AN ABSTRACT OF THE THESIS OF

Cecil L. Nelson, Jr. for the degree of Master of Science in

Computer Science (Major) presented on December 23, 1975 (Date).

Title: A Software Package for an Intelligent Graphic Display Terminal.

Redacted for Privacy

Abstract approved: _____

A cost reduction analysis is performed by coordinating the exchange of LANDSAT (formerly ERTS) data between a CDC 3300 and a PDP8/L minicomputer. The LANDSAT data is displayed on a 4002 Tektronix terminal by means of a grayscale output. Large amounts of data and number manipulation are processed in the PDP8/L in order to reduce the cost of production.

The combination of the PDP8L and the Tektronix terminal has stand alone computational power and appears as an intelligent terminal for the CDC 3300.

A SOFTWARE PACKAGE FOR AN INTELLIGENT GRAPHIC DISPLAY TERMINAL

by

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A THESIS

submitted to

Oregon State University

in partial fulfillment of the requirements

for the degree of

Master of Science

Completed December 29, 1975

Commencement June 1976

APPROVED:

Redacted for Privacy

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Date thesis is presented 12/29/75

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DEDICATION

I would like to thank Dr. J. Herzog, Roy Rathja, and Gary Oliver for the help they gave me in the preparation and production of my thesis.

I would like to dedicate the thesis to my wife Anne, whose encouragement and patience lasted throughout the entire production of my thesis.

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CHAPTER 1

PROBLEM DEFINITION

1.1 Background

The word ERTS is an acronym for Earth Resource Technology Satellite. The Satellite is a 1000 lb instrument which circles the earth in a near-polar orbit at an approximate velocity of 7.32×10^3 miles per hour. Solar radiation is reflected off the surface of the earth and imaged on an array of detectors by a rotating mirror and optics. The mirror oscillates in a west-to-east movement normally from -2.89^{o} to $+2.89^{o}$ at an almost constant rate. The oscillating mirror scans a path of 185 km in width and has an 11.56^{o} field of scan. Six scan lines are taken simultaneously per band to account for the distance covered between retrace cycles. There are four spectral bands being recorded which are shown in the table below.

Table 1

Spectral Band Format

BAND	COLOR	MICROMETERS	NASA REFERENCE NUMBER
1	Green	0.5 to 0.6	4
2	Red	0.6 to 0.7	5
3	Infrared	0.7 to 0.8	6
4	Infrared	0.8 to 1.1	7

From the mirror 24 detectors receive the reflected radiation, 6 detectors per band, and transform the spectral

data into numerical values. The samples are transmitted to a ground-based-receiving site at Goddard Space Flight Center at Greenbelt, Maryland. The samples received from the detectors are callibrated and corrected, then formatted into useable information upon computer compatible magnetic tapes.

The magnetic tapes are formatted in the following manner. The first record of the tape consists of a 23-word identifier header generated by the computer center at Oregon State University. The information found in the 23-word header is shown in Table 2.

Each record corresponds to one scan line (185 km), where there are a maximum of 2340 records per tape. Thus one LANDSAT data tape covers an area of about 185 km by 185 km. Each scan line is composed of a maximum of 3480 PIXELS. The word PIXEL is an acronym for picture element. A PIXEL is one data point, which consists of an area of about 260 ft by 260 ft. Each data point is a vector that consists of six or seven binary bits per band. All of the vector values are rounded off to six bits for data packing convenience in a 24 bit computer word. Therefore, one data point equals one character, where four characters make one word. The tape files are further interwoven as shown in Table 3.

All information on the LANDSAT magnetic tape files can be accessed for manipulation by a FORTRAN BUFFER OUT statement.

Table 2

LANDSAT Header Format

WORD	FORMAT	TYPE	CONTENTS DESCRIPTION
1	I4	ID	day since launch
2	I2	ID	hour at observation time
3	I2	ID	minute at observation time
4	I2	ID	seconds/10 at observation time
5	I5	DV	CDC 3300 words/record
6	1A4	ID	strip number
7	I5	C	first character
8	I5	C	last character
9	I5	DV	orig. first scan line
10	I5	DV	orig. last scan line
11	I5	C	current starting scan line
12	I5	C	number of scan lines
13	I5	ID	adjusted line length
14	I5	AN	day of observation
15	R3	AN	month of observation
16	I2	AN	year of observation
17	R1	AN	center latitude direction
18	I2	AN	center latitude degrees
19	I2	AN	center latitude minutes
20	R1	AN	center longitude direction
21	I3	AN	center longitude degrees
22	I2	AN	center longitude minutes
23	1A4	DV	band or band combination

Table 3

LANDSAT File Format

WORD	BAND CHARACTERS	BAND	NASA REFERENCE NUMBER
1	1-4	1	4
2	1-4	2	5
3	1-4	3	6
4	1-4	4	7
5	5-8	1	4
6	5-8	2	5
7	5-8	3	6
8	5-8	4	7
:	:	:	:
N	i-i+3	J	J+3
N+1	i-i+3	J+1	J+4
:	:	:	:

Where i = INTEGER $[(N-1)/4]*4+1$ and J = $(MOD_4(N-1))+1$.

1.2 Problem Description

This document covers the software design of a distributed computation system for the display of LANDSAT data.

At the present time, in order to obtain a grayscale output of a LANDSAT data file, the program *PIXOUT is used. An explanation of *PIXOUT is found in reference [10]. When using *PIXOUT the grayscale output is oriented towards characters produced by a line printer. The characters produced are either one symbol or overstrikes.

As shown in Figure 1, the complete system consists of a PDP8/L minicomputer, which has a Tektronix Terminal 4002 as a peripheral device, and a CDC 3300 computer with its input processor. Using the graphics display terminal, a wider variety of symbols displayed are possible and some of the data and number manipulation can be done in the PDP8/L. This makes the graphics terminal appear as an intelligent terminal. To accomplish this task three phases of analysis are used.

Phase one, Chapter 2, does a modest amount of data and number manipulation in the PDP8/L and uses those parts of *PIXOUT that deal with a display of the grayscale. This initial phase is done to establish both a basic communication between the CDC 3300 and the PDP8/L, and an estimation of the cost of producing a full screen Tektronix Terminal output.

Phase two, Chapter 3, reduces the parts of *PIXOUT used by increasing the data and number manipulation in the PDP8/L. In addition, some of the *PIXOUT programming is replaced with COMPASS assembler language programming to use less C.P.U. time.

Phase three, Chapter 4, further reduces cost by using an interrupt scheme. Conceptually, the less amount of time taken for the display of LANDSAT data the less C.P.U. time used.

Finally in Chapter six is found a User's Guide for practical application of the analysis.

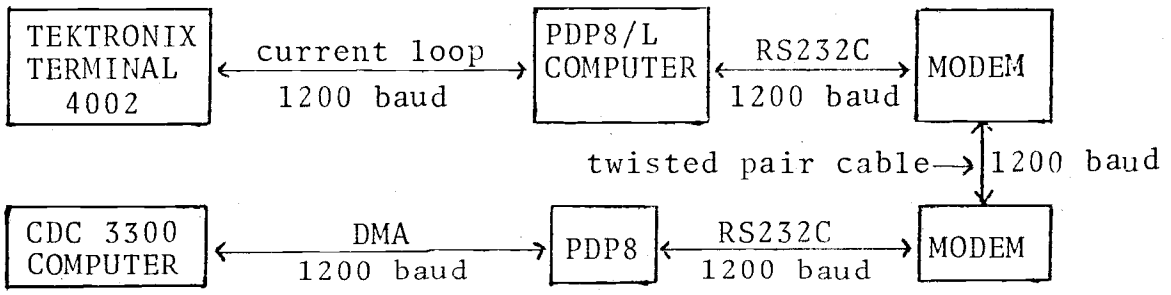


FIGURE 1. BLOCK DIAGRAM OF SYSTEM

CHAPTER 2

PHASE ONE: INITIAL ANALYSIS

2.1 Introduction

To establish a base for analysis, a procedure must be used which yields a valid comparison of the presently used programs to the newly developed programs. The following three headings were adopted for the analysis.

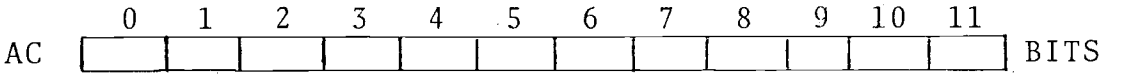
1) Basic Communication: between the CDC 3300 and the PDP8/L
2) Linkage Programs: between the CDC 3300 and the PDP8/L concerning LANDSAT data
3) Comparison Analysis: between the already existing programs and the linkage programs.

2.2 Basic Communication

The first step is to examine how the data are transferred between the CDC 3300 and the PDP8/L. The asynchronous communication system involves a high-speed modem and circuitry to convert the serial data to an eight bit form. This makes the PDP8/L appear as a high-speed receiving device. The information is transferred to the accumulator register (AC) from the interface upon program request. When information is received at the AC via the interface a bit pattern observed as shown in Table 4.

Table 4

Interface Pattern Representation



BITS	REPRESENTATION
11-4	data
3	set if overflow error occurs
2	set if framing error occurs
1	set if parity error occurs
0	set if bits 1, 2, or 3 were set

Information is transmitted at a 1200 baud rate, that is, 1200 bits per second. With each character there are associated 11 bits of information. Thus there are approximately 110 characters sent per second. The 4002 Tektronix terminal contains circuitry which can handle incoming information at a 1200 baud rate.

All I/O instructions for the PDP8/L are of the form 6XXY (octal), where XX is the device code and Y is the operation performed. The I/O operations which can be performed are explained in detail in reference [13]. The device codes that are available are shown in Table 5.

Table 5

Device Code Reference and I/O Instruction Format

DEVICE CODE	REFERENCE	SUBROUTINE MNEMONICS
40	data to CDC 3300	SEND
41	data from CDC 3300	RECEIVE
03	data from keyboard	INPUT
04	data to CRT or TTY	OUTPUT
01	data from HSR	--

When establishing basic communication in the CDC 3300 the best programming language available is FORTRAN. Unique to the CDC FORTRAN at OSU library are two subroutines that are useful in exchanging data. They are explained in Table 6.

Table 6

Subroutines CHIN and CHOUT

NAME	CALLING SEQUENCE	DESCRIPTION
CHIN	CALL CHIN (NX)	Looks for one ASCII character and puts value in Variable NX
CHOUT	CALL CHOUT (NX)	Sends one ASCII character located in Variable NX

Where NX is the form N, NB, or NO, which corresponds to BCD, binary, or octal.

Initially a hand-shake type program between the two computers was developed. The CDC 3300 sends data to the PDP8/L and waits for the PDP8/L to acknowledge that it has received the data. Conversely, the PDP8/L waits for data from the CDC 3300 and then sends data back to acknowledge that the data was received. Two such programs that facilitate all of the above information can be found in appendix 7.1 with an associated resulting output.

A delay loop was necessary when sending values to the CDC 3300 to allow a settling time for the CHIN routine. This loop was augumented in the basic PDP8/L sending routine, with respect to the CDC 3300.

2.3 Linkage Program

To minimize the amount of data and number manipulation, only the grayscale output on the Tektronix terminal was used in the first PDP8/L linkage program. To output LANDSAT data the 0 to 63 PIXEL values are assigned to one of eight symbols. This is accomplished by seven threshold values.

Conceptually there are three modes of operation for number manipulation. The first CDC 3300 linkage program sends values from 0 to nine to indicate which mode of operation to perform. The first mode outputs a grayscale value when the values are sent, corresponding to the number of lines to be drawn 0, 1, 2, 3, 4, 5, 8, or 16. The second mode starts a new scan line when the value six is received. The third mode ends the program when the value seven is received. In the first PDP8/L linkage program there must be routines to facilitate each mode of operation and send back information to the first CDC 3300 linkage program when the operation is completed.

Four package routines are found in appendix 7.2 with an in depth explanation. Two of these routines used in the first PDP8/L linkage program are PACKAGE and INTENSITY. A brief explanation of these routines are shown in Table 7.

The Tektronix terminal 4002 has a 760 by 1024 point resolution. In the INTENSITY routine a 23 by 16 area was selected. The size of the grid area was picked both from

Table 7

Package Routines and General Description

ROUTINES	DESCRIPTION
PACKAGE	Graphic display routines for incremental mode, point plot mode, and vector mode. An output routine and register save and restore routines.
XYPLANE	Uses PACKAGE to output an X-Y axis. The routine expects parameters to give length of axis, center point, and the size of the tic marks.
PATTERN	Uses PACKAGE to output a triangle or square, with parameters to tell the size of the pattern and where to place the pattern.
INTENSITY	Uses PACKAGE to output grayscale value in a 23 by 16 point area. It expects parameters to tell if the point is positioned or where to position it and the number of lines to be drawn in the area.

programming ease and distinguishability. The INTENSITY routine uses the vector mode and draws lines in a north-south direction, maximum of 16. Because there are eight intensity levels the following number of lines drawn in the area are: 0, 1, 2, 3, 4, 5, 8, or 16. These values were picked for visual distinction due to the logarithmic response of the eye.

The first CDC 3300 linkage program was divided into three parts.

PART I: Exchange of information needed to calculate area of LANDSAT output.

PART II: Output points and scan lines on the Tektronix terminal

PART III: Exchange of the pixel values needed to output the grayscale on the Tektronix terminal.

A monitor, refer to [11], was used in exchanging information in PART I and II because all data and number manipulation was done in the CDC 3300. In PART III control is passed to the first PDP8/L linkage program for minimal data and number manipulation.

2.4 Comparison Analysis

Because on line time using the Tektronix terminal with the CDC 3300 is critical concerning cost, a routine was written to find the amount of time it took to output a full grayscale screen. The program was run entirely on the PDP8/L

and a variety of grayscale values were used to get an approximate average. The display time was 1:51 minutes and the program is found in appendix 7.3.

Some of the undesirable features found in the first linkage programs are as follows:

One: When exchanging information in PART I and II it may happen the information to be displayed will fall below the limits of the screen area. If this happens the information is lost. In Phase two this problem is avoided by a program line counter.

Two: If the file name used doesn't exist, the first CDC 3300 linkage program will abort and the user losses all that had been done at that point. In phase two a compass subroutine is used to find out if the file exists and exchange the proper information.

Three: Because typing "YES" or "NO" for response to questions asked in PART I and II is bothersome, in phase two "Y" or "N" is used.

Four: Some of the cost burden can be alleviated by removing the monitor, compiling the first CDC 3300 linkage program as an overlay, and loading the first PDP8/L linkage program on the high-speed reader. All of these things are done in phase two.

The files used for the analysis and the display information are shown in Table 8. The line printer results of

this information obtained from *PIXOUT, the present CDC 3300 FORTRAN program on file, can be found in appendix 7.4.

A comparison of cost, to output the file used, between the first linkage programs and the program *PIXOUT is shown in Table 9. The cost for the first linkage programs is based on the fact the first PDP8/L linkage is already loaded and OSU computer cost is 4.6875 dollars per minute. In appendix 7.5 are found pictures taken of the files output on the Tektronix terminal at different exposure times.

Table 8

Files Used and Display Information

File name: *CR20412	Band used: 5
Points on file 129-251	Points used 132-188
Scan lines on file 1925-2100	Scan lines used 1930-1963
Thresholds used: 14, 15, 16, 17, 19, 20, 23	
File name: *CR20413	Band used: 5
Points on file 257-384	Points used 257-314
Scan lines on file 1925-2100	Scan lines used 1925-1958
Thresholds used: 14, 15, 16, 17, 18, 19, 20	
File name: *PH1LO1	Band used: 5
Points on file 1-128	Points used 1-58
Scan lines on file 1090-1258	Scan lines used 1099-1132
Thresholds used: 11, 12, 13, 14, 15, 16, 18	
File name: *PH1LO2	Band used: 5
Points on file 129-256	Points used 129-186
Scan lines on file 1090-1258	Scan lines used 1090-1123
Thresholds used: 12, 13, 14, 15, 16, 18, 23	

Table 9

Cost Comparison Between *PIXOUT and the First Linkage Programs

FILE NAME	(on line printer) *PIXOUT COST ($)	(on Tektronix terminal) FIRST LINKAGE PROGRAM ($)
*CR20412	.28	1.22
*CR20413	.29	1.21
*PH1L01	.28	1.24
*PH1L02	.29	1.27

CHAPTER 3

PHASE TWO: INTERMEDIATE ANALYSIS

3.1 Introduction

Since the initial analysis has been shown not to be cost effective, methods were investigated to further reduce the cost. With this in mind, the first linkage programs were revised and discussed under the following headings:

1) Second PDP8/L linkage program
2) Second CDC 3300 linkage program
3) Coordination problems
4) Comparison analysis

3.2 Second PDP8/L Linkage Program

3.2.1 Subroutine Format

More of the date and number manipulation done in the CDC 3300 must be done in the PDP8/L to reduce cost. Therefore, the following subroutines were augmented in the revised PDP8/L linkage program, referred to as the second PDP8/L linkage program, and are described in the following format.

"Subroutine Name" (N.P.) or (PAR1, PAR2, ...) with an associated description of what the subroutine does. (N.P.) means no parameter and (PAR1, PAR2, ...) refers to the parameters expected.

Ordinarily when returning from a subroutine, one returns to the next sequential location in the main program after the parameters. In the description this is referred to as return one. If a return two is stated, it is two sequential locations later and so fourth.

3.2.2 Subroutines

REPLY (N.P.)- looks for inputs followed by a carriage return. All inputs are echoed and the carriage return terminates the subroutine. If the inputs are neither the single input N or Y the response is "WHAT?" and a return one is performed. An N causes a return two and a Y causes a return three.

WHAT (N.P.)- outputs the message "WHAT?" followed by a carriage return line feed.

INTWO (N.P.) -looks for just one input followed by a carriage return. Echoes all input and terminates on a carriage return. If just one input is received, a return two is performed, otherwise a return one is performed.

BNIN (N.P.) -looks for one input between four and seven followed by a carriage return. Echoes input, if valid does a return two, otherwise a return one.

FLIN (N.P.) -looks for input of a ERTS data file name up to eight characters, the rest are ignored. Echoes all data, stores name, and terminates on a carriage return.

FLOUT (N.P.) -sends ERTS data file name to CDC 3300.

CPRN1 (N.P.) -checks to see if the value in memory location COMH, COML is ≥ 0. If not performs a return one, otherwise a return two.

THCK (N.P.) -checks to see if all inputted threshold values are positive and less than sixty-four. Also checks to see if each threshold is equal to or larger than the previous one. Performs a return two if values are good, otherwise a return one.

TABVAL (N.P.) -stores in a table, 64 locations long, each corresponding intensity value according to the input threshold values.

OUTOS3 (N.P.) -sends calculated values that are used in the FORTRAN linkage program for ERTS data output.

BDCON (BADR, DADR) -converts a binary value of two sequential locations starting at location BADR to a decimal value of four sequential locations starting at DABR.

REDN (N.P.) -used in BDCON to reduce the values found in the four decimal locations to a value of nine or less.

LIS (N.P.) -input routine from keyboard.

LIS40 (N.P.) -input routine from CDC 3300.

TYP41 (N.P.) -send ASCII values to CDC 3300, contains a delay loop for settling time.

ERASE (N.P.) -erase screen, puts pointer in home position and zeros out line counter for full page.

MESOUT (M^1, M^2, ..., 0) -uses each M^i as a starting address of a message to be output. It looks for the value 0 to terminate the message and if a carriage return is output, the line counter is increased by one.

BOTCK (N.P.) -checks to see if line counter for full page has been reached. If not returns, otherwise the message "FULL PAGE" is output and waits for any input. When an input is received does an ERASE and then returns.

NUMIN (MAS, DADR) - looks for a number to be input up to a MAX of them, echoes them and deposits them at DADR. DADR takes four sequential locations, does an ADJUST and returns.

DATIN (DADR, NDP) -uses DADR as the starting location of where to deposit incoming information from the CDC 3300 and NDP as the number of values to be received.

DATOUT (DADR, NDP) -outputs data starting at location DADR, where NDP is the number of values to output.

NUMOUT (DLOC) -outputs four decimal numbers starting at location DLOC, supresses leading zeros.

COMADI (N.P.) - adds one to location COMH, COML. Used for data calculations.

ROT (N.P.) -divides COMH, COML by two, used for data calculations.

ZEOUT (LOC, NUM) -zero outs NUM number of locations starting at location LOC.

BUFFIN (N.P.) -checks for buffer in error from the CDC 3300 linkage program.

ADJUST (N.P.) -takes the decimal number locations so the values are adjusted for correct decimal output.

THDIN (N.P.) -checks to see if the inputted threshold values follow the following form, where TH1 refers to the first threshold, TH2 to the second and so forth, and D refers to some delemeter that is not a number.

TH1D TH2D TH3D TH4D TH5D TH6D TH7 carriage return.

PRINT1 (N.P.) -outputs decimal numbers followed by a line feed and backspace. Used to output top boundary values.

RIGHT (N.P.) -outputs the message "CORRECT?"

CKFL (N.P.) -checks to see if the file name sent to the CDC 3300 is a legal file name. If not does a return one, otherwise a return two.

FFIN (N.P.) -looks for a ">" from the CDC 3300, then one space and then returns.

DTOB (DADR, BADR) -converts the decimal number of four sequential locations starting at DADR to a binary number and puts the result in two sequential locations starting at BADR.

DUBADD (NUM1, NUM2) -adds a double precision number starting at location NUM1 to a second number starting at location NUM2 and puts the result at COMH, COML.

DUBSUB (NUM1, NUM2) -subtracts a double precision number starting at location NUM2 and puts the result at COMH, COML.

ERROS3 (N.P.) -deposits unneeded values that are sent from the CDC 3300.

3.3 Second CDC 3300 Linkage Program

Cost reduction in this linkage program is handled in two ways. First, two compass subroutines were written which take less machine language than the equivalent FORTRAN. Second, the FORTRAN Program called OS3P, and COMPASS routines were put in an overlay to eliminate compiling costs.

The two COMPASS subroutines are described as follows:

NEQUIP (XNAME) -called SUB1, takes the file name, stored at symbol address of XNAME, and finds out if it is a legal OS3 file. If it is not a legal file the subroutine does a false return, otherwise equips the file to logical unit 20 and does a true return.

BUFOUT (I, J, CID) -called SUB2, outputs characters from the character array CID, where I is the number of characters to be output and J is the starting character in the array.

The overlay file created is called *OUPIX, which the user types directly for use. The overlay was produced in the following manner, where underlined text refers to what was typed at teletype. The two COMPASS routines and the FORTRAN program, referred to as the second and third CDC 3300 linkage program, can be found in appendix 7.6.

```
# FORTRAN, I=OS3P, X
    NO ERRORS FOR OS3PIX
    NO ERRORS FOR IDENT
# ASSEM, I=SUB1, X
    NO LINES OF ERROR FOR SUB1
# ASSEM, I=SUB2, X
    NO LINES OF ERROR FOR SUB2
# LOAD, 56, 0=*OVPIX
  END
```

3.4 Coordination Problems

To find coordination problems examination of the data that is to be exchanged between the two linkage programs is done. The method is to look at what is input and output by the second CDC 3300 linkage program.

I/O Performed	Input or Output Name: Description	Input Format
Input	XNAME: LANDSAT data file name	A10
Output	NEQUIP: Checks for legal file name	---
Input	WS: Band number minus three	FFIN(60)
Output	BUFOUT: Sends header values ID(5), ID(7), ID(8), ID(11), and ID(12)	---
Input	REM: Starting character value = initial point - ID(7)	FFIN(60)
Input	M: Length of character array = [ID(5)/4]+1	FFIN(60)
Input	LP: Line to print	FFIN(60)

Input	PP: Points to Print	FFIN(60)
Output	BUFOUT: Sends one scan line from data file	---
Input	CHIN(N): Acknowledge that the scan line was gotten and has been displayed	READ(60)

When exchanging data some of the problems that arose and how they are handled are given below.

Problem 1. The format for XNAME was too large. Ordinarily the size expected for an input file name is eight characters maximum. With a format of A10 some of the first characters of the file name were lost, thus the file name appears to be an illegal file name. To eliminate this problem the format A10 was changed to A8.

Problem 2. When information is sent to the CDC 3300 followed by a carriage return, the CDC 3300 sends back a line feed. The PDP8/L linkage program must absorb this input by doing either a RECEIVE, a general input subroutine from CDC 3300, or a KRB40.

Problem 3. Sending data to the CDC 3300 using a FFIN(60) format, the CDC 3300 sends a space, <, space, >, and space. Because of timing sometimes the PDP8/L linkage program may miss part of the information sent. Therefore, a routine was written to look for the > and then the space.

Problem 4. Because of timing the SEND command didn't always work because of the delay augmented. Now the information to be sent is saved, the delay is run then the

information is sent.

3.5 Comparison Analysis

Now a comparison of the costs of the four LANDSAT data files between the FORTRAN program on file, called *PIXOUT and the second linkage programs is shown in Table 10. Also a display time duration between the first and second linkage programs is shown. At this point output cost is cheaper and display time is shorter, a result that has been sought after.

Table 10

Cost Comparison Between *PIXOUT and the Second Linkage Program and Display Time Comparison Between the First and Second Linkage Programs on the Tektronix Terminal

FILE NAME	*PIXOUT PROGRAM COST ($)	SECOND LINKAGE PROGRAM COST - DURATION ($) - (MIN)	FIRST LINKAGE PROGRAM DURATION (MIN)
*CR20412	.28	.19 - 1:20	9:20
*CR20413	.29	.20 - 1:35	11:50
*PH1L01	.28	.20 - 2:05	12:55
*PH1L02	.29	.19 - 1:52	12:06

The comparison values are based on several runs with 30 or less users on the system at once.

CHAPTER 4

PHASE THREE: FINAL ANALYSIS

4.1 Introduction

The primary difference between this phase and the second phase is the use of interrupts to handle display data. Using the technique of phase II, cost is at a near minimum but display time can be reduced. This phase divided into two basic headings:

1) Program Change
2) Comparison Analysis

4.2 Program Change

Using an interrupt scheme, there must exist a routine, referred to as a service routine, to facilitate all possible devices that may cause an interrupt. It is assumed that the reader is familiar with basic interrupt programming. If not, refer to [13] Chapter 6. The PDP8/L used has five possible interrupt devices: keyboard, printer, high-speed reader, output CDC 3300, and input CDC 3300. The service routine takes care of each device in the following manner: the keyboard, high-speed reader and output CDC 3300 have their flags cleared and their request is ignored; the printer has a program flag set and the device flag is cleared; and input CDC 3300 has the incoming information taken care of in a subroutine called DATIN, explained later

in this chapter.

The only subroutine no longer used is the DATOUT, but the original DATIN routine is still used to take care of receiving ID(5), ID(7), ID(8), ID(11), and ID(12). It is renamed DATTIN.

The following ten subroutines were augmented in this phase and are described in the same manner as the format of subroutine found in phase two. There is a counter called OUTDAT which is zero when no output location is ready, positive otherwise.

DATIN (N.P.) -deposits incoming values and stores the value at the correct location in the correct upper or lower six bits. Checks to see if all values for that line have been received, if so jumps to NEWLIN subroutine which takes the appropriate action. Checks to see if location pointer is at the end of the storage location, if so, resets location pointer to 4000, resets length counter to -1000, and resets side pointer to left side (lower six bits).

DATOUT (N.P.) -checks to see if any data is ready to be output. If so, outputs grayscale of that data point. Checks to see if the location pointer is at the end of the storage, if so, resets location pointer format as the subroutine found in Phase two.

TYP (N.P.) -used to output information to the Tektronix terminal depending upon a program flag called IFL. The routine waits for IFL to become negative before displaying,

then makes IFL positive.

INITIAL (N.P.)-,for the input routine, DATIN sets input counter equal to minus the number of points to print, used for BUFFER routine; sets side pointer for left side location deposit; sets depositing pointer to location 4000; and sets page length counter to -1000. (Length of area used for incoming information.) For the output routine, DATOUT, sets output counter equal to minus the number of points to print, used for starting next display line; sets side pointer for left side location usage; sets data use pointer to location 4000; sets page length counter to -1000; and sets IFL negative. It also sets BUFFL1, BUFFL2, and NUBFL to zero, which are used for BUFFER, resets length counter to -1000, and resets side pointer to left side (lower six bits).

NEWLIN (N.P.) -sets BUFFL2 flag if the BUFFER subroutine is used inside the service routine, or sets BUFFL2 flag if the BUFFER subroutine is used outside the service routine when storage is full, or sets NUBFL flag if BUFFER subroutine is ignored. It also resets input counter to minus the number of points to be printed.

INTON (N.P.) -obtains the JMS value for PAKTYP and puts that value in the accumulator which is used for INTPUT.

INTPUT (N.P.) -takes the value in the accumulator and deposits it in the appropriate places in the PAKMOV and PAKVEC routines depending on whether program control or

interrupt control is being executed.

ECHO (N,P.) -exchanges information between the Tektronix Terminal and the CDC 3300. A control sends a pound sign (#) and a control C starts the PDPPIX 3 program.

OUTBUF (N.P.) -does the BUFFER routine, and clears both the printer and CDC 3300 output internal flags.

In appendix 7,7 can be found both the CDC 3300 and the PDP8/L third linkage programs.

4.3 Comparison Analysis

Shown in Table 11 is a comparison analysis of both cost and display time duration between the second and third linkage programs. The conclusion from this table is the third linkage program is a slight improvement over the second linkage program, but not enough to warrant an interrupt scheme.

Table 11

Cost and Display Time Comparison Between the Second and Third Linkage Programs on the Tektronix Terminal

FILE NAME	SECOND LINKAGE PROGRAM COST ($)	SECOND LINKAGE PROGRAM DURATION (MIN)	THIRD LINKAGE PROGRAM COST ($)	THIRD LINKAGE PROGRAM DURATION (MIN)
*CR20412	.19	1:20	.18	1:15
*CR20413	.20	1:35	.19	1:29
*PH1L01	.20	2:05	.19	1:58
*PH1L02	.19	1:52	.18	1:47

CHAPTER 5

CONCLUSION

5.1 Advantage

For a complete analysis of all the programs used a cost comparison for the four files between the three linkage programs and the FORTRAN program on file (called *PIXOUT) is shown in Table 11. Also found in this table is a comparison of the grayscale output display time between the three linkage programs. From the table it can be seen that from both a cost and a display time comparison the best program is the third linkage program. This points to the fact the main advantage of the third program is cost reduction.

5.2 Disadvantages

Looking at the other side of the coin there are three primary disadvantages of the third linkage program.

1) No hard copy
2) Limited amount of display time
3) The bleeding effect of the terminal

Both the second and third disadvantages point to the fact the Tektronix terminal 4002 is an inadequate device for the job at hand. A possible alternative is either a terminal that has a larger display area and a better resolution of that area or a terminal that outputs different colors, that

is, a minimum of three different colors for displaying eight different combinations. Also a hard copy can be added by expanding the third linkage program.

5.3 Improvements

Some of the possible improvements that can be made upon the third linkage program if the Tektronix terminal 4002 is still being used are:

1) Making any of the subroutines more efficient. This is usually done by decreasing the number of instructions through the use of more clever programming. The net result is less time spent in a particular subroutine.

2) Doing the third linkage program completely under interrupt control. At the present time only the grayscale output is done under interrupt control. When one is switching between program control and interrupt control, internal flag statuses are not known and unwanted problems arise. Programming should be consistent throughout and less time is lost waiting for flags to clear.

3) Changing the pixel output from a rectangular area to a character overstrike area. If this is done less calculation is needed to output the border numbers and the result can be output on the teletype, thus a hard copy can be created.

5.4 Future Work

Most additional work done in this area would have to do with the modification of the actual pixel value. For example doing a calculation which takes into consideration the effect the angle at which the satellite records the information. Or perhaps the effect the weather may have upon recording data. Possibly to adjust the data so it would fit into a longitude and latitude area instead of the skewed area obtained from the angle at which the satellite orbits. Another avenue of extention would be to display the data after it had been classified. There are of course numerable possibilities for the reader to investigate, but at this time only a few need be mentioned.

Table 12

Cost and Display Time Comparison

Between All Programs Used

FILE NAME	*PIXOUT PROGRAM $	FIRST LINKAGE PROGRAM $	SECOND LINKAGE PROGRAM $	THIRD LINKAGE PROGRAM $
*PH1LO1	.28	1.24	.20	.19
*PH1LO2	.29	1.27	.19	.18
*CR20412	.28	1.22	.19	.18
*CRO413	.29	1.21	.20	.19
		DISPLAY TIME (MIN)	DISPLAY TIME (MIN)	DISPLAY TIME (MIN)
*PH1LO1		12:55	2:05	1:58
*PH1LO2		12:06	1:52	1:47
*CR20412		9:20	1:20	1:15
*CR20413		11:50	1:35	1:29

CHAPTER 6

USER'S GUIDE

6.1 Definitions

AC: Accumulator Register

Home Position: Upper northwest corner of the Tektronix Terminal 4002

␣: Space Key

L: Link Register

SR: Switch Register

CRTL: Means to press the SHIFT key and the indicated key at the same time.

6.2 Guide Lines

If a SR switch is up the value for that bit is one, if down the value is zero.

All inputs must not contain leading or trailing spaces and are terminated by a carriage return.

In response to the displayed statement "CORRECT" the expected input is either a "Y" for yes or a "N" for no, any other input is handled by the displayed statement "WHAT?" and CORRECT?".

The user should give time, after turning on the computer, for the Tektronix terminal to warm up.

The Format for the threshold inputs are seven numbers followed by a carriage return. Between each number is any

non-numbered key called a delimeter. All numbers must be less than 64 decimal and be equal to an increase in value to the previous number.

EXAMPLE: 11␣ 11␣ 15␣ 19␣ 30␣ 48␣ 63 (carriage return)

If the statement displayed is "PAGE FULL" this indicated the user is near the bottom of the screen. The program is waiting for any input from the keyboard, the screen is then erased and the display pointer is put in the home position. The reason for waiting is for the convenience of the user to observe any information displayed before it is destroyed.

If the PDPPIX3 tape is not loaded, go to appendix 7.7, which explains how to load the tape. After the tape is loaded the status of the indicated keys is given below. The display light indicates the mode of the keys.

KEY	STATUS
ASCII TTY	TTY
ON LINE LOCAL	ON LINE
DIRECT COMPOSE	DIRECT

6.3 Program Example

The following is an example of the program where the user's answers are underlined, and helpful hints are found in parentheses. All alphabet letters found on the right margin are for reference only.

TO START

(1) Load 1200 in SR

(2) Press ADDR LOAD switch

(3) Press RUN switch

(4) CRTL A ($\begin{matrix}\text{CDI}\\\text{SOH}\end{matrix}$ key)

(If "#" is not displayed the terminal is probably not connected to the CDC 3300. Have the computer center patch in "terminal H3," information exchange begins here.)

#LOGIN (type user's code and validity code)

H #*OVPIX

START

CRTL C ($\begin{matrix}\text{CD3}\\\text{ETX}\end{matrix}$ key)

(Program begins here)

A WHAT IS THE INPUT FILE?

FILE NAME

(type name of LANDSAT file to be used)

CORRECT?

Y (if N is typed go to A)

(Wait for file name to be sent. If file name is not found go to A)

B WHAT ARE THE THRESHOLDS?

11␣ 11␣ 12␣ 30␣ 35␣ 48␣ 63

(If the threshold format is not correct the program will go to B)

C WHAT BAND?

4

(Band number must be between 4 and 7, if it is not the program will say so and go to C)

CORRECT?

Y (If N is typed the program will go to C)

(Wait for band number to be sent)

ON THIS FILE

POINTS 1-28

LINES 1090-53

(the second line value is the number of lines)

O WHAT IS THE INITIAL POINT?

1

CORRECT?

Y (If N is typed the program will go to D)

E NUMBER OF POINTS?

23

CORRECT?

Y (If N is typed the program will go to E)

F WHAT IS THE INITIAL LINE?

1090

CORRECT?

Y (If N is typed the program will go to F)

G NUMBER OF LINES?

33

CORRECT?

Y (If N is typed the program will go to G)

(If information falls beyond limit of the file on limit of the screen the program will state it and go back to the proper location to obtain new information. If all is correct wait for the exchange of information, then LANDSAT data is output with grayscole.)

PICTURE IS COMPLETE

(The program now waits for any input key, the screen is then erased.)

CRTL A ($\overset{\text{DC1}}{\text{SOH}}$ key)

(If the user wants another picture go to I)

#LOGOFF

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APPENDICES

APPENDIX 7.1

Appendix 7.1 is divided into three sections.

Section 1: The HAND Routine

Section 2: The SHAKE Routine

Section 3: The Output Results From Both Routines

```
/PROGRAM HAND

        TSF41=6411
        TLS41=6416
        KSF41=6031
        KCC41=6032
        KRB41=6036

        *200

        KCC41           /INITIALIZATION PART I
        TLC
        TLS41
        TAD     I7
        PDA     OUT
        TAD     LOC1
        PDA     I6
        TAD     LOC2
        PDA     I1
        TAD     I2B6
        PDA     OUT
ECHO,   TAD     OUT     /SEND TO PDA
        PDA I   I1
        TAD     OUT
        TSF41
        JMP     .-1
        TLS41
        PDA I   I5      /SAVE VALUE SENT
        CLA CLL
        TAD     I5
        SNA     CMI3
CVP,    KSF41           /RECEIVE FROM PDA
        JMP     .-1     /GET THREE VALUES
        RAR
        RAR
        TSF
        JMP     .-1
```

```
        TLS                     /PUT ON SCREEN
        CLA CLL
        ISZ     CNTS
        JMP     OVR
        ISZ     OUT
        JMS     LOOP            /DELAY BEFORE SENDING AGAIN
        ISZ     CNT
        JMP     REPEAT          /REPEAT ECHO
        TLS#1                   /INITIALIZATION PART II
        TAD     M7
        DCA     CNT
        TAD     LOC
        DCA     10
STORE,  TAD     OUT             /SEND OSS
        TSF41
        JMP     .-1
        TLS41
        CLA CLL
        KSF41                   /RECEIVE OSS
        JMP     .-1
        KRB41
        DCA I   10
        ISZ     OUT
        JMS     LOOP            /DELAY
        ISZ     CNT
        JMP     STORE
        JMP I   MON             /RETURN TO MONITOR
LOOP,                           /DELAY ROUTINE
        TAD     P1
        DCA     P2
        ISZ     P2
        JMP     .-1
        JMP I   LOOP
P1,     -
P2,     7600
M3,     7775
```

```
CNT3,   [illegible]
M7,     7771
MON,    74[illegible]
CNT,    [illegible]
OUT,    [illegible]
M26[illegible], 26[illegible]
LOC,    LOC
LOC1,   LOC1
LOC2,   LOC2
        [illegible]
```

```
C     EQUIP LUN6 EQUAL TO 5 BEFORE STARTING PROGRAM
      PROGRAM SHAKE
      DIMENSION N(24)
      DO 10 I=1,21,3
      N(I)=I+2+20B
      N(I+1)=212B
      N(I+2)=215B
10    CONTINUE
      WRITE(61,20)
20    FORMAT(' READY')
      CALL CHIN(L)
      DO 30 I=1,21,3
      CALL CHIN(L)
      L=AND(L,377B)
      WRITE(61,40)L
      CALL CHOUT(N(I))
      CALL CHOUT(N(I+1))
      CALL CHOUT(N(I+2))
30    CONTINUE
40    FORMAT(O4)
      CALL CHIN(L)
      J=20B
      DO 50 I=1,7
      J=J+3
      CALL CHIN(L)
      L=AND(L,377B)
      WRITE(5,60)L
      CALL CHOUT(J)
50    CONTINUE
60    FORMAT(' L=',O4)
      CALL CHIN(L)
      WRITE(61,70)
70    FORMAT(' END OF TEST')
      STOP
      END
```

7.1 SECTION 3

The Output Results From Both Routines

TEK. VALUES DISPLAYED	VALUES SENT FROM CDC3300
3	263
6	266
9	271
<	274
?	277
B	302
E	305

VALUE RECEIVED CDC3300	VALUE SENT BY PDP8/L
FILE: 260	LOC1: 260
261	261
262	262
263	263
264	264
265	265
266	266

LOC 2 same as LOC 1

APPENDIX 7.2

Appendix 7.2 is divided into five sections.

Section 1: Introduction

Section 2: PACKAGE Explanation and Routines

Section 3: INTENSITY Explanation and Routines

Section 4: XYPLANE Explanation and Routines

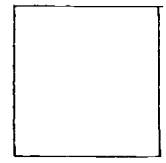
Section 5: PATTERN Explanation and Routines

7.2 Section 1 Introduction

The tek-terminal associated with the PDP-8 (t4002) is dimensioned in the following manner:

UNITS	SCREEN LENGTH	SCREEN WIDTH
Inches	8.18	6.08
Points Octal	1777	1367
Points Decimal	1024	760

Setting the screen up in the Octal x,y coordinate system depends upon the following corner values.



The approximate number of octal points per inch is 125. For ease of computation the ratio of octal points per inch used in the xyplane plot is 128. The error of three points out of 125 is within the realm of acceptability.

Subroutines in the four plot routines follow the general form:

Subroutine name(Para.1,...,Para.n) Location: xxxx

Therefore the calling sequence for a subroutine would be thus:

```
        JMS I NAME              /Any label not used
                                /The parameters that
        Para.1                  /are associated with
        Para.n                  /that substitute

NAME,   xxxx                    /Location of subroutine
```

The program would preform the subroutine being called and return to the main program at one location passed the last parameter needed.

7.2 Section 2 Package Plot

LABELS PAGE 24

Locations Used: 5000-5157

Label	Location	Usage
PAKACC	5021	/Accumulator storage location
PAKFS	5157	/Point plot mode control
PAKGS	5117	/Linear interpolation mode
PAKINK	5120	/Routine for incremental mode
PAKLNK	5022	/Link storage location
PAKMOV	5023	/Routine to position pointer
PAKMSK	5026	/Mask off part of data word
PAKORD	5057	/High order x or y bit
PAKORX	5060	/Low order x bit
PAKORY	5061	/Low order y bit
PAKPPM	5136	/Routine for point plot
PAKPX1	5150	/x value used in point plot
PAKPY1	5151	/Y value used in point plot
PAKRS	5134	/Incremental mode
PAKRST	5013	/Routine to restore registers
PAKSAV	5006	/Routine to save registers
PAKSVX	5063	/X storage in vector plot
PAKTYP	5000	/Routine to output data
PAKUS	5116	/Graphics mode
PAKVEC	5064	/Routine for vector plot

LABELS PAGE 24 (con)

Locations Used: 5000-5157

Label	Location	Usage
PAKX1	5067	/First x value for vector mode
PAKX2	5107	/Second x value for vector mode
PAKY1	5077	/First y value for vector mode
PAKY2	5110	/Second y value for vector mode
PAK40	5135	/Value used in incremental mode
PRBF	=6046	/TLS value for PDP-8
PRFL	=6041	/TSF value for PDP-8

PAKTYP Location: 5000

This is a general purpose output routine identical to the "type" routine found in most PDP-8 handooks. Its primary use is associated with other subroutines found on this page, but may be used by a program located elsewhere in memory*

PAKSAV Location: 5006

This subroutine is used to store the value of the accumulator and link so that information is not destroyed while a subroutine from this page is being executed. It also may be used by a program elsewhere in memory. If it is used by a program elsewhere in memory the information must be restored before PAKSAV is used again or the information is lost. Routines on this page that don't use PAKSAV are PAKTYP, PAKSAV, PAKRST, and PAKMOV.*

PAKRST Location: 5013

This subroutine is used to restore the values of the accumulator and link that were stored from a call to PAKSAV either from a program in memory or from a subroutine on this page.*

*Note calling sequence on next page.

Calling sequence for PAKTYP, PAKSAV, and PAKRST

MAIN PROGRAM

```
        JMS I NAME          /Any label not used
NAME,   xxxx                /Location value of sub-
                            /routine being called.
```

PAKMOV(X,Y) Location: 5023

The purpose of this subroutine is to place the pointer of a particular (X,Y) position on the screen. This routine is used by other routines on the page but may be used by a program elsewhere in memory as long as the status of the program is either point plot mode or linear interpolation mode. (vector mode)

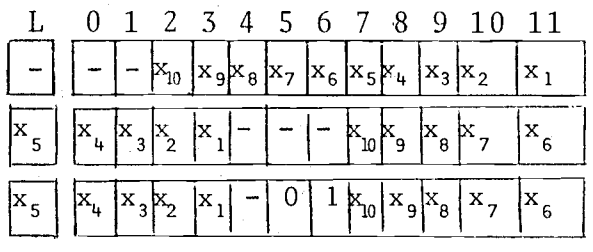
Because the computer expects the output of the Y coordinate first, but most users think in terms of the X coordinated first the subroutine automatically takes care of the situation. That is, the X coordinate is stored, then the Y coordinate is manipulated in the following manner:

The maximum number of bits a coordinate can use is ten, thus the word is divided into a high order (upper five bits) and a low order (lower five bits). The Y coordinate is rotated five places to the right to obtain the high order and then 40_8 is added, or the sixth bit is set to indicate a high order output, the result is then output by a call to

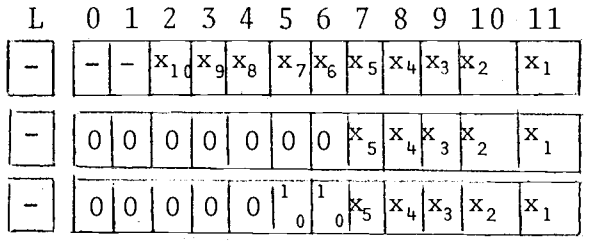
PAKTYP. The Y coordinate is loaded again and the high order bits are masked off, 140_8 is added or the sixth and seventh bits are set and the result is output by a call to PAKTYP.

Next the X coordinate is output in a similar manner except when the low order bits are output just the seventh bit is set or 100_8 is added.

Graphically as seen in the display register.



High order bits output



Low order bits output

The status of the computer is not changed while using this subroutine.

PAKVEC (X1,Y1,X2,Y2) Location: 5064

The subroutine draws a line between the two points (X1,Y1) and (X2,Y2) using the linear interpolation mode.

It may be entered by way of the alphanumeric or linear interpolation status. It stores the value of the

accumulator and link before execution and restores them after execution. After execution the terminal is set in Alphanumeric status, with the pointer at the (X2,Y2) position.

PAKPPM(X,Y) Location: 5136

The subroutine draws a point at the (X,Y) position specified. It may be entered by way of the alphanumeric or point plot mode. Both the accumulator and link are stored before execution and restored after execution. The terminal is in alphanumeric status after execution.

PAKNK(DIR) Location: 5120

The subroutine points the pointer in one of eight directions, as indicated by the picture found below, and executes one point in that direction. DIR expects one of sixteen values with each value associated with the indicated direction.

Pen down: $0 \leq DIR \leq 7$ Pen up: $10 \leq DIR \leq 17$

It may be entered by way of the alphanumeric or incremental mode. Both the accumulator and link are stored before execution and restored after execution. The status of the terminal after execution is alphanumeric.

```
*5000
PRFL=6741
PRBF=6046
PAKTYP,  .
         PRFL
         JMP .-1
         PRBF
         CLA CLL
         JMP I PAKTYP
PAKSAV,  .
         DCA PAKACC
         RAL
         DCA PAKLNK
         JMP I PAKSAV
PAKRST,  .
         CLA CLL
         TAD PAKLNK
         RAR
         TAD PAKACC
         JMP I PAKRST
PAKACC,  .
PAKLNK,  .
PAKMOV,  .
         TAD I PAKMOV
         DCA PAKSVX
         ISZ PAKMOV
         TAD I PAKMOV
         RTR
         RTR
         RAR
         AND PAKMSK
         TAD PAKORD
         JMS PAKTYP
         TAD I PAKMOV
         AND PAKMSK
         TAD PAKORY
```

/VALUE FOR PDP TLS
/VALUE FOR PDP
/RETURN ADDRESS
/IS PRINT FLAG SET
/WAIT FOR PRINT FLAG
/OUTPUT PRINT BUFFER
/CLEAR REGISTERS
/RETURN
/SAVE REGISTERS ROUTINE
/DEPOSIT ACC

/DEPOSIT LINK
/RETURN
/RESTORE REGISTERS ROUTINE
/CLEAR REGISTERS
/PUT IN LINK

/PUT IN ACC
/RETURN

/GET X VALUE
/SAVE X VALUE
/GET Y VALUE

/ROTATE TO GET HIGH Y VALUE

/REMOVE DATA TOO LARGE
/ADD HIGH Y VALUE
/OUTPUT HIGH Y COORD
/GET Y VALUE
/MASK OFF VALUE NOT NEEDED
/ADD LOW Y VALUE

```
        JMS  PAKTYP                 /OUTPUT LOW Y COORD
        TAD  PAKSVX                 /GET X VALUE
        RTR                         /ROTATE TO GET HIGH X VALUE
        RTR
        RAD
        AND  PAKMSK                 /MASK OFF DATA TOO LARGE
        TAD  PAKORD                 /GET HIGH X VALUE
        JMS  PAKTYP                 /OUTPUT HIGH X COORD
        TAD  PAKSVX                 /GET X VALUE
        AND  PAKMSK                 /MASK OFF VALUE NOT NEEDED
        TAD  PAKORX                 /ADD LOW X VALUE
        JMS  PAKTYP                 /OUTPUT LOW X COORD
        ISZ  PAKMOV                 /CORRECT RETURN ADDRESS
        JMP  I  PAKMOV              /RETURN
PAKORD, 40
PAKORY, 100
PAKORX, 140
PAKMSK, 37
PAKSVX, 0
PAKVEC,
        JMS  PAKSAV                 /SAVE REGISTERS
        TAD  I  PAKVEC              /GET X VALUE
        DCA  PAKX1                  /PUT IN X1 POS
        ISZ  PAKVEC
        TAD  I  PAKVEC              /GET Y VALUE
        DCA  PAKY1                  /PUT IN Y1 POS
        TAD  PAKBIG                 /PUT IN VECTOR MODE
        JMS  PAKTYP
        JMS  PAKMOV                 /OUTPUT FIRST TWO VALUES
PAKX1,  0
PAKY1,  0
        ISZ  PAKVEC
        TAD  I  PAKVEC              /GET SECOND X VALUE
        DCA  PAKX2                  /PUT IN X2 POS
        ISZ  PAKVEC
        TAD  I  PAKVEC              /GET Y2 VALUE
```

```
            DCA  PAKY2              /PUT IN Y2 POS
            JMS  PAKMOV             /OUTPUT SECOND TWO VALUES
PAKX2,      .
PAKY2,      .
            TAD  PAKUS              /PUT IN ALPHA MODE
            JMS  PAKTYP
            ISZ  PAKVEC             /GET CORRECT RETURN ADDRESS
            JMS  PAKRST             /RESTORE REGISTERS
            JMP  I PAKVEC           /RETURN
PAKUS,      237
PAKGS,      235
PAKINK,     .
            JMS  PAKSAV             /SAVE REGISTERS
            TAD  PAKRS              /PUT IN INCRE. MODE
            JMS  PAKTYP
            TAD  I PAKINK           /GET DIR
            TAD  PAK90
            JMS  PAKTYP             /PUT POINTER IN CORRECT POS
            ISZ  PAKINK             /GET CORRECT RETURN ADDRESS
            TAD  PAKUS              /PUT IN ALPHA MODE.
            JMS  PAKTYP
            JMS  PAKRST             /RESTORE REGISTERS
            JMP  I PAKINK           /RETURN
PAKRS,      206
PAK90,      .
PAKPPC,
            JMS  PAKSAV             /SAVE REGISTERS
            TAD  I PAKPPC           /GET X VALUE
            DCA  PAKPX1             /PUT IN X POS
            ISZ  PAKPPC
            TAD  I PAKPPC           /GET Y VALUE
            DCA  PAKPY1             /PUT IN Y POS
            TAD  PAKGS              /PUT IN PNT PLOT MODE
            JMS  PAKTYP
            JMS  PAKMOV             /OUTPUT COORD
PAKPY1,     .
```

```
PAKEX1,  0
         ISZ PAKPPM                    /GET CORRECT RETURN ADDRESS
         TAD PAKUS                     /PUT IN ALPHA MODE
         JMS PAKTYP
         JMS PAKRST                    /RESTORE REGISTERS
         JMP I PAKPPM                  /RETURN
PAKFS,   234
         1
```

7.2 Section 3 Intensity Plot

LABELS PAGE 26

Locations Used: 5400-5561

Label	Location	Usage
INTDIF	5544	/Difference between lines produced
INTEN	5400	/Routine to produce lines
INTMO	5453	/No lines in the rectangle
INTM1	5460	/One line in the rectangle
INTM16	5522	/Sixteen lines in the rectangle
INTM2	5465	/Two lines in the rectangle
INTM23	5536	/Depth of rectangle
INTM3	5472	/Three lines in the rectangle
INTM4	5514	/Four lines in the rectangle
INTM5	5506	/Five lines in the rectangle
INTM8	5511	/Eight lines in the rectangle
INTN1	5542	/Used to subtract from x coord.
INTN2	5541	/Finding which lines to output
INTN3	5540	/Finding which lines to output
INTN7	5537	/No longer used in subroutine
INTOVR	5474	/Routine to draw lines
INTPLT	5561	/Location of PAKVEC routine
INTPO	5415	/Label entry for form B
INTP10	5531	/Used in one line output
INTP2	5535	/Used in eight lines output
INTP20	5530	/Value of next X coordinate

LABELS PAGE 26 (con)

Locations Used: 5400-5561

Label	Location	Usage
INTP3	5534	/Used in five lines output
INTP4	5533	/Used in two and four lines output
INTP5	5532	/Used in three lines output
INTSAV	5543	/Storage for next X location
INTVEC	5545	/Routine to output lines
INTXL	5547	/First X value for line output
INTX2	5551	/Second X value for line output
INTY1	5550	/First Y value for line output
INTY2	5552	/Second Y value for line output
INXCAL	5554	/Routine to make INTX1=INTX2

INTEN(1,X,Y,NUMB) :FORM A LOCATION:5400

INTEN(0,NUMB) :FORM B LOCATION:5400

INTEN uses a sixteen by nineteen rectangle grid as it's working area. That is, there are a maximum of sixty-four rectangles across and thirty-nine rectangles down. In the working area the following number of lines can be drawn. Zero, one, two, three, four, five, eight, and sixteen. In order to draw that number of lines that exact number must be passed for NUMB or Zero lines are drawn. The X and Y parameters in FORM A refer to the upper left hand corner coordinate points.

INTEN has two forms that are used. Form A is basically used as an initialization of the X and Y coordinates. Form B is used if one know that the pointer is at the correct X and Y coordinated. Form B is used in conjunction with form A because after execution the pointer is placed to the right sixteen points. That is, one working area to the right. The two forms are easy to use when one is going across the screen, but to go down one either uses form A again or subtract nineteen (23_8) from INTY1 (5550) and INTY2 (5552).

One must enter in a graphics mode and after execution the terminal is in Alphanumeric mode.

```
*5430
INTEN,  0
        TAD I INTEN
        SNA CLA                 /FORM A OR B
        JMP INTP2               /FORM B
        ISZ INTEN               /GET NEXT INTEN LOC
        TAD I INTEN             /INITIAL X LOC
        DCA INTX1
        ISZ INTEN               /GET NEXT INTEN. LOC
        TAD I INTEN             /GET X LOC
        DCA INTY1               /Y1 VALUE FOR VEC ROUTINE
        TAD INTY1               /GET Y1 VALUE
        TAD INT422              /SUB. EIGHTEEN
        DCA INTY2               /Y2 VALUE FOR VEC ROUTINE
INTP1,  TAD INTX1               /GET X COORD
        TAD INTP20              /ADD SIXTEEN
        DCA INTSAV              /NEXT X LOC GOING NW
        ISZ INTEN               /NEXT INTEN LOC
        TAD I INTEN             /GET NUMBER OF LINES
        SNA
        JMP INT..               /NO LINES
        RAR
        SNA
        JMP INT.1               /ONE LINE
        RAR
        SNA
        JMP INT42               /TWO LINES
        RAR
        SNA
        JMP INT.4               /FOUR LINES
        RAR
        SNA
        JMP INT.3               /EIGHT LINES
        RAR
        SNA CLA
        JMP INTI16              /SIXTEEN LINES
```

```
        TAD I INTEN             /GET NUMBER OF LINES
        TAD INTN3               /MINUS THREE
        SMA
        JMP INTM3               /THREE LINES
        TAD INTN2               /MINUS TWO
        SNA CLA
        JMP INTM5               /FIVE LINES
INTM1,  TAD INTSAV              /GET NEXT X COORD
        JMS INXCAL              /X1 = X2
        CLA CLL
        ISZ INTEN               /GET NEXT INTEN LOC
        JMP I INTEN             /RETURN
INTM1,  TAD INTX1               /GET X1 VALUE
        TAD INTP10              /ADD EIGHT
        JMS INXCAL              /X1=X2
        JMS INTVEC              /OUTPUT LINE
        JMP INTM1               /RETURN
INTM2,  TAD INTX1               /GET X1 VALUE
        TAD INTP4               /ADD FOUR
        JMS INXCAL              /X1=X2
        JMS INTVEC              /OUTPUT LINE
        JMP INTM1               /OUTPUT NEXT LINE
INTM3,  TAD INTP5               /ADD FIVE
        DCA INTDIF              /PUT IN LINE LENGTH
INTOVR, TAD INTX1               /GET X1 COORD
        TAD INTDIF              /ADD NEXT LINE COORD
        JMS INXCAL              /X1=X2
        TAD INTSAV              /GET NEXT X COORD
        CMA IAC                 /MAKE NEG
        TAD INTX1
        SMA CLA                 /END OF LINES
        JMP INTM2
        JMS INTVEC              /NO, DRAW LINE
        JMP INTOVR              /COMPARE X1 VALUE
INTM5,  TAD INTP3               /ADD THREE
        DCA INTDIF              /PUT IN LINE LENGTH
```

```
            JMP  INTOVR          /OUTPUT LINES
INTM8,      TAD  INTP2           /ADD TWO
            DCA  INTDIF          /LINE LENGTH
            JMP  INTOVR          /OUTPUT LINES
INTM4,      TAD  INTX1           /GET X1
            TAD  INTN1           /SUB. ONE
            JMS  INXCAL          /PUT X1=X2
            TAD  INTP4           /ADD FOUR
            DCA  INTDIF          /PUT IN LINE LENGTH
            JMP  INTOVR          /OUTPUT LINES
INTM16,     TAD  INTX1           /GET X1
            TAD  INTN1           /SUB. ONE
            JMS  INXCAL          /PUT X1 =X2
            IAC                  /ADD ONE
            DCA  INTDIF          /PUT IN LINE LENGTH
            JMP  INTOVR          /PUTPUT LINES
INTP22,     22
INTP10,     12
INTP5,      5
INTP4,      4
INTP3,      3
INTP2,      2
INTM22,     -22
INTM7,      -7
INTM3,      -3
INTM2,      -2
INTM1,      -1
INTSAV,     .
INTDIF,     .
INTVEC,     .
            JMS I INTPLT
INTX1,      0
INTY1,      .
INTX2,      .
INTY2,      .
            JMP I INTVEC
```

```
INXCAL,   0
          DCA I INTX1
          TAD INTX1
          DCA I INTX2
          JMP I INXCAL
INTPLT,   5264
$
```

7.2 Section 4 XYPlane Plot

LABELS PAGE 23

Locations Used: 4600-4776

Label	Location	Usage
IR10	-	/Autoindex 10
XY10	4776	/Amount added for tic marks
XY400	4761	/Axis length for no tic marks
XYAXIS	4625	/Outputs pos. or neg. (x and y)
XYCM1	4756	/Boundary comparison pos. axis
XYCM2	4757	/Boundary comparison neg. axis
XYCNT	4765	/Counter
XYCOM	4705	/Outside boundary
XYLNT	4766	/Distance between tic marks
XYLRG	4751	/Pos. boundary for x or y axis
XYM3	4763	/Para. input length for y axis
XYM5	4764	/Para. input length for x axis
XYM20	4775	/Amount sub. for tic marks
XYORG	4612	/Puts pointer at origin
XYPAN	4670	/Outputs axis section
XYPLAN	4600	/Subroutine to output x-y axis
XYPLOT	4740	/Output lines of axis
XYPLP	4677	/Loop indicator for links
XYPLST	4734	/Outputs last link of section
XYP2	4774	/0 for x axis, 1 for y axis
XYSML	4752	/Neg. boundary for x and y axis

Label	Location	Usage
XYTAB	4750	/Table head for parameters
XYTICM	4753	/Length between tic marks
XYTLP	4646	/Loop indicator for tic length
XYTOT	4652	/Location jump for no tic marks
XYTWO	4762	/Used for finding locations
XYVEC	4760	/PAKVEC location
XYVV1	4771	/xyx1 or xyy1 for axis output
XYVV2	4772	/xyx2 or xyy2 for axis output
XYVV3	4773	/xyy1 or xyx2 for tic output
XYXOR	4754	/x origin value
XYXVL	4767	/xyx1 location for axis output
XYX1	4742	/x1 PAKVEC parameter
XYX2	4744	/x2 PAKVEC parameter
XYYOR	4755	/y origin value
XYYVL	4770	/xyy1 location for tic output
XYY1	4743	/y1 PAKVEC parameter
XYY2	4745	/y2 PAKVEC parameter

XYPLAN Location:4600

(XLRG,XSML,XTIC,XOR,YOR,YLRG,YSML,YTIC)

The purpose of this routine is to output an X-Y axis where XOR and YOR parameters are the origin of the axis. The XLRG and YLRG parameters are the positive axis boundaries, that is the positive end of the x and Y axis respectively. The XSML and YSML are the counter parts of XLRG and YLRG or the negative end of the X and Y axis. The following inequalities must be observed or the output results cannot be guaranteed.

(1) XOR XLRG 1777 (2) YOR YLRG 1367

(3) 0 XSML XOR (4) 0 YSML YOR

The parameters XTIC and YTIC of course deal with their indicated axis and use the following format:

VALUE INPUT	TIC MARK LENGTH (inches)
0	No tic marks
1	1/128
2	1/64
3	1/32
4	1/16
5	1/8
6	1/4
7	1/2
10	1

One must be careful to observe that with numbers larger than eight you will get one of the three following possibilities.

(1) Larger than an inch

(2) Larger than the axis length

(3) One of the previously stated values

What happens is the value is made negative and decreased by one as a bit is rotated through the accumulator by one until the value becomes zero. As you can see a bit can rotate clear back around the accumulator.

One must enter by way of Alphanumeric status and after execution the terminal is in Alphanumeric status with the pointer at the origin of the axis. One must also have PACKAGE PLOT in memory.

```
*4620
XYPLAN,  0                  /X - Y AXIS OUTPUT
         CLA CLL            /CLEAR REGISTERS
         DCA XYP2           / 0 FOR X AXIS
         TAD XYM5           /INITIALIZATION FOR X AXIS
         JMS XYAXIS         /OUTPUT X AXIS
         ISZ XYP2           / 1 FOR Y AXIS
         TAD XYM3           /INITIALIZATION FOR Y AXIS
         JMS XYAXIS         /OUTPUT Y AXIS
         JMS XYORG          /PUT POINTER AT ORGIN
         JMP I XYPLAN       /RETURN TO MAIN PROGRAM
XYORG,   0                  /SUBROUTINE TO PUT POINTER
         TAD XYXOR          /AT ORGIN
         DCA XYX1           /X ORGIN IN XYX1
         TAD XYX1
         DCA XYX2           /X ORGIN IN XYX2
         TAD XYYOR
         DCA XYY1           /Y ORGIN IN XYY1
         TAD XYY1
         DCA XYY2           /Y ORGIN IN XYY2
         JMS XYPLOT         /POINTER TO ORGIN
         JMP I XYORG        /RETURN FROM SUBROUTINE
XYAXIS,  0                  /SUBROUTINE TO OUTPUT AXIS
                            /SECTION
         DCA XYCNT          /TABLE LENGTH COUNTER
         TAD XYTAB          /PARA. TABLE LOC.
         DCA IP1            /GET NEXT PARA,
         TAD I XYPLAN       /DEPOSIT NEXT PARA,
         DCA I IP1
         ISZ XYPLAN         /ALL PARA. GOTTEN
         ISZ XYCNT          /NO, GET MORE
         JMP .-4            /MAKE LINK LENGTH 4000
         TAD XY4000         /STORE AT LINK LENGTH
         DCA XYLNT          /GET LENGTH PARA.
         TAD XYTION         /IS IT EQUAL TO ZERO
         SNA
```

```
            JMP  XYTOT          /YES
            CIA                 /NO MAKE NEG.
            DCA  XYCNT          /MAKE COUNTER VALUE
            STL                 /MAKE LINK ONE
XYTLP,      RAL                 /ROTATE TILL ZERO
            ISZ  XYCNT          /COUNTER ZERO
            JMP  XYTLP          /NO
            DCA  XYLNT          /YES,STORE AT LINK LEN
XYTOT,      TAD  XYCM1          /BOUNDARY COMPARISON
            DCA  XYCOM
            JMS  XYORG          /POINTER AT ORGIN
            JMS  XYPAN          /OUTPUT AXIS SECTION
            JMS  XYORG          /PUT POINTER AT ORGIN
            TAD  XYLNT          /TIC LENGTH
            CIA                 /MAKE NEG.
            DCA  XYLNT          /STORE AT TIC LENGTH
            TAD  XYCM2          /BOUNDARY COMPARISON
            DCA  XYCOM
            TAD  XYSVL          /EXCHANGE BOUNDARY
            DCA  XYLMG          /VALUES
            JMS  XYPAN          /OUTPUT AXIS SECTION
            JMS  I XYAXIS       /RETURN FROM SUBROUTINE
XYPAN,      0                   /SUBROUTINE TO OUTPUT AXIS
                                /SECTIONS
            TAD  XYP2           /X OR Y AXIS OUTPUT
            TAD  XYXVL          /XYX1 LOCATION
            DCA  XYVV1          /MAKE XYX1 OR XYY1 LOC.
            TAD  XYVV1
            TAD  XYTMO          /MAKE XYX2 OR XYY2 LOC.
            DCA  XYVV2          /XYX1 OR XYY1 LOC.
XYPLP,      TAD  I XYVV1        /ADD OR SUB. TIC LENGTH
            TAD  XYLNT          /PUT IN XYX2, XYY2 LOC
            DCA  I XYVV2
            TAD  I XYVV2        /MAKE XYX2 OR XYY2 NEG.
            CMA CLL             /BOUNDARY
            TAD  XYLMG
```

```
XYCOM,  0
        JMP XYPLST
        JMS XYPLOT
        TAD I XYVV2
        DCA I XYVV1
        TAD XYTICM
        SNA CLA
        JMP XYPLP
        TAD XYYVL
        TAD XYP2
        DCA XYVV3
        TAD I XYVV3
        TAD XY10
        DCA I XYVV3
        JMS XYPLOR

        TAD I XYVV3
        TAD XY20
        DCA I XYVV3
        JMS XYPLOT

        TAD XY10
        TAD I XYVV3
        DCA I XYVV3
        JMP XYPLP
XYPLST, TAD XYLRG
        DCA I XYVV2
        JMS XYPLOT
        JMP I XYPAN
XYPLOT, 0
        JMS I XYVEC
XYX1,   0
XYY1,   0
XYX2,   0
XYY2,   0
        CLA CLL
```

```
        /OUTSIDE BOUNDARY
        /YES
        /NO, OUTPUT SECTION LINK
        /TAKE XYX2 OR XYY2 AND
        /PUT IN XYX1 OR XYY1
        /DO YOU WANT TIC MARKS

        /ADD NEXT LENGTH
        /XYY1 LOCATION
        /0 FOR X AND 1 FOR Y
        /XYY1 OR XYX2
        /X OR Y ORGIN
        /ADD 10

        /OUTPUT UPPER OR LEFT
        /TIC MARKS
        /XYY1 OR XYX2
        /SUB. 20
        /XYY1 OR XYX2
        /OUTPUT LOWER OR RIGHT
        /TIC MARKS
        /ADD 10
        /MAKE XYY1 OR XYX2
        /ORIGNAL VALUE
        /ADD NEXT LENGTH
        /GET BOUNDARY VALUE
        /PUT IN XYX2 OR XYY2
        /OUTPUT LAST LINK
/RETURN FROM SUBROUTINE
/SUBROUTINE TO OUTPUT LINES
        /PAKVEC SUBROUTINE
        /PAKVEC PARA.
        /   ''   ''
        /   ''   ''
        /   ''   ''
        /CLEAR REGISTERS
```

```
          JMP I XYPLOT
XYTAB,    XYTAB
XYLRG,    4
XYSML,    -4
XYTICK,   4
XYXORG,   3
XYYORG,   1
XYCM1,    SPA CLA
XYCM2,    SMA CLA
XYVEC,    5064
XY4K,     4000
XYTWO,    2
XY3,      -3
XY5,      -5
XYCNT,    7
XYLPT,    8
XYXVL,    XYA1
XYYVL,    XYY1
XYV1,     1
XYV2,     2
XYV3,     3
XYP2,     1
XYM2,     -2
XY1,      1
IF1,      1
```

```
/RETURN FROM SUBROUTINE
      /PARA. TABLE LOC.
      /LARGE X OR Y BOUNDARY
      /SMALL X OR Y BOUNDARY
      /LINK LENGHT SIZE
      / X ORGIN
      /Y ORGIN
      /BOUNDARY COMPARISON
      /BOUNDARY COMPARISON
      /PARVEC LOCATION
```

7.2 Section 5 Pattern Plot

LABELS PAGE 25

Locations Used: 5200-5366

Label	Location	Usage
SQN10	5364	/Size of square counter
SQPLT	5366	/Location of PAKVEC routine
SQSAV	5363	/Size calculation storage
SQSIZ	5365	/Location for square size
SQUARE	5301	/Subroutine to output square
SQVEC	5354	/Line output subroutine
SQX1	5356	/First X value for line output
SQX2	5360	/Second X value for line output
SQY1	5357	/First Y value for line output
SQY2	5361	/Second Y value for line output
TRIANG	5200	/Subroutine to output triangle
TRICK	5274	/Leg of triangle counter
TRIFIX	5276	/X coord. length of triangle
TRIFIY	5277	/Y coord. length of triangle
TRIOVR	5206	/X or Y coordinate loop
TRIPLT	5234	/Location of PAKVEC routine
TRISIZ	5275	/Number of X and Y increases
TRIVEC	5300	/Leg output routine
TRIX1	5235	/First X value for leg output
TRIX2	5237	/Second X value for leg output
TRIY1	5236	/First Y value for leg output

LABELS PAGE 25 (con)

Locations Used: 5200-5362

Label	Location	Usage
TRIY2	5240	/Second Y value for leg output
TRI2	5251	/Second leg of triangle output
TRI3	5260	/Third leg of triangle output
TRI4	5273	/One half base added per size
TRI7	5272	/Height added per size

TRIANG(SIZ,X,Y) LOCATION: 5200

The pattern produced here is an almost equalaterial triangle. The parameter SIZ indicates the size of the triangle that is to be produced. The triangle format is a 8^{size+1}X 7^{size+1} that is, the width of the triangle is equal to 8^{size+1} and the height is equal to 7^{size+1}. The X and Y parameters refer to the upper left hand coordinate values of the triangle. In order to use this routine the package plot routine must be in memory. The user must enter by way of a graphics status and after execution the terminal will be in Alphanumeric status mode.

SQUARE(SIZ,X,Y) LOCATION: 5200

The pattern produced here is a square of an eight by eight multiple. The parameter SIZ indicates the size of the square to be produced. The square format is 8^{size+1}X 8^{size+1}. The X and Y parameters refer to the upper left hand coordinate values of the square. In order to use this routine the package plot routine must be in memory. The user must enter by way of a graphics status and after execution the terminal will be in Alphanumeric status mode.

```
*5200
TRIANG,  0                  /RETURN ADDRESS
         TAD I TRIANG       /PICK UP TRIANGLE SIZE
         CMA                /MAKE NEG.
         DCA TRISIZ         /USE FOR LENGTH SIZE
         DCA TRIFIX         /MAKE X COORD ZERO
         DCA TRIFIY         /MAKE Y COORD ZERO
TRIOVR,  TAD TRIFIX         /GET X COORD LENGTH
         TAD TRI4           /ADD 4 TO X COORD LENGTH
         DCA TRIFIX         /DEPOSIT IN X COORD LENGTH
         TAD TRIFIY         /GET Y COORD LENGTH
         TAD TRI7           /ADD 7 TO Y COORD LENGTH
         DCA TRIFIY         /DEPOSIT IN Y COORD LENGTH
         ISZ TRISIZ         /ADDED TO COORD ENOUGH
         JMP TRIOVR         /NO
         ISZ TRIANG         /YES, GET X LOCATION
         TAD I TRIANG       /GET X POSITION
         DCA TRIX2          /DEPOSIT X2 OF VEC ROUTINE
         ISZ TRIANG         /GET Y LOCATION
         TAD I TRIANG       /GET Y POSITION
         DCA TRIY1          /DEPOSIT Y1 OF VEC ROUTINE
         TAD TRIX2          /GET X2 VALUE
         TAD TRIFIX         /ADD X COORD LENGTH
         DCA TRIX1          /DEPOSIT  X1 OF VEC ROUTINE
         TAD TRIFIY         /GET Y COORD LENGTH
         CMA IAC            /MAKE NEG.
         TAD TRIY1          /ADD X1 OF VEC ROUTINE
         DCA TRIY2          /DEPOSIT Y2 OF VEC ROUTINE
         DCA TRICK          /MAKE LEG COUNTER ZERO
TRIPLT,  JMS I TRIVEC       /OUTPUT FIRST LEG OF TRIANGLE
TRIX1,   0                  /FIRST X VALUE OF VEC OUTPUT
TRIY1,   0                  /FIRST Y VALUE OF VEC OUTPUT
TRIX2,   0                  /SECOND X VALUE OF VEC OUTPUT
TRIY2,   0                  /SECOND Y VALUE OF VEC OUTPUT
         TAD TRICK          /GET LEG COUNTER
         SNA                /IS IT ZERO
```

```
            JMP TRI2                /YES, OUTPUT SECOND LEG
            RAP                     /NO
            SNA CLA CLL             /IS IT ONE
            JMP TRI3                /YES, OUTPUT THIRD LEG
            ISZ TRIANG              /NO, RETURN
            JMP I TRIANG            /RETURN
TRI2,       TAD TRIFIX              /ADD X COORD LENGTH
            TAD TRIFIX              /ADD X COORD LENGTH AGAIN
            TAD TRIX2               /ADD X2 OF VEC ROUTINE
            DCA TRIX2               /DEPOSIT X2 OF VEC ROUTINE
            IAC                     /ADD ONE TO ACC.
            DCA TRICK               /DEPOSIT IN LEG COUNTER
            JMP TRIPLT              /OUTPUT SECOND LEG
TRI3,       TAD TRIFIX              /ADD XCOORD LENGTH
            CMA IAC                 /MAKE NEG
            TAD TRIX1               /ADD X1 OF VEC ROUTINE
            DCA TRIX1               /DEPOSIT X1 OF VEC ROUTINE
            TAD TRIY2               /ADD Y2 OF VEC ROUTINE
            DCA TRIY1               /DEPOSIT Y2 OF VEC ROUTINE
            TAD TRICK
            IAC
            DCA TRICK
            JMP TRIPLT
TRI7,       7
TRI4,       4
TRICK,      0
TRISIZ,     0
TRIFIX,     0
TRIFIY,     0
TRIVEC,     6364
SQUARE,     0
            TAD I SQUARE            /GET X COORD
            CMA
            DCA SQSAV
            ISZ SQUARE
            TAD I SQUARE
```

```
DCA  SQX1          /PUT IN X1 FOR VEC ROUTINE
DCA  SQSIZ         /ZERO SIZE OF SQUARE
ISZ  SQUARE        /GET NEXT SQUARE LOC
TAD  I SQUARE      /GET Y COORD
DCA  SQY1          /PUT IN Y1 FOE VEC ROUTINE
TAD  SQN19         /INITIAL SQUARE LENGTH
TAD  SQSIZ         /ADD TO LENGTH OF SQUARE
DCA  SQSIZ         /STORE IN LENGTH
ISZ  SQSAV         /SQUARE LARGE ENOUGH
JMP  .-4           /NO
TAD  SQX1          /YES
TAD  SQSIZ         /LENGTH OF SQUARE
DCA  SQX2          /PUT IN X2 VALUE FOR VEC ROUTINE
TAD  SQY1          /GET Y COORD
DCA  SQY2          /PUT IN Y2 VALUE
JMS  SQVEC         /FIRST LEG OF SQUARE
TAD  SQX1          /GET X COORD
DCA  SQX2          /X2 VALUE FOR VEC ROUTINE
TAD  SQSIZ         /LENGTH OF SQUARE
CMA  IAC           /MAKE NEG
TAD  SQY1          /ADD Y1 COORD
DCA  SQY2          /Y2 VALUE FOR VEC ROUTINE
JMS  SQVEC         /LEG TWO
TAD  SQY2          /GET Y2 COORD
DCA  SQY1          /Y1 VALUE FOR LEG THREE
TAD  SQX2          /GET X2 VALUE
TAD  SQSIZ         /LENGTH OF SQUARE
DCA  SQX1          /X1 VALUE FOR LEG THREE
JMS  SQVEC         /LEG THREE
TAD  SQX1          /GET X1 COORD
DCA  SQX2          /X2 VALUE FOR LEG 4
TAD  SQY1          /GET Y1 COORD
TAD  SQSIZ         /LENGTH OF SQUARE
DCA  SQY2          /Y2 VALUE FOR LEG 4
JMS  SQVEC         /LEG FOUR
ISZ  SQUARE        /GET NEXT SQUARE LOC
```

```
            JMP I SQUARE        / RETURN
SQVEC,      0                   / LEG OUTPUT
            JMP I SQPLT         / VECTOR SUBROUTINE
SQX1,       0
SQY1,       0
SQX2,       0
SQY2,       0
            JMP I SQVEC
SQSAV,      0
SQMAG,      100
SQSIZ,      0
SQPLT,      5664
$
```

APPENDIX 7.3

Appendix 7.3 deals with a full screen output. The program outputs a variety of possible grayscal values in the largest area used, that is 58 by 34 points.

```
/OUTPUTS FULL SCREEN USING INTENSITY ROUTINE

        *21?
        CLA CLL
        TLS                     /CLEAR FLAG
        TAD     TAB             /INTEN TABLE HEAD
        DCA     10
        TAD     P22             /LENGTH OF TABLE
        DCA     TABCNT
        TAD     P60             /MAX NUMB. OF ROWS
        DCA     ROWCNT
        TAD     P42             /MAX NUMB. OF LINES
        DCA     LINCNT
        TAD     P1230
        DCA     FAY1            /INITIAL Y LOC.
        TAD     P1170
        DCA     FAX1            /INITIAL X LOC.
        IAC
        DCA     FA1             /OPTION 1 FOR INTEN
        TAD     P0
        DCA     FA2             /LEFT EDGE OUTPUT
START,  JMS I   TESVEC
FA1,    .                       /OPTION 1
FAX1,   0
FAY1,
FA2,    0
AGAIN,  TAD I   10              /NEXT TABLE VALUE
        DCA     FA2
        JMS     TABLP           /RESTART TABLE?
        JMS I   TESVEC          /OUTPUTS NEXT ROW VALUE
FB1,    .                       /OPTION 2
FB2,    2
        JMS     LINLP           /NEXT LINE CHECK
        JMP     AGAIN           /CONTINUE

TABLP,  0                       /END OF TABLE?
```

```
        ISZ     TABCNT
        JMP I   TABLP   /NO,RETURN
        TAD     M22     /YES,RESTART COUNTER
        DCA     TABCNT
        TAD     TAB     /RESTART TABLE HEAD
        DCA     I 3
        JMP I   TABLP   /RETURN

LINLP,  0               /END OF LINE CHECK
        ISZ     ROWCNT
        JMP I   LINLP   /NO,RETURN
        TAD     FAY1    /NEW Y LOC.
        TAD     M22
        DCA     FAY1
        TAD     P11A    /NEW X LOC.
        DCA     FAX1
        TAD     M66     /RESTART COUNTER
        DCA     ROWCNT
        ISZ     LINCNT  /LAST LINE+
        JMP     START   /NO,CONTINUE
        HLT             /YES,STOP
ROWCNT, 0
TABCNT, 0
LINCNT, 0
P4,     1.
P11A,   11.
P12SA,  125
TESVEC, 0 1
M20,    -20
M22,    -22
M42,    -42
M66,    -66
TAB,    TAB
        2
        2
        1
```

APPENDIX 7.4

Appendix 7.4 is divided into four sections.

Section 1: *PHILO1 Line Printer Output.

Section 2: *PHILO2 Line Printer Output.

Section 3: *CR20412 Line Printer Output.

Section 4: *CR20413 Line Printer Output.

810
820
830
840
850
BAND
THESE.

130
140
150
160
170
180
SAND
5
THRES.
12
13
14
15
16
18
23

140
150
160
170
180
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
BAND
5
TAPES.
14
15
16
17
20
23

260
270
280
290
300
310
BAND
5
THRES.
14
15
16
17
18
19
20

APPENDIX 7.5

Appendix 7.5 is divided into four sections.

Section 1: *PHILO1 and Shutter time

Section 2: *PHILO2 and Shutter time

Section 3: *CR20412 and Shutter time

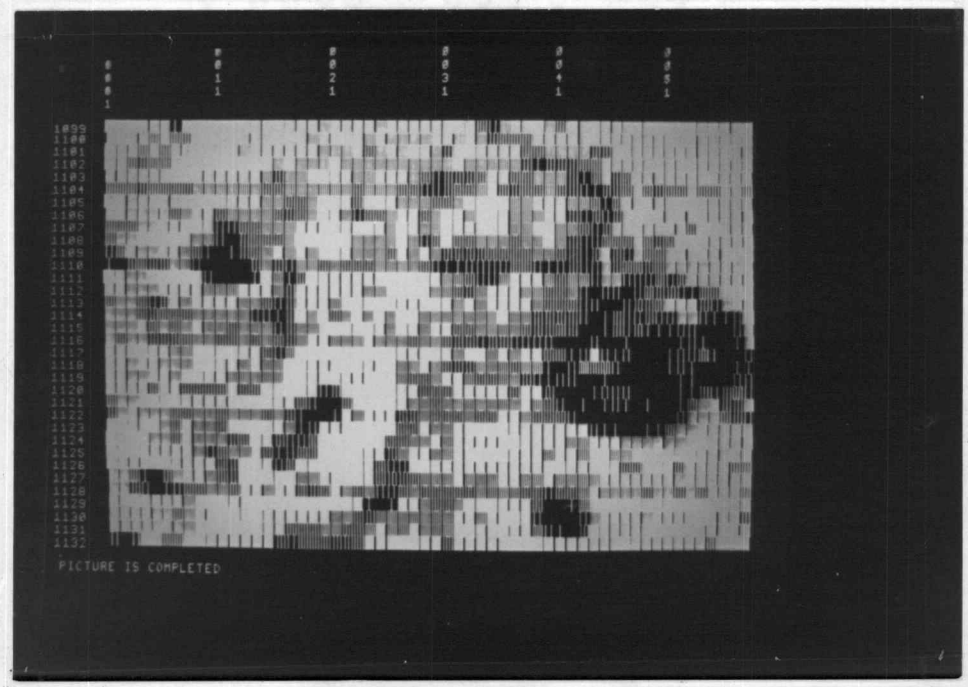
Section 4: *CR20413 and Shutter time

7.5 Section 1 *PHILO1

Shutter speed: 1/30

F stop: 1.8

ASA 125

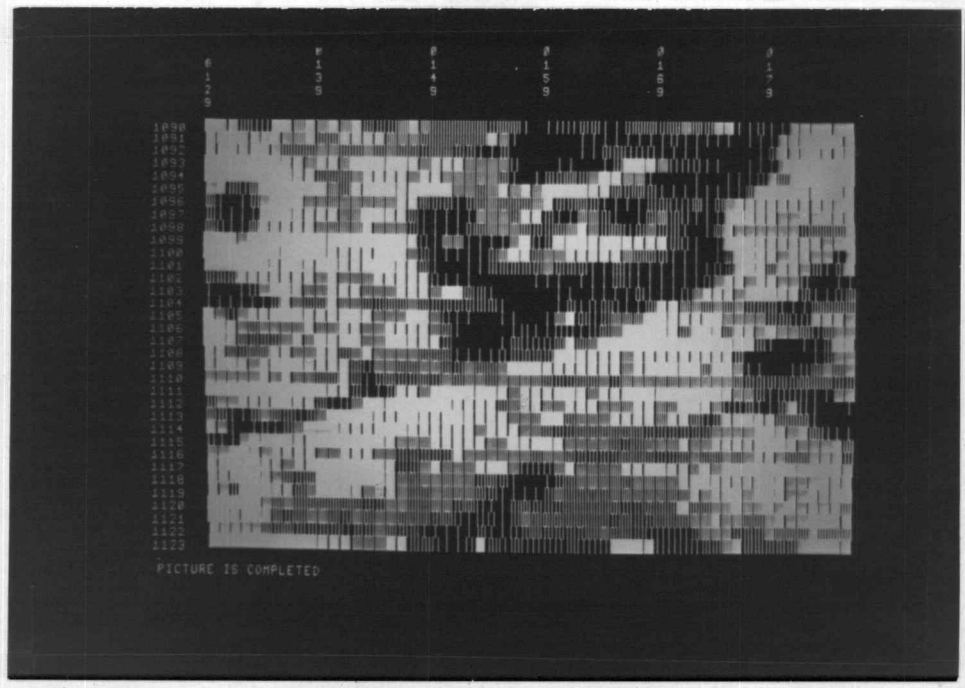


7.5 Section 2 *PHILO2

Shutter speed: 1/30

F stop: 1.8

ASA 125

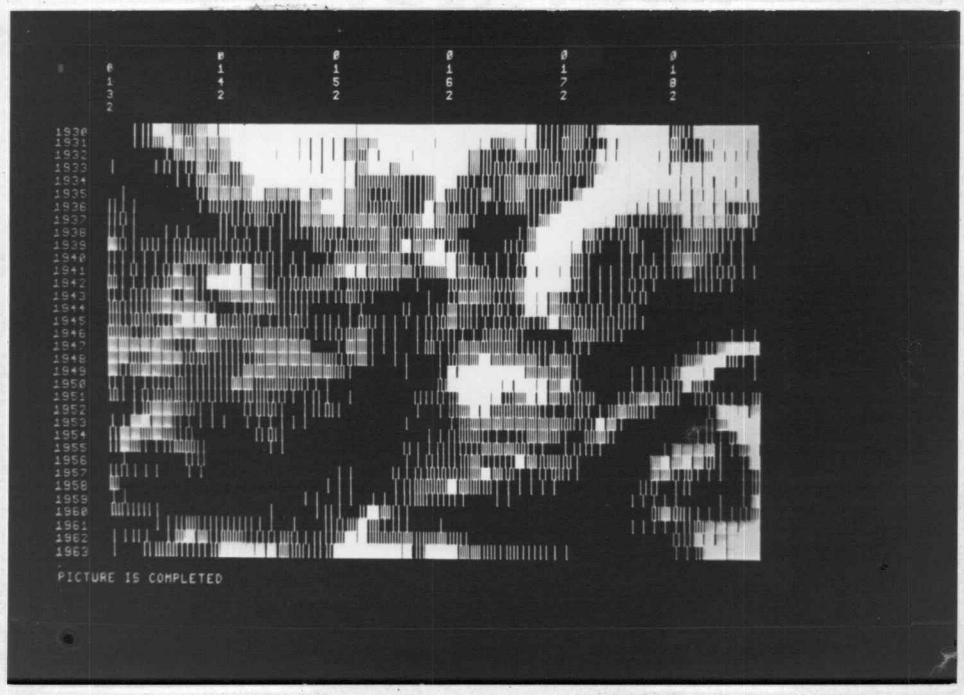


7.5 Section 3 *CR20412

Shutter speed: 1/15

F stop: 1.8

ASA 125

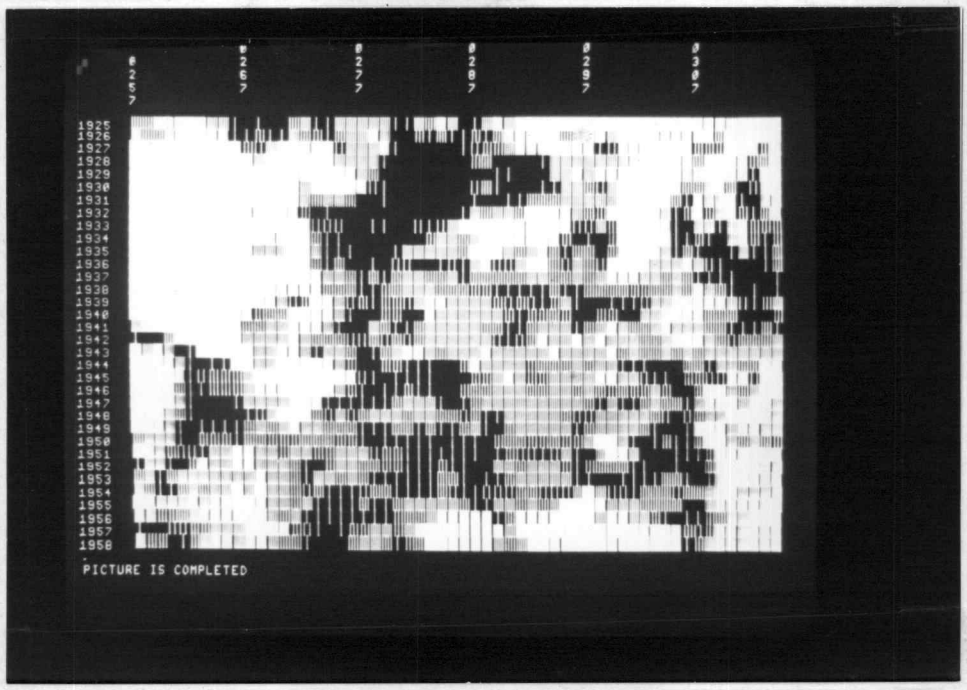


7.5 Section 4 *CR20413

Shutter speed: 1/15

F stop: 1.8

ASA 125



APPENDIX 7.6

Appendix 7.6 is divided into four sections.

Section 1: The third CDC 3300 Linkage Program

Section 2: The BUFOUT Subroutine

Section 3: The NEQUIP Subroutine

Section 4: The third PDP8/L Linkage Program

```
      PROGRAM OS3PIX3
C     ***************************************************
C     *                                                 *
C     *     OS3PIX IS A COMMUNICATION PROGRAM BETWEEN   *
C     * OS3 AND THE PDP8-L USING THE ORIGINAL ERTS       *
C     * BINARY FILE.  LUN 20 IS THE INPUT FILE.         *
C     ***************************************************
      DIMENSION ID(23),INPUT(870),IWORK(218)
      INTEGER PP,REM,WS,WSS
      CHARACTER CWORK(872),CID(92)
      EQUIVALENCE(IWORK,CWORK),(CID,ID)
      WRITE(61,100)
100   FORMAT(' START')
110   CALL CHIN(N)
120   CALL UNEQUIP(20)
      READ(60,130)XNAME
130   FORMAT(A8)
      IF(NEQUIP(20,XNAME)) 150,140
140   CALL CHIN(N)
      CALL CHOUT(58)
      GO TO 120
150   CALL CHIN(N)
      CALL CHOUT(48)
      CALL IDENT(ID,10,LD)
      IF (LD .EQ. 2) GO TO 120
      WS=FFIN(60)
C
C SEND ID(5)& ID(7),ID(8)& ID(11,ID(12)
C
      I=4
      J=16
      CALL BUFOUT(I,J,CID)
      I=I+4
      J=J+8
      CALL BUFOUT(I,J,CID)
      J=J+16
```

```
      CALL BUFOUT(I,J,OID)
      RE=FFIN(60)
      P=FFIN(64)
      LP=FFIN(61)
      LS=FFIN(62)
      PP=FFIN(63)
      LENGTH=IO(5)
C
C     BUFFER OVER TO STARTING BLOCK
C
      DO 17? I=1,LS
         BUFFER IN(24,1)(INPUT(1),INPUT(LENGTH))
16?      WAIT(16?,17?,22?,22?),UNITSTF(2?)
17?   CONTINUE
      CALL CHIN(4)
      CALL CHOUT(4=)
      CALL CHIN( )
C
C     BUFFER IN THAT PART OF BLOCK TO OUTPUT
C
      DO 21? I=1,LP
         BUFFER IN(2?,1)(INPUT(1),INPUT(LENGTH))
14?      WAIT(14?,19?,22?,22?),UNITSTF(2?)
19?      JSS=?3
      CALL CHIN(?)
         CALL CHOUT(16)
            DO 2?? J=1,?
               INBUF(J)=INPUT(JSS)
               JSS=JSS+4
2??         CONTINUE
      CALL BUFOUT(FP,RE,CHORA)
21?   CONTINUE
      STOP
22?   CALL CHIN( )
      CALL CHOUT(?3)
      GO TO 11.
```

```
      END
      SUBROUTINE IDENT(ID,LUN,LP)
      DIMENSION ID(23)
      CALL C-IN(LUN)
      BUFFER IN (23,1) (ID(1),ID(23))
1     GO TO (1,2,3,3),UNITSTF(23)
2     LP=1
      CALL CHIN(LUN)
      CALL C-OUT(48)
      RETURN
3     LP=2
      CALL CHIN(LUN)
      CALL C-OUT(58)
      RETURN
      END
```

```
        IDENT   BUFOUT
        ENTRY   BUFOUT
BUFOUT  UJP     **
        LDI     BUFOUT,3        GET ADR OF PARM,
        LDA,I   1,3             GET # OF FIRST CHAR
        SHAQ    24              STORE IN Q
        LDA     2,3             GET CHAR ADR OF ARRAY
        LPA     MASK            MASK OFF 77
        AQA                     ADD OFF SET AND CHAR ADR
        SCHA    STCHA           STORE CHAR ADR
        LDA,I   0,3             GET # OF CHARS TO OUTPUT
        ENI     0,1             PUT 0 IN IR1
        UJP     EOL             GET CHAR OUTPUT LOOP
STCHA   LACH    **,1            GET CHAR VALUE
EOL     IJD     STCHA,2         ALL CHAR OUTPUTTED ?
        CTO                     OUTPUT CHAR
        INI     1,1             NEXT CHAR
        TAI     2               STORE IN IR2
        UJP     3,3
MASK    OCT     00777777B
        END
```

```
        IDENT   NEQUIP
        ENTRY   NEQUIP
NEQUIP  UJP     **
        LDI     NEQUIP,3        PUTS LUN ADR IN 3
        LDA,I   0,3             GET LUN VALUE
        STA     LUN             STORE LUN VALUE AT LUN
        LDAC,I  1,3             PUTS NAME IN A0
        EQI     3,1             PUTS 3 IN 1 (EQUIP)
        XREQ,I  LUN             EQUIP LUN WITH A0
        ENA     1               TRUE RETURN
        ISG     1,1             SKIP NEXT LINE IF NO ERROR
        UJP     2,3             RETURN
        ENA     0               FALSE RETURN
LUN     BSS     1               LUN STORAGE
        END
```

7.6 Section 4 PDP8/L Linkage Routine

```
3300 PAL/OS3 VER 3.1   12/09/75  23:42                    PAGE  1

                          1
                          2  KCC40   =6402
                          3  KSF40   =6401
                          4  KPR40   =6406
                          5  TSF41   =6411
                          6  TCF41   =6412
                          7  TLS41   =6416
                          8
                          9
                         10          /SERVICE ROUTINE
                         11
          0001            12          *0001
0001      5020          13          JMP     SERVE
                         14
          0020            15          *0020
                         16
0020      4536          17  SERVE,  JMS I   SAVREG  /SAVE REGISTERS
0021      6401          18          KSF40           /FROM OS3A
0022      7410          19          SKP             /NO
0023      5124          20          JMP     OS3IN
0024      6411          21          TSF41           /TO OS3A
0025      7410          22          SKP             /NO
0026      6412          23          TCF41           /CLEAR FLAG
0027      6031          24          KSF             /FROM PDPRA
0030      7410          25          SKP             /NO
0031      6032          26          KCC             /CLEAR FLAG
0032      6011          27          RSF             /FROM HSRA
0033      7410          28          SKP             /NO
0034      6012          29          RRB             /CLEAR FLAG
0035      6041          30          TSF             /TO PDPRA
0036      5133          31          JMP     RETT
0037      7140          32  PDPOUT, CMA             /SET OUTPUT FLAG
0040      3043          33          DCA     IFL
0041      6042          34          TCF
0042      5133          35          JMP     RETT    /RETURN
                         36
0043      0000          37  IFL,    0
0044      0000          38  BUFFL1, 0
0045      0000          39  BUFFL2, 0
0046      0000          40  NUMBUF, 0
0047      0000          41  NUMFL,  0
0050      0201          42  HOME,   201
0051      2660          43  LIS1,   LIS
0052      5660          44  TYP1,   PARTYP
0053      2610          45  LIS2,   LIS40
0054      2615          46  TYP2,   TYP41
0055      2700          47  SCFULL, BOTCK
0056      2653          48  MESS,   MESOUT
0057      3124          49  BUF,    BUFFIN
0060      0000          50  NUMCNT, 0
0061      0000          51  PLH,    0000    /+1 D.P.
0062      0001          52  PLL,    0001
0063      7777          53  MLH,    7777    /-1 D. P.
0064      7777          54  MLL,    7777
0065      0215          55  P215,   215
0066      0212          56  P212,   212
0067      0260          57  P260,   260
0070      7520          58  M260,   -260
0071      7563          59  M215,   -215
0072      7774          60  M4,     -4
0073      0000          61  ID5H,   0       /ID(5) BINARY
0074      0000          62  ID5L,   0
0075      0000          63  ID7H,   0       /ID(7) BINARY
0076      0000          64  ID7L,   0
0077      0000          65  ID8H,   0       /ID(8) BINARY
0100      0000          66  ID8L,   0
0101      0000          67  ID11H,  0       /ID(11) BINARY
0102      0000          68  ID11L,  0
0103      0000          69  ID12H,  0       /ID(12) BINARY
0104      0000          70  ID12L,  0
0105      0000          71  BANO,   0
0106      0000          72  IPH,    0       /INITIAL POINT
0107      0000          73  IPL,    0
0110      0000          74  PPH,    0       /POINTS TO PRINT
0111      0000          75  PPL,    0
0112      0000          76  LSH,    0       /START LINE
0113      0000          77  LSL,    0
0114      0000          78  LPH,    0       /LINES TO PRINT
0115      0000          79  LPL,    0
0116      0000          80  COMH,   0       /MANIPULATION STORAGE
```

```
3300 PAL/OS3 VER 3.1   12/29/75  23:42                    PAGE   2

0117  0000     91  COML,   0
0120  0000     92  NUM81,  0         /1000#S
0121  0000     93  NUM82,  0         /100#S
0122  0000     94  NUM83,  0         /10#S
0123  0000     95  NUM84,  0         /UNITS
                96
0124  4654     97  OS3IN,  JMS I     DATPUT
0125  1047     98          TAD       NUBFL     /SKIP BUFFER FLAG SET?
0126  7650     99          SNA CLA             /YES, SKIP BUFFER
0127  1044    100          TAD       BUFFL1    /BUFFER FLAG SET?
0130  7640    101          SZA CLA
0131  4457    102          BUFFER              /YES, BUFFER
0132  3044    103          DCA       BUFFL1    /NO
0133  4637    104  RETT,   JMS I     REGRES    /RESTORE REGISTERS
0134  6001    105          ION
0135  5400    106          JMP I     0
0136  5006    107  SAVREG, PAKSAV
0137  5013    108  REGRES, PAKRST
                109
0140  0000    110  TYP,    0
0141  3155    111          DCA       KEYP      /SAVE VALUE
0142  1343    112          TAD       IFL       /OUTPUT FLAG SET
0143  7700    113          SMA CLA             /YES,CONTINUE
0144  5142    114          JMP       .-2       /NO,WAIT
0145  1155    115          TAD       KEYP      /GET VALUE
0146  6002    116          IOF                 /TURN INTERRUPT OFF,CLEAR FLAG
0147  6046    117          TLS
0150  7300    118          CLA CLL
0151  3043    119          DCA       IFL
0152  6001    120          ION                 /TURN ON INTERRUPT
0153  5540    121          JMP I     TYP       /RETURN
                122
0154  3000    123  DATPUT, DATIN
0155  0000    124  KEYP,   0
              125  INPUT  =JMS I     LIS1
              126  OUTPUT =JMS I     TYP1
              127  RECEIVE=JMS I     LIS2
              128  SEND   =JMS I     TYP2
              129  SCREEN =JMS I     SCFULL
              130  MESSAGE=JMS I     MESS
              131  BUFFER =JMS I     BUF
                132
                133  /SET UP FOR BUFFER IN ERROR
                134
          0177  135          *0177
0177  4451    136  NEW,    INPUT
```

```
3300 PAL/OS3 VER 3.1   12/08/75  23:42                    PAGE   3

                    128
                    129
                    130  /THE EXCHANGE OF ERT#S DETA FROM THE 3300 TO FORA/L
                    131
                    132  /BY CECIL L NELSON
                    133
                    134  /NOV., 1975
                    135
          0200      136          *200
0200      7300      137  BEGIN,  CLA CLL
0201      6746      138          TLS                 /CLEAR ALL FLAGS
0202      6416      139          TLS41
0203      4776      140          JMS I    WIPE       / ERASE SCREEN
0204      4456      141  ME0,    MESSAGE
0205      5603      142          MESSA               /WHAT
0206      5611      143          MESSC               /IS THE
0207      5621      144          MESSD               /INPUT FILE
0210      5606      145          MESSB               /^
0211      0000      146          0
0212      4783      147          JMS I    FLSTR      /STORE THE FILE NAME
0213      4456      148  ME1,    MESSAGE
0214      5611      149          MESSC               /IS THE
0215      5621      150          MESSD               /INPUT FILE
0216      5635      151          MESSE               /CORRECT
0217      5606      152          MESSB               /^
0220      0000      153          0
0221      4762      154          JMS I    ANS        /REPLY ROUTINE
0222      5213      155          JMP      ME1        /ERROR RETURN
0223      5204      156          JMP      ME0        /NO RETURN
0224      4764      157          JMS I    INFIL      /YES RETURN: SEND FILE
0225      4761      158          JMS I    FLCK       /FILE EXIST^
0226      5204      159          JMP      ME0        /NO
0227      4454      160          SEND
0230      4457      161          BUFFER              /BUFFER IN ERROR^
0231      4456      162  ME2,    MESSAGE
0232      5600      163          MESSA               /WHAT
0233      5646      164          MESSF               /ARE THE THRESHOLDS
0234      5606      165          MESSB               /^
0235      0000      166          0
0236      4765      167          JMS I    THOVAL     /STORE THRESHOLDS
0237      5231      168          JMP      ME2        /INPUT ERROR
0240      4456      169  ME4,    MESSAGE
0241      5635      170          MESSE               /CORRECT (THRESHOLDS)
0242      5606      171          MESSB               /^
0243      0000      172          0
0244      4762      173          JMS I    ANS        /REPLY ROUTINE
0245      5240      174          JMP      ME4        /ERROR RETURN
0246      5231      175          JMP      ME2        /NO RETURN
0247      4766      176          JMS I    THCHCK     /YES RETURN:LEGAL VALUES^
0250      5231      177          JMP      ME2        /NOT LEGAL
0251      4767      178          JMS I    VALTAB     /SETS UP TABLE VALUE
0252      4456      179  ME5,    MESSAGE
0253      5600      180          MESSA               /WHAT
0254      5762      181          MESS1               /BAND NUMBER
0255      5606      182          MESSB               /^
0256      0000      183          0
0257      4770      184          JMS I    BNDCK      /BAND #: BETWEEN (4-7)^
0260      5263      185          JMP      ME7        /NO
0261      4456      186  ME6,    MESSAGE
0262      5635      187          MESSE               /CORRECT
0263      5608      188          MESS3               /^
0264      0000      189          0
0265      4762      190          JMS I    ANS        /REPLY ROUTINE
0266      5261      191          JMP      ME6        /ERROR RETURN
0267      5252      192          JMP      ME5        /NO RETURN
0270      1105      193          TAD      BAND       /YES RETURN
0271      1374      194          TAD      MIN3
0272      4454      195          SEND
0273      1265      196          TAD      P215
0274      4454      197          SEND                /SEND WITHOUT DELAY
0275      4453      198          RECEIVE             /GET LINE FEED
0276      7200      199          CLA                 /CLEAR ACC
0277      4775      200          JMS I    IDAT       /INPUT ID(5,7,8,11,12)
0300      0173      201          IOSH
0301      7754      202          7754
0302      4777      203          JMS I    INFF       /CHECK FOR < >
0303      4456      204          MESSAGE
0304      6044      205          MESSO               /ON THIS FILE
0305      5703      206          MESSH               /POINT
0306      5711      207          MESSI               /S
```

```
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0307  0000  208            0
0310  4771  209            JMS I   BIDEC   /CONVERTS IO(7) TO DECIMAL
0311  0075  210            IO7H            /IO(7) BINARY
0312  3304  211            ION7            /IO(7) DECIMAL
0313  4772  212            JMS I   IOOUT
0314  3307  213            ION8-1          /DECIMAL OUTPUT IO(7)
0315  4456  214            MESSAGE
0316  6150  215            MESSR           /SPACE-SPACE
0317  0000  216            0
0320  4771  217            JMS I   BIDEC   /CONVERT IO(8) TO DECIMAL
0321  0077  218            IO8H            /IO (8) BINARY
0322  3310  219            ION8            /IO (8) DECIMAL
0323  4772  220            JMS I   IOOUT   /
0324  3313  221            ION11-1         /DECIMAL OUTPUT IO(8)
0325  4456  222            MESSAGE
0326  5760  223            MESSM           /CRLF
0327  5727  224            MESSK           /LINE
0330  5711  225            MESSI           /S
0331  0000  226            0
0332  4771  227            JMS I   BIDEC   /CONVERT IO(11) TO DECIMAL
0333  0101  228            IO11H           /IO(11) BINARY
0334  3314  229            ION11           /IO(11) DECIMAL
0335  4772  230            JMS I   IOOUT
0336  3317  231            ION12-1         /DECIMAL OUTPUT IO(11)
0337  4456  232            MESSAGE
0340  6150  233            MESSR           /SPACE-SPACE
0341  0000  234            0
0342  4771  235            JMS I   BIDEC   /CONVERT IO(12) TO DECIMAL
0343  0103  236            IO12H           /IO (12) BINARY
0344  3320  237            ION12           /IO (12) DECIMAL
0345  4772  238            JMS I   IOOUT
0346  3323  239            ION12+3         /DECIMAL OUTPUT IO(12)
0347  4456  240            MESSAGE
0350  5760  241            MESSM           /CRLF
0351  0000  242            0
0352  5773  243            JMP I   PAGE4
0353  4456  244  MF7,       MESSAGE
0354  5762  245            MESS1           /RAND # MUST BE ...
0355  5777  246            MESS2
0356  6020  247            MESSN           /ENTER # AGAIN ...
0357  0000  248            0
0360  5552  249            JMP     ME5
0361  3554  250  FLCK,     CKFL
0362  2000  251  ANS,      REPLY
0363  3077  252  FLSTR,    FLIN
0364  2145  253  INFIL,    FLOUT
0365  3400  254  THOVAL,   THOIN
0366  2300  255  THCHCK,   THCK
0367  2232  256  VALTAB,   TABVAL
0370  2564  257  BNOCK,    BNIN
0371  2400  258  BIDEC,    BCDBN
0372  1303  259  IOOUT,    NUMOUT
0373  0400  260  PAGE4,    0400
0374  7775  261  MIN3,     -3
0375  1343  262  IOAT,     DATTIN
0376  2525  263  WIPE,     ERASE
0377  3565  264  INFF,     FFIN
              265
      0400  266            *400
              267
0400  4456  268  ME8,      MESSAGE
0401  5600  269            MESSA           /WHAT
0402  5611  270            MESSC           /IS THE
0403  5672  271            MESSG           /INITIAL
0404  5703  272            MESSH           /POINT
0405  5606  273            MESS8           /A
0406  0000  274            0
0407  4763  275            JMS I   GET     /INPUT INITIAL POINT
0410  7773  276            7773            /-(MAX # INPUTS) +1
0411  0573  277            ST1             /STORAGE LOC.
0412  5200  278            JMP     ME8     /ERROR INPUT
0413  4765  279            JMS I   CORCT   /REPLY ROUTINE
0414  5213  280            JMP     .-1     /ERROR RETURN
0415  5200  281            JMP     ME8     /NO RETURN
0416  4764  282            JMS I   DECB    /YES RETURN: CHANGE TO BINARY
0417  0573  283            ST1             /DECIMAL ADR
0420  0106  284            IPH             /BINARY ADR
0421  4767  285            JMS I   DPSUB   /IO(7)-IP
0422  0106  286            IPH
0423  0075  287            IO7H
```

```
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0424   4770   288            JMS I   COMP    /RESULTS<=0^
0425   4353   289            JMS     ME12    /NO
0426   5200   290            JMP     ME8
0427   4456   291   ME9,     MESSAGE
0430   5714   292            MESSJ           /NUMBER OF
0431   5703   293            MESSH           /POINT
0432   5711   294            MESSI           /S
0433   5606   295            MESSB           /^
0434   0000   296            0
0435   4763   297            JMS I   GET     /INPUT POINTS TO PRINT
0436   7775   298            7775            /-(MAX > INPUTS) +1
0437   0573   299            ST1             /STORAGE LOC.
0440   5227   300            JMP     ME9     /ERROR INPUT
0441   4765   301            JMS I   CORCT   /REPLY ROUTINE
0442   5241   302            JMP     .-1     /ERROR RETURN
0443   5227   303            JMP     ME9     /NO RETURN
0444   4764   304            JMS I   DECB    /YES RETURN: CHANGE TO BINARY
0445   0573   305            ST1             /DECIMAL ADR
0446   0110   306            PPH             /BINARY ADR
                307
                308   /CHECK TO SEE IF INITIAL POINT AND POINTS TO PRINT LEGAL
                309
0447   4766   310            JMS I   DPADD   /POINT PRINT + INITIAL POINT
0450   0106   311            IDPH
0451   0110   312            PPH
0452   4767   313            JMS I   DPSUB
0453   0077   314            IDAH            /RESULTS - ID(A)
0454   0116   315            COMH
0455   4766   316            JMS I   DPADD   /RESULTS -1
0456   0063   317            MLH
0457   0116   318            COMH
0460   4770   319            JMS I   COMP    /RESULT<=0^
0461   4353   320            JMS     ME12    /NO
0462   5200   321            JMP     ME8
0463   4767   322            JMS I   DPSUB   /YES:POINTS TO PRINT -58
0464   0571   323            N58H
0465   0110   324            PPH
0466   4770   325            JMS I   COMP    /RESULTS<=0^
0467   4353   326            JMS     ME12    /NO
0470   5227   327            JMP     ME9
0471   4456   328   ME10,    MESSAGE
0472   5600   329            MESSA           /WHAT
0473   5611   330            MESSC           /IS THE
0474   5672   331            MESSG           /INITIAL
0475   5727   332            MESSK           /LINE
0476   5606   333            MESSB           /^
0477   0000   334            0
0500   4763   335            JMS I   GET     /INPUT INITIAL LINE
0501   7773   336            7773            /-(MAX > INPUTS) +1
0502   0573   337            ST1             /STORAGE LOC.
0503   5271   338            JMP     ME10    /ERROR INPUT
0504   4765   339            JMS I   CORCT   /REPLY ROUTINE
0505   5504   340            JMP     .-1     /ERROR INPUT
0506   5271   341            JMP     ME10    /NO RETURN
0507   4764   342            JMS I   DECB    /YES RETURN: CHANGE TO BINARY
0510   0573   343            ST1             /DECIMAL ADR
0511   0112   344            LSH             /BINARY ADR
0512   4456   345   ME11,    MESSAGE
0513   5714   346            MESSJ           /NUMBER OF
0514   5727   347            MESSK           /LINE
0515   5711   348            MESSI           /S
0516   5606   349            MESSB           /^
0517   0000   350            0
0520   4763   351            JMS I   GET     /INITIAL LINE INPUT
0521   7773   352            7773            /-(MAX > INPUTS) +1
0522   0573   353            ST1             /STORAGE LOC.
0523   5312   354            JMP     ME11    /ERROR INPUT
0524   4765   355            JMS I   CORCT   /REPLY ROUTINE
0525   5324   356            JMP     .-1     /ERROR RETURN
0526   5312   357            JMP     ME11    /NO RETURN
0527   4764   358            JMS I   DECB    /YES RETURN: CHANGE TO BINARY
0530   0573   359            ST1             /DECIMAL ADR
0531   0114   360            LRH             /BINARY ADR
0532   4762   361            JMS I   ONINT   /SET TYPE ROUTINE
                362
                363   /CHECK TO SEE IF INITIAL LINE AND LINES TO PRINT OK
                364
0533   4767   365            JMS I   DPSUB   /ID(11) - START LINE
0534   0112   366            LSH
0535   0101   367            ID11H
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0536  4770   358            JMS I   COMP     /RESULT<=0^
0537  4353   359            JMS     ME12     /NO
0540  5271   370            JMP     ME10
0541  4766   371            JMS I   OPADD    /RESULTS + ID(12)
0542  0116   372            COMH
0543  0103   373            ID12H
0544  4767   374            JMS I   OPSUB    /RESULTS - > OF LINES
0545  0116   375            COMH
0546  0114   376            LPH
0547  4770   377            JMS I   COMP     /RESULTS<=0^
0550  4353   378            JMS     ME12     /NO
0551  5271   379            JMP     ME10
0552  5761   380            JMP I   PAG6     /YES, NEXT PAGE
0553  0000   381  ME12,     0
0554  4456   382            MESSAGE
0555  6062   383            MESS4            /EXCEED SCREEN . . .
0556  6020   384            MESSN            /ENTER NUMBER . . .
0557  0000   385            0
0560  5753   386            JMP I   ME12
0561  0600   387  PAG6,     600
0562  1247   388  ONINT,    INTOFF
0563  2732   389  GET,      NUMIN
0564  3560   390  DECR,     DTOR
0565  3540   391  CORCT,    RIGHT
0566  3575   392  OPADD,    OUBADD
0567  3724   393  OPSUB,    OUBSUB
0570  2162   394  COMP,     CPRN1
0571  0005   395  N58H,     5
0572  0072   396  N58L,     72
0573  0000   397  ST1,      0
               398
               399  / SEND REM,M,LP,AND PP TO CDC3300
               400
         0600  401            *600
               402
0600  4742   403            JMS I   OPMIN    /LINES TO PRINT -34
0601  0764   404            N34H
0602  0114   405            LPH
0603  4761   406            JMS I   CMPR     /RESULTS<=0^
0604  4762   407            JMS I   RF12     /NO
0605  5763   408            JMP I   RF11
0606  4742   409            JMS I   OPMIN    /INITIAL POINT- ID(7)
0607  0075   410            ID7H
0610  0106   411            IPH
0611  4757   412            JMS I   OS3OUT   /REM= IP - ID(7)
0612  4766   413            JMS I   FINF     /CHECK FOR < >
0613  1073   414            TAD     ID5H
0614  3116   415            DCA     COMH
0615  1074   416            TAD     ID5L
0616  3117   417            DCA     COML
0617  7100   418            CLL
0620  4744   419            JMS I   ROT1
0621  4744   420            JMS I   ROT1     /ID(5)/4 INTO COM
0622  4743   421            JMS I   OPLUS    /RESULTS +1
0623  0061   422            PLH
0624  0116   423            COMH
0625  4757   424            JMS I   OS3OUT   /M= (ID(5)/4) + 1
0626  4766   425            JMS I   FINF     /CHECK FOR < >
0627  1114   426            TAD     LPH
0630  3116   427            DCA     COMH
0631  1115   428            TAD     LPL
0632  3117   429            DCA     COML
0633  4757   430            JMS I   OS3OUT   /LP= LP
0634  4766   431            JMS I   FINF     /CHECK FOR < >
0635  4742   432            JMS I   OPMIN    /LINE START-ID(11)
0636  0101   433            ID11H
0637  0112   434            LSH
0640  4757   435            JMS I   OS3OUT   /LS= LS - ID(11)
0641  4766   436            JMS I   FINF     /CHECK FOR < >
0642  1110   437            TAD     PPH
0643  3116   438            DCA     COMH
0644  1111   439            TAD     PPL
0645  3117   440            DCA     COML
0646  4757   441            JMS I   OS3OUT   /PP= PP
0647  4453   442            RECEIVE          /EXPECT LINE FEED
0650  4457   443            BUFFER
0651  4454   444            SEND
0652  4745   445            JMS I   CLEAN    /CLEAN SCREEN
               446
               447  /OUTPUT ROWS AND LINES OF FRTS DATA
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                    448
0653   1346   449           TAD     MIN6
0654   3356   450           DCA     COUT1
0655   1347   451           TAD     SPAC
0656   4452   452           OUTPUT
0657   2357   453           ISZ     COUT1
0660   5255   454           JMP     .-3
0661   4760   455           JMS I   BCNVD   /POINTS TO PRINT TO DECIMAL
0662   0110   456           PPH             /BINARY ADR
0663   0120   457           NUMB1           /DECIMAL ADR
0664   7200   458           CLA
0665   1121   459           TAD     NUMB2
0666   7040   460           CMA
0667   3353   461           DCA     COUT1
0670   1351   462           TAD     NP11C   /SET X PARA. FOR MOVE
0671   3335   463           DCA     X1
0672   1335   464           TAD     X1
0673   3337   465           DCA     X2
0674   4760   466           JMS I   BCNVD   /INITIAL POINT TO DECIMAL
0675   0106   467           IPH             /BINARY ADR
0676   0120   468           NUMB1           /DECIMAL ADR
0677   1123   469   ROWOUT, TAD     NUMB4   /OUTPUTS ROW
0700   4752   470           JMS I   PRINO
0701   1122   471           TAD     NUMB3
0702   4752   472           JMS I   PRINO
0703   1121   473           TAD     NUMB2
0704   4752   474           JMS I   PRINO
0705   1120   475           TAD     NUMB1
0706   4752   476           JMS I   PRINO
0707   2350   477           ISZ     COUT1   /DONE^
0710   5312   478           JMP     .+2     /NO,CONTINUE
0711   5756   479           JMP I   PAGN    /YES,NEXT PAGE
0712   2121   480           ISZ     NUMB2
0713   1121   481           TAD     NUMB2   /DIGIT>=10^
0714   1353   482           TAD     MN10
0715   7640   483           SZA CLA         /YES
0716   5327   484           JMP     NEXROW  /NO
0717   3122   485           DCA     NUMB3
0720   2122   486           ISZ     NUMB3
0721   1122   487           TAD     NUMB3   /DIGIT >=10^
0722   1353   488           TAD     MN10    /YES
0723   7640   489           SZA CLA         /NO
0724   5327   490           JMP     NEXROW
0725   3122   491           DCA     NUMB3
0726   2123   492           ISZ     NUMB4
0727   1354   493   NEXROW, TAD     N24C    /CALCULATE NEXT ROW
0730   1335   494           TAD     X1
0731   3335   495           DCA     X1
0732   1335   496           TAD     X1
0733   3337   497           DCA     X2
0734   4755   498           JMS I   MOV
0735   0000   499   X1,     0
0736   1367   500   Y1,     1367
0737   0000   501   X2,     0
0740   1367   502   Y2,     1367
0741   5277   503           JMP     ROWOUT
0742   3724   504   DPMIN,  DOBSUB
0743   3575   505   DPLUS,  DOBADD
0744   1411   506   ROT1,   ROT
0745   2525   507   CLEAN,  ERASE
0746   7772   508   MIN6,   -6
0747   0240   509   SPAC,   240
0750   0000   510   COUT1,  0
0751   0110   511   NP11C,  110
0752   3527   512   PRINO,  PRINT1
0753   7766   513   MN10,   -12
0754   0240   514   N24C,   240
0755   5064   515   MOV,    PAKVEC
0756   1000   516   PAGN,   1000
0757   2345   517   OS3OUT, OUTOS3
0760   2400   518   BCNVD,  BDCON
0761   2162   519   CMPP,   CPRN1
0762   0553   520   ME12,   ME12
0763   0512   521   ME11,   ME11
0764   0000   522   N34H,   0
0765   0042   523   N34L,   42
0766   3565   524   FINF,   FFIN
                    525
       1000   526           *1000
              527
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1000  1065  529          TAD     P215     /PLACE POINTER DOWN 6 SPACES
1001  4452  529          OUTPUT
1002  1066  530          TAD     P212
1003  4452  531          OUTPUT
1004  1066  532          TAD     P212
1005  4452  533          OUTPUT
1006  1115  534          TAD     LPL
1007  7041  535          CIA
1010  3357  536          DCA     LINCT    /-? LINES TO PRINT
1011  1357  537          TAD     LINCT
1012  3360  538          DCA     LSAV
1013  1356  539          TAD     M154
1014  3325  540          DCA     LY1
1015  1325  541          TAD     LY1
1016  3327  542          DCA     LY2
1017  4761  543          JMS I   LPDEC    /LINES START DEC
1020  0112  544          LSH              /BINARY ADR
1021  0120  545          NUMB1            /DECIMAL ADR
1022  4771  546  LINOUT,  JMS I   OUTNUB  /OUTPUTS LINES
1023  0123  547          NUMB4
1024  2357  548          ISZ     LINCT
1025  5227  549          JMP     .+2      /DONE,YETA
1026  5254  550          JMP     DATA     /YES
1027  2100  551          ISZ     NUMB1    /INCREASE UNITS
1030  1120  552          TAD     NUMB1    /DIGIT>=10A
1031  1362  553          TAD     NEG10
1032  7640  554          SZA CLA          /YES
1033  5252  555          JMP     NEXLN    /NO,CONTINUE
1034  3120  556          DCA     NUMB1
1035  2121  557          ISZ     NUMB2
1036  1121  558          TAD     NUMB2    /DIGIT>=10A
1037  1362  559          TAD     NEG10
1040  7640  560          SZA CLA          /YES
1041  5252  561          JMP     NEXLN    /NO,CONTINUE
1042  3121  562          DCA     NUMB2    /AND SO FOURTH
1043  2122  563          ISZ     NUMB3
1044  1122  564          TAD     NUMB3
1045  1362  565          TAD     NEG10
1046  7640  566          SZA CLA
1047  5252  567          JMP     NEXLN
1050  3122  568          DCA     NUMB3
1051  2363  569          ISZ     NUMB4
1052  4322  570  NEXLN,   JMS     DWNLIN   /NEXT LINE
1053  5222  571          JMP     LINOUT   /CONTINUE WITH LINES
1054  1351  572  DATA,    TAD     P1230    /SETS UP POINTER FOR GRAY SCALE
1055  3754  573          DCA I   YVAL
1056  1351  574          TAD     P1230
1057  1370  575          TAD     MM22
1060  3755  576          DCA I   YVAL2
1061  1352  577          TAD     P110
1062  3753  578          DCA I   XVAL
1063  1360  579          TAD     LSAV
1064  3357  580          DCA     LINCT
1065  4776  581          JMS I   INITL    /RESETTING ROUTINE
1066  4775  582          JMS I   BUFOUT   /SEND BUFFER
1067  4773  583          JMS I   TRNION   /CHANGE TO INTERRUPT TYPE
1070  6001  584  DATLN,   ION
1071  1111  585          TAD     PPL
1072  7041  586          CIA
1073  3721  587          DCA I   DAPR2
1074  4766  588          JMS I   OUTDAT   /YES, GET NEXT POINT
1075  4336  589          JMS     NEXLIN   /NEXT DATA LINE
1076  6002  590          IOF
1077  1347  591          TAD     NUBFL    /SKIP BUFFER FLAG SETA
1100  7650  592          SNA  CLA         /YES,SKIP
1101  1045  593          TAD     BUFFL2   /BUFFER FLAG 2 SETA
1102  7640  594          SZA CLA          /NO
1103  4775  595          JMS I   BUFOUT   /YES, SEND BUFFER
1104  3045  596          DCA     BUFFL2   /CLEAR FLAG 2
1105  2357  597          ISZ     LINCT    /DONE?
1106  5270  598          JMP     DATLN    /NO,CONTINUE
1107  4774  599          JMS I   TRNIOF
1110  4322  600          JMS     DWNLIN
1111  1066  601          TAD     P212
1112  4452  602          OUTPUT
1113  4456  603          MESSAGE
1114  5734  604          MESSL            /PICTURE IS COMPLETE
1115  0000  605          0
1116  4451  606          INPUT
1117  5720  607          JMP I   ECHO
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 1120  1200  608  ECHO,   EXCHNG
 1121  3115  609  DAPP2,  DATCT
 1122  0000  610  DWNLIN,  0
 1123  4767  611          JMS I   MOVER
 1124  0000  612  LX1,     0
 1125  0000  613  LY1,     0
 1126  0000  614  LX2,     0
 1127  0000  615  LY2,     0
 1130  1325  616          TAD     LY1
 1131  1376  617          TAD     M422
 1132  3325  618          DCA     LY1
 1133  1325  619          TAD     LY1
 1134  3327  620          DCA     LY2
 1135  5722  621          JMP I   DWNLIN
 1136  0000  622  NEXLIN,  0                       /SUBROUTINE TO CHANGE X AND
 1137  7200  623          CLA                     /Y COORD FOR NEXT DATA LINE
 1140  1754  624          TAD I   YVAL
 1141  1370  625          TAD     M422
 1142  3754  626          DCA I   YVAL
 1143  1755  627          TAD I   YVAL2
 1144  1370  628          TAD     M422
 1145  3755  629          DCA I   YVAL2
 1146  1352  630          TAD     P110
 1147  3753  631          DCA I   XVAL
 1150  5736  632          JMP I   NEXLIN
 1151  1230  633  P1230,  1230
 1152  0110  634  P110,   110
 1153  5547  635  XVAL,   INTX1
 1154  5550  636  YVAL,   INTY1
 1155  5552  637  YVAL2,  INTY2
 1156  1165  638  M154,   1165
 1157  0000  639  LINCT,  0
 1160  0000  640  LSAV,   0
 1161  2400  641  LPDEC,  BDCON
 1162  7766  642  NEG10,  -12
 1163  7772  643  LS6,    -6
 1164  0000  644  PNT,    0
 1165  0240  645  SPC,    240
 1166  3046  646  OUTDAT,  DATOUT
 1167  5064  647  MOVER,  PAKVEC
 1170  7756  648  M422,   -22
 1171  1303  649  OUTNUB,  NUMOUT
 1172  7774  650  LS4,    -4
 1173  1241  651  TRNION,  INTON
 1174  1247  652  TRNIOF,  INTOFF
 1175  1471  653  BUFOUT,  OUTPUF
 1176  1423  654  INITL,  INITAL
               655
               656          /ECHO INPUT-OUTPUT
               657
       1200  658          *1200
 1200  7300  659  EXCHNG,  CLA CLL             /CLEAR FLAGS
 1201  6046  660          TLS
 1202  6416  661          TLS41
 1203  6031  662  AGAIN,  KSF                   /IS IT THE KEYBOARD
 1204  7410  663          SKP                   /NO
 1205  5215  664          JMP     OS3           /YES,SEND
 1206  6411  665          KSF40                 /IS IT OS3
 1207  5203  666          JMP     AGAIN         /NO TRY AGAIN
 1210  6406  667          KRB40                 /RECEIVE
 1211  6041  668          TSF                   /TEK OUTPUT
 1212  5211  669          JMP     .-1
 1213  6046  670          TLS
 1214  5203  671          JMP     AGAIN         /NEXT
 1215  6036  672  OS3,    KRB                   /BUFFER CLT
 1216  1235  673          TAD     M203          /IS IT C>
 1217  7450  674          SNA
 1220  5634  675          JMP I   GO            /BEGIN PROGRAM
 1221  1236  676          TAD     P203          /ADD VALUE BACK
 1222  6411  677          TSF41                 /SEND OS3
 1223  5222  678          JMP     .-1
 1224  6416  679          TLS41
 1225  1237  680          TAD     M201          /IS IT A >
 1226  7450  681          SNA
 1227  5232  682          JMP     .+3           /YES DON'T SEND
 1230  1240  683          TAD     P201          /ECHO
 1231  6046  684          TLS
 1232  7300  685          CLA CLL
 1233  5203  686          JMP     AGAIN         /NEXT
 1234  0200  687  GO,     200
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     1235  7575   688  M203,   -203
     1236  0203   689  P203,   203
     1237  7577   690  M201,   -201
     1240  0201   691  P201,   201
                  692
                  693  / ION-IOF ROUTINES FOR USING PAKVEC OUTPUT
                  694
           4140   695  TYPIO=  JMS     TYP
     1241  0000   696  INTON,   0                /INTERRUPT TYPE ROUTINE
     1242  1244   697          TAD     .+2
     1243  7410   698          SKP
     1244  4140   699          TYPIO
     1245  4254   700          JMS     INTPUT   /PLACES IN PAKMOV ROUTINE
     1246  5641   701          JMP I   INTON    /RETURN
                  702
     1247  0000   703  INTOFF,  0                /GENERAL TYPE ROUTINE
     1250  6002   704          IOF              /TURN OFF INTERRUPT
     1251  1302   705          TAD     N4200
     1252  4254   706          JMS     INTPUT   /PLACES IN PAKVEC ROUTINE
     1253  5647   707          JMP I   INTOFF   /RETURN
                  708
     1254  0000   709  INTPUT,  0                /PLACES CORRECT TYPE ROUTINE
     1255  3273   710          DCA     INTVAL   /SAVE TYPE LOC.
     1256  1273   711          TAD     INTVAL
     1257  3674   712          DCA I   CH1      /FIRST REPLACE LOC
     1260  1273   713          TAD     INTVAL
     1261  3675   714          DCA I   CH2      /SECOND REPLACE LOC
     1262  1273   715          TAD     INTVAL
     1263  3676   716          DCA I   CH3      /THIRD REPLACE LOC
     1264  1273   717          TAD     INTVAL
     1265  3677   718          DCA I   CH4      /FOURTH REPLACE LOC
     1266  1273   719          TAD     INTVAL
     1267  3700   720          DCA I   CH5      /FIFTH REPLACE LOC
     1270  1273   721          TAD     INTVAL
     1271  3701   722          DCA I   CH6      /SIXTH REPLACE LOC
     1272  5654   723          JMP I   INTPUT   /RETURN
     1273  0000   724  INTVAL,  0
     1274  5035   725  CH1,    PAKT1
     1275  5041   726  CH2,    PAKT2
     1276  5050   727  CH3,    PAKT3
     1277  5054   728  CH4,    PAKT4
     1300  5073   729  CH5,    PAKT5
     1301  5111   730  CH6,    PAKT6
     1302  4200   731  N4200,  4200
                  732
                  733  /OUTPUT DECIMAL NUMBERS
                  734
     1303  0000   735  NUMOUT, 0
     1304  1072   736          TAD     M4       /MAX # OF NUMBERS
     1305  3340   737          DCA     NRCNT    /COUNTER
     1306  3341   738          DCA     OUTCK    /ZERO CHECK
     1307  1703   739          TAD I   NUMOUT   /UNITS ADDRESS
     1310  3342   740          DCA     NUMPT    /POINTER
     1311  2303   741          ISZ     NUMOUT   /PROPER RETURN
     1312  1742   742  NUMNEX, TAD I   NUMPT    /GET NUMBER
     1313  7450   743          SNA              /IS IT A 0?
     1314  5334   744          JMP     ZEROCK   /YES,SO PRINT 0
     1315  4327   745          JMS     NUMPRI
     1316  7240   746  NOPRI,  CLA CMA          /GET NEXT NUMBER
     1317  1342   747          TAD     NUMPT
     1320  3342   748          DCA     NUMPT
     1321  2340   749          ISZ     NRCNT    /LOOPED 4 TIMES?
     1322  5312   750          JMP     NUMNEX   /NO, CONTINUE
     1323  1341   751          TAD     OUTCK    /YES, ANY OUTPUT
     1324  7650   752          SNA CLA
     1325  4327   753          JMS     .+2      /NO,PRINT 0
     1326  5703   754          JMP I   NUMOUT   /YES RETURN
     1327  0000   755  NUMPRI, 0                /OUTPUTS NUMBER
     1330  1667   756          TAD     P260
     1331  4452   757          OUTPUT
     1332  2341   758          ISZ     OUTCK    /INDICATE NUMBER PRINTED
     1333  5727   759          JMP I   NUMPRI   /RETURN
     1334  1341   760  ZEROCK, TAD     OUTCK
     1335  7640   761          SZA CLA
     1336  4327   762          JMS     NUMPRI
     1337  5316   763          JMP     NOPRI
     1340  0000   764  NRCNT,  0
     1341  0000   765  OUTCK,  0
     1342  0000   766  NUMPT,  0
                  767
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     1343   0000    768  DATTIN, 0
     1344   1743    769          TAD I    DATTIN   /PARAM. 1
     1345   3373    770          DCA      DATTPT   /STARTING ADR.
     1346   2343    771          ISZ      DATTIN   /PARAM. 2
     1347   1743    772          TAD I    DATTIN   /.(NUMBER OF CHAR.)
     1350   3374    773          DCA      DATTCT   /COUNTER
     1351   2343    774          ISZ      DATTIN   /PROPER RETURN
     1352   4453    775  DATTOV, RECEIVE            /GET CHAR.
     1353   0375    776          AND      DATT77   /JUST UPPER 6 BITS
     1354   7006    777          RTL
     1355   7006    778          RTL
     1356   7006    779          RTL
     1357   3773    780          DCA I    DATTPT   /STORE RESULTS
     1360   2374    781          ISZ      DATTCT   /DONE?
     1361   5363    782          JMP      .+2      /NO
     1362   5743    783          JMP I    DATTIN   /YES,RETURN
     1363   4453    784          RECEIVE           /GET CHAR.
     1364   0375    785          AND      DATT77   /JUST UPPER 6 BITS
     1365   1773    786          TAD I    DATTPT   /ADD LOWER 6 BITS
     1366   3773    787          DCA I    DATTPT   /STORE
     1367   2373    788          ISZ      DATTPT   /NEXT STORE
     1370   2374    789          ISZ      DATTCT   /DONE?
     1371   5352    790          JMP      DATTOV   /NO,CONTINUE
     1372   5743    791          JMP I    DATTIN   /YES,RETURN
     1373   0000    792  DATTPT, 0
     1374   0000    793  DATTCT, 0
     1375   0077    794  DATT77, 77
                    795
            1400    796          *1400
     1400   0000    797  COMAD1, 0          /ADD ONE TO COMH,COML
     1401   7100    798          CLL
     1402   1117    799          TAD      COML     /ADD ONE TO COML
     1403   7001    800          IAC
     1404   3117    801          DCA      COML
     1405   7004    802          RAL               /IF OVERFLOW ADD TO COMH
     1406   1116    803          TAD      COMH
     1407   3116    804          DCA      COMH
     1410   5600    805          JMP I    COMAD1   /RETURN
                    806
     1411   0000    807  ROT,    0          /DIVIDES COMH,COML BY TWO
     1412   7100    808          CLL
     1413   1116    809          TAD      COMH     /GET COMH ROTATE
     1414   7010    810          RAR
     1415   3116    811          DCA      COMH
     1416   1117    812          TAD      COML     /ADD LINK IF SET
     1417   7010    813          RAR
     1420   7100    814          CLL
     1421   3117    815          DCA      COML
     1422   5611    816          JMP I    ROT      /RETURN
                    817
                    818  /INITIAL DATA INPUT-OUTPUT ROUTINE
                    819
     1423   0000    820  INITAL, 0
     1424   1111    821          TAD      PPL
     1425   7041    822          CIA
     1426   3556    823          DCA I    OUTCT   /SET INPUT POINT COUNTER
     1427   1111    824          TAD      PPL
     1430   7141    825          CIA CLL
     1431   3557    826          DCA I    CNTDAT   /SET OUTPUT POINT COUNTER
     1432   3560    827          DCA I    SIDE1    /SET INPUT LEFT SIDE POINTER
     1433   3561    828          DCA I    SIDE2    /SET OUTPUT LEFT SIDE POINTER
     1434   1267    829          TAD      N4000
     1435   3562    830          DCA I    DATPT3   /SET INPUT VALUE LOC. POINTER
     1436   1267    831          TAD      N4000
     1437   3563    832          DCA I    DATPT4   /SET OUTPUT VALUE LOC. POINTER
     1440   1270    833          TAD      M1000
     1441   3564    834          DCA I    DAT11    /SET PAGE LENGTH INPUT
     1442   1270    835          TAD      M1000
     1443   3565    836          DCA I    DAT12    /SET PAGE LENGTH OUTPUT
     1444   1115    837          TAD      LPL
     1445   7041    838          CIA
     1446   3046    839          DCA      NUMBUF
     1447   7040    840          CMA
     1450   3043    841          DCA      IFL      /SET OUTPUT INTERRUPT FLAG
     1451   3044    842          DCA      BUFFL1   /ZERO BUFFER FLAG 1
     1452   3045    843          DCA      BUFFL2   /ZERO BUFFER FLAG 2
     1453   3047    844          DCA      NUMFL    /ZERO OUT LINE BUFFER FLAG
     1454   3566    845          DCA I    PNTDAT   /ZERO I/O FLAG
     1455   5623    846          JMP I    INITAL   /RETURN
     1456   3162    847  OUTCT,  OUTCNT
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1457  3115   848  CNTDAT, DATCT
1460  3044   849  SIDE1,  SIDCNT
1461  3117   850  SIDE3,  SIDECT
1462  3043   851  DATPT3, DATPT1
1463  3113   852  DATPT4, DATPT2
1464  3041   853  DAT11,  DATCNT
1465  3116   854  DAT12,  PGEND
1466  3114   855  PNTDAT, DATPNT
1467  4000   856  N4000,  4000
1470  7000   857  M1000,  -1000
1471  0000   858  OUTBUF, 0
1472  6002   859          IOF
1473  4457   860          BUFFER
1474  6411   861          TSF41           /CLEAR FLAGS
1475  5274   862          JMP     .-1
1476  6412   863          TCF41
1477  6041   864          TSF
1500  5277   865          JMP     .-1
1501  6042   866          TCF
1502  7040   867          CMA
1503  3043   868          DCA     IFL     /MAKE OUTPUT FLAG NEG.
1504  5671   869          JMP I   OUTBUF  /RETURN
                870
                871
                872  /ZERO OUT LOCATIONS
                873  /PARM. 1 LOC ADDRESS
                874  /PARM. 2 -(# OF LOC)
                875
1505  0000   876  ZEOUT,  0
1506  1705   877          TAD I   ZEOUT   /GET PARM. 1
1507  3321   878          DCA     ZEADR
1510  2305   879          ISZ     ZEOUT
1511  1705   880          TAD I   ZEOUT   /GET PARM. 2
1512  3322   881          DCA     ZECNT
1513  3721   882  ZENEX,  DCA I   ZEADR   /ZERO  LOC
1514  2321   883          ISZ     ZEADR   /NEXT LOC
1515  2322   884          ISZ     ZECNT   /DONE?
1516  5313   885          JMP     ZENEX   /NO, CONTINUE
1517  2305   886          ISZ     ZEOUT   /PROPER RETURN
1520  5705   887          JMP I   ZEOUT   /RETURN
1521  0000   888  ZEADR,  0
1522  0000   889  ZECNT,  0
                890
                891  /BASIC SUBROUTINES,REPLY,INTWO,GNIN,ETC
                892
                893  /REPLY
                894  /RETURN 1 ERROR INPUT
                895  /RETURN 2 N     INPUT (NO)
                896  /RETURN 3 Y     INPUT (YES)
                897
        2000    898          *2000
2000  0000   899  REPLY,  0
2001  4336   900          JMS     INTWO   /CHECKS FOR ONE LETTER INPUT
2002  5600   901          JMP I   REPLY   /ERROR RETURN
2003  1227   902          TAD     KEEP    /WHICH LETTER?
2004  1225   903          TAD     M316    /IS IT AN N?
2005  7450   904          SNA             /NO
2006  5215   905          JMP     NOUT    /YES
2007  1226   906          TAD     M13     /IS IT A Y
2010  7650   907          SNA CLA         /NO
2011  5214   908          JMP     YOUT    /YES
2012  4217   909          JMS     WHAT    /ERROR RETURN
2013  5600   910          JMP I   REPLY   /RETURN
2014  2200   911  YOUT,   ISZ     REPLY   /PROPER Y RETURN
2015  2200   912  NOUT,   ISZ     REPLY   /PROPER N RETURN
2016  5600   913          JMP I   REPLY   /RETURN
                914
                915  /OUTPUTS WHAT
                916
2017  0000   917  WHAT,   0
2020  4456   918          MESSAGE
2021  5600   919          MESSA           /WHAT
2022  5606   920          MESSB           /A
2023  0000   921          0
2024  5617   922          JMP I   WHAT    /RETURN
2025  7462   923  M316,   -316
2026  7765   924  M13,    -13
2027  0000   925  KEEP,   0
                926
                927  /CHECKS FOR JUST ONE INPUT RESPONCE
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                    928
2030   0000         929  INTWO,  0
2031   4451         930          INPUT             /1 RESPONCE
2032   6046         931          TLS               /ECHO
2033   3227         932          DCA     KEEP      /STORE
2034   4451         933          INPUT             /2 RESPOND
2035   6046         934          TLS               /ECHO
2036   1071         935          TAD     M215
2037   7650         936          SNA CLA           /IS IT A CRA
2040   5241         937          JMP     RET1      /YES
2041   4451         938          INPUT             /NEXT RESPONCE
2042   6046         939          TLS               /ECHO
2043   1071         940          TAD     M215
2044   7640         941          SZA CLA           /IS IT A CRA
2045   5241         942          JMP     .-4       /NO
2046   4455         943          SCREEN            /SCREEN FULLA
2047   4217         944          JMS     WHAT
2050   5630         945          JMP I   INTWO     /ERROR RETURN
2051   4455         946  RET1,   SCREEN            /IS SCREEN FULLA
2052   2230         947          ISZ     INTWO
2053   5630         948          JMP I   INTWO     /GOOD RETURN
                    949
                    950  /RETURN 1 ERROR INPUT
                    951  /RETURN 2 GOOD  INPUT
                    952
2054   0000         953  BNIN,   0
2055   4230         954          JMS     INTWO     /CHECK FOR ONE INPUT
2056   5654         955          JMP I   BNIN      /ERROR RETURN
2057   1227         956          TAD     KEEP      /GET INPUT
2060   3105         957          DCA     BAND      /STORE
2061   1105         958          TAD     BAND
2062   1276         959          TAD     M264      /GREATER OR =4 A
2063   7510         960          SPA               /YES
2064   5272         961          JMP     BRET1     /ERROR RETURN
2065   1275         962          TAD     M3        /LESS OR = 7A
2066   7740         963          SMA SZA CLA       /YES
2067   5272         964          JMP     BRET1     /ERROR RETURN
2070   2254         965          ISZ     BNIN      /PROPER RETURN
2071   5654         966          JMP I   BNIN      /RETURN
2072   7200         967  BRET1,  CLA
2073   4217         968          JMS     WHAT
2074   5654         969          JMP I   BNIN      /RETURN
2075   7775         970  M3,     -3
2076   7514         971  M264,   -264
                    972
                    973
                    974  /FILE SAVE MAX. LENGTH 10 CHAR.
                    975
2077   0000         976  FLIN,   0
2100   1327         977          TAD     F12       /LENGHT OF FILE
2101   3330         978          DCA     FCNT      /COUNTER
2102   1331         979          TAD     FLST      /LOCATION OF FILE SAVE
2103   3010         980          DCA     10
2104   4451         981  FOVR,   INPUT             /GET A CHAR.
2105   6046         982          TLS               /ECHO
2106   1071         983          TAD     M215      /IS IT A CRA
2107   7450         984          SNA               /NO
2110   5323         985          JMP     FRET      /YES,RETURN
2111   1215         986          TAD     P215      /ADD BACK
2112   3410         987          DCA I   10        /STORE ASCII
2113   2330         988          ISZ     FCNT      /END OF STORAGEA
2114   5304         989          JMP     FOVR      /NO, CONTINUE
2115   4451         990  FOVR2,  INPUT             /JUST ECHO
2116   6046         991          TLS
2117   1071         992          TAD     M215      /IS IT A CRA
2120   7550         993          SMA CLA           /FOUND
2121   5323         994          JMP     .+2       /YES
2122   5315         995          JMP     FOVR2     /NO,CONTINUE
2123   4455         996  FRET,   SCREEN            /IS SCREEN FULLA
2124   1265         997          TAD     P215      /PUT  CR AT END
2125   3410         998          DCA I   10
2126   5677         999          JMP I   FLIN      /RETURN
2127   7766        1000  F12,    -12
2130   0000        1001  FCNT,   0
2131   2131        1002  FLST,   .
2132   0000        1003          0
2133   0000        1004          0
2134   0000        1005          0
2135   0000        1006          0
2136   0000        1007          0
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 2137  0000  1008          0
 2140  0000  1009          0
 2141  0000  1010          0
 2142  0000  1011          0
 2143  0000  1012          0
 2144  0000  1013          0
               1014
               1015  /OUTPUTS FILE
               1016
 2145  0000  1017  FLOUT,  0
 2146  1331  1018          TAD     FLST    /GET FILE HEAD
 2147  3010  1019          DCA     10
 2150  1410  1020  FILOVR, TAD I   10      /GET NEXT CHAR.
 2151  1271  1021          TAD     M215    /IS IT A CR
 2152  7450  1022          SNA
 2153  5357  1023          JMP     FLON    /YES
 2154  1065  1024          TAD     P215    /ADD BACK
 2155  4454  1025          SEND            /TO OS3
 2156  5350  1026          JMP     FILOVR  /REPEAT
 2157  1165  1027  FLON,   TAD     P215    /SEND TO OS3
 2160  4454  1028          SEND
 2161  5745  1029          JMP I   FLOUT   /RETURN
               1030
               1031  /ARE RESULTS < OR = TO 0
               1032
 2162  0000  1033  CPRN1,  0
 2163  1116  1034          TAD     COMH    /GET RESULTS HIGH
 2164  7510  1035          SPA             /POS
 2165  5374  1036          JMP     .+7     /NO,GOOD RETURN
 2166  7640  1037          SZA CLA         /RESULTS = 0
 2167  5762  1038          JMP I   CPRN1   /ERROR RETURN
 2170  1117  1039          TAD     COML    /GET RESULTS LOW
 2171  7650  1040          SNA CLA         /RESULTS = 0
 2172  5374  1041          JMP     .+2     /YES
 2173  5762  1042          JMP I   CPRN1   /ERROR RETURN
 2174  2362  1043          ISZ     CPRN1
 2175  2362  1044          ISZ     CPRN1
 2176  5762  1045          JMP I   CPRN1   /GOOD RETURN
               1046
               1047  /CHECKS FOR LEGAL THRESHOLD INPUT VALUES
               1048
               1049          *2200
 2200  0000  1050  THCK,   0
 2201  1307  1051          TAD     TABM6
 2202  3341  1052          DCA     TABCNT  /# OF CHECKS
 2203  1227  1053          TAD     TABL    /TH(1) ADDRESS -1
 2204  3010  1054          DCA     10
 2205  1330  1055          TAD     TABL1   /TH(2) ADDRESS -1
 2206  3011  1056          DCA     11
 2207  1630  1057          TAD I   TABL1   /IS FIRST ENTRY POSITIVE
 2210  7710  1058          SPA CLA
 2211  5600  1059          JMP I   THCK    /NO
 2212  1410  1060          TAD I   10      /TH(I)
 2213  7041  1061          CIA             /NEGATE
 2214  1411  1062          TAD I   11      /TH(I+1)
 2215  7710  1063          SPA CLA         /NEGATIVE RESULT
 2216  5600  1064          JMP I   THCK    /NO, ERROR RETURN
 2217  2341  1065          ISZ     TABCNT  /CHECK ALL VALUES
 2220  5212  1066          JMP     .-6     /NO,CONTINUE
 2221  1410  1067          TAD I   10      /YES, FINAL VALUE LESS THAN
 2222  1226  1068          TAD     M65
 2223  7710  1069          SPA CLA
 2224  2200  1070          ISZ     THCK    /PROPER RETURN
 2225  5600  1071          JMP I   THCK    /RETURN
 2226  7677  1072  M65,    -101
 2227  3512  1073  TABL,   THHD
 2230  3513  1074  TABL1,  THHD+1
 2231  7700  1075  M100,   -100
               1076
               1077  /STORES CORRECT GRAY SCAL VALUE IN TABLE
               1078
 2232  0000  1079  TABVAL, 0
 2233  1312  1080          TAD     TABL2   /STARTING ADDRESS OF THS.
 2234  3340  1081          DCA     TABPT
 2235  1231  1082          TAD     M100    /8 ALL OF TABLE
 2236  3341  1083          DCA     TABCNT  /COUNTER
 2237  3342  1084          DCA     TABVL   /VALUE OF DEPOSITS
 2240  4322  1085          JMS     TABIN   /DOES DEPOSITING
 2241  4316  1086          JMS     PINEG   /1'S UP TO TH(7)
 2242  3341  1087          DCA     TABCNT  /# OF DEPOSITS
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2243  4311  1088            JMS     TABINC  /VALUE OF DEPOSIT
2244  4322  1089            JMS     TABIN   /DOES DEPOSITING
2245  4333  1090            JMS     TABDEC  /DECREASE POINTER
2246  4316  1091            JMS     PTNEG   /2*S UP TO TH(6)
2247  3341  1092            DCA     TABCNT  /SO FOURTH
2250  4311  1093            JMS     TABINC
2251  4322  1094            JMS     TABIN
2252  4333  1095            JMS     TABDEC
2253  4316  1096            JMS     PTNEG   /3*S UP TO TH(5)
2254  3341  1097            DCA     TABCNT
2255  4311  1098            JMS     TABINC
2256  4322  1099            JMS     TABIN
2257  4333  1100            JMS     TABDEC
2260  4316  1101            JMS     PTNEG   /4*S UP TO TH(4)
2261  3341  1102            DCA     TABCNT
2262  4311  1103            JMS     TABINC
2263  4322  1104            JMS     TABIN
2264  4333  1105            JMS     TABDEC
2265  4316  1106            JMS     PTNEG   /5*S UP TO TH(3)
2266  3341  1107            DCA     TABCNT
2267  4311  1108            JMS     TABINC
2270  4322  1109            JMS     TABIN
2271  4333  1110            JMS     TABDEC
2272  4316  1111            JMS     PTNEG   /8*S UP TO TH(2)
2273  3341  1112            DCA     TABCNT
2274  7105  1113            IAC RAL CLL
2275  4311  1114            JMS     TABINC
2276  4322  1115            JMS     TABIN
2277  4333  1116            JMS     TABDEC
2300  4316  1117            JMS     PTNEG   /16*S UP TO TH(1)
2301  3341  1118            DCA     TABCNT
2302  1342  1119            TAD     TABVL
2303  7104  1120            RAL CLL
2304  3342  1121            DCA     TABVL
2305  4322  1122            JMS     TABIN
2306  5632  1123            JMP I   TABVAL
2307  7772  1124  TABM6,    -6
2310  3521  1125  TABL2,    THHD+7
2311  0000  1126  TABINC,   0                       /INCREASES VALUE TO DEPOSIT
2312  7001  1127            IAC
2313  1342  1128            TAD     TABVL
2314  3340  1129            DCA     TABVL
2315  5711  1130            JMP I   TABINC
2316  0000  1131  PTNEG,    0
2317  1740  1132            TAD I   TABPT
2320  7041  1133            CIA
2321  5716  1134            JMP I   PTNEG
2322  0000  1135  TABIN,    0                       /ACTUALL DEPOSITING OF VALUES
2323  1343  1136            TAD     TABH
2324  3344  1137            DCA     TABP
2325  1342  1138            TAD     TABVL
2326  3744  1139            DCA I   TABP
2327  2344  1140            ISZ     TABP
2330  2341  1141            ISZ     TABCNT
2331  5325  1142            JMP     .-4
2332  5722  1143            JMP I   TABIN
                1144
2333  0000  1145  TABDEC,   0                       /DECREASES THRES ADDRESS
2334  7240  1146            CLA CMA
2335  1340  1147            TAD     TABPT
2336  3340  1148            DCA     TABPT
2337  5733  1149            JMP I   TABDEC  /RETURN
2340  0000  1150  TABPT,    0
2341  0000  1151  TABCNT,   0
2342  0000  1152  TABVL,    0
2343  3200  1153  TABH,     TABHED
2344  0000  1154  TABP,     0
                1155
                1156  /SENDS DATA VALUES TO OS3
                1157
2345  0000  1158  OUTOS3,   0
2346  4777  1159            JMS I   BCOND   /CHANGE TO DECIMAL
2347  0116  1160            COMH            /BINARY ADR
2350  0120  1161            NUMB1           /DECIMAL ADR
2351  4356  1162            JMS     NUMST   /SEND TO 3300
2352  0123  1163            NUMB4
2353  1665  1164            TAD     P215
2354  4454  1165            SEND
2355  5745  1166            JMP I   OUTOS3
2356  0000  1167  NUMST,    0
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     2357  1072  1168            TAD     M4
     2360  3375  1169            DCA     OS3CNT
     2361  1756  1170            TAD I   NUMST
     2362  3376  1171            DCA     OS3SND
     2363  2356  1172            ISZ     NUMST
     2364  1776  1173  OS3OVR,   TAD I   OS3SND
     2365  1067  1174            TAD     P266
     2366  4454  1175            SEND
     2367  7240  1176            CMA CLA
     2370  1376  1177            TAD     OS3SND
     2371  3376  1178            DCA     OS3SND
     2372  2375  1179            ISZ     OS3CNT
     2373  5364  1180            JMP     OS3OVR
     2374  5756  1181            JMP I   NUMST
     2375  0000  1182  OS3CNT,   0
     2376  0000  1183  OS3SND,   0
     2377  2400  1184  BCOND,   BDCON
                 1185
                 1186
                 1187  /BINARY TO DECIMAL CONVERSION
                 1188  /TWO PARM. (1)=BINARY NUMBER ADDRESS
                 1189  /          (2)=DECIMAL NUMBER ADDRESS
                 1190
           2400  1191            *2400
                 1192
     2400  0000  1193  BDCON,   0
     2401  1600  1194            TAD I   BDCON   /ADDRESSS OF NUMBER
     2402  3350  1195            DCA     BDPT1
     2403  2200  1196            ISZ     BDCON   /NEXT PARAMETER
     2404  1600  1197            TAD I   BDCON   /ADDRESS OF RESULTS
     2405  3212  1198            DCA     BDPT2   /STORE
     2406  1600  1199            TAD I   BDCON   /KEEP INITIAL ADDRESS
     2407  3351  1200            DCA     BDPT3
     2410  2200  1201            ISZ     BDCON   /PROPER RETURN
     2411  4752  1202            JMS I   CLEAR   /ZERO OUT SCRATCH AREA
     2412  0000  1203  BDPT2,    0               /ADDRESS PARAM.
     2413  7774  1204  BDM4,     7774            /NUMBER OF LOCATION TO ZERO
     2414  1750  1205            TAD I   BDPT1   /ANY 4096 BITS*
     2415  4322  1206            JMS     MAKOFF
     2416  5225  1207            JMP     BD512   /NO
     2417  1332  1208            TAD     BDOCT   /YES,FIND AMOUNT TO ADD
     2420  7104  1209            RAL CLL
     2421  7004  1210            RAL             /ADDRESS*4
     2422  1353  1211            TAD     HD409   /ADD 4096 ADDRESS HEAD
     2423  7007  1212            IAC RTL
     2424  4333  1213            JMS     BDCNT   /DEPOSIT NUMBERS
     2425  2350  1214  BD512,    ISZ     BDPT1   /GET REST OF TOTAL NUMB.
     2426  1750  1215            TAD I   BDPT1   /GET FIRST TRIPLE
     2427  7106  1216            RTL CLL
     2430  7006  1217            RTL
     2431  4322  1218            JMS     MAKOFF  /ANY 512 BITS*
     2432  5242  1219            JMP     BD64    /NO
     2433  1332  1220            TAD     BDOCT   /YES,FIND AMOUNT TO ADD
     2434  7104  1221            RAL CLL
     2435  7004  1222            RAL             /ADDRESS*4
     2436  1354  1223            TAD     HD512   /ADD 512 ADDRESS HEAD
     2437  3362  1224            DCA     BDPT    /STORE,DEPOSITING
     2440  7007  1225            IAC RTL
     2441  4333  1226            JMS     BDCNT   /DEPOSIT
     2442  1750  1227  BD64,     TAD I   BDPT1   /GET SECOND TRIPLE
     2443  7112  1228            RTR CLL
     2444  7012  1229            RTR
     2445  7012  1230            RTR
     2446  4322  1231            JMS     MAKOFF  /ANY 64 BITS*
     2447  5266  1232            JMP     BD8     /AND SO FOURTH
     2450  1332  1233            TAD     BDOCT
     2451  3332  1234            DCA     BDOCT
     2452  1332  1235            TAD     BDOCT
     2453  7104  1236            RAL CLL
     2454  1332  1237            TAD     BDOCT   /AMOUNT TO ADD * 3
     2455  1355  1238            TAD     HD64
     2456  3362  1239            DCA     BDPT
     2457  7120  1240            STL
     2460  7055  1241            IAC RAL
     2461  4333  1242            JMS     BDCNT
     2462  1750  1243  BD8,      TAD I   BDPT1   /GET THIRD TRIPLE
     2463  7112  1244            RTR CLL
     2464  7010  1245            RAR
     2465  4322  1246            JMS     MAKOFF  /ANY 8TH BITS*
     2466  5275  1247            JMP     BD1
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2467  1332  1249            TAD     BOOCT
2470  7104  1249            RAL CLL
2471  1356  1250            TAD     HDA
2472  3362  1251            DCA     BOPT
2473  7505  1252            IAC RAL CLL
2474  4333  1253            JMS     BOCNT
2475  1750  1254  BD1,      TAD I   BOPT1   /ANY FOURTH TRIPLES
2476  0361  1255            AND     MSK7
2477  1751  1256            TAD I   BOPT3
2500  3751  1257            DCA I   BOPT3
2501  1213  1258  CONVER,   TAD     BOM4    /CONVERT TO 9 OR LESS
2502  3350  1259            DCA     BOPT1   /COUNTER
2503  1751  1260            TAD     BOPT3   /INITIAL ADDRESS
2504  3212  1261            DCA     BOPT2   /MOVEABLE ADDRESS
2505  3367  1262  CONNEX,   DCA     BOCRY   /ZERO OUT CARRY
2506  1612  1263            TAD I   BOPT2   /REDUCE NUMBER
2507  7450  1264            SNA             /IS IT ZERO
2510  5313  1265            JMP     CONOUT  /YES, GET NEXT NUMBER
2511  4363  1266            JMS     REDN    /ACTUALLY REDUCES
2512  3612  1267            DCA I   BOPT2   /STORE RESULTS
2513  2212  1268  CONOUT,   ISZ     BOPT2   /GET NEXT ADDRESS
2514  1612  1269            TAD I   BOPT2
2515  1367  1270            TAD     BOCRY   /ADD CARRY
2516  3612  1271            DCA I   BOPT2   /STORE RESULTS
2517  2350  1272            ISZ     BOPT1   /DONE
2520  5305  1273            JMP     CONNEX  /NO,CONTINUE
2521  5600  1274            JMP I   BOCON   /RETURN
2522  0000  1275  MAKOFF,   0               /MASK OFF UNWANTED BITS
2523  0361  1276            AND     MSK7
2524  7450  1277            SNA             /RESULTS=0A
2525  5723  1279            JMP I   MAKOFF  /YES,RETURN
2526  3332  1279            DCA     BOOCT   /STORE FOR COUNTER
2527  1063  1280            TAD     MLH
2530  2322  1281            ISZ     MAKOFF
2531  5722  1282            JMP I   MAKOFF  /RETURN
2532  0000  1283  BOOCT,    0
2533  0000  1284  BOCNT,    0               /DOES ACTUAL STORING
2534  7041  1285            CIA
2535  3369  1286            DCA     BOST2   /# OF DEPOSITS
2536  1762  1287  BONEX,    TAD I   BOPT    /LOC. OF DEPOSIT
2537  1612  1288            TAD I   BOPT2   /ADD VALUE OF DEPOSIT
2540  3612  1289            DCA I   BOPT2   /STORE
2541  2362  1290            ISZ     BOPT    /NEXT DEPOSIT LOC
2542  2212  1291            ISZ     BOPT2   /NEXT VALUE TO DEPOSIT
2543  2369  1292            ISZ     BOST2   /DONE
2544  5336  1293            JMP     BONEX   /NO,CONTINUE
2545  1351  1294            TAD     BOPT3   /YES, INITIAL ADDRESS
2546  3212  1295            DCA     BOPT2
2547  5733  1296            JMP I   BOCNT   /RETURN
2550  0000  1297  BOPT1,    0
2551  0000  1298  BOPT3,    0
2552  1505  1299  CLEAR,    ZEOUT
2553  5277  1300  HD409,    041
2554  5243  1301  HD542,    051
2555  5216  1302  HD64,     0641
2556  5260  1303  HDA,      OA1
2557  0000  1304  BOCRY,    0
2560  0000  1305  BOST2,    0
2561  0007  1306  MSK7,     7
2562  0000  1307  BOPT,     0
2563  0000  1308  REDN,     0               /REDUCE NUMBER TO 9 OR LESS
2564  1373  1309            TAD     RDM12   /-10
2565  7510  1310            SPA             /NEGATIVE YET
2566  5371  1311            JMP     .+3     /YES
2567  2357  1312            ISZ     BOCRY   /NO, ADD TO CARRY
2570  5364  1313            JMP     .-4     /CONTINUE REDUCTION
2571  1374  1314            TAD     RDP12   /ADD BACK
2572  5763  1315            JMP I   REDN    /RETURN
2573  7766  1316  RDM12,    -12
2574  0012  1317  RDP12,    12
              1318
              1319  / I/O ROUTINES
              1320
        2600  1321            *2600
2600  0000  1322  LIS,      0               /FROM PDP8
2601  6031  1323            KSF
2602  7410  1324            SKP
2603  5206  1325            JMP     .+3     /CHECKS FOR ERROR MESSAGE FROM
2604  4624  1326            JMS I   ERRIN   /OS3
2605  5201  1327            JMP     .-4
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 2606  6036  1328           KRB
 2607  5600  1329           JMP I   LIS
                1330
 2610  0000  1331   LIS4C,  0       /FROM OS3
 2611  6401  1332           KSF40
 2612  5211  1333           JMP     .-1
 2613  6406  1334           KRB40
 2614  5616  1335           JMP I   LIS4C
                1336
 2615  0000  1337   TYP41,  0       /TO OS3
 2616  3240  1338           DCA     LIS     /SAVE FOR OUTPUT
 2617  4240  1339           JMS     DELAY
 2620  1240  1340           TAD     LIS     /OUTPUT VALUE
 2621  6416  1341           TLS41
 2622  7300  1342           CLA CLL
 2623  5615  1343           JMP I   TYP41
 2624  3754  1344   ERRIN,  ERROS3
                1345
                1346   / SCREEN PUTS POINTER AT HOME
                1347
 2625  0000  1348   ERASE,  0
 2626  7300  1349           CLA
 2627  1237  1350           TAD     CAN     /ERASE SCREEN
 2630  4727  1351           JMS I   TYPR
 2631  4240  1352           JMS     DELAY   /WAIT
 2632  1250  1353           TAD     HOME    /PUT POINTER AT HOME
 2633  4727  1354           JMS I   TYPR
 2634  3236  1355           DCA     LNCNT   /ZERO LINE COUNTER
 2635  5625  1356           JMP I   ERASE
 2636  0000  1357   LNCNT,  0
 2637  0230  1358   CAN,    230
 2640  0000  1359   DELAY,  0               /DELAY ROUTINE
 2641  1251  1360           TAD     P1
 2642  3362  1361           DCA     P2
 2643  3377  1362           DCA     ADST
 2644  2377  1363           ISZ     ADST
 2645  5244  1364           JMP     .-1
 2646  2252  1365           ISZ     P2
 2647  5244  1366           JMP     .-3
 2650  5640  1367           JMP I   DELAY
 2651  7747  1368   P1,     7747
 2652  0000  1369   P2,     0
                1370
                1371   /OUTPUTS MESSAGE CHECKS END OF MESSAGE
                1372   /INCREMENTS LINE COUNTER IF 212 RECEIVED
                1373
 2653  0000  1374   MESOUT, 0
 2654  7300  1375           CLA CLL
 2655  1653  1376           TAD I   MESOUT  /END OF MESSAGE ^
 2656  7440  1377           SZA
 2657  5262  1378           JMP     .+3     /NO
 2660  2253  1379           ISZ     MESOUT  /YES,PROPER RETURN
 2661  5653  1380           JMP I   MESOUT  /RETURN
 2662  3277  1381           DCA     MESPT   /SAVE WORD ADDRESS
 2663  1677  1382           TAD I   MESPT
 2664  7440  1383           SZA             /END OF WORDS OUTPUT^
 2665  5270  1384           JMP     .+3     /NO
 2666  2253  1385           ISZ     MESOUT  /YES,NEXT SET OF WORDS
 2667  5254  1386           JMP     MESOUT+1/START OVER
 2670  4727  1387           JMS I   TYPR    /OUTPUT LETTER OF WORDS
 2671  1677  1388           TAD I   MESPT   /IS LETTER A CR
 2672  7771  1389           TAD     M215    /BOTTOM CHECK
 2673  7650  1390           SNA CLA         /NO
 2674  4302  1391           JMS     BOTCK   /YES,CHECK
 2675  2277  1392           ISZ     MESPT   /GET NEXT LETTER ADDRESS
 2676  5263  1393           JMP     .-13    /GET NEXT LETTER
 2677  0000  1394   MESPT,  0
                1395
                1396   /IS POINTER AT BOTTOM OF THE SCREEN
                1397
 2700  0300  1398   BOTCK,  0
 2701  1253  1399           TAD     MESOUT  /SAVE RETURN ADR
 2702  3330  1400           DCA     BSAV1
 2703  1277  1401           TAD     MESPT   /SAVE WORD ADR
 2704  3331  1402           DCA     BSAV2
 2705  2236  1403           ISZ     LNCNT   /INCREASE LINE COUNTER
 2706  1236  1404           TAD     LNCNT   /GET COUNTER
 2707  1326  1405           TAD     M36     /36 LINES YET^
 2710  7640  1406           SZA CLA         /RESULT=0^
 2711  5317  1407           JMP     .+6
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 2712  4456  1428           MESSAGE
 2713  6154  1429           MESSV           /PAGE FULL
 2714  0000  1430           0
 2715  4451  1431           INPUT
 2716  4225  1432           JMS     ERASE   /YES, NEW SCREEN
 2717  1366  1433           TAD     P212    /DOWN ONE LINE
 2720  4727  1434           JMS I   TYPP
 2721  1330  1435           TAD     BSAV1   /RETURN SAVED ADR
 2722  3253  1436           DCA     MESOUT
 2723  1331  1437           TAD     BSAV2
 2724  3277  1438           DCA     MESPT
 2725  5700  1439           JMP I   BOTCK   /RETURN
 2726  7742  1440  M36,     -36
 2727  5000  1441  TYPP,    PAKTYP
 2730  0000  1442  BSAV1,   0
 2731  0000  1443  BSAV2,   0
               1444
               1445
               1446  /PARAMETER (1) -(MAX. # OF INPUTS +1)
               1447  /PARAMETER (2) ADDRESS OF DEPOSIT
               1448
 2732  0000  1449  NUMIN,   0
 2733  1732  1450           TAD I   NUMIN   /FIRST PARM.
 2734  3373  1451           DCA     NUMCNT  /MAX # INPUTS +1
 2735  3366  1452           DCA     NUBCNT
 2736  2332  1453           ISZ     NUMIN
 2737  1732  1454           TAD I   NUMIN   /SECOND PARM.
 2740  3374  1455           DCA     NUMIT   /ADR OF DEPOSIT
 2741  1732  1456           TAD I   NUMIN
 2742  3377  1457           DCA     ADST
 2743  2332  1458           ISZ     NUMIN   /PROPER RETURN
 2744  4200  1459  NUNEX1,  JMS     LIS     /GET INPUT
 2745  6046  1460           TLS             /ECHO
 2746  1071  1461           TAD     M215    /IS IT A CR#
 2747  7450  1462           SNA
 2750  5366  1463           JMP     NUOUT1  /YES, RETURN ONE
 2751  1065  1464           TAD     P215    /ADD BACK
 2752  0375  1465           AND     MS17    /JUST NUMBER VALUE
 2753  3774  1466           DCA I   NUMIT   /STORE
 2754  2060  1467           ISZ     NUBCNT
 2755  2374  1468           ISZ     NUMIT   /NEXT ADR
 2756  2373  1469           ISZ     NUMCNT  /DONE#
 2757  5344  1470           JMP     NUNEX1  /NO, CONTINUE
 2760  4200  1471  NUMEX2,  JMS     LIS     /ECHO
 2761  6046  1472           TLS
 2762  1071  1473           TAD     M215    /IS IT A CR#
 2763  7650  1474           SNA CLA
 2764  5371  1475           JMP     NUOUT2  /YES, RETURN ONE
 2765  5360  1476           JMP     NUMEX2  /NO, CONTINUE
 2766  1377  1477  NUOUT1,  TAD     ADST
 2767  4776  1478           JMS I   PUSDWN
 2770  2332  1479           ISZ     NUMIN
 2771  4300  1480  NUOUT2,  JMS     BOTCK   /BOTTOM OF SCREEN#
 2772  5732  1481           JMP I   NUMIN   /RETURN
 2773  0000  1482  NUMCNT,  0
 2774  3000  1483  NUMIT,   0
 2775  0017  1484  MS17,    17
 2776  3340  1485  PUSDWN,  ADJUST
 2777  0000  1486  ADST,    0
               1487
       3000  1488           *3000
 3000  0000  1489  DATIN,   0
 3001  6406  1490           KRB4
 3002  3240  1491           DCA     DATVAL  /SAVE INPUT VALUE
 3003  2362  1492           ISZ     OUTCNT  /NEXT BUFFER LINE
 3004  5206  1493           JMP     .+2     /NO
 3005  4335  1494           JMS     NEWLIN  /YES
 3006  1244  1495           TAD     SIDCNT  /LEFT OR RIGHT SIDE#
 3007  7640  1496           SZA CLA
 3010  5222  1497           JMP     RTGIN   /RIGHT SIDE
 3011  1240  1498  LFTIN,   TAD     DATVAL  /LEFT SIDE
 3012  0245  1499           AND     DAT77   /JUST 6 BITS
 3013  7106  1500           RTL CLL
 3014  7006  1501           RTL
 3015  7006  1502           RTL
 3016  3643  1503           DCA I   DATPT1  /PUT IN LEFT LOC SIDE
 3017  7040  1504           CMA             /SET FOR RIGHT DEPOSIT
 3020  3244  1505           DCA     SIDCNT
 3021  5600  1506           JMP I   DATIN   /RETURN
 3022  1240  1507  RTGIN,   TAD     DATVAL  /RIGHT SIDE
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 3023  0245  1488                AND     DAT77   /JUST 6 BITS
 3024  1643  1489                TAD I   DATPT1
 3025  3643  1490                DCA I   DATPT1  /PUT IN RIGHT LOC SIDE
 3026  2243  1491                ISZ     DATPT1  /NEXT DATA LOC
 3027  3244  1492                DCA     SIDCNT  /SET FOR LEFT DEPOSIT
 3030  2314  1493                ISZ     DATPNT  /INCREASE LOC POINTER
 3031  2241  1494                ISZ     DATCNT  /END OF PAGE?
 3032  5237  1495                JMP     .+5     /NO
 3033  1320  1496                TAD     M7000   /YES
 3034  3241  1497                DCA     DATCNT  /RESET COUNTER
 3035  1242  1498                TAD     P4000
 3036  3243  1499                DCA     DATPT1  /RESET POINTER
 3037  5600  1500                JMP I   DATIN   /RETURN
 3040  0000  1501  DATVAL, 0
 3041  0000  1502  DATCNT, 0
 3042  4000  1503  P4000,  4000
 3043  0000  1504  DATPT1, 0
 3044  0000  1505  SIDCNT, 0
 3045  0077  1506  DAT77,  77
               1507
 3046  0000  1508  DATOUT, 0
 3047  1314  1509                TAD     DATPNT  /ANY OUTPUT VALUES?
 3050  7640  1510                SZA CLA
 3051  5253  1511                JMP     .+2     /YES,CONTINUE
 3052  5247  1512                JMP     .-3     /ASK AGAIN
 3053  1317  1513                TAD     SIDECT  /LEFT OR RIGHT SIDE?
 3054  7640  1514                SZA CLA
 3055  5271  1515                JMP     RTGOUT  /RIGHT SIDE
 3056  1713  1516  LFTOUT, TAD I   DATPT2  /GET LEFT CHAR.
 3057  7012  1517                RTR
 3060  7012  1518                RTR
 3061  7012  1519                RTR
 3062  0245  1520                AND     DAT77   /JUST 6 BITS
 3063  4321  1521                JMS     GRAY    /OUTPUT GRAY SCALE
 3064  2315  1522                ISZ     DATCT   /LINE DONE?
 3065  5267  1523                JMP     .+2     /NO
 3066  5646  1524                JMP I   DATOUT  /YES
 3067  7240  1525                CMA CLA
 3070  3317  1526                DCA     SIDECT  /SET FOR RIGHT SIDE
 3071  1713  1527  RTGOUT, TAD I   DATPT2  /GET RIGHT CHAR.
 3072  0245  1528                AND     DAT77   /JUST 6 BITS
 3073  4321  1529                JMS     GRAY    /OUTPUT GRAY SCALE
 3074  2313  1530                ISZ     DATPT2  /NEXT ADR.
 3075  7240  1531                CLA CMA         /GET NEXT OUTPUT LOC
 3076  1314  1532                TAD     DATPNT
 3077  3314  1533                DCA     DATPNT
 3100  3317  1534                DCA     SIDECT  /SET FOR LEFT SIDE
 3101  2316  1535                ISZ     PGEND   /END OF PAGE?
 3102  5307  1536                JMP     .+5     /NO
 3103  1320  1537                TAD     M7000   /YES
 3104  3316  1538                DCA     PGEND   /RESET COUNTER
 3105  1242  1539                TAD     P4000
 3106  3313  1540                DCA     DATPT2  /RESET POINTER
 3107  2315  1541                ISZ     DATCT   /LINE DONE?
 3110  5312  1542                JMP     .+2     /NO
 3111  5646  1543                JMP I   DATOUT  /YES,RETURN
 3112  5247  1544                JMP     DATOUT+1/CONTINUE
 3113  0000  1545  DATPT2, 0
 3114  0000  1546  DATPNT, 0
 3115  0000  1547  DATCT,  0
 3116  0000  1548  PGEND,  0
 3117  0000  1549  SIDECT, 0
 3120  7000  1550  M7000,  -1000
               1551
               1552
 3121  0000  1553  GRAY,   0                     /OUTPUTS GRAY SCALE
 3122  1332  1554                TAD     THVAL   /ADD TABLE VALUE ADD.
 3123  3334  1555                DCA     GRYVAL  /ADD INTEN VALUE
 3124  1734  1556                TAD I   GRYVAL  /GET INTEN VALUE
 3125  3330  1557                DCA     PAR2    /DEPOSIT IN PARM. OF
 3126  4733  1558                JMS I   INTROU  /INTEN ROUTINE
 3127  0000  1559                0
 3130  0000  1560  PAR2,   0                     /INTEN VALUE
 3131  5721  1561                JMP I   GRAY    /RETURN
 3132  3200  1562  THVAL,  TABHED
 3133  5400  1563  INTROU, INTEN
 3134  0000  1564  GRYVAL, 0
               1565
 3135  0000  1566  NEWLIN, 0
 3136  2046  1567                ISZ     NUBBUF  /ANY MORE LINES?
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     3137  5341  1568           JMP      .+2       /YES
     3140  5357  1569           JMP      NONBUF    /NO
     3141  1314  1570           TAD      DATPNT    /OVER FLOW INPUTS?
     3142  1111  1571           TAD      PPL
     3143  1320  1572           TAD      M7000     /SET FLAG 1 OR 2
     3144  7710  1573           SPA CLA
     3145  7001  1574           IAC
     3146  3044  1575           DCA      BUFFL1    /SET BUFFER FLAG 1
     3147  1044  1576           TAD      BUFFL1    /IS FLAG 1 SET?
     3150  7650  1577           SNA CLA            /YES
     3151  7040  1578           CMA
     3152  3045  1579           DCA      BUFFL2    /SET BUFFER FLAG 2
     3153  1111  1580  SETPPR,  TAD      PPL
     3154  7041  1581           CIA
     3155  3362  1582           DCA      OUTCNT    /RESET BUFFER LINE COUNTER
     3156  5735  1583           JMP I    NEWLIN    /RETURN
     3157  7040  1584  NONBUF,  CMA
     3160  3047  1585           DCA      NUBFL     /SET NO BUFFER FLAG
     3161  5353  1586           JMP      SETPPR    /RETURN
     3162  0000  1587  OUTCNT,  0
                 1588
                 1589
                 1590  /TABLE VALUES AND ID'S 5,7,8,11,12
                 1591  /AND BUFFER ERROR ROUTINE
                 1592
           3200  1593           *3200
     3200  0000  1594  TABHED,  0          /ZERO FROM 3200 TO 3277
                 1595
           3300  1596           *3300
     3300  0000  1597  IDN5,    0
     3301  0000  1598           0
     3302  0000  1599           0
     3303  0000  1600           0
     3304  0000  1601  IDN7,    0
     3305  0000  1602           0
     3306  0000  1603           0
     3307  0000  1604           0
     3310  0000  1605  IDN8,    0
     3311  0000  1606           0
     3312  0000  1607           0
     3313  0000  1608           0
     3314  0000  1609  IDN11,   0
     3315  0000  1610           0
     3316  0000  1611           0
     3317  0000  1612           0
     3320  0000  1613  IDN12,   0
     3321  0000  1614           0
     3322  0000  1615           0
     3323  0000  1616           0
                 1617
                 1618  /CHECKS FOR BUFFER INPUT OK
                 1619  /IF RECEIVES A 4 OK: 5 BAD
                 1620
     3324  0000  1621  BUFFIN,  0
     3325  4454  1622           SEND
     3326  4453  1623           RECEIVE            /GET NUMBER
     3327  1372  1624           TAD      M4        /OK?
     3330  7540  1625           SZA CLA
     3331  5333  1626           JMP      .+2
     3332  5724  1627           JMP I    BUFFIN    /YES,RETURN
     3333  6046  1628           TLS
     3334  4456  1629           MESSAGE
     3335  6117  1630           MESSQ              /BUFFER ERROR
     3336  0000  1631           0
     3337  5177  1632           JMP      NEW       /START OVER
                 1633
                 1634  /USE FOR BDCON ROUTINE
                 1635
     3340  0000  1636  ADJUST,  0
     3341  3372  1637           DCA      ADSAV1    /1000'S ADR
     3342  1365  1638           TAD      NURCNT    /# OF INPUTS
     3343  1372  1639           TAD      M4        /LESS 4
     3344  7450  1640           SNA               /ANY TOO PUSH DOWN
     3345  5740  1641           JMP I    ADJUST    /NO
     3346  3376  1642           DCA      RNDCNT    /YES,SAVE #
     3347  1372  1643           TAD      ADSAV1    /1000'S ADR
     3350  7001  1644           IAC
     3351  3373  1645           DCA      ADSAV2    /100'S ADR
     3352  1373  1646           TAD      ADSAV2
     3353  7001  1647           IAC
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     3354   3374   1648            DCA      ADSAV3  /10'S ADR
     3355   1374   1649            TAD      ADSAV3
     3356   7001   1650            IAC
     3357   3375   1651            DCA      ADSAV4  /UNITS ADR
     3360   1774   1652  PUSOVR,   TAD I    ADSAV3  /GET 10'S ADR
     3361   3775   1653            DCA I    ADSAV4  /PUT IN UNITS
     3362   1773   1654            TAD I    ADSAV2  /GET 100'S ADR
     3363   3774   1655            DCA I    ADSAV3  /PUT IN 10'S ADR
     3364   1772   1656            TAD I    ADSAV1  /GET 1000'S ADR
     3365   3773   1657            DCA I    ADSAV2  /PUT IN 1000'S ADR
     3366   3772   1658            DCA I    ADSAV1  /0 IN 100'S
     3367   2376   1659            ISZ      RNDCNT  /DONE?
     3370   5360   1660            JMP      PUSOVR  /NO,CONTINUE
     3371   5740   1661            JMP I    ADJUST  /YES, RETURN
     3372   0000   1662  ADSAV1,   0
     3373   0000   1663  ADSAV2,   0
     3374   0000   1664  ADSAV3,   0
     3375   0000   1665  ADSAV4,   0
     3376   0000   1666  RNDCNT,   0
                   1667
                   1668  /CHECKS THE THRESHOLD INPUTS
                   1669
                3400   1670        *3400
     3400   0000   1671  THOIN,    0
     3401   1252   1672            TAD      THM7    /MAX NUMBER OF INPUTS
     3402   3253   1673            DCA      THCNT
     3403   1312   1674            TAD      THHD    /THRES HEAD ADDRESS
     3404   3311   1675            DCA      THPT
     3405   2311   1676            ISZ      THPT
     3406   4451   1677  THIN1,    INPUT             /GET FIRST INPUT
     3407   6046   1678            TLS               /ECHO
     3410   4220   1679            JMS      THNUB   /CHECK FOR NUMBER
     3411   5256   1680            JMP      THRET1  /NOT A NUMBER
     3412   3254   1681            DCA      THST1   /STORE NUMBER
     3413   4451   1682  THIN2,    INPUT             /GET NEXT INPUT
     3414   6046   1683            TLS               /ECHO
     3415   4220   1684            JMS      THNUB   /CHECK FOR NUMBER
     3416   5277   1685            JMP      THDEL   /DELIMINTER INPUT
     3417   5265   1686            JMP      THOCTL  /CONVERT TO OCTAL
     3420   0000   1687  THNUB,    0
     3421   3325   1688            DCA      THST0   /STORE INPUT
     3422   1325   1689            TAD      THST0
     3423   1371   1690            TAD      M215    /IS IT A CR?
     3424   7450   1691            SNA
     3425   5240   1692            JMP      THOUT1  /YES,EXIT
     3426   1250   1693            TAD      THM43   /NO
     3427   7510   1694            SPA               /IS INPUT A NUMBER?
     3430   5620   1695            JMP I    THNUB   /NO RETURN
     3431   1251   1696            TAD      THM11   /IS INPUT A NUMBER?
     3432   7740   1697            SMA SZA CLA
     3433   5620   1698            JMP I    THNUB   /NO RETURN
     3434   1325   1699            TAD      THST0
     3435   0324   1700            AND      MSK17
     3436   2320   1701            ISZ      THNUB   /NUMBER RETURN
     3437   5620   1702            JMP I    THNUB
     3440   4455   1703  THOUT1,   SCREEN
     3441   1254   1704            TAD      THST1
     3442   3711   1705            DCA I    THPT
     3443   7001   1706            IAC
     3444   1253   1707            TAD      THCNT   /CHECK FOR 7 INPUTS
     3445   7440   1708            SZA
     3446   5620   1709            JMP I    THOIN   /ERROR RETURN
     3447   5322   1710            JMP      THPT2
     3450   7775   1711  THM43,    -43
     3451   7767   1712  THM11,    -11
     3452   7771   1713  THM7,     -7
     3453   0000   1714  THCNT,    0
     3454   0000   1715  THST1,    0
     3455   0000   1716  THST2,    0
     3456   4451   1717  THRET1,   INPUT             /JUST ECHO
     3457   6046   1718            TLS
     3460   1371   1719            TAD      M215
     3461   7940   1720            SZA CLA
     3462   5256   1721            JMP      .-4
     3463   4455   1722            SCREEN            /CHECK FOR FULL SCREEN
     3464   5600   1723            JMP I    THOIN   /ERROR RETURN
     3465   3255   1724  THOCTL,   DCA      THST2   /STORE
     3466   1254   1725            TAD      THST1   /GET FIRST NUMBER
     3467   7041   1726            CIA               /NEGATE
     3470   3254   1727            DCA      THST1
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3471  1326  1728          TAD     RADIX   /ADD 12 FIRST 2 TIMES
3472  2354  1729          ISZ     THST1
3473  5271  1730          JMP     .-2
3474  1255  1731          TAD     THST2   /ADD SECOND NUMBER
3475  3254  1732          DCA     THST1   /STORE RESULTS
3476  5213  1733          JMP     THIN2
3477  7200  1734  THOEL,  CLA
3500  1254  1735          TAD     THST1
3501  3711  1736          DCA I   THPT    /STORE
3502  2253  1737          ISZ     THCNT   /7 TIMES^
3503  7000  1738          NOP
3504  1253  1739          TAD     THCNT   /=0^
3505  7450  1740          SNA
3506  5256  1741          JMP     THRET1  /NO, ECHO
3507  2311  1742          ISZ     THPT    /NEXT ADDRESS
3510  5206  1743          JMP     THIN1   /CONTINUE
3511  0000  1744  THPT,   0
3512  3512  1745  THHD,   THHD
3513  0000  1746          0
3514  0000  1747          0
3515  0000  1748          0
3516  0000  1749          0
3517  0000  1750          0
3520  0000  1751          0
3521  0000  1752          0
3522  2200  1753  THPT2,  ISZ     THOIN
3523  5600  1754          JMP I   THOIN   /PROPER RETURN
3524  0017  1755  MSK17,  17
3525  0000  1756  THST0,  0
3526  0012  1757  RADIX,  12
              1758
3527  0000  1759  PRINT1, 0               /BACK AND LF
3530  1267  1760          TAD     P268    /ADD > VALUE
3531  4452  1761          OUTPUT
3532  1266  1762          TAD     P212    /LF
3533  4452  1763          OUTPUT
3534  1337  1764          TAD     BS      /BACK SPACE
3535  4452  1765          OUTPUT
3536  5727  1766          JMP I   PRINT1
3537  0210  1767  BS,     210
              1768
              1769  /IS THE INPUT CORRECT^
              1770
3540  0000  1771  RIGHT,  0
3541  4456  1772          MESSAGE
3542  5635  1773          5635            /CORRECT
3543  5606  1774          5606            /^
3544  0000  1775          0
3545  4753  1776          JMS I   RETORT
3546  5352  1777          JMP     .+4     /ERROR RETURN
3547  5351  1778          JMP     .+2     /NO RETURN
3550  2340  1779          ISZ     RIGHT   /YES RETURN
3551  2340  1780          ISZ     RIGHT
3552  5740  1781          JMP I   RIGHT   /RETURN...
3553  2000  1782  RETORT, REPLY
3554  0000  1783  CKFL,   0
3555  4453  1784          RECEIVE         /GET LINE FEED
3556  4454  1785          SEND
3557  4453  1786          RECEIVE         /CHECK IF OS3 FILE
3560  1272  1787          TAD     M4
3561  7640  1788          SZA CLA
3562  5754  1789          JMP I   CKFL    /NOT A OS3 FILE RETURN
3563  2354  1790          ISZ     CKFL    /IS A OS3 FILE RETURN
3564  5362  1791          JMP     .-2
              1792
              1793  /CHECK FOR FFIN(60) OUTPUT
              1794
3565  0000  1795  FFIN,   0
3566  4453  1796          RECEIVE
3567  0377  1797          AND     MK377   /MASK OFF UNWANTED BITS
3570  1276  1798          TAD     M276    /IS IT A >^
3571  7640  1799          SZA CLA
3572  5366  1800          JMP     .-4     /NO,KEEP LOOKING
3573  4453  1801          RECEIVE         /YES, TAKE IN SPACE
3574  7200  1802          CLA
3575  5765  1803          JMP I   FFIN    /RETURN
3576  7502  1804  M276,   -276
3577  0377  1805  MK377,  377
              1806
              1807  /DECIMAL TO BINARY CONVERSION
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                1838  /PARAM. (1)= DECIMAL NUMBER ADDRESS
                1839  /PARAM. (2)= BINARY NUMBER ADDRESS
                1840
          3600  1841        *3600
3600    0000    1842  DTOB,   0
3601    1660    1843        TAD I   DTOB    /DECIMAL ADDRESS
3602    3262    1844        DCA     DBPT1
3603    2200    1845        ISZ     DTOB
3604    1600    1846        TAD I   DTOB    /BINARY ADDRESS
3605    3207    1847        DCA     DBPT2
3606    4667    1848        JMS I   CLR1    /CLEAR BINARY  LOC.
3607    0000    1849  DBPT2,  0
3610    7776    1850        7776            /2 OF LOC. TO CLEAR
3611    1270    1851        TAD     DBHD    /TABLE HEADS
3612    3010    1852        DCA     10
3613    1662    1853        TAD I   DBPT1   /GET NUMBER VALUE
3614    1410    1854        TAD I   10      /ADD ADDRESS
3615    3263    1855        DCA     DBPT4
3616    2207    1856        ISZ     DBPT2   /GET LOW ADDRESS
3617    1663    1857        TAD I   DBPT4   /GET BINARY VALUE
3620    3607    1858        DCA I   DBPT2   /STORE AT LOW
3621    3264    1859        DCA     DBLNK   /ZERO CARRY
3622    1662    1860        TAD I   DBPT1   /IS 1000#S <4A
3623    1272    1861        TAD     M4
3624    7550    1862        SPA SNA         /YES
3625    5233    1863        JMP     .+6     /NO
3626    2264    1864        ISZ     DBLNK   /ADD TO LINK CARRY
3627    1272    1865        TAD     M4      /IS 1000#S <8A
3630    7550    1866        SPA SNA         /YES
3631    5233    1867        JMP     .+2     /NO
3632    2264    1868        ISZ     DBLNK   /ADD TO CARRY
3633    7300    1869        CLA CLL
3634    1266    1870        TAD     DBM3    /3 TIMES THROUGH
3635    3265    1871        DCA     DBCNT   /COUNTER
3636    2262    1872  DBAGA,  ISZ     DBPT1   /NEXT DECIMAL UNIT
3637    1662    1873        TAD I   DBPT1   /GET NUMBER VALUE
3640    1410    1874        TAD I   10      /ADD ADDRESS
3641    3263    1875        DCA     DBPT4
3642    1663    1876        TAD I   DBPT4   /GET VALUE
3643    1607    1877        TAD I   DBPT2   /ADD LOW VALUE
3644    3607    1878        DCA I   DBPT2
3645    7430    1879        SZL             /OVERFLOW
3646    2264    1880        ISZ     DBLNK   /YES ADD TO CARRY
3647    7100    1881        CLL
3650    2265    1882        ISZ     DBCNT   /DONE
3651    5236    1883        JMP     DBAGA   /NO,CONTINUE
3652    7240    1884        CLA CMA         /YES
3653    1207    1885        TAD     DBPT2   /GET HIGH ADDRESS
3654    3607    1886        DCA     DBPT2
3655    1264    1887        TAD     DBLNK   /GET CARRY
3656    1607    1888        TAD I   DBPT2
3657    3607    1889        DCA I   DBPT2   /STORE RESULTS
3660    2200    1890        ISZ     DTOB    /PROPER RETURN
3661    5600    1891        JMP I   DTOB    /RETURN
3662    0000    1892  DBPT1,  0
3663    0000    1893  DBPT4,  0
3664    0000    1894  DBLNK,  0
3665    0000    1895  DBCNT,  0
3666    7775    1896  DBM3,   -3
3667    1505    1897  CLR1,   ZEROUT
3670    3676    1898  DBHD,   DBHD
3671    5345    1899  DB1000, THS             /THS
3672    5333    1900  DB100,  HUND            /HUND
3673    5321    1901  DB10,   TEN             /TEN
3674    5307    1902  DB1,    UNITS           /UNITS
                1903
                1904
                1905  /DOUBLE PERCISION ADD AND SUB.
                1906  /PARAM. (1) ADDRESS OF NUMB 1
                1907  /PARAM. (2) ADDRESS OF NUMB. 2
                1908
3675    0000    1909  DUBADD, 0
3676    7300    1910        CLA CLL
3677    1675    1911        TAD I   DUBADD  /PARAM. 1
3700    3322    1912        DCA     DBAP1
3701    2275    1913        ISZ     DUBADD
3702    1675    1914        TAD I   DUBADD  /PARAM. 2
3703    3323    1915        DCA     DBAP2
3704    2275    1916        ISZ     DUBADD  /PROPER RETURN
3705    1722    1917        TAD I   DBAP1   /NUMB. 1 HIGH
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     3706  1723  1898          TAD I   DBAP2   /NUMB. 2 HIGH
     3707  3116  1899          DCA     COMH    /STORE HIGH RESULTS
     3710  7100  1900          CLL
     3711  2322  1901          ISZ     DBAP1   /LOW ADDRESSES
     3712  2323  1902          ISZ     DBAP2
     3713  1722  1903          TAD I   DBAP1   /NUMB. 1 LOW
     3714  1723  1904          TAD I   DBAP2   /NUMB. 2 LOW
     3715  3117  1905          DCA     COML    /STORE RESULTS
     3716  7004  1906          RAL             /GET CARRY IF ANY
     3717  1116  1907          TAD     COMH
     3720  3116  1908          DCA     COMH    /STORE RESULTS
     3721  5675  1909          JMP I   DUBADD  /RETURN
     3722  0000  1910  DBAP1,  0
     3723  0100  1911  DBAP2,  0
                 1912
                 1913  /DOUBLE PERCISION SUB.
                 1914
     3724  0100  1915  DUBSUB, 0
     3725  7300  1916          CLA CLL
     3726  1724  1917          TAD I   DUBSUB  /PARAM. 1
     3727  3262  1918          DCA     DBPT1
     3730  2324  1919          ISZ     DUBSUB
     3731  1724  1920          TAD I   DUBSUB  /PARAM. 2
     3732  3267  1921          DCA     DBPT2
     3733  2324  1922          ISZ     DUBSUB  /PROPER RETURN
     3734  1662  1923          TAD I   DBPT1   /NUMB. 1 HIGH
     3735  7040  1924          CMA             /NEGATE
     3736  1667  1925          TAD I   DBPT2   /ADD NUMB. 2 HIGH
     3737  3116  1926          DCA     COMH    /STORE RESULTS
     3740  7100  1927          CLL
     3741  2262  1928          ISZ     DBPT1   /GET LOW ADDRESSES
     3742  2267  1929          ISZ     DBPT2
     3743  1662  1930          TAD I   DBPT1   /SUB LOW
     3744  7041  1931          CIA             /NEGATE
     3745  1667  1932          TAD I   DBPT2
     3746  3117  1933          DCA     COML    /STORE RESULTS
     3747  7004  1934          RAL             /ADD CARRY
     3750  1116  1935          TAD     COMH
     3751  3116  1936          DCA     COMH    /STORE RESULTS
     3752  7100  1937          CLL
     3753  5724  1938          JMP I   DUBSUB  /RETURN
                 1939
                 1940  /CHECKS FOR UNWANTED VALUES SENT FROM OS3
                 1941
     3754  0000  1942  ERROS3, 0
     3755  6401  1943          KSF40           /FLAG SET?
     3756  5754  1944          JMP I   ERROS3  /NO,RETURN
     3757  6406  1945  ERRNEX, KRB40           /GET VALUE
     3760  3362  1946          DCA     ERRLOC  /CLEAR BUFFER
     3761  5754  1947          JMP I   ERROS3  /RETURN
     3762  0000  1948  ERRLOC, 0
                 1949
                 1950  /STORAGE FOR ERTS DATA INPUT
                 1951  /MAX. OF FOUR PAGES
                 1952
           4000  1953          *4000
                 1954
           5000  1955  *5000
     5000  0000  1956  PAKTYP,  0                       /RETURN ADDRESS
     5001  6041  1957          PRFL                    /IS PRINT FLAG SET
     5002  5201  1958          JMP     .-1
     5003  6046  1959          PRBF                    /OUTPUT PRINT BUFFER
     5004  7300  1960          CLA CLL                 /CLEAR REGISTERS
     5005  5600  1961          JMP I   PAKTYP  /RETURN
           6041  1962  PRFL=6041
           6046  1963  PRBF=6046                       /VALUE FOR PDP
     5006  0000  1964  PAKSAV,  0                       /SAVE REGISTERS ROUTINE
     5007  3221  1965          DCA PAKACC              /DEPOSIT ACC
     5010  7004  1966          RAL
     5011  3222  1967          DCA PAKLNK              /DEPOSIT LINK
     5012  5606  1968          JMP I PAKSAV            /RETURN
     5013  0000  1969  PAKRST,  0                       /RESTORE REGISTERS ROUTINE
     5014  7300  1970          CLA CLL                 /CLEAR REGISTERS
     5015  1222  1971          TAD PAKLNK              /PUT IN LINK
     5016  7010  1972          RAR
     5017  1221  1973          TAD PAKACC              /PUT IN ACC
     5020  5613  1974          JMP I PAKRST            /RETURN
     5021  0000  1975  PAKACC,  0
     5022  0000  1976  PAKLNK,  0
     5023  0000  1977  PAKMOV,  0
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 5024  1623  1968                TAD I PAKMOV          /GET X VALUE
 5025  3263  1969                DCA PAKSVX            /SAVE X VALUE
 5026  2223  1970                ISZ PAKMOV            /GET Y VALUE
 5027  1623  1971                TAD I PAKMOV
 5030  7012  1972                RTR                   /ROTATE TO GET HIGH Y VALUE
 5031  7012  1973                RTR
 5032  7010  1974                RAR
 5033  0262  1975                AND PAKMSK            /REMOVE DATA TOO LARGE
 5034  1257  1976                TAD PAKORD            /ADD HIGH Y VALUE
 5035  4200  1977  PAKT1,        JMS PAKTYP            /OUTPUT HIGH Y COORD
 5036  1623  1978                TAD I PAKMOV          /GET Y VALUE
 5037  0262  1979                AND PAKMSK            /MASK OFF VALUE NOT NEEDED
 5040  1261  1980                TAD PAKORY            /ADD LOW Y VALUE
 5041  4200  1981  PAKT2,        JMS PAKTYP            /OUTPUT LOW Y COORD
 5042  1263  1982                TAD PAKSVX            /GET X VALUE
 5043  7012  1983                RTR                   /ROTATE TO GET HIGH X VALUE
 5044  7012  1984                RTR
 5045  7010  1985                RAR
 5046  0262  1986                AND PAKMSK            /MASK OFF DATA TOO LARGE
 5047  1257  1987                TAD PAKORD            /GET HIGH X VALUE
 5050  4200  1988  PAKT3,        JMS PAKTYP            /OUTPUT HIGH X COORD
 5051  1263  1989                TAD PAKSVX            /GET X VALUE
 5052  0262  1990                AND PAKMSK            /MASK OFF VALUE NOT NEEDED
 5053  1260  1991                TAD PAKORX            /ADD LOW X VALUE
 5054  4200  1992  PAKT4,        JMS PAKTYP            /OUTPUT LOW X COORD
 5055  2223  1993                ISZ PAKMOV            /CORRECT RETURN ADDRESS
 5056  5623  1994                JMP I PAKMOV          /RETURN
 5057  0040  1995  PAKORD,       40
 5060  0100  1996  PAKORX,       100
 5061  0140  1997  PAKORY,       140
 5062  0037  1998  PAKMSK,       37
 5063  0000  1999  PAKSVX,       0
 5064  0000  2000  PAKVEC,       0
 5065  1664  2001                TAD I PAKVEC          /GET X VALUE
 5066  3275  2002                DCA PAKX1             /PUT IN X1 POS
 5067  2264  2003                ISZ PAKVEC
 5070  1664  2004                TAD I PAKVEC          /GET Y VALUE
 5071  3276  2005                DCA PAKY1             /PUT IN Y1 POS
 5072  1315  2006                TAD PAKGS             /PUT IN VECTOR MODE
 5073  4200  2007  PAKT5,        JMS PAKTYP
 5074  4223  2008                JMS PAKMOV            /OUTPUT FIRST TWO VALUES
 5075  0000  2009  PAKX1,        0
 5076  0000  2010  PAKY1,        0
 5077  2264  2011                ISZ PAKVEC
 5100  1664  2012                TAD I PAKVEC          /GET SECOND X VALUE
 5101  3306  2013                DCA PAKX2             /PUT IN X2 POS
 5102  2264  2014                ISZ PAKVEC
 5103  1664  2015                TAD I PAKVEC          /GET Y2 VALUE
 5104  3307  2016                DCA PAKY2             /PUT IN Y2 POS
 5105  4223  2017                JMS PAKMOV            /OUTPUT SECOND TWO VALUES
 5106  0000  2018  PAKX2,        0
 5107  0000  2019  PAKY2,        0
 5110  1314  2020                TAD PAKUS             /PUT IN ALPHA MODE
 5111  4200  2021  PAKT6,        JMS PAKTYP
 5112  2264  2022                ISZ PAKVEC            /GET CORRECT RETURN ADDRESS
 5113  5664  2023                JMP I PAKVEC          /RETURN
 5114  0237  2024  PAKUS,        237
 5115  0235  2025  PAKGS,        235
 5116  0000  2026  PAKINK,       0
 5117  4206  2027                JMS PAKSAV            /SAVE REGISTERS
 5120  1331  2028                TAD PAKPS             /PUT IN INCRE. MODE
 5121  4200  2029                JMS PAKTYP
 5122  1716  2030                TAD I PAKINK          /GET DIP
 5123  1332  2031                TAD PAK40
 5124  4200  2032                JMS PAKTYP            /PUT POINTER IN CORRECT POS
 5125  2316  2033                ISZ PAKINK            /GET CORRECT RETURN ADDRESS
 5126  1314  2034                TAD PAKUS             /PUT IN ALPHA MODE
 5127  4200  2035                JMS PAKTYP
 5130  5716  2036                JMP I PAKINK          /RETURN
 5131  0236  2037  PAKPS,        236
 5132  0040  2038  PAK40,        40
 5133  0000  2039  PAKPPM,       0
 5134  4206  2040                JMS PAKSAV            /SAVE REGISTERS
 5135  1733  2041                TAD I PAKPPM          /GET X VALUE
 5136  3346  2042                DCA PAKPX1            /PUT IN X POS
 5137  2333  2043                ISZ PAKPPM
 5140  1733  2044                TAD I PAKPPM          /GET Y VALUE
 5141  3345  2045                DCA PAKPY1            /PUT IN Y POS
 5142  1354  2046                TAD PAKFS             /PUT IN ENT PLOT MODE
 5143  4200  2047                JMS PAKTYP
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     5144   4223   2048          JMS PAKMOV                      /OUTPUT COORD
     5145   0000   2049  PAKPY1,  0
     5146   0000   2050  PAKPX1,  0
     5147   2333   2051          ISZ PAKPPM                      /GET CORRECT RETURN ADDRESS
     5150   1314   2052          TAD PAKUS                       /PUT IN ALPHA MODE
     5151   4206   2053          JMS PAKTYP
     5152   4213   2054          JMS PAKRST                      /RESTORE REGISTERS
     5153   5733   2055          JMP I PAKPPM                    /RETURN
     5154   0234   2056  PAKFS,  234
                   2057
                   2058  /DECIMAL AND BINARY TABLES
                   2059
            5200   2060          *5200
                   2061  /BINARY TABLE
                   2062
     5200   0010   2063  081,    10          /TWO TABLE ENTRIES
     5201   0000   2064          0
     5202   0006   2065  082,    6
     5203   0001   2066          1
     5204   0004   2067  083,    4
     5205   0002   2068          2
     5206   0002   2069  084,    2
     5207   0003   2070          3
     5210   0000   2071  085,    0
     5211   0004   2072          4
     5212   0010   2073  086,    10
     5213   0004   2074          4
     5214   0006   2075  087,    6
     5215   0005   2076          5
     5216   0004   2077  0641,   4           /THREE TABLE ENTRIES
     5217   0006   2078          6
     5220   0000   2079          0
     5221   0010   2080  0642,   10
     5222   0002   2081          2
     5223   0001   2082          1
     5224   0002   2083  0643,   2
     5225   0011   2084          11
     5226   0001   2085          1
     5227   0006   2086  0644,   6
     5230   0005   2087          5
     5231   0002   2088          2
     5232   0000   2089  0645,   0
     5233   0002   2090          2
     5234   0003   2091          3
     5235   0004   2092  0646,   4
     5236   0010   2093          10
     5237   0003   2094          3
     5240   0010   2095  0647,   10
     5241   0004   2096          4
     5242   0004   2097          4
     5243   0002   2098  051,    2           /FOUR TABLE ENTRIES
     5244   0001   2099          1
     5245   0005   2100          5
     5246   0001   2101          0
     5247   0004   2102  052,    4
     5250   0002   2103          2
     5251   0000   2104          0
     5252   0001   2105          1
     5253   0006   2106  053,    6
     5254   0003   2107          3
     5255   0005   2108          5
     5256   0001   2109          1
     5257   0010   2110  054,    10
     5260   0004   2111          4
     5261   0000   2112          0
     5262   0002   2113          2
     5263   0000   2114  055,    0
     5264   0006   2115          6
     5265   0005   2116          5
     5266   0002   2117          2
     5267   0002   2118  056,    2
     5270   0007   2119          7
     5271   0000   2120          0
     5272   0003   2121          3
     5273   0004   2122  057,    4
     5274   0010   2123          10
     5275   0005   2124          5
     5276   0003   2125          3
     5277   0006   2126  041,    6           /FOUR TABLE ENTRIES
     5300   0011   2127          11
```

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5301  0000  2128            0
5302  0004  2129            4
5303  0002  2130  042,       2
5304  0011  2131            11
5305  0001  2132            1
5306  0010  2133            10
                2134
                2135  /DECIMAL TABLE
                2136
5307  0000  2137  UNITS,    0
5310  0001  2138            1
5311  0002  2139            2
5312  0003  2140            3
5313  0004  2141            4
5314  0005  2142            5
5315  0006  2143            6
5316  0007  2144            7
5317  0010  2145            10
5320  0011  2146            11
5321  0000  2147  TEN,      0
5322  0012  2148            12
5323  0024  2149            24
5324  0036  2150            36
5325  0050  2151            50
5326  0062  2152            62
5327  0074  2153            74
5330  0106  2154            106
5331  0120  2155            120
5332  0132  2156            132
5333  0000  2157  HUND,     0
5334  0144  2158            144
5335  0310  2159            310
5336  0454  2160            454
5337  0620  2161            620
5340  0764  2162            764
5341  1130  2163            1130
5342  1274  2164            1274
5343  1440  2165            1440
5344  1604  2166            1604
5345  0000  2167  THS,      0
5346  1750  2168            1750
5347  3720  2169            3720
5350  5670  2170            5670
5351  7640  2171            7640
5352  1610  2172            1610
5353  3560  2173            3560
5354  5530  2174            5530
5355  7500  2175            7500
5356  1450  2176            1450
                2177
      5400  2178  *5400
5400  0000  2179  INTEN,    0
5401  1600  2180            TAD I INTEN
5402  7650  2181            SNA CLA                 /FROM 1 OR 8
5403  5215  2182            JMP INTP0               /FROM 2
5404  2200  2183            ISZ INTEN               /GET NEXT INTEN LOC
5405  1600  2184            TAD I INTEN             /INITIAL X LOC
5406  3347  2185            DCA INTX1
5407  2200  2186            ISZ INTEN               /GET NEXT INTEN LOC
5410  1600  2187            TAD I INTEN             /GET X LOC
5411  3350  2188            DCA INTY1               /Y1 VALUE FOR VEC ROUTINE
5412  1350  2189            TAD INTY1               /GET Y1 VALUE
5413  1336  2190            TAD INTM22              /SUB. EIGHTEEN
5414  3352  2191            DCA INTY2               /Y2 VALUE FOR VEC ROUTINE
5415  1347  2192  INTP0,    TAD INTX1               /GET X COORD
5416  1336  2193            TAD INTP20              /ADD SIXTEEN
5417  3348  2194            DCA INTSAV              /NEXT X LOC GOING NW
5420  2200  2195            ISZ INTEN               /NEXT INTEN LOC
5421  7300  2196            CLA CLL
5422  1600  2197            TAD I INTEN             /GET NUMBER OF LINES
5423  7450  2198            SNA
5424  5253  2199            JMP INTM0               /NO LINES
5425  7010  2200            RAR
5426  7450  2201            SNA
5427  5260  2202            JMP INTM1               /ONE LINE
5430  7010  2203            RAR
5431  7450  2204            SNA
5432  5265  2205            JMP INTM2               /TWO LINES
5433  7010  2206            RAR
5434  7450  2207            SNA
```

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J300 PAL/OS3 VF2 3.1   12/08/75  23142                    PAGE  29

5435  5314  2208            JMP INTM4                    /FOUR LINES
5436  7010  2209            RAR
5437  7450  2210            SNA
5440  5311  2211            JMP INTM8                    /EIGHT LINES
5441  7110  2212            RAR
5442  7650  2213            SNA CLA
5443  5322  2214            JMP INTM16                   /SIXTEEN LINES
5444  1600  2215            TAD I INTEN                  /GET NUMBER OF LINES
5445  1340  2216            TAD INTN3                    /MINUS THREE
5446  7450  2217            SNA
5447  5272  2218            JMP INTM3                    /THREE LINES
5450  1341  2219            TAD INTN2                    /MINUS TWO
5451  7650  2220            SNA CLA
5452  5306  2221            JMP INTM5                    /FIVE LINES
5453  1343  2222  INTM0,     TAD INTSAV                   /GET NEXT X COORD
5454  4354  2223            JMS INXCAL                   /X1 = X2
5455  7300  2224            CLA CLL
5456  2200  2225            ISZ INTEN                    /GET NEXT INTEN LOC
5457  5600  2226            JMP I INTEN                  /RETURN
5460  1347  2227  INTM1,     TAD INTX1                    /GET X1 VALUE
5461  1331  2228            TAD INTP10                   /ADD EIGHT
5462  4354  2229            JMS INXCAL                   /X1=X2
5463  4345  2230            JMS INTVEC                   /OUTPUT LINE
5464  5253  2231            JMP INTM0                    /RETURN
5465  1347  2232  INTM2,     TAD INTX1                    /GET X1 VALUE
5466  1333  2233            TAD INTP4                    /ADD 4
5467  4354  2234            JMS INXCAL                   /X1=X2
5470  4345  2235            JMS INTVEC                   /OUTPUT LINE
5471  5260  2236            JMP INTM1                    /OUTPUT NEXT LINE
5472  1332  2237  INTM3,     TAD INTP5                    /ADD FIVE
5473  3344  2238            DCA INTDIF                   /PUT IN LINE LENGTH
5474  1347  2239  INTOVR,    TAD INTX1                    /GET X1 COORD
5475  1344  2240            TAD INTDIF                   /ADD NEXT LINE COORD
5476  4354  2241            JMS INXCAL                   /X1=X2
5477  1343  2242            TAD INTSAV                   /GET NEXT X COORD
5500  7041  2243            CMA IAC                      /MAKE NEG
5501  1347  2244            TAD INTX1
5502  7700  2245            SMA CLA                      /END OF LINES
5503  5253  2246            JMP INTM0
5504  4345  2247            JMS INTVEC                   /NO, DRAW LINE
5505  5274  2248            JMP INTOVR                   /COMPARE X1 VALUE
5506  1334  2249  INTM5,     TAD INTP3                    /ADD THREE
5507  3344  2250            DCA INTDIF                   /PUT IN LINE LENGTH
5510  5274  2251            JMP INTOVR                   /OUTPUT LINES
5511  1335  2252  INTM8,     TAD INTP2                    /ADD TWO
5512  3344  2253            DCA INTDIF                   /LINE LENGTH
5513  5274  2254            JMP INTOVR                   /OUTPUT LINES
5514  1347  2255  INTM4,     TAD INTX1                    /GET X1
5515  1342  2256            TAD INTN1                    /SUB. ONE
5516  4354  2257            JMS INXCAL                   /PUT X1=X2
5517  1333  2258            TAD INTP4                    /ADD FOUR
5520  3344  2259            DCA INTDIF                   /PUT IN LINE LENGTH
5521  5274  2260            JMP INTOVR                   /OUTPUT LINES
5522  1347  2261  INTM16,    TAD INTX1                    /GET X1
5523  1342  2262            TAD INTN1                    /SUB. ONE
5524  4354  2263            JMS INXCAL                   /PUT X1=X2
5525  7001  2264            IAC                          /ADD ONE
5526  3344  2265            DCA INTDIF                   /PUT IN LINE LENGTH
5527  5274  2266            JMP INTOVR                   /PUTPUT LINES
5530  0020  2267  INTP20,    20
5531  0010  2268  INTP10,    10
5532  0005  2269  INTP5,     5
5533  0004  2270  INTP4,     4
5534  0003  2271  INTP3,     3
5535  0002  2272  INTP2,     2
5536  7756  2273  INTN22,    -22
5537  7771  2274  INTN7,     -7
5540  7775  2275  INTN3,     -3
5541  7776  2276  INTN2,     -2
5542  7777  2277  INTN1,     -1
5543  0000  2278  INTSAV,    0
5544  0000  2279  INTDIF,    0
5545  0000  2280  INTVEC,    0
5546  4761  2281            JMS I INTPLT
5547  0000  2282  INTX1,     0
5550  0000  2283  INTY1,     0
5551  0000  2284  INTX2,     0
5552  0000  2285  INTY2,     0
5553  5745  2286            JMP I INTVEC
5554  0000  2287  INXCAL,    0
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     5555  3347  2288            DCA INTX1
     5556  1347  2289            TAD INTX1
     5557  3351  2290            DCA INTX2
     5560  5754  2291            JMP I INXCAL
     5561  5564  2292  INTPLT,   PAKVEC.
                 2293
                 2294  / WORD TABLE FOR MESSAGE OUTPUT
                 2295
           5600  2296            *5600
     5600  0327  2297  MESSA,    327       /W
     5601  0310  2298            310       /H
     5602  0301  2299            301       /A
     5603  0324  2300            324       /T
     5604  0240  2301            240       /SPACE
     5605  0000  2302            0
     5606  0277  2303  MESS9,    277       /^
     5607  0215  2304            215       /CR
     5610  0000  2305            0
     5611  0311  2306  MESSC,    311       /I
     5612  0323  2307            323       /S
     5613  0240  2308            240
     5614  0324  2309            324       /T
     5615  0310  2310            310       /H
     5616  0305  2311            305       /E
     5617  0240  2312            240       /SPACE
     5620  0000  2313            0
     5621  0311  2314  MESSD,    311       /I
     5622  0316  2315            316       /N
     5623  0320  2316            320       /P
     5624  0325  2317            325       /U
     5625  0324  2318            324       /T
     5626  0240  2319            240       /SPACE
     5627  0306  2320            306       /F
     5630  0311  2321            311       /I
     5631  0314  2322            314       /L
     5632  0305  2323            305       /E
     5633  0240  2324            240       /SPACE
     5634  0000  2325            0
     5635  0303  2326  MESSE,    303       /C
     5636  0317  2327            317       /O
     5637  0322  2328            322       /R
     5640  0322  2329            322       /R
     5641  0305  2330            305       /E
     5642  0303  2331            303       /C
     5643  0324  2332            324       /T
     5644  0240  2333            240       /SPACE
     5645  0000  2334            0
     5646  0301  2335  MESSF,    301       /A
     5647  0322  2336            322       /R
     5650  0305  2337            305       /E
     5651  0240  2338            240       /SPACE
     5652  0324  2339            324       /T
     5653  0310  2340            310       /H
     5654  0305  2341            305       /E
     5655  0240  2342            240       /SPACE
     5656  0324  2343            324       /T
     5657  0310  2344            310       /H
     5660  0322  2345            322       /R
     5661  0305  2346            305       /E
     5662  0323  2347            323       /S
     5663  0310  2348            310       /H
     5664  0317  2349            317       /O
     5665  0314  2350            314       /L
     5666  0324  2351            324       /D
     5667  0323  2352            323       /S
     5670  0240  2353            240       /SPACE
     5671  0000  2354            0
     5672  0311  2355  MESSG,    311       /I
     5673  0316  2356            316       /N
     5674  0311  2357            311       /I
     5675  0324  2358            324       /T
     5676  0311  2359            311       /I
     5677  0301  2360            301       /A
     5700  0314  2361            314       /L
     5701  0240  2362            240       /SPACE
     5702  0000  2363            0
     5703  0320  2364  MESSH,    320       /P
     5704  0317  2365            317       /O
     5705  0311  2366            311       /I
     5706  0316  2367            316       /N
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5707  0324  2368          324     /T
5710  0000  2369          0
5711  0323  2370  MESSI,  323     /S
5712  0240  2371          240     /SPACE
5713  0000  2372          0
5714  0316  2373  MESSJ,  316     /N
5715  0325  2374          325     /U
5716  0315  2375          315     /M
5717  0302  2376          302     /B
5720  0305  2377          305     /E
5721  0322  2378          322     /R
5722  0240  2379          240     /SPACE
5723  0317  2380          317     /O
5724  0306  2381          306     /F
5725  0240  2382          240     /SPACE
5726  0000  2383          0
5727  0314  2384  MESSK,  314     /L
5730  0311  2385          311     /I
5731  0316  2386          316     /N
5732  0305  2387          305     /F
5733  0000  2388          0
5734  0320  2389  MESSL,  320     /P
5735  0311  2390          311     /I
5736  0303  2391          303     /C
5737  0324  2392          324     /T
5740  0325  2393          325     /U
5741  0322  2394          322     /R
5742  0305  2395          305     /E
5743  0240  2396          240     /SPACE
5744  0311  2397          311     /I
5745  0323  2398          323     /S
5746  0240  2399          240     /SPACE
5747  0303  2400          303     /C
5750  0317  2401          317     /O
5751  0315  2402          315     /M
5752  0320  2403          320     /P
5753  0314  2404          314     /L
5754  0305  2405          305     /E
5755  0324  2406          324     /T
5756  0305  2407          305     /E
5757  0304  2410          304     /D
5760  0215  2409  MESSM,  215     /CR
5761  0000  2410          0
5762  0302  2411  MESS1,  302     /B
5763  0301  2412          301     /A
5764  0316  2413          316     /N
5765  0304  2414          304     /D
5766  0240  2415          240     /SPACE
5767  0316  2416          316     /N
5770  0325  2417          325     /U
5771  0315  2418          315     /M
5772  0302  2419          302     /B
5773  0305  2420          305     /E
5774  0322  2421          322     /R
5775  0240  2422          240     /SPACE
5776  0000  2423          0
5777  0302  2424  MESS2,  302     /B
6000  0325  2425          325     /E
6001  0324  2426          324     /T
6002  0327  2427          327     /W
6003  0305  2428          305     /E
6004  0305  2429          305     /E
6005  0316  2430          316     /N
6006  0240  2431          240     /SPACE
6007  0264  2432          264     /4
6010  0240  2433          240     /SPACE
6011  0301  2434          301     /A
6012  0316  2435          316     /N
6013  0304  2436          304     /D
6014  0240  2437          240     /SPACE
6015  0267  2438          267     /7
6016  0215  2439          215     /CR
6017  0000  2440          0
6020  0316  2441  MESSN,  316     /N
6021  0316  2442          316     /N
6022  0324  2443          324     /T
6023  0305  2444          305     /E
6024  0322  2445          322     /R
6025  0240  2446          240     /SPACE
6026  0316  2447          316     /N
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6027  0325  2448          325     /U
6030  0315  2449          315     /M
6031  0302  2450          302     /B
6032  0305  2451          305     /E
6033  0322  2452          322     /R
6034  0240  2453          240     /SPACE
6035  0301  2454          301     /A
6036  0307  2455          307     /G
6037  0301  2456          301     /A
6040  0311  2457          311     /I
6041  0316  2459          316     /N
6042  0215  2460          215     /CR
6043  0000  2460          0
6044  0317  2461  MESSO,  317     /O
6045  0316  2462          316     /N
6046  0240  2463          240     /SPACE
6047  0324  2464          324     /T
6050  0310  2465          310     /H
6051  0311  2466          311     /I
6052  0323  2467          323     /S
6053  0240  2468          240     /SPACE
6054  0306  2469          306     /F
6055  0311  2470          311     /I
6056  0314  2471          314     /L
6057  0305  2472          305     /E
6060  0240  2473          240     /SPACE
6061  0000  2474          0
6062  0305  2475  MESS4,  305     /E
6063  0330  2476          330     /X
6064  0303  2477          303     /C
6065  0305  2478          305     /E
6066  0305  2479          305     /E
6067  0304  2480          304     /D
6070  0240  2481          240     /SPACE
6071  0323  2482          323     /S
6072  0303  2483          303     /C
6073  0322  2484          322     /R
6074  0305  2485          305     /E
6075  0305  2486          305     /E
6076  0316  2487          316     /N
6077  0240  2488          240     /SPACE
6100  0317  2489          317     /O
6101  0322  2490          322     /R
6102  0240  2491          240     /SPACE
6103  0306  2492          306     /F
6104  0311  2493          311     /I
6105  0314  2494          314     /L
6106  0305  2495          305     /E
6107  0240  2496          240     /SPACE
6110  0314  2497          314     /L
6111  0311  2498          311     /I
6112  0315  2499          315     /M
6113  0311  2500          311     /I
6114  0324  2501          324     /T
6115  0215  2502          215     /CR
6116  0000  2503          0
6117  0302  2504  MESSQ,  302     /B
6120  0325  2505          325     /U
6121  0306  2506          306     /F
6122  0306  2507          306     /F
6123  0305  2508          305     /E
6124  0322  2509          322     /R
6125  0240  2510          240     /SPACE
6126  0305  2511          305     /E
6127  0322  2512          322     /R
6130  0322  2513          322     /R
6131  0317  2514          317     /O
6132  0322  2515          322     /R
6133  0240  2516          240     /SPACE
6134  0323  2517          323     /S
6135  0324  2518          324     /T
6136  0301  2519          301     /A
6137  0322  2520          322     /R
6140  0324  2521          324     /T
6141  0240  2522          240     /SPACE
6142  0317  2523          317     /O
6143  0326  2524          326     /V
6144  0305  2525          305     /E
6145  0322  2526          322     /R
6146  0215  2527          215     /CR
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6147  0000  2528            0
6150  0240  2529  MESSR.    240     /SPACE
6151  0255  2530            255     /-
6152  0240  2531            240     /SPACE
6153  0000  2532            0
6154  0212  2533  MESSV.    212     /LF
6155  0320  2534            320     /P
6156  0301  2535            301     /A
6157  0307  2536            307     /G
6160  0305  2537            305     /E
6161  0240  2538            240     /SPACE
6162  0306  2539            306     /F
6163  0325  2540            325     /U
6164  0314  2541            314     /L
6165  0314  2542            314     /L
6166  0000  2543            0
6167  0000  2544            $$$$
            2545
```

NO DIAGNOSTICS

APPENDIX 7.7

Appendix 7.7 is divided into three sections.

Section 1: To load High-Speed Reader Tape

Section 2: To load RIM

Section 3: To load BIN

7.7 Section 1 Load High-Speed Tape

F-1: To Load High-Speed Reader Tape

There are three switches on the High-Speed Reader

S1: the on-off switch

S2: back-center-forward moving switch

S3: load-ready switch

Loading Procedure

1. S1 in off position

   S2 in center position

   S3 in load position

2. Place tape in high-speed reader, punched leader should be near user.

3. S1 in on position

   S3 in ready position

4. Load 7777 (actual) in SR

   Press ADDR LOAD switch

5. Make bit Ø of SR zero (push down)

6. Press Run switch

   If tape stalls before entirely fed apply small amount of tention on tape being fed, then let go. If tape doesn't continue go to 1.

7. If tape is loaded properly

   AC=Ø ; L=1 return to user guide

8. If tape didn't load properly the first time go to 1, if it doesn't load properly the second time go to F-2.

If user continues to have trouble loading tape, tape may be bad, user needs new tape.

7.7 Section 2 Load Rim

F-2: To Load RIM

First make sure RIM is not in memory by going to the examine section.

I Load Section

1. Load 7756 (octal) in SR
   Press ADPR LOAD switch
2. Load 6014 in SR
   Press deposit switch (this places 6014 in memory location 7756)
3. Load 6011 in SR
   Press deposit switch (this places 6011 in memory location 7757)
4. Continue pattern found in Rim loader table (high-speed). Now go to F-3.

II Examine Section

1. Load 7756 (octal) in SR
   Press ADDR load switch
   Contents of memory locator 7756 found in AC
2. Press examine switch twice for next location (7757)
3. To get next sequential memory location press examine switch once. Continue until all locations are all right or until a location is bad. If location is bad go to Load Section. If all right go to F-3.

7.7 Section 3 Load BIN

F-3: To Load BIN

To load BIN follow the same instructions as F1 except for a few changes. At introduction 4 user loads 7756 (octal) in SR, skip instruction 5,7, and 8. Assume BIN got loaded properly when tape done and press stop switch. Now go to F-1.