digital

vp15a
graphics software

digital equipment corporation
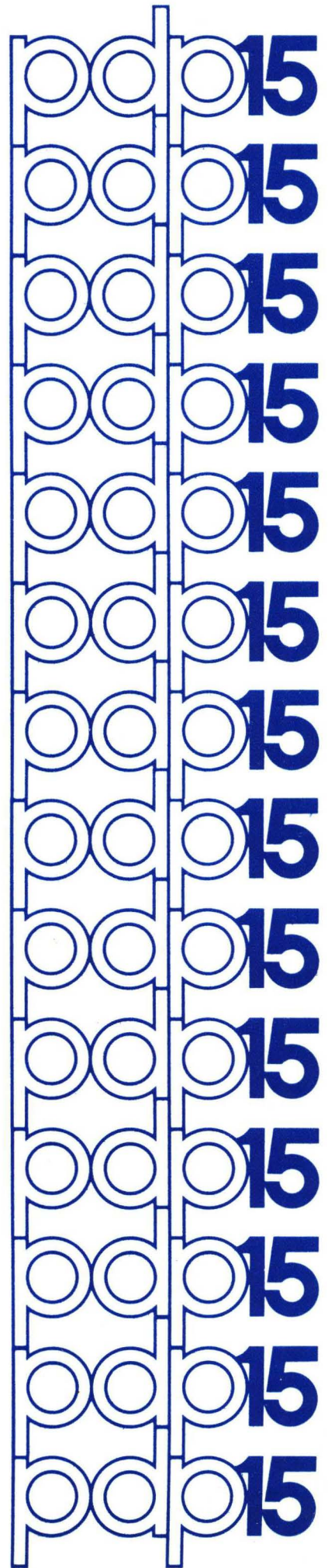
pdp 15
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V P 1 5 A

G R A P H I C S

S O F T W A R E

P D P - 1 5

Instruction times, operating speeds and the
like are included in this manual for
reference only; they are not to be taken as
specifications.

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CHAPTER 1

INTRODUCTION

The VP15A Graphics Software consists of an I/O device handler program, several subprograms, which may be called either by FORTRAN IV, or by MACRO-15 user programs, and an ASCII text line editing program. The purpose of this software is to provide the user with a simplified means for programming the VP15A Storage Tube Display System by eliminating the need for detailed familiarity with the hardware.

1.1 REFERENCE DOCUMENTS

The user should be familiar with the operation of the PDP-15 computer as described in the software manuals listed below.

TITLE	IDENTIFICATION
Advanced Monitor Software System for the PDP-15/20/30/40	DEC-15-MR2A-D
PDP-15/20 User's Guide	DEC-15-MG2B-D
MACRO-15	DEC-15-AMZA-D
PDP-15 Utility Programs Manual	DEC-15-YWZB-D

PDP-15, DOS Software System:
  a) User's Guide
  b) Reference Manual
	DEC-15-MRDA-D

PDP-15 FORTRAN IV:
  a) Language Manual
  b) Operating Environment
	DEC-15-GFWA-D
	DEC-15-GFZA-D

1.2 VP15A SYSTEM PROGRAMS

The VP15A software (refer to Table 1-1) operates in the environment of the PDP-15 Monitor System. Its function is to compile display commands at the discretion of the user, allowing him to define display elements and to direct the linking and displaying of those elements. The device handler (VPA), described in Chapter 2, uses standard System MACRO instructions to plot points or to display ASCII characters. The subprograms, discussed in Chapter 3, further simplify the user's tasks by providing text display and line drawing functions for use with FORTRAN IV or MACRO-15 programs. The VP15A Text Editor (EDITVP) is a version of the System Editor (EDITOR), which permits editing of ASCII text using the VP15A. The operation of

EDITVP is exactly the same as that of the System Editor, described in the Utility Programs Manual, except for the VP15A display functions which are described in Chapter 4.

TABLE 1-1

VP15A System Software

Name	Function	Size (Octal)
VPA	Device Handlers	1175
VPA.S		1211
VECTOR	FORTRAN/ MACRO Callable Subroutines	575
FORT		201
NUVAL		63
EDITVP	System Editor plus display control TV ON/OFF	7041

All of the programs mentioned above are supplied to the user either on paper tape or on DECtape, depending upon his system configuration.

Users having at least a PDP-15/20 Advanced Monitor System will receive the VP15A software on the System Peripheral Tape as relocatable binary files. For additional convenience, all programs, except EDITVP, may be inserted into the System Library or a user library, using the utility program UPDATE.

In DOS systems, EDITVP will be installed as a system program callable directly from the keyboard.

1.3 DISPLAY HARDWARE

The VP15A Storage Tube Display System is an on-line point plotting graphics system designed for use with the PDP-15 computer. The system consists of a VT01 Storage Tube Display Scope which is interfaced to the computer via the VP15 Display Controller.

1.3.1 Display Surface

The system uses a rectangular cathode ray tube (CRT) display device having a useful plotting area 8-1/4 inches high by 6-3/8 inches wide. For programming purposes (at the IOT instruction level[1]), the CRT

---

[1]See Appendix A for a list of VP15A IOT instructions and sample program.

screen may be considered a dot matrix comprised of over a million
(1024 x 1024) illuminable points (dots) spaced at 0.008 inch inter-
vals in the Y axis and at 0.006 intervals in the X axis (see
Figure 1-1). For display purposes, the matrix dots are illuminated
selectively by an electron beam generated within the CRT. The
illumination of a series of adjacent dots in any direction results
in a visually continuous line of uniform resolution. Images are
developed on the screen of the CRT by the controlled generation and
positioning of the CRT electron beam in direct response to programmed
instructions. Images which exceed any edge of the screen will be
"wrapped around" to the opposite side of the screen.
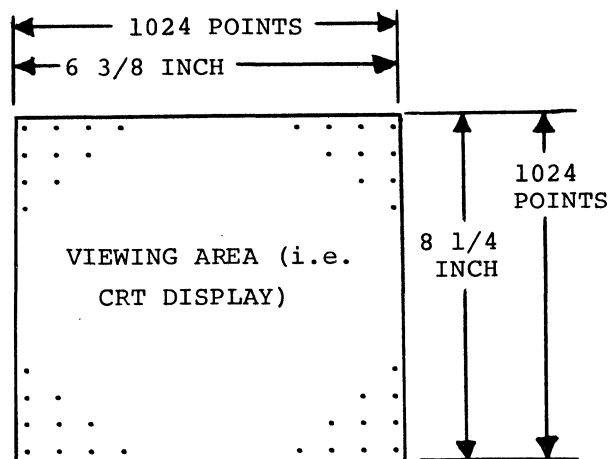
Figure 1-1. VP15A Storage Tube Display Area

1.3.2 Operating Modes

Two program selectable modes of operation are possible with the VP15A.
Store Mode permits plotted points to remain visible on the screen for
periods up to 15 minutes without refreshing (replotting) the displayed
information. Non-store Mode allows a faster point-plotting rate
(82 µsec as opposed to 100 µsec); however, the display must be re-
freshed at least thirty times per second to remain visible.

1.3.3 Controls

The two push-buttons ERASE and VIEW, located on the front panel, operate as follows:

ERASE   Provides a means for manually erasing information on the CRT.

VIEW   As long as information is output to the display every 90 seconds or sooner, the normal brightness is maintained. Beyond this time, however, the brightness is automatically reduced to a lower level to prolong CRT life. Pressing VIEW restores the brightness for a 90 second period.

WARNING

The same information should not remain on the CRT longer than 15 minutes or damage to the phosphor may result. The user should erase the CRT either manually (ERASE button) or under program control (.INIT Macro).

1.4 GENERAL CONSIDERATIONS

1.4.1 Programmable Display Area

As previously discussed, the hardware provides a 1024 x 1024 dot matrix plotting capability. This requires 10 bits of information for each coordinate to fully utilize the available display surface. In the interests of efficient core management, however, the handler and subprograms have been designed to accept 9 bits of information per coordinate, thus permitting one pair of coordinates to be packed in an 18-bit word. This results in a 512 x 512 dot matrix capability on the 8-1/4 x 6-3/8 inch display surface (i.e., the handler skips every second point of the original 1024 x 1024 dot matrix). Since the individual point diameter is approximately 2.0 mils, however, no loss in visual resolution results.

1.4.2 Scale Factor

The Scale Factor is a value which specifies to the handler the amount of space to be left between the intensified dots during an operation which involves the displaying of line or text information. For example, Scale 1 intensifies adjacent points, Scale 2 intensifies every other point, etc. The VP15A handler permits 31_{10} possible Scale

Factor Values (1 through 31_{10}), depending upon the mode of operation.
Figure 1-2 illustrates the manner in whick several common Scale Factor
Values affect the display.

Scale	Point Spacing	Points Displayed
1	● ● ● ● ● ● ● ● ●	All
2	● ○ ● ○ ● ○ ● ○ ●	2nd
3	● ○ ○ ● ○ ○ ● ○ ○	3rd
4	● ○ ○ ○ ● ○ ○ ○ ●	4th

Figure 1-2   Scale Settings

1.4.3 Dimensioning Displays

In programming displays, the dimensions of the graphic elements used
to form the picture are specified in terms of Basic Raster Units and
Display Raster Units. The Basic Raster Unit is defined as the
distance between any two adjacent dot matrix illuminable points. The
physical length of a Basic Raster Unit, using the VP15A software, is
0.016 inch for displacements in the Y axis and 0.012 inch for dis-
placements in the X axis. A Display Raster Unit is defined as the
distance between any two sequential illuminated points of a display
image. The size of a Display Raster Unit is directly dependent upon
the current Scale Factor value. In relation to Display Raster Units,
Scale Factor values are regarded as distance multipliers. For
example, 125 Display Raster Units will occupy more space when displayed
at a Scale Factor of 3 than when displayed at a Scale Factor of 2.
Table 1-2 illustrates the effect of several common Scale Factor values
upon a specified Display Raster Unit value.

Table 1-2

Dimensional Effect of Scale Factor

Scale Factor	Display Raster Units	Displayed Length		
		Basic Raster Units	Inches	
			X Axis	Y Axis
1	125	125	1.50	2.00
2	125	249	2.98	3.98
3	125	373	4.47	5.96
4	125	500	6.00	8.00

Additional calculations may be made for other values using the general formula:

$$B = SD-(S-1)$$

where:

B = Length in Basic Raster Units

S = Scale Factor value

D = Length in Display Raster Units

DEVICE HANDLER CHARACTERISTICS

The VP15A Device Handler (VPA) provides an interface between the user and the
VP15A Display hardware which conforms to the conventions of the Monitor Soft-
ware Systems for the PDP-15. Output functions are initiated by standard user
program commands (System MACROs). All interrupt management for the display
hardware is performed automatically by the handler.

The primary functions of the device handler are to relieve the user from the
necessity of creating his own output subroutines and to centralize all direct
communication between the PDP-15 and the VP15A controller. The handler out-
puts to the display in one of five possible data modes (three ASCII Modes
and two Dump Modes). Display information residing in the calling program's
I/O buffer is output to the display in response to ordinary .WRITE state-
ments[2]. The ASCII Data Modes enable the handler's character generator to
form alphanumeric characters on the face of the display based upon a 5 x 7
spot matrix. The character display rate is approximately 1700 cps. The
handler treats each word of data to be output in one of the Dump Modes as
two 9-bit coordinates which describe a point to be displayed.

The following paragraphs describe the detailed functions of the handler and
System MACROs. Appendix B contains a sample program using System MACROs.

2.1 LEGAL FUNCTIONS

2.1.1 .INIT (Initialize Device)

The .INIT macro causes the display to be initialized. This command must be
given prior to any output command referencing the .DAT slots specified in
the argument.

Form:
      .INIT a,F,R

Variables:

     a   Device Assignment Table (.DAT) Slot number (octal radix)
         assigned to the VP15A device.

     F   File Type: This value must be 1 (1 = output file)

     R   Restart Address: Ignored(but must be present for proper
         evaluation of the I/O macro).

---

[1] A slightly larger version of VPA, named VPA.S, is available. This version
provides all of the features of VPA plus a paging mode of operations. The
paging feature permits the user to display text in 56-line (full screen)
units which are called "pages". Paging is controlled by setting and reset-
ting Accumulator switch 0 (ACS0); each cycle of ACS0 erases the currently
displayed page and displays the next sequential set of 56_8 lines (i.e. page).

[2] Refer to the applicable Monitor System manual for further information
regarding the setup and use of I/O buffers.

Expansion:

```
LOC      CAL+F_{7-8}+a_{9-17}
LOC+1    1
LOC+2    R
LOC+3    N        (Standard buffer size (34_{10}))
```

Operations:

    a.   Return standard I/O buffer size (34_{10}).

    b.   Setup API channel register (54_8).

    c.   Set x and y coordinates to locate the starting point at the top left corner, one line above the first visible line on the screen.

    d.   Set the I/O underway indicator.

    e.   Erase the screen.

    f.   Enable interrupts.

2.1.2 .WRITE

The .WRITE macro is used to perform output from the user program to the display.

Form:

    .WRITE a,M,L,W

Variables:

    a   .DAT Slot number (octal radix)

    M   Data Mode: 2 - IOPS ASCII (scale 2)
                        12 - IOPS ASCII (scale 4)
                         3 - Image ASCII
                         4 - Dump (store mode)
                        14 - Dump (non-store mode)

    L   Line Buffer Address

    W   Word Count: This value (decimal radix) specifies the number of words in the I/O buffer (including header word pair required for ASCII modes) and must be an even number in IOPS modes.

Expansion:

```
LOC      CAL+M_{6-8}+a_{9-17}
LOC+1    10
LOC+2    L
         .DEC
LOC+3    -W
```

Data Mode Functions:

    a.   IOPS ASCII (Data Modes 2 and 12) - These Data Modes allow

5/7 ASCII records (lines) to be displayed from the addressed
I/O buffer. Header word pair and word pair count must be
supplied. Data Mode 2 displays characters using a scale of 2.
Data Mode 12 displays characters using a scale of 4.

b. Image ASCII (Data Mode 3) - This Data Mode allows 7 or 8 bit
ASCII records, stored one character per word in the addressed
I/O buffer, to be displayed. (Header word pair and word
pair count must be supplied.) Characters may be displayed
at any legal scale ($1-31_{10}$). Each data word may be used
to specify a different scale factor (see Figure 2-1).
If bit 0 is set to 1, the handler determines a new scale
factor from bits 1-5. If bit 0 is set to 0, bits 1-5 are
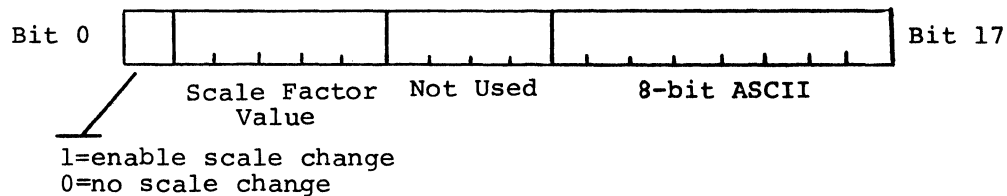ignored and the previous scale factor is used.

Bit 0   Bit 17

Scale Factor   Not Used   8-bit ASCII
Value

1=enable scale change
0=no scale change

Figure 2-1   VPA Image ASCII Word Structure

c. Dump (Data Modes 4 and 14) - These data modes allow one
point for each data word in the addressed I/O buffer to
be displayed (no header word pair required). Each data
word in the buffer is treated as two 9-bit coordinates
which describe the location of a point. Bits 0 through
8 represent the X coordinate value while bits 9 through
17 represent the Y coordinate value. Data Mode 4 selects
Store Mode and Data Mode 14 selects Non-store Mode, which,
during assembly, causes Bit 5 of the first word of the
.WRITE macro expansion to be set either to 0 (Store Mode)
or 1 (Non-store Mode). Points plotted in Store Mode will
remain visible for periods up to 15 minutes. Points
plotted in Non-store Mode, however, must be refreshed at
least 30 times per second to remain visible. This feature
is particularly useful for repeatedly displaying a small
movable figure such as a cursor. Also, a single Non-store
point may be utilized for setting a starting point for
ASCII text or Store Mode plots.

Additional Functions:

a. Set I/O underway indicator.

b. Allow previous output to terminate.

Special Characters:

a. A carriage return terminates an output character string
and automatically initiates a carriage return/line feed
sequence on the display (IOPS ASCII only).

b. An ALT MODE terminates an output character string but does
not change the beam position. Thus the next IOPS ASCII
.WRITE following a line terminated by ALT MODE will start
displaying at the next character position on that same line.

c. A line feed moves the beam down one line but does not

affect the horizontal character position. Line feed is not a legal line terminator.

d. A CTRL TAB moves the beam 8 spaces to the right.

e. Form feed erases the screen and repositions the beam at the beginning of the first line at the top of the screen. It is not a legal terminator and may occur at the beginning of a line.

Printing Rules:

a. When using a Scale Factor of 2 (default assumption in IOPS ASCII), the VP15A displays 72 characters per line and 56 lines per "page".

b. If the screen has been filled with 56 lines, a subsequent IOPS ASCII .WRITE command will cause the display to be erased and the new line to be displayed at the top of the screen.

c. If the beam has been positioned at the bottom line of the screen by a Dump Mode (non-store) .WRITE and two subsequent ASCII .WRITEs are issued, and the second ASCII .WRITE will cause the display to be erased as in "b" above.

d. When using Image ASCII Mode, the user must set the starting point for the first line to be output after device initialization (.INIT) (see 2.1.1c). This may be accomplished either by issuing a Dump Mode .WRITE referencing the desired starting point, or by including a Line Feed as the first character in the line buffer (first word after the header word pair).

2.1.3 .WAIT

The .WAIT macro is used to detect the availability of the user's I/O buffer. If the buffer is available, control is returned to the user immediately after the .WAIT. If it is not available, control returns to the .WAIT macro.

Form:

        .WAIT a

Variable:

        a   .DAT slot number (octal)

Expansion:

        LOC   CAL+a$_{9-17}$
        LOC+1   12

2.1.4 .WAITR

The .WAITR macro is also used to detect the availability of the user's I/O buffer. If the buffer is available, control is returned immediately after the .WAITR macro. If the transfer of data has not been completed, control is given to the instruction at "addr". It is the user's responsibility to return to the .WAITR macro to again test for the availability of the buffer.

Form:

        .WAITR a, addr

Variables:

      a   .DAT slot number (octal)

      addr   Location in the user's program to which control
              is passed if the I/O buffer is not available.

Expansion:

      LOC   CAL+1000+a_{9-17}
      LOC+1 12
      LOC+2 addr

2.1.5 .CLOSE

The .CLOSE macro must be used to indicate the termination of an action
on a file.

Form:

      .CLOSE a

Variable:

      a   .DAT slot number (octal)

Expansion:

      LOC   CAL+a_{9-17}
      LOC+1 6

Function:

      1.   Allows previous output to terminate.

      2.   Disables interrupts.

2.1.6 .FSTAT

The .FSTAT macro tests the status of a file specified by the file
entry block. On completion, the AC will contain zero, and bits 0 - 2
of LOC+2 will also be zero, indicating that the device is non-file-
oriented.

Form:

      .FSTAT, a, D

Variables:

      a   .DAT slot number (octal)

      D   Starting address of a three word block of storage in the
           user's program containing the file name and extension of
           the file name whose presence on the device associated with
           .DAT slot "a" is to be determined.

Expansion:

      LOC   CAL+3000+a_{9-17}
      LOC+1 2
      LOC+2 D

2.2 IGNORED SYSTEM MACROS

The following is a list of system macros which are not meaningful
to the function of the display and are, therefore, ignored:

```
.ENTER
.DLETE
.RENAM
.TRAN
.MTAPE
.CLEAR
```

2.3 ILLEGAL SYSTEM MACROS

The following system macros are contrary to the function of the dis-
play and if executed will result in an IOPS06 Monitor error:

```
.SEEK
.READ
```

CHAPTER 3

VP15A SUBPROGRAM PACKAGE

The VP15A Subprogram Package consists of a number of routines which
may be referenced by FORTRAN IV or MACRO-15 programs through the use
of CALL statements or .GLOBL pseudo-ops, respectively. These routines
allow the user to incorporate point plotting, line drawing, and text
display facilities in his programs with minimum effort. In addition,
standard FORTRAN IV WRITE statements may be used for direct display of
text using the H-Conversion field descriptor. Appendix C provides
several programming examples using these routines.

3.1 INIT SUBROUTINE

The INIT subroutine performs an initializing sequence which sets up
essential parameters and issues an erase command to the display.

Form:

    FORTRAN   CALL INIT

    MACRO-15   .GLOBL INIT
                JMS*   INIT

3.2 VECTOR SUBROUTINE

The VECTOR subroutine displays the points which are required to draw
a line through a specified displacement from the current beam
position.

Form: FORTRAN   CALL VECTOR (ISCALE,IDELTX,IDELTY)

       MACRO-15   .GLOBL   VECTOR
                   JMS*   VECTOR
                   JMP   .+4
                   .DSA   ISCALE
                   .DSA   IDELTX
                   .DSA   IDELTY

Variables:

    Use decimal radix for FORTRAN and octal radix for MACRO-15

    ISCALE   Scale Factor value (1 through 31_{10}). The length of
              the line (Display Raster Units) is multiplied by the
              Scale Factor to establish the spacing between
              displayed points.

    IDELTX   Horizontal (X) coordinate of the beam displacement
              in Display Raster Units (integer).

    IDELTY   Vertical (Y) coordinate of the beam displacement
              in Display Raster Units (integer).

Restrictions:

    a.   IDELTX and IDELTY are signed integers the magnitude of which must not exceed 511.

    b.   Scale Factor values greater than 1 may cause wraparound.

3.3 POINT SUBROUTINE

The POINT subroutine displays the individual points specified by the given absolute coordinates. Either Store Mode or Non-store Mode may be used.

Form:

    FORTRAN   CALL   POINT (INUMBR, IMODE, IA)

```
MACRO-15    .GLOBL   POINT
            JMS*     POINT
            JMP      .+4
            .DSA     INUMBR
            .DSA     IMODE
            .DSA     IA
```

Variables:

    Use decimal radix for FORTRAN and octal radix for MACRO-15.

INUMBR	Number of points to be displayed.
IMODE	0 = Store Mode
	1 = Non-store Mode
IA	First point of INUMBR to be plotted. If INUMBR>1, IA is an array element.

Restrictions:

    a.   The format of IA must be as follows:

        Bits 0 - 8 contain X coordinate

        Bits 9 - 17 contain Y coordinate

    The NUVAL function (see 3.5) simplifies this operation.

    For example:

        IA=NUVAL(0, IX, IY)

        Places the X coordinate value in bits 0 - 8 and the Y coordinate value in bits 9 - 17.

    b.   The X and Y values must be unsigned integers which do not exceed 511.

    c.   If the X value exceeds 255, the NUVAL function (or user's equivalent) must be used to prevent FORTRAN from interpreting bit 0 as a sign bit.

3.4 TEXT SUBROUTINE

The TEXT subroutine displays the identified text string starting at the current beam position.

Form:

```
        FORTRAN     CALL        TEXT (ICHAR, ISCALE, ARRAY)


        MACRO-15    .GLOBL      TEXT
                    JMS*        TEXT
                    JMP         .+4
                    .DSA        ICHAR
                    .DSA        ISCALE
                    .DSA        ARRAY
```

Variables:

Use decimal radix for FORTRAN and octal radix for MACRO-15.

ICHAR	Number of characters to be displayed.
ISCALE	Scale Factor value (1 through 31_{10}, although 5 is a practical maximum).
ARRAY	Name of the array containing the text to be displayed.

Restriction:

ARRAY must contain IOPS ASCII text.

3.5 NUVAL FUNCTION

The function of NUVAL is to protect bit 0 in arrays of coordinates where the X value (bits 0 - 8) is larger than 255. This is necessary because FORTRAN uses bit 0 as a sign bit. In addition, NUVAL provides automatic packing of 9-bit coordinate pairs for use in arrays.

Form:

```
        FORTRAN     I = NUVAL (IVAL, IX, IY)
```

Variables:

Use decimal radix.

IVAL	Last value of the coordinate X-Y
IX	X coordinate (relative)
IY	Y coordinate (relative)

NOTE

When IVAL=0, IX and IY are absolute values.

Example:

```
        IDATA (I+1) = NUVAL (IDATA (I), IX, IY)
```

Adds IX and IY to the current point coordinate value to form a new coordinate value.

3.6 WRITE STATEMENT

The FORTRAN WRITE statement may be used for direct output display of

IOPS ASCII characters using the H-Conversion field descriptor. The
.DAT slot specified in the argument must be assigned to VPA. Refer
to the FORTRAN IV Manual for a complete description of the WRITE
statement.

Example:
```
      WRITE (10,1)
    1 FORMAT (1X, 14HTHIS IS A TEST)
```

Restrictions:

      a.   The execution of the first WRITE to the display causes the
           display to be erased (.INIT) and the beam positioned
           at the beginning of the first line on the screen.

      b.   After the first WRITE has been executed, the text may
           be positioned as desired, using the POINT subroutine.

CHAPTER 4

VP15A TEXT EDITOR

This chapter describes a version of the System Editor which uses the
VP15A Storage Tube Display and the device handler (VPA) to display
the text being created or edited. The VP15A Text Editor (EDITVP) is
a relocatable program (as opposed to a system program) which is
loaded and used as described in the following paragraphs. The
program is supplied to bulk storage users as a relocatable binary
file on their system peripheral tape. Paper tape users receive an
absolute binary paper tape. It is assumed that the user is familiar
with the operation of the System Editor described in the PDP-15
Utility Programs Manual (DEC-15-YWZB-D).

4.1 LOADING PROCEDURE

4.1.1 Bulk Storage Systems

EDITVP uses the same .DAT slot assignments as the System Editor with
the addition of .DAT slot 10 which must be assigned to VPA (Monitor
ASSIGN command). The loading commands to be typed by the user
(underlined) and the responses are as follows:

        PDP-15:

                    $GLOAD (CARRIAGE RETURN)
                    LOADER Vnn
                    >P←EDITVP (ALTMODE)
                    EDITVP xxxxxx
                    VPA   xxxxxx
                    (other device handlers)
                    EDITVP Vnn
                    >

                            NOTE

                    Omission of the "P" in the loader command
                    string suppresses Loader Map output.

        PDP-9:

                    $GLOAD (CARRIAGE RETURN)
                    LOADER Vnn
                    >EDITVP (ALTMODE)
                    EDITVP xxxxxx
                    VPA   xxxxxx
                    (other device handlers)
                    EDITVP Vnn
                    >

4.1.2 Paper Tape Systems

Perform the following steps to load EDITVP using the Basic I/O
Monitor System (PDP-15).

a. Place the EDITVP tape in the paper tape reader.

b. Set the ADDRESS switches to 17720.

c. The tape will advance through the paper tape reader.

d. When loaded, the program will type:

      EDITVP Vnn
      >

4.2 PROGRAM OPERATION

The following paragraphs describe the characteristics and functions which distinguish EDITVP from the System Editor.

4.2.1 TV $\left\{ \begin{array}{l} \text{ON} \\ \text{OFF} \end{array} \right.$

This command enables or disables the display according to the ON/OFF parameter. The command may be given at any time. Typing TV ON implies VERIFY OFF (no Teletype output); however, typing TV OFF does not automatically set VERIFY ON. When EDITVP is first loaded, TV is OFF. If, at the top of a file or BLOCK (i.e., OPEN or TOP was just typed), TV ON is typed, a Locative Request (e.g., NEXT, FIND, LOCATE, etc.) must be given before any lines are displayed. If TV ON is typed after the execution of a Locative Request, a group of lines most recently added to the output file or block will be displayed with the current line (to which modifications apply) appearing as the last line.

4.3 LINE MODIFICATION

If any part of the current line is modified (as with RETYPE, CHANGE, OVERLAY, or DELETE), a dashed line is drawn through the current line and the modified line is displayed below it. When a section of text which has been modified as described above is re-displayed (after a TOP command), the crossed-out line is eliminated.

APPENDIX A

VP15A IOT INSTRUCTIONS AND SAMPLE PROGRAM

INSTRUCTIONS

Mnemonic	Instruction Code	Function
CXB	700502	Clear X coordinate buffer.
CYB	700602	Clear Y coordinate buffer
LXB	700504	Load X coordinate buffer from AC bits 8 - 17.
LYB	700604	Load Y coordinate buffer from AC bits 8 - 17.
EST	700724	Erase storage tube when done.
SDDF	700521	Skip if display done flag is set.
CDDF	700722	Clear display done flag.

STORE MODE ONLY

LXBD	700564	Load the X coordinate buffer and display (stored) the point specified by the X and Y buffers.
LYBD	700664	Load the Y coordinate buffer and display (stored) the point specified by the X and Y buffers.

NON-STORE MODE ONLY

LXDNS	700544	Load the X coordinate buffer and display (non-stored) the point specified by the X and Y buffers.
LYDNS	700644	Load the Y coordinate buffer and display (non-stored) the point specified by the X and Y buffers.

SAMPLE PROGRAM

This program draws a diagonal line and halts. Depressing CONTINUE
erases the display. Depressing CONTINUE again repeats the sequence.

Location	Data	Mnemonic	Comments
00	1		/INCREMENT CONSTANT
01	1777		/FINISH CONSTANT
100	750000	CLA	/CLEAR AC
101	340000	TAD 0	/ADD 1
102	700504	LXB	/LOAD X
103	700664	LYBD	/LOAD Y AND DISPLAY
104	700521	SDDF	/WAIT FOR DISPLAY FLAG
105	600104	JMP .-1	
106	540001	SAD 1	/LINE FINISHED?
107	600111	JMP .+2	/YES HALT
110	600101	JMP 101	/NO, PLOT NEXT POINT
111	740040	HLT	/STOP
112	700724	EST	/ERASE TUBE
113	700521	SDDF	/FINISHED?
114	600113	JMP .-1	/NO
115	740040	HLT	/YES, STOP
116	600100	JMP 100	/DO AGAIN

SAMPLE PROGRAM USING VPA SYSTEM MACROS

```
        .TITLE TEST1
        .IODEV 10
START   .INIT 10,1,DUMMY
        JMS TVIO
        TEXT1
        TEXT2
        -1
        .CLOSE 10
        HLT
        JMP START
TVIO    0
        LAC* TVIO
        SAD (777777
        JMP DONE
        DAC TWRITE+2
TWRITE  .WRITE 10,2,DUMMY,32
        .WAIT 10
        ISZ TVIO
        JMP TVIO+1
DONE    ISZ TVIO
        JMP* TVIO
TEXT1   TEXT2-TEXT1/2*1000
        0
        .ASCII "IOPS ASCII TEST OF THE VP STORAGE SCOPE"<15>
TEXT2   TEXTND-TEXT2/2*1000
        0
        .ASCII "USING SCALE TWO-------------------------"<15>
TEXTND=.
DUMMY   0
        .END START
```

```
C COPYRIGHT DIGITAL EQUIPMENT CORP.
C SJCC DEMO - BOSTON 1969
          DIMENSION IDATA(250),T(9),S(1),R(1)
          DATA T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9)/
          15HTHIS ,5HPROGR,5HAM PL,5HOTS  ,5HY=A+(,5HEXP(-,5HBX))(,
          25HSIN(C,5HX))  /
          DATA S(1),R(1)/1HX,1HY/
          CALL INIT
          KA=NUVAL(0,15,470)
          CALL POINT(1,1,KA)
          CALL TEXT(45,3,T)
20        WRITE (3,4)
4         FORMAT (36H INPUT FOR A,B,C, IN FORMAT NN NN NN)
31        READ (4,5)IA,IB,IC
5         FORMAT (3(I2,1X))
          A=IA
          B=IB
          C=IC
          DN=50
          CNT=0
          IF (A-1.) 20,22,22
22        IF (A-3.) 24,24,20
24        IF (B) 20,26,26
26        IF (C) 20,28,28
28        IT=DN*5.
          DO 30 I=1,IT
          CNT=CNT+1.
          X=CNT/DN
          G=-B*X
          D=C*X
          IX=X*80.+60.
          IY=(A+EXP (G)*SIN(D))*80.+48.
          IDATA(I)=NUVAL(0,IX,IY)
30        CONTINUE
          JA=NUVAL(0,460,48)
          CALL POINT(1,0,JA)
          CALL VECTOR (1,-400,0)
          CALL VECTOR (1,0,400)
          KA=NUVAL(0,40,440)
          CALL POINT(1,1,KA)
          CALL TEXT(1,3,R)
          KA=NUVAL(0,440,30)
          CALL POINT(1,1,KA)
          CALL TEXT(1,3,S)
          CALL POINT(250,0,IDATA(1))
          GO TO 20
          STOP
          END
```

(continued)

```
C--PROGRAM BOX
        IA=NJVAL (0,100,100)
        CALL INIT
C--DRAW A SQUARE BOX STARTING AT X=100, Y=100
20      CALL POINT (1,0,IA)
        CALL VECTOR (1,100,0)
        CALL VECTOR (1,0,-100)
        CALL VECTOR (1,-100,0)
        CALL VECTOR (1,0,100)
        GO TO 20
        STOP
        END
```

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