4061    1
1233   4001    A
1234    404   DD
1235   2205   RE
1236   2323   SS
1237   5017   (0
1240    324   CT
1241    114   AL
1242   5172   ):
1243           /
1244   4334     JMS GETOCL
               /
1245   3777     DCA ADCORE
1246   4420     JMS I MESAGX
1247    611   TEXT /FI
1250   1601   NA
1251   1440   L
1252    104   AD
1253    422   DR
1254    523   ES
1255   2372   S:
1256           /
1257   4334     JMS GETOCL
1260   3327     DCA LASTAD
1261   1777     TAD ADCORE
1262   3331     DCA ADDRTM
1263   7200   GETCOR,CLA
1264   6211     CDF 10          /DATA IS ALWAYS IN FIELD 1
1265   1731     TAD I ADDRTM
1266   7450     SNA
1267   5303     JMP FIXUP
```

```
P>
1270   333     AND PP377
1271  3731     DCA I ADDRTM
1272  6201   NEXTAD,CDF
1273  2331     ISZ ADDRTM
1274  1331     TAD ADDRTM
1275  7041     CIA
1276  7100     CLL
1277  1327     TAD LASTAD
1300  7430     SZL
1301  5263     JMP GETCOR
1302  5325     JMP ABDONE
1303  1331   FIXUP,TAD ADDRTM
1304  7001     IAC
1305  3330     DCA TEMPRR
1306  1730     TAD I TEMPRR
1307   332     AND PP7400     /IS IT AN ADDRESS?
1310  7650     SNA CLA
1311  5324     JMP FIXED      /NO
1312  1730     TAD I TEMPRR
1313   333     AND PP377
1314  3731     DCA I ADDRTM
1315  1730     TAD I TEMPRR
1316   332     AND PP7400
1317  7112     CLL RTR
1320  7012     RTR
1321  7012     RTR
1322  7012     RTR    /GET TOP 4 BITS
1323  3730     DCA I TEMPRR
1324  5272   FIXED,JMP NEXTAD
             /
1325  6201   ABDONE,CDF
1326  5623     JMP I ABSET
             /
1327         LASTAD,0
1330         TEMPRR,0
1331         ADDRTM,0
1332  7400   PP7400,7400
1333   377   PP377,377
             /
1334         GETOCL,0
1335  3330     DCA TEMPRR
1336  4776   GETOCT,JMS GETCHR
1337  1030     TAD CHAR
1340  6046     TLS    /ECHO
1341  1775     TAD M260
1342  7510     SPA
1343  5354     JMP DONEO
1344  7012     RTR
1345  7012     RTR    /MOVE LOW 3 TO TOP
1346  7421     MQL
1347  1330     TAD TEMPRR
1350  7413     SHL
1351     2     2
1352  3330     DCA TEMPRR
1353  5336     JMP GETOCT
1354  7300   DONEO,CLA CLL
1355  1330     TAD TEMPRR
1356  5734     JMP I GETOCL
             /
1375   362
```

```
P?
1376    400
1377    451

.LOAD
*IN-S:DDTU
*
ST=
.SAVE DDTU!0-1377:200
```