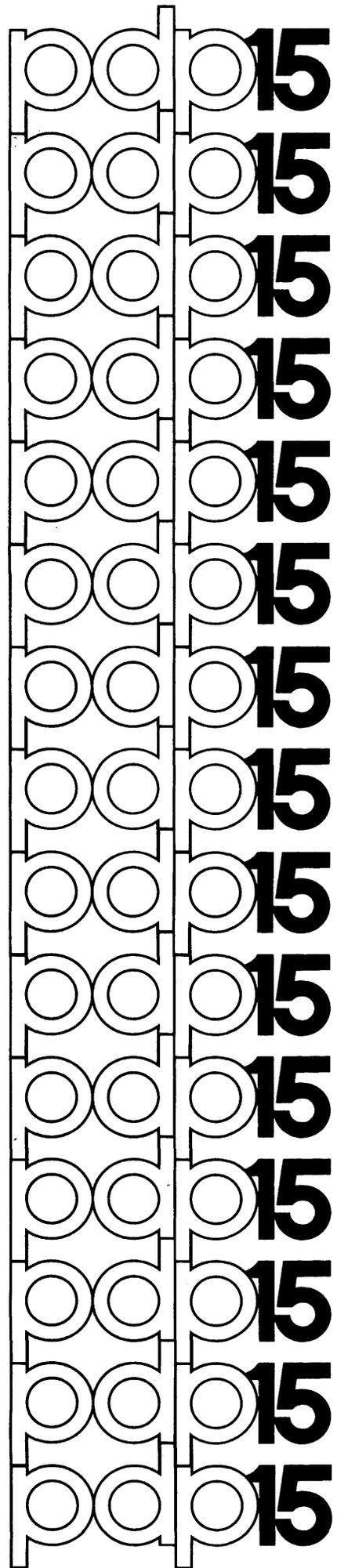digital

graphic 15

programming manual

digital equipment corporation

VT-15

GRAPHICS SOFTWARE

SYSTEM

PROGRAMMING MANUAL

PREFACE

This manual describes the software provided for the VT15 Graphics
Display Processor and its optional:

a) VLØ4 Light Pen,
b) LK35 Keyboard, and,
c) VWØ1BP Writing Tablet and Control.

The information provided is applicable for users employing either the
Disk Operating System (DOS) or Advanced Monitor Software System (ADSS).

It was assumed in the preparation of this manual that the user was
familiar with the contents of the software manual describing the
operating system (DOS or ADSS) being used. A list of applicable manuals
is given in Section 1.

ⅩⅩⅩⅩⅩⅩⅩ

REFERENCE MANUALS

The user should be familiar with the following DEC documents.

PDP-15/20/30/40 ADVANCED Monitor Software System - ADVANCED Monitor
System description. (DEC-15-MRZA-D)

UTILITY PROGRAMS MANUAL - Utility programs common to PDP-15 Monitor
Systems. (DEC-15-YWZA-D)

MACRO-15 - MACRO assembly language for the PDP-15. (DEC-15-AMZA-D)

FORTRAN IV - PDP-15 version of the FORTRAN IV compiler language.
(DEC-15-KFZA-D)

GRAPHIC-15 REFERENCE MANUAL - This Reference Manual describes the
basic Graphic 15 processor and its interfacing arrangement with the
PDP-15 computer. The information in this manual is intended to provide
the Graphic 15 user with the knowledge necessary for programming at
the machine-language level, to familiarize him with the operation of
the basic Graphic 15 system, and to provide a brief description of
the programming philosophy and principles of operation. (DEC-15-GWSA-D)

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CHAPTER 1

INTRODUCTION

This manual presents a detailed description of the PDP-15/VT15 Graphics Sub-program Package and is primarily concerned with those display subroutines and calling user programs used to exhibit information and communicate with the computer. The Graphics subprograms generate display commands that allow the user to define display elements and direct the linking, displaying, and deleting of those elements. Their primary purpose is to provide a simplified means of using the VT15 Graphic Display device without requiring detailed familiarity with the hardware.

In this manual, Graphic Routines are described in detail as follows:

> Chapter 2.   Subpicture Routines
> 3.   Main Display File Routines
> 4.   Input Routines
> 5.   Relocating Routines
> 6.   System I/O Device Handler
> 7.   LK35 Keyboard Handler (LKA)
> 8.   VW01 Writing Tablet Handler (VWA)
> 9.   Text Display/Edit Functions

Subprograms which consist of Graphic Routines mentioned above are called by user programs written in MACRO or FORTRAN IV language. The depth of coverage of these routines is intended to provide a very basic understanding of the use of the VT15 Graphic Display system. Much useful information may be found in appendices following Chapter 6.

The PDP-15 is designed with an autonomous systems structure and the VT15 follows this same philosophy; it operates asynchronously from the basic processor. Features include a cycle time of 750 nanoseconds, a character generator (with 64 printing characters and 4 control characters), a hardware program counter, a fast vector capability (1/4 inch in 1 usec), and a wide range of hardware options. The VT15 Graphics Software is designed for a minimum hardware configuration, as follows:

> PDP-15 with KSR-33
> 8K Core Memory (12K required for Text Editor)
> Paper Tape High-Speed Reader/Punch
> VT15 Display Processor
> VT04 Display Console
> Two DECtape Units

The Graphics Software consists of a group of routines that can be called by user programs. Calls to these routines build display files in a portion of PDP-15 memory that has been allocated by the calling program for such a purpose. The display files contain instructions and data upon which the VT15 Processor operates and to which its digital control and analog outputting circuits respond. The VT15 Processor has a set of 12 basic machine-language instructions which give it excellent versatility in the display of points, basic vectors, graphic plots, and ASCII characters. The commands contained in a main display file link together individual subpicture files causing the desired image to be displayed. Calls to other routines control the flow of the program upon the occurrence of light pen or push button interrupt. In this way, program paths can be enabled to modify the sequence of display commands and therefore modify the picture.

The VT15 Graphics Software is designed to run in Bank/Page Mode and to be used with either FORTRAN IV or MACRO-15 programs. FORTRAN IV programs devised by the user will consist of standard FORTRAN IV statements and calls to routines within the VT15 Graphics package. Other than system software normally used for compilations, assemblies, loading, etc., the VT15 Graphics software does not require use of any other programs.

The following manuals contain information useful in understanding and utilizing the contents of this manual.

DOS Users

    a) DOS Users Manual   DEC-15-MRDA-D

ADSS Users

    a. ADVANCED Monitor Software System for
        PDP-15/20/30/40 Systems   DEC-15-MRZB-D

Common Manuals

    a) MACRO15, Macro-Assembler Program   DEC-15-AMZC-D
    b) FORTRAN IV Programmer Reference Manual
        (8K Systems)   DEC-15-KFZB-D
    c) Utility Program Manuals   DEC-15-YWZB-D
    d) FORTRAN IV Language Manual
        (16K Systems)   DEC-15-GFWA-D
    e) FORTRAN IV Operating Environment
        (16K Systems)

Hardware Manuals

    a) Graphic-15 Reference Manual   DEC-15-GWSA-D
    b) VW01 Writing Tablet, Vol. 1   DEC-00-H4AA-D

The GRAPHIC-15 Reference Manual is of particular importance to the
VT15 programmer. This manual describes the basic Graphic 15 processor
and its interfacing arrangement with the PDP-15 computer. The informa-
tion in this manual provides the user with the data needed for machine
level programming and familiarizes the user with the operation of the
Graphic System.

CHAPTER 2

SUBPICTURE ROUTINES

These routines allow the user to incorporate point plotting, line drawing, and text display in his programs with minimum effort. Calls to these routines together with standard FORTRAN or MACRO statements build self-contained sub-picture display files with executable display instructions. Each subpicture file contains all the display instructions needed to generate a specific image on the VTØ4 Display console. These files are accessed by a Main Display File (described in Chapter 3) in any order or sequence during the execution of the display program. Most Subpicture Routines will normally be called prior to initiating execution of a Main Display File, thus building a library of accessible graphics (i.e., complete or partial pictorial images) from which complex images may be formed. The subpicture display routines and their functions are:

> LINE - Draws a line (intensified) or moves the beam (not intensified) from current position. (Provides for using random vector option, if available.)

> TEXT - Displays strings of 5/7 ASCII text previously defined by the user in dimensioned arrays.

> COPY - Links subpicture files (similar to subroutining) to form a composite display image. Provides for using hardware SAVE/RESTORE feature, if desired.

> PRAMTR - Sets scale, intensity, light pen sensitivity, blink, etc., for this subpicture, or some portion thereof.

> GRAPH - Displays specified data points in graph form.

> BLANK - Inhibits display of any copy of this subpicture.

> UNBLNK - Reverses the action of the BLANK subroutines.

All display file storage is supplied by the FORTRAN user in the form of dimen-sioned integer arrays; MACRO-15 users must also allocate display file storage in some appropriate manner. To facilitate storage management, the first location of each file contains the length of the file. Limited reuse of storage is provided for in the Main Display File routines.

The first location of a subpicture file (PNAME) contains its current length - this value must be set to zero when the first reference to the subpicture display file is made. After the first reference, the contents of PNAME is set equal to the length of the subpicture file; this value is updated by any subsequent calls to the subpicture routines. (See figure 2-1.)

LOCATION	CONTENTS
PNAME	(6)
+1	return*
+2	vector command
+3	vector command
+4	vector command
+5	vector command
+6	DJMP* PNAME+1

*Return address stored by any dis-
play JMS (DJMS) to this subpicture.

Figure 2-1. Subpicture File Containing Four Vector Commands

Since display files are generated and stored in arrays dimensioned by the user,
they are fully accessible to the user and can be written out or read in using
FORTRAN unformatted I/O statements.

Storage overhead for each subpicture display file is three words; the first word
contains the file length, the second is used for a return address, and the third
(last in file) contains the VT15 display command DJMP* PNAME+1.

The procedure for generating a subpicture file such as that illustrated in
Figure 2-1 requires some further explanation. The four calls to subroutine LINE,
shown below, will result in such a file. This subpicture file will simply draw
a square when accessed by the Main Display File or another subpicture file.

```
        DIMENSION IPNAME(1Ø)
        IPNAME(1)=Ø
          .
          .
          .
        CALL LINE (1ØØ,Ø,1,IPNAME(1))
        CALL LINE (Ø,1ØØ,1)
        CALL LINE (-1ØØ,Ø,1)
        CALL LINE (Ø,-1ØØ,1)
          .
          .
          .
```

Note in the above example that storage allocation for the subpicture file was
provided by the DIMENSION statement. Also, the first location, IPNAME(1), was
set to zero before the first reference to it, thus indicating a new file. The
identity of a subpicture file is the address of its first location (PNAME)and is
given or implied, as an argument in all calls to subpicture routines. Each sub-
picture file is left in displayable form so that it can be manipulated dynamically

2-2

while being displayed.

Limited reuse of storage is provided for in the main display file routines RSETPT, REPLOT, and DELETE which are explained in Chapter 3. In this chapter, the number of locations required for display instructions generated by each subroutine call is indicated in each of the subroutine descriptions. Naturally, the total number of locations that can be allocated for display files is limited by the amount of core memory available.

2.1 GENERAL RESTRICTIONS

The following general restrictions apply to all subpicture routines except BLANK and UNBLNK.

    a. All arguments (constants or variables) must be of integer form.
    b. The variable PNAME must be set equal to zero before the first call referencing it.
    c. Sufficient space must follow PNAME to contain the subpicture file.

2.2 LINE SUBROUTINE

The LINE subroutine adds to the specified subpicture file the commands necessary to draw a line (beam intensified) or move the beam (not intensified) through a specified displacement from the current beam position.

The call statement has the form:

        CALL LINE (DELTAX,DELTAY,INT[,PNAME])

where the enclosing brackets [ ] indicate an optional argument.

DELTAX represents the horizontal component of beam displacement in raster units and DELTAY represents the vertical component. The integer variable INT indicates whether the line is to be intensified (INT=1, the line will be visible; INT=$\emptyset$ the line will not be visible). The variable PNAME represents the first location of this subpicture display file and is the name by which the subpicture is referred to in later manipulation. For example, if a subpicture is to start in the dimensioned array ILEMNT, the form is:

        CALL LINE(DELTAX,DELTAY,INT,ILEMNT(1))

Subroutine LINE adds one command to the display file if DELTAX and DELTAY define one of the eight basic directions:

        VN!INCR   (where VN is vector direction n, and INCR is units)
                    (the exclamation operator indicates an inclusive OR function)

If DELTAX and DELTAY do not define one of the eight basic directions, LINE tests for availability of the random vector option, and, if available, adds two commands to the display file:

SVX!DELTAX (stroke vector, x displacement)

SVY!DELTAY (stroke vector, y displacement)

If not one of the eight basic directions, and if the random vector option is not available, LINE approximates the required line with a series of basic vectors. The number of commands added to the display file is added to the contents of location PNAME.

In addition to the general restrictions (paragraph 2.1) outlined previously for subpicture routines, there is another restriction that should be considered when using subroutine LINE: DELTAX and DELTAY should always be signed integers with magnitudes not exceeding 1Ø23. The following two statements illustrate the use of the LINE subroutine.

CALL LINE (Ø,6Ø,1,ILINE(1))

This statement generates a display instruction to draw a vertical line 6Ø raster units long. The display instruction (a basic vector) is stored at the end of subpicture file ILINE.
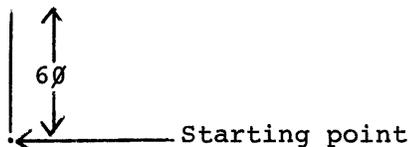
The following statement illustrates use of the LINE routine to draw a sloped line:

CALL LINE(IDX,IDY,1,ILINE(1))

where IDX=-3ØØ and IDY=2ØØ, we obtain the following:
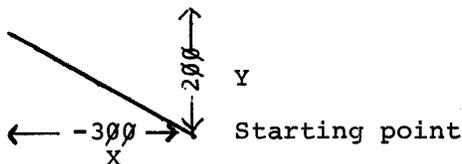
Note that the random vector option is assumed to be available (otherwise, such a line would be approximated).

2-4

2.3 TEXT SUBROUTINE

The TEXT subroutine adds to the specified subpicture file commands necessary to display an identified text string - starting at the current beam position. The standard text font is drawn on a 1∅ by 14 dot matrix. Each character causes an increment of 14 raster units to the X position of the beam. The form is:

        CALL TEXT(STR,N[,PNAME])

The input variable STR identifies the dimensioned real array that contains the string of characters to be displayed in IOPS ASCII (Hollerith) form - five 7-bit characters packed in two words. The variable, N, is an integer variable that indicates the number of characters to be displayed in the referenced array. If N≠∅, an ALT MODE will be inserted after the nth character to allow escape from the character mode. If N=∅, ALT MODE will not be inserted in the TEXT array. The variable PNAME is the first location of this subpicture file, as in the call to LINE.

The TEXT subroutine adds three locations to the assembled display file; three is added to the contents of PNAME.

        CHARS*   .+2

        DJMP   .+2

        (FULL 15-BIT ADDRESS)

<div align="center">NOTE</div>

> If 5/7 ASCII data is loaded into the array from an external source (as opposed to being defined in a FORTRAN DATA statement), it may contain certain non-printing characters (such as carriage return, line feed, etc.) that must be allowed for when specifying the argument N.

In addition to the general restrictions outlined in paragraph 2.1, the array referred to by TEXT must be of sufficient size to accommodate the escape character that will be inserted by TEXT. Also, to ensure that the display processor is conditioned to escape on ALT MODE, it is necessary to start up an empty Main File with a call to DINIT (described in Chapter 3). When this is done, a display parameter word is inserted in the new Main File to enable escape on ALT MODE only. (The alternative is to escape on carriage return or ALT MODE, whichever comes first; however, this option is not selectable using Main File or subpicture routines.)

The following example illustrates the manner in which TEXT to be displayed is set up and called:

Setup to display "15 ASSABET RD." is

```
DIMENSION ADDR(4)
DATA ADDR(1)/5H15 AS/,ADDR(2)/5HSABET/,ADDR(3)/4H RD./
```

The call statement to display the TEXT from subpicture IPIC is:

```
CALL TEXT(ADDR(1),14,IPIC(1))
```

2.4 COPY SUBROUTINE

The COPY subroutine enables two or more subpicture display files to be linked together to generate a composite display image. This is accomplished by a display subroutining technique. COPY adds to one subpicture display file the commands necessary to call a second subpicture. The second subpicture begins at the last beam position specified by the first subpicture. The form is:

```
CALL COPY(RST,PNAME1[,PNAME])
```

The variable, RST, indicates whether to save and restore display parameters[1] when copying the specified subpicture. RST may be set to 0 or 1; 0 indicates no SAVE/RESTORE option and 1 indicates SAVE/RESTORE option is to be used. The variable PNAME1 is the first location of the subpicture to be copied. PNAME is the first location of the subpicture file to which display instructions generated by this call are to be added.

The COPY subroutine adds three locations to the display file when the SAVE/RESTORE option is not specified. These three locations are as follows:

```
DJMS*      .+2

DJMP       .+2

(ADDRESS of PNAME1+1)
```

However, when SAVE/RESTORE is specified, COPY adds six locations to the display file as follows:

```
SAVE       .+4
DJMS*      .+2
DJMP       .+3
(ADDRESS of PNAME1+1)
(STATUS)
RSTR       .-1
```

---

[1]These parameters include (but are not limited to) scale, intensity, blink, offset, and rotate, which can be set by calling subroutine PRAMTR (see paragraph 2.5.1) For a detailed description of parameters effected by the SAVE/RSTR instruction, refer to GRAPHIC-15 Reference Manual (DEC-15-GWSA-D).

where the SAVE instruction stores the effected display parameter settings in the STATUS word before executing the normal sequence of COPY commands. Upon returning from the subpicture, these parameters are restored to their original settings by the RSTR instruction. The contents of PNAME is increased by three or six, as required.

In addition to the general restrictions outlined in paragraph 2.1, PNAME 1 need not be defined when COPY is called but must be a defined subpicture when PNAME is displayed. The following statement:

CALL COPY($\emptyset$,WINDOW(1),HOUSE(1))

adds a call to the window subpicture file to the file identified as HOUSE. Note that the SAVE/RESTORE option was not specified.

2.5 PRAMTR SUBROUTINE

The PRAMTR subroutine allows the user to add to the specified subpicture file the commands necessary to set up the following display features. (See DEC, Graphic-15 Reference Manual, PDP-15, for more detailed information.)

Scale setting - Setting the scale has a different effect, depending on where it is used. If used when plotting characters or vectors, it specifies the number of times ($\emptyset$ - 15) that the unscaled vector (or stroke of a character) is to be repeated. If used in conjunction with the graph subroutine, the scale specifies the coordinate distance between given points.

Intensity Setting - The brightness of the display can be controlled in eight incremental steps between maximum dark and maximum light by specifying an integer variable or constant to represent the wanted brightness, between $\emptyset$ and 7.

Light Pen Sensitivity - The ability of the light pen to sense a "hit" can be controlled by means of this feature.

Blink Setting - Use of this feature enables blinking of some portion or all of the displayed image. This feature causes characters as well as vectors to blink at a rate of approximately four times a second.

Dash Setting - This feature enables drawing of dashed lines and can be set from $\emptyset$ to 3 as follows:

Setting	Illuminated Raster Points
$\emptyset$	ALL ON
1	3 ON 1 OFF
2	4 ON 2 OFF
3	4 ON 4 OFF

Offset Setting - Since the VT15 display processor defines a square drawing area, a standard rectangular tube would normally have some unused area. The VT15 makes

use of this area by means of the offset feature. When the offset is enabled, the absolute origin is relocated to the lower right-hand corner of the normal display area. This small area (approximately 9-1/2 x 1-1/2 in.) can be used for light buttons, special figures, etc., without disturbing the normal graphics area.

Rotate Setting - This feature allows the displayed image to be rotated 9Ø degrees in the counterclockwise direction or returned to its normal orientation if it is currently rotated. This could be useful for labeling graphs on the vertical axis or for any of a number of other applications.

Name Register Setting - The ability to set the Name Register is required to identify the location of light pen hits when using subroutine LTORPB. However, it is a feature which, when used at the programmer's discretion, can be helpful in many other applications. Once set, it retains its value until set to a different value.

Sync Feature - This feature can be used to avoid phospher burnout when displaying files that require 32 milliseconds or less for execution. The display will halt and remain stopped until a sync pulse, derived from the local power main, enables execution to resume. This essentially locks execution of the display file to the power line frequency, which eliminates a visible swimming effect on the CRT.

By using the PRAMTR call statement, more than one feature (each with its corresponding settings) may be specified, using the following technique:

1. Add together the integer code numbers that identify the selected features and assign this value to the variable FEATR. For example: For scale (1) and Intensity (2), FEATR will have the value 3.

2. List the desired settings, as arguments, in ascending order according to the values of the numeric assigned to their corresponding features (the argument list 3,2,6 would specify a value of 2 for scale (feature 1) and of 6 for Intensity (feature 2)). The general call statement form is:

    (a) One feature - CALL PRAMTR(FEATR,VALUE[,PNAME])
    (b) More than one feature and setting -
         CALL PRAMTR(FEATR(S),VALUE1,VALUE2...[,PNAME])

The variable FEATR represents the display feature being set. The variable VALUE is the value to which FEATR is set. (See Table 2.1 for FEATR and VALUE settings.) PNAME is the first location of this subpicture file.

The PRAMTR subroutine adds from one to four commands to the display file, depend-

ing on the type of argument list used.[1] The number of commands added to the file is added to the contents of location PNAME.

Table 2.1 Display Parameter Settings

Parameter	Integer Code for FEATR	Possible Settings
Scale	1	0 (Low) to 15 (High)
Intensity	2	0 (Low) to 7 (High)
Light Pen	4	0 (OFF) and 1 (ON)
Blink	8	0 (OFF) and 1 (ON)
Dash	16	0 (Solid) to 3 (Finest dash)
Offset	32	0 (OFF) and 1 (ON)
Rotate	64	1 (CCW 90°) and 0 (Return CW 90°)
Name Reg.	128	0 (Lowest) to 127 (Highest)
Sync	256	0 (OFF) and 1 (ON)

Note: The abbreviation CCW = counterclockwise
                          CW = clockwise

In addition to the general restrictions, the PRAMTR subroutine must be used with care, since the setting given is in effect until explicitly changed. Thus, if the blink is turned on at the beginning of a subpicture, it must be turned off at the end, otherwise the entire display image will blink (unless, of course, the SAVE/RESTORE option is used in calls to this subpicture).

The following single feature statement:

        CALL PRAMTR (2,7,HOUSE(1))

specifies an intensity level of 7, for the subpicture display file starting at the first location of array HOUSE. The following multiple-feature statement:

        CALL PRAMTR (SCALE+INT+LPEN,0,4,1,IN(1))

specifies the values 0 and 4 for scale and intensity, and turns on the light pen sensitivity. Appropriate display commands are added to the file that begins with

---

[1]Scale and intensity settings, when combined, generate only one display command. Light pen, blink, offset, and rotate, when combined, generate only one display command. Sync and dash features, when combined, generate only one display command. Setting the Name Register generates one command.

the first location of array IN.

2.6 GRAPH SUBROUTINE

The GRAPH subroutine adds to the specified subpicture file the commands necessary to display in graph form the identified set of data points. One coordinate is sequentially set to the value of each data point, the other coordinate is then automatically incremented (in the current scale), leaving the beam positioned one increment past the end of the graph. Note that axes and labeling must be provided separately. The call statement form is:

        CALL GRAPH (DTA,N,A[,PNAME])

DTA represents an INTEGER array that contains the set of data points, one per word, in the range 0 to 1023. The variable N indicates the number of data points to be displayed. The variable A indicates which axis to increment, where A is set to either 0 or 1. (A=0 specifies incrementing the X axis and setting Y to data values; A=1 specifies incrementing the Y axis and setting X to data values.) The variable PNAME specifies the first location of the subpicture file to which the generated display commands are to be added.

The GRAPH subroutine adds to the subpicture file a number of graph-plot commands equal to the number of entries in the data set, as shown below. The number of commands added to the file is added to the contents of PNAME.

        GX!VAL1   GY!VAL1
        GX!VAL2   GY!VAL2
          .   .
          .   .
          .   or   .
        GX!VALn   GY!VALn

One way to summarize the discussion up to this point is to review a program, (Figure 2-2 Sine Wave Program Example) which illustrates the use of GRAPH and other subroutines.

2.7 BLANK SUBROUTINE

The BLANK subroutine is used to prevent the displaying of any copy of the specified subpicture. However, the display file length is not changed. The form is:

        CALL BLANK (PNAME)

where the variable PNAME is the subpicture to be blanked.

```
C
C   ARRAY INITALIZATION
        INTEGER SINWV(300),Y(200)
        DIMENSION TITL(10),MAINFL(20)
        DATA TITL(1),TITL(2),TITL(3),TITL(4)/5HTHIS ,
       1 5HIS A ,5HSINE ,4HWAVE/
C
C   SET UP INTEGER ARRAY OF VALUES TO BE PLOTTED.
C
10      X=0
        DO 20 I=1,200
        Y(I)=IFIX(SIN(X)*256.)+512
        X= X+.0628
20      CONTINUE
C
C   SET UP SUBPICTURE TO PLOT THOSE VALUES.
C
        SINWV(1)=0
        CALL PRAMTR(3,0,7,SINWV(1))
        CALL LINE(1000,0,1)
        CALL LINE(-1000,0,0)
        CALL LINE (0,250,0)
        CALL LINE(0,-500,1)
        CALL LINE (0,250,0)
        CALL PRAMTR (1,4)
        CALL GRAPH (Y(1),100,0)
        CALL GRAPH (Y(101),100,0,SINWV(1))
C
C   SET UP MAIN FILE TO DISPLAY THE GRAPH.
C   (MAIN FILE CALLS BELOW, DESCRIBED IN CHPT. 3)
C
        MAINFL(1)=0
        CALL DINIT (MAINFL(1))
        CALL SETPT (10,512)
        CALL PLOT (0,0,SINWV(1))
        CALL SETPT (100,100)
        CALL PLOT (2,1,1)
        CALL PLOT (3,TITL(1),19)
        CALL DCLOSE
        STOP
        END
```

Figure 2-2.   Sine Wave Program Example

PNAME	LENGTH
+1	Return Add.
+2	First Display Inst.
.	.
.	.
.	.
DJMP*	PNAME+1

Figure 2-4. Operation of BLANK/UNBLANK Subroutine

In figure 2-4 the command in location PNAME+2 (the first executable command in the subpicture file) is interchanged with the DJMP* PNAME+1 located at the end of the subpicture file. PNAME must be a defined subpicture file (BLANK has no meaning as the first call referring to PNAME). The subpicture files should not be modified while BLANKed. The following example would prevent the subpicture display file starting at the first location of array IPIC from being displayed.

        CALL BLANK (IPIC(1))

2.8 UNBLNK SUBROUTINE

The UNBLNK subroutine reverses the action of the BLANK subroutine, allowing a previously BLANKed subpicture to be displayed. The form is,

        CALL UNBLNK (PNAME)

where the variable PNAME is the subpicture to be UNBLNKed. The command in the last location of the subpicture file (placed there by a call to BLANK) is interchanged with the DJMP* in location PNAME+2. If the referenced subpicture is not already BLANKed, UNBLNK will return without changing the file.

The following statement will enable the previously BLANKed subpicture IPIC to be displayed.

        CALL UNBLNK (IPIC(1))

2.9 CIRCLE SUBROUTINE

The CIRCLE subroutine enables the user to construct approximations of arcs and circles as subpictures by specifying the length of a series of chords and the start and stop points of the arc or circle to be constructed.

The form of the FORTRAN call for the CIRCLE subroutine is:

        CALL CIRCLE (R,THETA,GAMMA,DEG,PNAME)

where the call variables are defined as:

1) R, the radius, in raster units, of the circle to be constructed.

2) THETA, the start of a constructed arc expressed in degrees from the X-Axis, rotating counterclockwise about the center of the screen.

3) GAMMA, the end point of a constructed arc expressed in degrees rotating counterclockwise about the center of the screen.

4) DEG, the chord length expressed in degrees.

5) PNAME, the name of the location at which the CIRCLE subroutine will start the new subpicture array.

                              NOTES

        1) Circles are only produced if
            GAMMA - THETA - 360°

        2) The array at PNAME is as long as there are chords
            in the constructed arc or circle.

The MACRO form of the CIRCLE subroutine using the same variable representations as above is:

```
        .GLOBL          CIRCLE
        JMS             CIRCLE
        JMP             .+7
        .DSA            R
        .DSA            THETA
        .DSA            GAMMA
        .DSA            DEG
        .DSA            PNAME
```

                              NOTE
            CIRCLE Subroutines require the arbitrary vector.

2.10 ROTATE SUBROUTINE

The ROTATE subroutine enables the user to plot three-dimensional figures from basic + wt.-dimensioned figures. Displayed items may be rotated about a specified axis through a designated angle of rotation. This subroutine achieves the rotation effect by modifying the users array.

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A single call to the ROTATE subroutine can effect a rotation about one or more of the X, Y, or Z-axes. The rotation of a display about any other axis requires more than one call to be made to the subroutine.

The ROTATE subroutine utilizes the same left-handed system that is used throughout the graphics software, that is:

a)   X, horizontal movement, positive to the right;
b)   Y, vertical movement, positive is up;
c)   Z, axis into the display screen (positive movement)

The setpoint defines the origin of the axis of rotation.

CAUTION

The ROTATE subroutine should be used carefully, particularly when rotating large figures, or off-center origins.

If, during rotation, the end-point of a line of the rotating figure passes off screen, part or all of the figure may be lost. It is good practice in rotating large figures to save the original buffer before calling ROTATE.

The following restrictions must be observed:

1)   The values in the user's array must be in floating point format.
2)   The user must calculate the sine and cosine of the angle of rotation before he calls ROTATE.
3)   The user must change integers into floating point numbers, and make the correct calls for displaying the rotated figure.

The FORTRAN and MACRO formats for calls to ROTATE are:

FORTRAN:
    CALL ROTATE(ISTR,IA,IB,IC,X, Y, Z, SINA, CSA)

MACRO:
```
        .GLOBL          ROTATE
        JMS             ROTATE
        JMP             .+12
        .DSA            ISTR
        .DSA            IA
        .DSA            IB
        .DSA            IC
        .DSA            X
        .DSA            Y
        .DSA            Z
        .DSA            SINA
        .DSA            CSA
```

where the input variables are defined as:

1. ISTR, the array length.

2. IA, specifies whether rotation about the Z axis is desired
   If IA=1, rotation will occur about the Z axis.
   If IA=∅, there will be no rotation about the X-axis

3. IB, specifies whether rotation about the Y-axis is desired.
   IB=1 indicates rotation is desired, as with IA.

4. IC, specifies whether rotation about the X-axis is desired.
   IC=1 indicates rotation is desired, as with IA.

5. X, the name of the X array.
6. Y, the name of the Y array
7. Z, the name of the Z array.
8. SINA, the sine of the angle of rotation.
9. CSA, the cosine of the angle of rotation.

CHAPTER 3

MAIN DISPLAY FILE ROUTINES

Calls to Main File routines together with standard FORTRAN IV statements will,
when compiled, build a "Main Display File" in a portion of the PDP-15 memory
that has been allocated by the calling program. The commands contained in
this file link together individual subpicture display files causing the desired
image to be displayed.

These routines are used to generate a Main Display File to which the display
processor is directed when initiating display, and which is presumed to be calling
upon the subpicture files generated with the routines described in Chapter 2.
As is the case with subpicture files, storage used for the main file is supplied
by the calling FORTRAN program as a dimensioned array. This array is identified
by only one call to the initializing routine (DINIT) and is implicit in all other
calls (which assume that reference is made to the storage identified by DINIT).
These call statements are concerned, however, with the identification of each
entry to the main display file. Thus most main file routines have as an optional
argument the location of the display code generated by that particular call,
which provides a "handle" to a particular graphic entity. This supplies the
flexibility required to build and modify a display file in an interactive environ-
ment, and enables the user to perform limited storage management. The main dis-
play file routines and their functions are:

> DINIT - initializes and starts the display via device number
> (.DAT SLOT) 1∅

> DCLOSE - stops the display and leaves the main file in a form
> such that it can be called as a subpicture file.

> SETPT - sets absolute starting point of display. (Point not
> intensified.)

> PLOT - displays predefined but not necessarily complete sub-
> pictures, individual LINEs, or ASCII text; also used
> to define display parameters.

> DELETE - deletes named subpicture file from main display file.

> REPLOT - similar to PLOT, but permits reuse of previously
> defined areas in the main file.

> RSETPT - similar to SETPT, but permits reuse of previously
> defined areas in the main file.

When returned from PLOT or SETPT, CNAME[1] contains a count of the instructions
generated by that particular call in the high-order 3 bits. REPLOT and RSETPT
use this count to determine whether the required number of locations is avail-
able. If there are not enough locations available, these routines check to see
if there are enough contiguous locations containing display NOP's to satisfy the
requirement. If the requirement is not satisfied, the function fails, an
indicator to that effect is returned, and the display file is not changed. If the
requirement is satisfied, the new group of instructions is inserted into the file
along with enough display NOP's, if necessary, to match the size of the original
group of instructions, and a logical success indicator is returned.

The DELETE function operates in a similar fashion, checking for a legal instruc-
tion count in the high-order 3 bits of CNAME. If the instruction count is zero,
the function fails, an indicator to that effect is returned, and the display file
is not changed. Otherwise, the number of instructions indicated (by the high-
order 3 bits of CNAME) are replaced with display NOP's and a logical success
indicator is returned.

An exception to this file management technique is when random direction lines
must be approximated for calls to PLOT. In this case, the count returned in the
high order bits of CNAME is set equal to 7 (this count is less than 7 for all
other calls). The instructions for line approximation are added to the display
file in the following format, where the actual count of instructions added to
the file (plus 2) is stored in CNAME+1.

```
SKP
(COUNT=N+2)
V1
V2
  .
  .
  .
VN
```

This difference in file management is invisible to the user since REPLOT and
DELETE still operate the same externally.

Smaller groups of instructions can be packed into memory formerly required by a
larger group. CNAME must be manipulated to accomplish this, and caution is ad-
vised in following this procedure.

As an example, assume that a previous call to PLOT has generated six instructions

---

[1]The optional output argument (CNAME) which is returned from PLOT and SETPT is
a pointer to the display code generated by that call. It is a required input
argument to subroutines REPLOT and RSETPT that permit reuse of locations in the
main display file. It is also a required input to subroutine DELETE.

starting with the tenth location of the integer array IBUF. Also assume
that CNAME was requested as an output argument of that call to PLOT, and is
assigned to the variable IPLOT. When returned from the call to PLOT, IPLOT
would point to IBUF(1Ø), and the three high-order bits would equal six (the
number of display commands inserted in the file).

If at a later time you wish to reuse these locations by inserting two
successive calls to REPLOT (each of which generates three display commands),
you can do so as follows:

```
        CALL REPLOT (....,IPLOT)
        IPLOT=(IPLOT*8/8)+3
        CALL REPLOT (.....,IPLOT)
```

In the second statement of the above sequence, the portion in parentheses
zeroes out the count in the high order three bits of IPLOT. (When this count
is zero, REPLOT simply checks to see if enough DNOP'ed locations are available
to satisfy the requirement.) Three is then added so that IPLOT now points to
the first free location. It should be emphasized that simply adding three to
the value of IPLOT is not satisfactory, since the count would not be valid for
the second REPLOT (in fact, an additional three DNOP's would be added to the
file to satisfy the original count of six). Therefore, it is imperative to
know the exact number of locations available when using this technique, and
to proceed with caution.

3.1 DINIT (DISPLAY INITIALIZE) SUBROUTINE

The DINIT subroutine initializes the display via device number (.DAT SLOT) 1Ø.
The VT15 device handler (VTA) must be associated with .DAT slot 1Ø as DINIT
contains .IODEV 1Ø, which causes the device handler associated with .DAT slot
1Ø to be loaded. DINIT can be used to set up for a new display main file, to
start up an old one, or to start up any previously defined subpicture as the
current main file. The call statement form is:

```
        CALL DINIT (MAINFL(1))
```

MAINFL is the first location of the Main Display file. Like PNAME, it is an
element of a dimensioned integer array. Location MAINFL contains the length
of the Main Display File. This is updated by all main file routines.

Subroutine DINIT stores a DJMP* MAINFL+1 at the end of the main file, inserts
the address of MAINFL+2 into MAINFL+1, initializes the display, and starts
the display running at MAINFL+2.

Certain restrictions must be noted when using DINIT. If a new display file is

being formed, location MAINFL must contain zero; if this is a previously defined file, location MAINFL contains the file length and must not be altered. Sufficient storage must follow MAINFL to accommodate the main display file that is to be generated. Only one main display file can be running at a time.

<div align="center">NOTE</div>

When a new main display file is being initialized, DINIT inserts a display parameter word to turn off blink, offset, rotate and light pen, and to enable character string escape on ALT MODE (175_8). To change the initial settings for blink, offset, rotate, and light pen, or to ensure that other display features (i.e., scale, intensity, dash, name register, and sync) are initially set as desired, the calling program should contain a PRAMTR type call to PLOT (described in paragraph 3.4.3) following the call to DINIT.

The following statement initializes the execution of the Main Display File starting at the first location of array MAINFL.

        CALL DINIT (MAINFL(1))

3.2 DCLOSE (DISPLAY TERMINATE) SUBROUTINE

The DCLOSE subroutine is used to stop the display. DCLOSE also leaves the current main file in displayable form such that it can later be called as a subpicture file or restarted as a main file. The call statement form is simply:

        CALL DCLOSE

3.3 SETPT (SET POINT) SUBROUTINE

The SETPT subroutine is used to locate the beam on the display surface in absolute display coordinates (raster units). The beam is not intensified with this call. The call statement form is:

        CALL SETPT (X,Y[,CNAME])

where the variable X represents the horizontal coordinate of beam location and Y represents the vertical coordinate of beam location. The variable CNAME is a pointer to the first location of the display commands generated by this call. SETPT adds two commands to the main file, as follows:

        PY!Y
        PX!X

Two is added to the contents of location MAINFL. The location PY!Y is stored in CNAME (if given).

The variables X and Y must be positive integers and their values must not exceed 1023. A call to SETPT causes the beam to be given an absolute location, as opposed to a relative displacement. This action effectively severs any following parts of the display from any preceding parts; if a section of the display is completely defined in terms of relative vectors, then its location on the

<div align="center">3-4</div>

display surface depends on where the beam was initially located, and it can be made to move as a unit by changing the initial setting. Giving the beam an absolute location disregards any previous motion and serves as a new reference point in the display.

CNAME is an optional output of this subroutine. Use of the same variable name as one used in a previous call will destroy the previous contents. The following statement establishes an absolute beam position with display coordinates X = 1∅, Y = 1∅.

       CALL SETPT (1∅,1∅)

3.4 PLOT SUBROUTINE

The PLOT subroutine is the prime active agent in the generation of the Main Display File. There are four forms of calls corresponding to the four subpicture routines, COPY, LINE, PRAMTR, and TEXT. These calls are used to display pre-defined (but not necessarily complete) subpictures and individual lines or text strings, and to introduce appropriate display control commands. In all cases, the requested display or control function is identified as a separate entity and may be manipulated independently of the rest of the display. The first entry in the argument list defines the type of call to PLOT as follows:

FIRST ARG	TYPE OF PLOT
∅	COPY
1	LINE
2	PRAMTR
3	TEXT

3.4.1 Plot a Subpicture (COPY)

The call statement form is:

       CALL PLOT (∅,RST,PNAME[,CNAME])

where the value ∅ indicates this is a COPY type call to PLOT. RST is the indicator for the SAVE/RESTORE option (same as COPY). PNAME is the name (first location) of the subpicture to be displayed.

CNAME is an optional output argument that will contain a pointer to the first location of the group of display commands generated by this call. The number of commands added to the display file is added to the contents of MAINFL. In general, the same restrictions apply as for the COPY subroutine. Again, multiple use of the same variable CNAME will destroy previous contents. The following example illustrates use of a COPY type call to PLOT:

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```
CALL PLOT (COPI,Ø,HOUSE(1),MAIN)
```

In this example, COPI has the integer value Ø; the next argument (Ø) is the
indicator for the SAVE/RESTORE option; HOUSE identifies the subpicture file to
be displayed; and MAIN is an optional output argument by which the group of dis-
play instructions inserted for this call may be referenced.

3.4.2 Plot a Line (or Reposition the Beam)

The call statement form is:

```
CALL PLOT (1,DELTAX,DELTAY,INT[,CNAME])
```

This type of PLOT is basically the same as the LINE subpicture routine, except
for the first argument which defines this as a line type call to PLOT. The
variable CNAME is an optional output argument and will contain a pointer to the
first location of the group of display commands generated by this call. The
number of commands added to the display file is added to the contents of MAINFL.
The location of the first display command is stored in CNAME (if given).

As in SETPT, CNAME is an output variable and multiple use of the same variable
name will destroy previous contents. Otherwise, the same general restrictions
apply as for the LINE subpicture routine. The following example illustrates a
LINE type call to PLOT.

```
CALL PLOT (LYNE,1ØØØ,1ØØ,ON,IEDGE(1))
```

where LYNE and ON have assigned values of 1 and IEDGE(1) is a display identifier
to be used for later reference to this LINE.

3.4.3 Plot a Control Command (PRAMTR)

The call statement form is:

```
CALL PLOT (2,FEATR,VALUE[,CNAME])
```

where FEATR and VALUE must be specified in the same manner as for PRAMTR sub-
picture calls. Also, as with the PRAMTR call, multiple features can be specified
in a single PLOT call of the following form:

```
CALL PLOT (2,FEATRs,VALUE1,VALUE2,...,VALUEn[,CNAME])
```

The number of commands added to the display file is added to the contents of
MAINFL. The location of the first command is stored in CNAME (if given). The
same general restrictions apply as for the PRAMTR subpicture routine. The

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following example illustrates the use of this type of PLOT to set the BLINK feature in a Main File.

        CALL PLOT (2,8,1)

The multiple-feature statement

        CALL PLOT (PRAM,SCALE+INT+LPEN,∅,4,1,IN)

establishes values ∅ and 4 for display features SCALE and INT, and turns the light pen sensitivity on. The variable IN is supplied for the optional CNAME output argument. (PRAM=2, to specify a PRAMTR type call to PLOT.)

3.4.4 Plot a Text String (TEXT)

The call statement form is:

        CALL PLOT (3,STR,N[,CNAME])

This type of call to PLOT is essentially the same as that for the TEXT subpicture routine, except for the first argument which defines this as a TEXT type call to PLOT. The number of commands added to the display file is added to the contents of MAINFL. The location of the first generated display command is returned in CNAME (if given). The same restrictions apply as for the TEXT subroutine. The following example illustrates the use of the TEXT type call to PLOT

        CALL PLOT (3,STRING,15,SAVNAM)

where STRING contains the 15 characters to be displayed, and SAVNAM will contain a pointer to the group of display commands inserted by this call.

3.5 DELETE FUNCTION

The DELETE function is used to delete from the Main Display File any display entity formed by a single call to a main file routine and assigned to CNAME. If CNAME does not contain a legal instruction count (1-7), the DELETE fails and has no effect on the display file. The function and call statement forms are:

        I = DELETE (CNAME)

or

        CALL DELETE (CNAME)

The input variable CNAME is the location of the group of display commands to be

3-7

deleted. In the function form (I=), the output variable I is a Boolean success indicator; TRUE indicates a successful deletion, FALSE indicates an unsuccessful deletion. CNAME is checked to see if it contains a legal instruction count in high-order bits. If it does, all commands in this group are replaced by display NOP's (DNOPs); otherwise, no action is taken.

The example:

```
        CALL DELETE (NAME(2))
```

deletes from the Main Display File the display entity whose first command is pointed at or identified by the second element of array NAME.

3.6 REPLOT FUNCTION

The function REPLOT allows use to be made of previously defined locations in the Main Display File. This can serve two purposes: (1) to reuse locations freed by DELETE, and (2) to change an existing group of display commands. REPLOT checks whether the group being inserted is longer than the space pointed at by CNAME, if it is, REPLOT then checks to see if there are enough DNOPed locations following the group to be overlaid. If there still are not sufficient locations available, the REPLOT fails and the display file is not affected. By manipulating CNAME, smaller groups can be packed into the space formerly used by a larger group. For example, up to three control commands could be inserted into the space left by a DELETEd copy group. There are four forms of call to REPLOT, each of which is similar to the corresponding call to PLOT (Paragraph 3.4).

The first entry in the argument list defines the type of call to REPLOT as follows:

FIRST ARG	TYPE OF REPLOT
0	COPY
1	LINE
2	PRAMTR
3	TEXT

It is important to note that while CNAME is an optional output of PLOT it is a required input of REPLOT since it identifies the locations to be modified in the Main Display File. It also must be recognized that CNAME must have been given as an argument to a PLOT call for it to be available for REPLOT.

Since all of the REPLOT functions are similar to corresponding calls to PLOT, only the COPY type REPLOT is described as an example. The call statement forms for a COPY type REPLOT are:

```
            I = REPLOT (Ø,RST,PNAME,CNAME)
```

or

```
            CALL REPLOT (Ø,RST,PNAME,CNAME)
```

The input variables are the same as in the corresponding call to PLOT, except
CNAME, which points to the first location of a block in which to store the dis-
play commands generated. The output variable I is a logical success indicator:
TRUE indicates that the REPLOT was successful, and FALSE indicates that there
was not enough room at the location pointed to by CNAME. It should be emphasized
that if the above form is used, both I and REPLOT must be declared as LOGICAL in
a type statement.

The COPY type REPLOT checks whether CNAME points to a large enough block of
locations; no action is taken if the block is not large enough. Otherwise,
REPLOT inserts the necessary commands starting at the location pointed to by
CNAME, and inserts DNOP's in any remaining locations within the block. The same
general restrictions apply as for the corresponding call to PLOT. The following
example illustrates a COPY type call to REPLOT:

```
            CALL REPLOT (Ø,IRST,SLIDE(M),NAME)
```

where Ø indicates that this is a COPY type call. IRST is equal to zero to
indicate no SAVE/RESTORE option, M represents the first location of the sub-
picture display file (in array SLIDE) and NAME identifies the first location in
the display file into which this group of commands is to be inserted.

3.7 RSETPT FUNCTION

Like SETPT, the function RSETPT permits absolute beam locations to be defined;
it can be used in the same manner as REPLOT to reuse any deleted locations or
to change any existing group of commands. The same checking of needed space
versus available space is done by RSETPT as in REPLOT.

The call statement forms are:

```
            I = RSETPT (X,Y,CNAME)
```

or

```
            CALL RSETPT (X,Y,CNAME)
```

The variable X represents the horizontal coordinate of beam location; Y repre-

sents the vertical coordinate of beam location. CNAME is an input argument
that points to the first location of a block in which to store the display
commands that are generated. If the function form (I=) is used with RSETPT,
both I and RSETPT must be declared as LOGICAL in a type statement. RSETPT first
checks whether CNAME points to a large-enough block of locations; no action is
taken if the block is not large enough. Otherwise, RSETPT inserts two position-
ing commands at the location pointed to by CNAME:

```
        PY!Y
        PX!X
```

RSETPT also inserts DNOPs in any remaining locations belonging to a former command
group at this address. The following example illustrates the use of a call to
RSETPT:

```
        CALL RSETPT (1Ø,1Ø,NAME)
```

where the value of 1Ø is assigned to the X and Y coordinates and NAME identifies
the starting location of a block within the display file into which the position-
ing commands are to be inserted.

INPUT ROUTINES

Input routines enable the user (through his program) to deal with display con-
sole interaction using the light pen and pushbuttons. Routine LTORPB can inform
the user whether there has been a light pen or pushbutton action and, if so,
return the appropriate information that is required. The user program is not
(logically) interrupted when such action occurs. The light pen or pushbutton
action at the console merely causes an indicator to be set in the corresponding
routine. This may affect the user's flow of control at his discretion. The
light pen tracking routine (TRACK) provides a somewhat different use of the
light pen, allowing the user to control input and generation of graphics.

4.1 LTORPB FUNCTIONS

The function LTORPB is used to determine whether a light pen or pushbutton hit
has occurred. If it has not, the function returns an indicator to this effect.
If a hit has occurred, the logical (contents of name register) and physical
(Y and X raster coordinates) location of the light pen and the status of the
pushbutton box are returned as well as the indicator that a hit has occurred.
For example, this routine may be used as a switch in a FORTRAN logical IF state-
ment (see example below). The IF statement could branch to itself if no hit has
occurred, or to the user's light pen hit processing code if a hit has occurred.

The function statement form is:

        I = LTORPB (IX,IY,NAMR,PB,IWICH)

LTORPB and the variables I and PB must be declared logical in a type statement.

The output variable I is a logical success indicator; TRUE indicates that a light
pen or pushbutton hit has occurred, and FALSE indicates no light pen hit has
occurred. It should be emphasized that if I is FALSE, IX, IY, NAMR, and PB
have no meaning.

The variable IX is the horizontal coordinate at end of the vector that caused
a light pen hit.   IY is the vertical coordinate at end of vector which caused
a light pen hit. The variable NAMR will contain the value of the name register
at the time of the light pen hit. PB should be defined in the calling program
as a six-element array. Each element will contain either the logical TRUE or
FALSE corresponding to ON or OFF for each of the six pushbuttons. IWICH will
be either of two values; IWICH=1 if a light pen hit has occurred, or IWICH=2 if

· a pushbutton hit has occurred.

LTORPB issues a .READ on light pen or pushbutton interrupt to the display
device handler. It returns if no interrupt was posted. Otherwise, it reads
appropriate display registers and returns with appropriate output variables.

The following statement illustrates use of LTORPB as a switch in a FORTRAN
IF statement:

IF(LTORPB (LPX,LPY,NAME,PB,IWICH)) GOTO 1ØØ

In the above statement, if a hit has occurred (LTORPB is TRUE) LPX and LPY
contain the X and Y coordinates of the end of the vector that was hit. The
contents of the name register, the status of the pushbuttons and which hit it
was are returned, and the program is directed to execute statement 1ØØ.

4.2 TRACK SUBROUTINE

The TRACK subroutine is used for light pen tracking or drawing. Tracking being
the input of an x-y coordinate where the tracking pattern is to be initially
displayed. The user then moves the tracking pattern with the light pen to the
desired location; and presses a pushbutton to escape from the tracking sub-
routine. The final x-y coordinate is then returned through the x-y input
arguments. Drawing is the same as tracking with the addition of an array stor-
ing the vectors which describe the tracking path, (the path is displayed during
tracking). The vector array is structured the same as a subpicture file and
may be recalled by the user. The array must be dimensioned by the calling
program, keeping in mind the number of vectors that will be inserted into it.
A straight line requires an array of seven locations. The form of the call
statement to track is as follows:

CALL TRACK(IX,IY,IOPT,IARRAY)

Use of the TRACK subroutine requires four arguments. Two already mentioned
are the initial x coordinate and the initial y coordinate; these are also
used as return arguments of the final x coordinate and final y coordinate. The
third required argument is the direction option which allows the user to restrict
movement of the tracking pattern in certain directions. The direction option
is also used to draw straight lines in the horizontal or vertical direction.
If the value of the direction is zero, tracking is allowed in any direction.
A description of the direction options available can be found in Table 4.1
(Input Variables). The fourth required argument indicates whether the draw
option is desired. A zero indicates tracking only. If drawing is desired,
the argument will be the user's array location, where the intensified vectors

will be stored. Examples of the use of these arguments can be found in the following sample program that calls TRACK.

```
C     THE FOLLOWING FORTRAN PROGRAM USES THE TRACKING ROUTINE
C     TO DETERMINE THE DISTANCE BETWEEN (100,400), THE INITIAL
C     POSITION OF THE TRACKING PATTERN AND ANY POINT ON A LINE
C     OF SLOPE 20, DRAWN FROM A SET POINT AT X=750 Y=250
C
      DIMENSION MF(150),IUSER(200)
      MF(1)=0
      IOPT=3
      IX1=100
      IY1=400
C
C     INITIALIZE THE DISPLAY
C     CALL SET POINT TO POSITION BEAM
C     DRAW LINE FROM SET POINT
C     CALL TRACKING ROUTINE
C
      CALL DINIT(MF(1))
      CALL SETPT(750,250)
      CALL PLOT(1,25,500,1)
      IX2=IX1
      IY2=IY1
      CALL TRACK(IX1,IY1,IOPT,IUSER)
C
C     GET CHANGE IN X VALUE
C     GET CHANGE IN Y VALUE
C     CALCULATE DISTANCE BETWEEN POINTS
C
      IDELX=IX1-IX2
      IDELY=IY1-IY2
      IDELAB=SQRT((IDELX**2)+(IDELY**2))
      STOP
      END
```

Figure 4-1. Sample TRACK Program (FORTRAN Example)

Table 4.1   Description of CALL TRACK Arguments

Example:

CALL TRACK (IX,IY,IOPT,IARRAY)

INPUT VARIABLES:	
IX	Initial Absolute X-Position of Tracking Point ($\emptyset$-1$\emptyset$23)
IY	Initial Absolute Y-Position of Tracking Point ($\emptyset$-1$\emptyset$23)
IOPT	Tracking Direction Option ($\emptyset$-6)

OPTION	ALLOWABLE TRACKING DIRECTIONS		
$\emptyset$	ALL AXIS DIRECTIONS		
1	+X	-X	
2	+Y	-Y	
3	+X	+Y	-Y
4	+X	-X	+Y
5	-X	+Y	-Y
6	+X	-X	-Y

IARRAY	- Tracking Draw Option

USER DIMENSIONED ARRAY	DRAW OPTION DESIRED Intensified Vectors Following the Light Pen Movement Are Stored in This Array and are Displayed.
$\emptyset$	DRAW OPTION NOT DESIRED

OUTPUT VARIABLES	
IX -	Final Absolute X - Position of Tracking Point ($\emptyset$-1$\emptyset$23)
IY -	Final Absolute Y - Position of Tracking Point ($\emptyset$-1$\emptyset$23)

When TRACK is called, the X and Y input arguments are inserted into the track
display file. The track display file is then linked to the main file by insert-
ing into main file a DJMS* to a second location in the main file; into which
has been inserted the address of the track display file. The direction option is
then used to increment down a dispatch table which in turn sets up a second
table so only light pen hits on certain sides of the tracking octagon are valid.
The draw option is tested for and, if desired, the user's vector storage array
is set up and linked to the track display file in the same manner that it was
linked to the main file. Track then issues a .READ on Light Pen or Pushbutton
interrupt, to the display device handler. If a light pen hit on a valid side
of the octagon occurs, the tracking octagon is moved two raster units in the
appropriate direction. If the draw option was specified, track adds a two raster
unit vector to the user's vector storage array or increases the length of the last
vector in the array if the hit was on the same side of the octagon as the previous
hit. If a pushbutton interrupt occurs, TRACK removes all the created links and
restores the main file to its previous form. The final X and Y coordinates of
the tracking point are returned and control is released to the calling program.

The macro calling sequence to track is as follows:

```
        .GLOBL     TRACK
        JMS*       TRACK
        JMP        .+5
        .DSA       IX
        .DSA       IY
        .DSA       IOPT
        .DSA       IARRAY
```

Internal Structures Created by Track:

Main File Link to Track:

```
        MFTOP      LENGTH
                   .+1
                   DJMS*      .+2
                   SKP
                   ADDRESS
                     .
                     .
                     .
                   DJMS*      .+2          /Link to track display file
                   DJMP*      MFTOP+1      /Jump to top of MAIN FILE
                   TRCK                    /Address of Track display file
```
   Note: Track requires two temporary locations in the user's main
          file. A main file must be running when track is called.

Vector Array for Draw Option:

```
ARTOP       LENGTH                  /File length
            Ø                       /Return address
            PX                      /X set point
            PY                      /Y set point
            VI                      /Intensified vectors
            VI
             .
             .
             .
            DJMP*   ARTOP+1         /Display Jump to calling file
```

Note: The X and Y set points must be set by the user if he desires
        to relocate his array of intensified vectors, when recalling
        it.

(See MACRO 15 TRACK program page 4-7.)

```
/        THE FOLLOWING MACRO 15 PROGRAM USES THE TRACKING ROUTINE
/        TO LOCATE OR POSITION A SET POINT ON THE DISPLAY SCREEN.
/        THE POSITIONED SET POINT IS THEN USED TO DRAW A FIGURE.
/
         .GLOBL  DINIT
SAMP2    JMS*    DINIT               /INITIALIZE THE DISPLAY
         JMP     .+2
         .DSA    MAINBF
CHK0     LAC     (450                /SET INITIAL POSITION OF TRACKING PATTERN
         DAC     IX1
         DAC     IY1
         .GLOBL  TRACK
CHK1     JMS*    TRACK               /CALL TO TRACKING ROUTINE
         JMP     .+5
         .DSA    IX1                 /X-POSITION
         .DSA    IY1                 /Y-POSITION
         .DSA    CNST4               /DIRECTION OPTION
         .DSA    CNST4               /DRAW OPTION
         .GLOBL  SETPT
CHK2     JMS*    SETPT               /CALL TO SET POINT ROUTINE
         JMP     .+3
         .DSA    IX1                 /X-POSITION RETURNED FROM TRACKING
         .DSA    IY1                 /Y-POSITION RETURNED FROM TRACKING
         .GLOBL  PLOT
CHK3     JMS*    PLOT                /CALL TO PLOT ROUTINE
         JMP     .+5
         .DSA    CNST0               /ARG. TO PLOT A LINE
         .DSA    CNST1               /DELTA X
         .DSA    CNST1               /DELTA Y
         .DSA    CNST0               /INTENSIFY THE LINE
CHK4     JMS*    PLOT
         JMP     .+5
         .DSA    CNST0
         .DSA    CNST1
         .DSA    CNST2
         .DSA    CNST0
CHK5     JMS*    PLOT
         JMP     .+5
         .DSA    CNST0
         .DSA    CNST3
         .DSA    CNST4
         .DSA    CNST0
         HLT
MAINBF   .BLOCK 50                   /DISPLAY MAIN FILE BUFFER
IX1      0
IY1      0
CNST0    1
CNST1    25
CNST2    -25
CNST3    -50
CNST4    0
         .END
```

Figure 4-2. Sample TRACK Program (MACRO 15 Example)

RELOCATING ROUTINES

The subroutines DYSET and DYLINK are used to allow display main or subpicture files, which refer to each other (via COPY or PLOT (∅....)), to be output and input relocatably. This includes arrays of 5/7 ASCII that are referred to via TEXT or PLOT(3....). Prior to outputting, interdependent display files and their user-assigned ASCII names are listed as arguments in a call to DYSET, which converts each subpicture call to the ASCII name of the subpicture being called. After input, and prior to displaying, a corresponding call is made to DYLINK, which uses the listed ASCII names to reinstate the appropriate subpicture calls or text references. A display file cannot be displayed after having been processed by DYSET; DYLINK must be used to return it to displayable form.

5.1 DYSET SUBROUTINE

The DYSET subroutine converts subpicture calls or text references to a symbolic form independent of core memory location, using specified ASCII strings. The forms are,

        CALL DYSET (PNAME1,ASCII1,...,PNAMEN,ASCIIN)
or
        CALL DYSET (PNAME1,ASCII1,...,PNAMEK,ASCIIK,∅,PNAMEL,ASCIIL,...
                                    ,PNAMEN,ASCIIN)

The variable PNAMEs are the first locations of the interdependent display files, both calling and called. If a ∅ argument appears in the argument string, subsequent PNAMEs refer to arrays of 5/7 ASCII text. (These files will not be searched for memory references.) The ASCIIs are the names of real arrays containing nine characters of 5/7 IOPS ASCII, which may be used for filenames on output.

Subroutine DYSET searches each listed display file (PNAME) for a DJMS or CHARS instruction. When it finds one, it appends the ASCII name of the file referenced to the file being searched, if that name is not already there. The operand of the DJMS is made a relative pointer to the ASCII name of the referenced file. The first location of the file being searched is increased by four each time an ASCII name is appended to the file.

Certain restrictions must be noted; space provided for a display file must include four locations for each subpicture that is called. Display commands must not be added to a display file nor can a file be displayed once it has been processed by DYSET, or until after it has been processed by DYLINK. (Thus DYSET must be called

after DCLOSE for a main display file.) Also, it is the user's responsibility to list all relevant display files when calling DYSET. The subroutine does not check the list for completeness in order to allow multiple calls to it. Once a zero appears in the argument string, all subsequent PNAMEs must refer to arrays of 5/7 ASCII text.

5.2 DYLINK SUBROUTINE

The DYLINK subroutine converts file names to appropriate DJMS or CHARS instruction references to the corresponding files. The forms are:

        CALL DYLINK(PNAME1,ASCII1,...,PNAMEN,ASCIIN)
or
        CALL DYLINK(PNAME1,ASCII1,...,PNAMEK,ASCIIK,∅,PNAMEL,
                ASCIIL,...,PNAMEN,ASCIIN)

where the input variables are the same as for DYSET. DYLINK searches each listed display file for a DJMS or CHARS instruction. When it finds one, it searches the argument list for a pointer to an ASCII string equal to the one pointed at by the operand of the DJMS or CHARS instruction. This operand is replaced by the address of the corresponding file, obtained from the argument list. The first location of each display file that is searched is reduced to the actual number of display commands in the file (excluding the ASCII blocks).

It is the user's responsibility to list all relevant display files when calling DYLINK. The subroutine does not check the argument list for completeness, to allow multiple calls. Once a zero appears in the argument string, all subsequent PNAMEs must refer to arrays of 5/7 ASCII text. See Figure 5-1 for DYSET/DYLINK Program.

```
C
C  ARRAY INITALIZATION
C
        DIMENSION NWPIC0(40), NWPIC1(20), NWPIC2(20)
        DIMENSION RTXTA(2), RTXTB(2)
        DIMENSION IMAIN(40), IPICA(20), IPICB(20)
        DIMENSION TEXTA(2), TEXTB(2)
        DIMENSION TITL1(2), TITL2(2), TITL3(2), TITL4(2), TITL5(2)
        DATA TITL1(1), TITL1(2)/5HJPIC0, 4H BIN/,
       2TITL2(1), TITL2(2)/5HJPICA, 4H BIN/,
       3TITL3(1), TITL3(2)/5HJPICB, 4H BIN/,
       4TITL4(1), TITL4(2)/5HCHRSA, 4H BIN/,
       5TITL5(1), TITL5(2)/5HCHRSB, 4H BIN/
        DATA TEXTA(1), TEXTA(2)/5HI AM ,4HBOXA/,
       1TEXTB(1), TEXTB(2)/5HI AM , 4HBOXB/
C
C  INITIALIZE DISPLAY FILES.
C
        IMAIN(1)=0
        IPICA(1)=0
        IPICB(1)=0
C
C  BUILD BOXB   (IPICB)
C
        CALL TEXT (TEXTB(1),9, IPICB(1))
        CALL LINE (100,0,1)
        CALL LINE (0,100,1)
        CALL LINE (-100,0,1)
        CALL LINE (0,-100,1)
C
C  BUILD BOXA   (IPICA)
C
        CALL LINE (300,0,1,IPICA(1))
        CALL LINE (0,300,1)
        CALL LINE (-300,0,1)
        CALL LINE (0,-300,1)
        CALL LINE (30,30,0)
        CALL COPY (0,IPICB(1))
C
C  BUILD MAIN (IMAIN)
C
        CALL DINIT (IMAIN(1))
        CALL PLOT (2,19,0,4,0)
        CALL SETPT (20,20)
        CALL PLOT (3,TEXTA(1),9)
        CALL PLOT (0,1,IPICA(1))
        CALL SETPT (534,20)
        CALL PLOT (3,TEXTA(1),9)
        CALL PLOT (0,0,IPICA(1))
C
C
C  DCLOSE, CALL DYSET, AND OUTPUT TO DECTAPE (DAT 5)
C
C
        CALL DCLOSE
        CALL DYSET (IMAIN(1),TITL1,IPICA(1),TITL2,IPICB(1),TITL3,0,
       1TEXTA(1),TITL4,TEXTB(1),TITL5)
        CALL ENTER (5,TITL1)
        J=IMAIN(1)+1
        WRITE (5) (IMAIN(I), I=1,J)
        CALL CLOSE (5,TITL1)
```

Figure 5-1.   DYSET/DYLINK Program Example

```fortran
        CALL ENTER (5,TITL2)
        J=IPICA(1)+1
        WRITE (5) (IPICA(I), I=1,J)
        CALL CLOSE (5,TITL2)
C
C

        CALL ENTER (5,TITL3)
        J=IPICB(1)+1
        WRITE (5) (IPICB(I), I=1,J)
        CALL CLOSE (5,TITL3)
C
C

        CALL ENTER (5,TITL4)
        WRITE (5) (TEXTA)
        CALL CLOSE (5,TITL4)
C
C

        CALL ENTER (5,TITL5)
        WRITE (5) (TEXTB)
        CALL CLOSE (5,TITL5)
        PAUSE 222
C
C INPUT FROM DECTAPE, CALL DYLINK AND DINIT
C
        CALL SEEK (5,TITL1)
        READ (5) J, (NWPIC0(I+1), I=1,J)
        NWPIC0(1)=J
        CALL CLOSE (5,TITL1)
C
C

        CALL SEEK (5,TITL2)
        READ (5) J, (NWPIC1(I+1), I=1,J)
        NWPIC1(1)=J
        CALL CLOSE (5,TITL2)
C
C

        CALL SEEK (5,TITL3)
        READ (5) J,  (NWPIC2(I+1), I=1,J)
        NWPIC2(1)=J
        CALL CLOSE (5,TITL3)
C
C

        CALL SEEK (5,TITL4)
        READ (5) RTXTA
        CALL CLOSE (5,TITL4)
C
C

        CALL SEEK (5,TITL5)
        READ (5) RTXTB
        CALL CLOSE (5,TITL5)
C
C

        CALL DYLINK (NWPIC0(1),TITL1,NWPIC1(1),TITL2,NWPIC2(1),TITL3,0,
       1RTXTA(1),TITL4,RTXTB(1),TITL5)
        CALL DINIT (NWPIC0(1))
        STOP
        END
```

SYSTEM I/O DEVICE HANDLER

The VT15 Graphic Display Device Handler provides an interface between the user
and the hardware. In general, it conforms to the conventions of the Keyboard
Monitor System, as described in DEC manual Monitors, ADVANCED Software System.
Input or output functions are initiated by standard user program commands and
all display interrupt management is done automatically by the handler. The
primary goals of the device handler are to relieve the user from writing his own
device handling subprograms and to centralize all direct communication between
the PDP-15 and the display processor. To start up a display, the user generates
a display file consisting of display commands then calls the device handler to
start it running. To interact with it, the device handler is used to read
display controller registers and to dispatch on appropriate interrupts.

6.1 .INIT (INITIALIZE) MACRO

The macro .INIT causes the display to be initialized and must be given before
any other I/O macro to the display is issued. The display is initialized
according to four words of standard settings contained in the handler. The
user may substitute his own settings for any of these.

The Device Handler is connected to the Monitor Interrupt system (PIC or API)
in the same manner as other system device handlers.

The form is:

        .INIT   A, F, R

    A = Device Assignment Table (.DAT) slot number
    F = initialization flag
        $\emptyset$ use standard display initialization
        1   user's initialization is pointed to by R
    R = optional pointer to user's initialization settings
    If F = 1, R points to a word containing initial settings.
    If F = $\emptyset$ and R = 1, clearing the READ BUSY switch is the only action
        taken by the handler.

    The expansion is:

    LOC   CAL + F(7-8) + A(9-17)
    LOC+1   1
    LOC+2   R

The normal settings are:

    a.   Set display status to
        1.   DISABLE edge flag interrupts
        2.   ENABLE light pen interrupts
        3.   ENABLE pushbutton interrupts
        4.   ENABLE external stop interrupts
        5.   ENABLE full 12 Bit X and Y beam position registers
        6.   ENABLE internal stop interrupts

    b.   Connect handler to PIC or API

    c.   Clear READ BUSY switch

Initialization IOT

SIC (7Ø3Ø24) Set Initial Conditions – SIC sets up a number of status registers in the display. The instruction enables five display flags onto the Interrupt Line. The IOT is issued with settings loaded in the AC in the following format:

```
        ┌0─┬1─┬2─┬3─┬4─┬5─┬6─┬7─┬8─┬9─┬10─┬11─┬12─┬13─┬14─┬15─┬16─┬17─┐
        └──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴───┴───┴───┴───┴───┴───┴───┴──┘
STOP FLAG INTR
LP FLAG INTR
EDGE FLAG INTR
PB HIT INTR
EXT STOP INTR
CLR STOP FLAG
CLR LP FLAG
CLR EDGE FLAG
CLR PB FLAG
CLR EXT STOP
PA  CHANGE EN
PAO
PAL
NOT USED
```
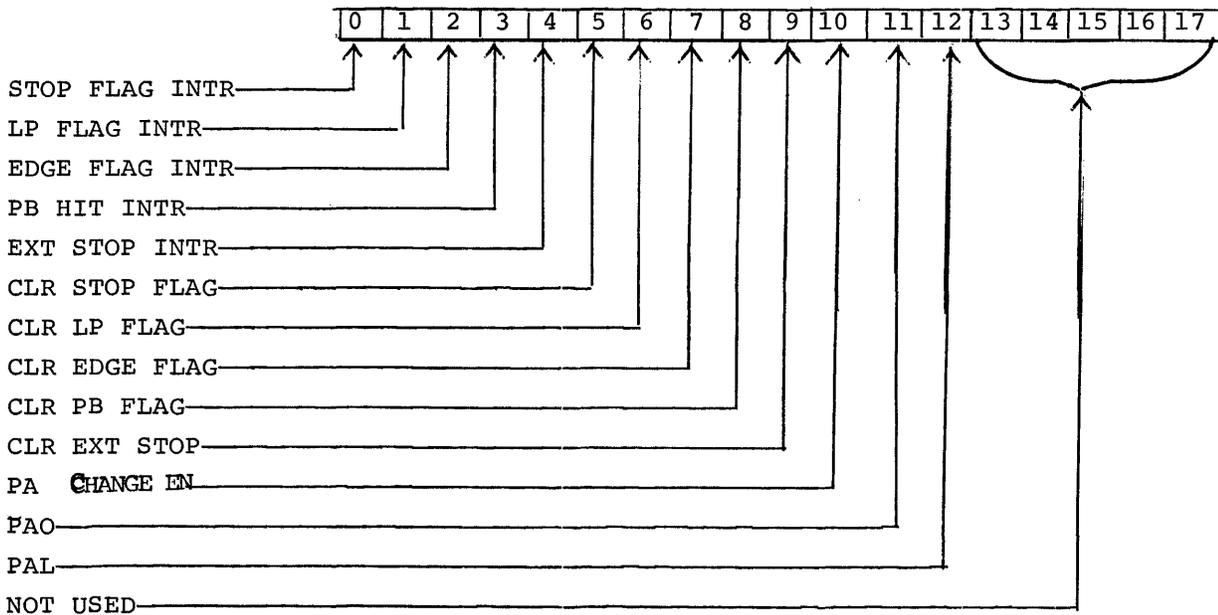
  Ø Sets the Stop Flag Interrupt Enable Flop
  1 Sets the LP Flag Interrupt Enable Flop
  2 Sets Edge Flag Interrupt Enable Flop
  3 Sets PB Hit Interrupt Enable Flop
  4 Sets External Stop Interrupt Enable Flop
  5 Clears Stop Flag
  6 Clears LP Flag
  7 Clears Edge Flag
  8 Clears PB Flag
  9 Clears External Stop Flag
10 Allow a Change in Virtual Paper Size
11 New Virtual Paper Size
12 New Virtual Paper Size

__Bits 11 & 12__ (New paper Size)
ØØ = 9.5 inch (1Ø bits)
    1Ø24 raster units

Ø1 = 19 inch
    2Ø48 raster units

1Ø = 28.4 inch
    3Ø72 raster units

11 = 38 inch (12 bits)
    4Ø96 raster units

6.2 .READ MACRO

The .READ macro is used for input to the user program from the hardware registers of the display controller. The user may select standard groups of registers to be read, in response to each possible display interrupt flag, or he may indicate his own group of flags and registers. This is done with an optional descriptive word following the .READ macro, the first five bits of that word indicate which interrupts are of interest and the next nine indicate the registers to read if any of those interrupts are set.

The form is,

        .READ A, M, L, W
        NSTD

where NSTD = optional word describing non-standard groups.

The variables A = .DAT slot number, M = type of read:

    Ø = READ,PB,XP,YP,S1,S2   Read now, no interrupts
    1 = READ,PB,XP,YP,DPC,S1,S2,NR   If stop flag interupt flag is set
    2 = READ,PB,XP,YP,DPC,S1,S2,NR   If pushbutton interrupt flag is set
    3 = READ,PB,XP,YP,DPC,S1,S2,NR   If light pen interrupt flag is set
    4 = READ,PB,XP,YP,DPC,S1,S2,NR   If edge flag interrupt flag is set
    5 = READ,PB,XP,YP,DPC,S1,S2,NR   If external stop interrupt flag is set
    7 = NSTD specifies registers and interrupt flags as follows:

        Bit Ø on service internal stop interrupt
        Bit 1 on service pushbutton interrupt
        Bit 2 on service light pen interrupt
        Bit 3 on service edge flag interrupt
        Bit 4 on service external stop interrupt
        Bit 5 on read pushbuttons (PB)
        Bit 6 on READ X position register (XP)
        Bit 7 on READ Y position register (YP)
        Bit 8 on READ DISPLAY program counter (DPC)
        Bit 9 on READ STATUS one (S1)
        Bit 10 on READ STATUS TWO (S2)
        Bit 11 on READ NAME REGISTER (NR)
        Bit 12 on READ SLAVE GROUP 1 (SG1)
        Bit 13 on READ SLAVE GROUP 2 (SG2)

L = return buffer address, C(1) = descriptive word showing what this interrupt was and which registers were read in the order listed above. C(L+1) = contents of first register actually read, C(L+2) = contents of second register read, etc. W = 1 (W must equal 1).

The expansion is:

```
LOC        CAL + M(6-8) + A(9-17)
LOC+1      1Ø
LOC+2      L
LOC+3      -W      /DECIMAL
LOC+4      NSTD
```

.READ determines interrupts to be serviced and turns on read busy flag.

6.3   .WRITE MACRO

The .WRITE macro is used to transmit information from the user program to the display controller, once a display file has been generated. Its location is passed on to the display controller by a call to .WRITE, and the display starts up.

.WRITE is also used to stop the display, by issuing an external stop, and to start the display if it has been stopped. A .WRITE to the display is done immediately and requires no waiting.

The form is,

```
        .WRITE A,  M,  L,  W
```

A = .DAT slot number

M = type of write,
     where Ø = restart display (L not required)
           1 = resume display after internal stop
           Note: The display is automatically resumed after
                  LP or EDGE violation interrupt.
           2 = stop display (external stop)
           4 = start display pointed to by L

L = display file starting address

W = not used

The expansion is:

```
LOC        CAL + M(6-8) + A(9-17)
LOC+1      11
LOC+2      L
           .DEC
LOC+3      -W      /DECIMAL
```


6.4   .WAIT MACRO

The .WAIT macro is used to synchronize the user program with the interrupt activity of the display. .WAIT is only defined with respect to .READ. If a .WAIT is given, the user program waits until the previous .READ has completed,

that is, the interrupt has occurred. If the previous .READ specified more than one kind of interrupt flag, the descriptive word(s) in the input buffer can be interrogated to determine what flags were set. .WAIT does not initiate any display activity.

The form is,

        .WAIT A

The variable A = .DAT slot number.

The expansion is,

        LOC   CAL + A(9-17)
        LOC+1   12

.WAIT allows a previous .READ to be completed and turns off input busy flag.

6.5 .WAITR MACRO

The .WAITR macro allows the user program to proceed in line if the previous .READ is complete. If the previous .READ is not complete, control is given to the location in the user program specified by the .WAITR call. This allows the user to branch to some other part of his program while waiting for the .READ to finish. The user must continue to check for completion by periodically issuing .WAITRs or by issuing a .WAIT.

The form is,

        .WAITR A, ADDR

The variables A = .DAT slot number, and ADDR = location in the user program to branch to if input is not completed.

The expansion is,

        LOC   CAL+1ØØØ + A(9-17)
        LOC+1   12
        LOC+2   ADDR

6.6 .CLOSE MACRO

The .CLOSE macro is used to terminate the current display. External STOP and CLEAR flags IOTs are issued. It is up to the user to save the display file if desired.

6-5

The form is .CLOSE A where A = .DAT slot number.

The expansion is,

```
LOC        CAL + A(9-17)
LOC+1      6
```

6.7   .FSTAT MACRO

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

The form is,

```
.FSTAT A, D
```

where the variables A = .DAT slot number, and D = starting address of three word block of storage in user area containing the file name and extension of the file name whose presence on the device associated with .DAT slot A is to be examined.

The expansion is,

```
LOC        CAL+3000 + A(9-17)
LOC+1      2
LOC+2      D
```

6.8   IGNORED FUNCTIONS

The following system I/O macros are ignored by the VT15 display device handler:

1.   .DLETE
2.   .RENAM
3.   .ENTER
4.   .CLEAR
5.   .MTAPE
6.   .SEEK
7.   .TRAN

CHAPTER 7

LK35 KEYBOARD HANDLER

The LK35 Keyboard device handler (LKA) provides an interface between the user and
the hardware. In general, the handler, LKA, conforms to the conventions of the
DOS and ADSS monitor software systems. Since the LK35 is a send-only device,
the LKA handler provides only input functions. Input functions are initiated by
standard user program commands; all interrupt management is done automatically
by LKA.

The LKA handler relieves the user of the task of writing his own device handling
subprograms and centralizes all direct communications between the PDP-15 computer
and the LK35 Keyboard. This handler only inputs IOPS ASCII or IMAGE ASCII
data into a user-designated buffer; it is up to the user to develop the display
of any input text on the VT04 display CRT or output it to any other device.
The LK35 Keyboard is connected to either an LT15 or LT19D controller.

The LKA handler is a resident program, it resides with the Keyboard Monitor and
other required device handlers. It does not require EAE and it operates with
both PI and API.

7.1 .INIT (Initialize) MACRO

This macro initializes the LK35 Keyboard; it must be called before any other
I/O macro is issued to this device.

When .INIT is issued it initializes the LKA handler, which returns the size of
the current line buffer (34_{10} standard) to the macro.

If .INIT is issued during a .READ, it will abort this operation.

The form of this macro is:

        .INIT a,f,r

where:
        a = .DAT slot number
        f = ignored by LKA
        r = control p address

The expansion of this macro is

$$\text{LOC} \qquad \text{CAL} + f_{7-8} + a_{9-17}$$

```
LOC+1    1
LOC+2    r
LOC+3    n        (standard buffer size 34_{10})
```

$$\text{LOC+3} \quad n \qquad (\text{standard buffer size } 34_{10})$$

7.2 .READ MACRO

This macro performs the operations required to input data from the LK35 Keyboard and transfer it to the memory input line buffer. In performing this function, the .READ macro:

a)   allows any previous input operation to terminate,

b)   sets the "input underway" indicator,

c)   accepts and performs the operations indicated by:

    1)   RUBOUT - delete previously entered (typed) character,

    2)   CTRL U ($\uparrow$U) - delete all entries made prior to $\uparrow$U.

d)   recognizes IOPS ASCII string terminators ALT MODE and RETURN (carriage return   ).

e)   is terminated, during IMAGE ASCII read operations when the given line buffer word count (see form) is reached.

The form of the .READ macro is:

    .READ a,M,L,W

where:

    a   = .DAT slot number

    M   = Data Mode

            2 = IOPS ASCII
            3 = IMAGE ASCII

    L   = Line buffer address

    W   = Line buffer word count (including 2-word header pair)

The expansions of this macro are:

$$\text{LOC} \qquad \text{CAL} + M_{6-8} + a_{9-17}$$

```
LOC+1    10
LOC+2    L
LOC+3    -W
```

7.3 .WAIT MACRO

The .WAIT macro is used to detect the availability of the user's line buffer for data transfer operations. If the buffer is unavailable when tested, control remains with the macro; if the buffer is available, control is returned to the user.

The form of this macro is:

        .WAIT a

where a represents a .DAT slot number

The expansion of the macro is:

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

7.4   .WAITR Macro

This macro enables the user to test the status of a previously initiated .READ operation. If the .READ operation is complete the user's program is permitted to proceed in line; if the .READ operation is not complete control is given to a user-specified location expressed in the .WAITR macro call. The latter feature permits the user to branch to some other part of his program while waiting for the completion of the .READ operation.

The form of this macro is:

        .WAITR a,ADDR

where:

        a   = .DAT slot number
        ADDR   = location to branch to if .READ operation is incomplete.

The expansion of this macro is:

        LOC   CAL+1000+A$_{9-17}$
        LOC+1   12
        LOC+2   ADDR

7.5 .CLOSE MACRO

The LKA handler regards the .CLOSE macro as being the same as the .WAIT macro (see 7.3).

The form of this macro is:

    .CLOSE a

where A = .DAT slot number.

The expansion of this macro is:

    LOC   CAL+a$_{9-17}$
    LOC+1   6

7.6 .FSTAT Macro

If used, this macro will return a zero to the AC since the LK35 is a non-directoried device. The form of this macro is:

    .FSTAT a,D

where:

    a   =   .DAT slot number
    D   =   ignored by LKA.

The expansion of .FSTAT is:

    LOC   CAL+3000+a$_{9-17}$
    LOC+1   2
    LOC+2   D

7.7 IGNORED FUNCTION

The .SEEK macro is ignored by the LKA handler.

7.8 ILLEGAL FUNCTIONS

The following macros are illegal with regard to the LKA handler.

    .WRITE
    .DLETE
    .RENAM
    .ENTER
    .CLEAR
    .MTAPE
    .TRAN

7.9 LEGAL CONTROL CHARACTERS

The following keyboard control entries are recognized by LKA:

	ENTRY	OPERATION
1)	CTRL C (↑C)	Performs on .EXIT to the Monitor.
2)	CTRL P (↑P)	Transfers control to the address given in the .INIT cal.
3)	CTRL D (↑D)	Gives an End-of-Medium header word pair to the user.

CHAPTER 8

VW01 Writing Tablet Handler

The VW01 Sonic Digitizer Writing Tablet converts graphical information, in the form of X- and Y-coordinates, to digital data that can be input to a digital computer. The major components of the VW01, are the writing tablet, spark pen, component box, and computer interface logic.

The user places a sheet of paper on the writing tablet and draws sketches, schematics, and hand-written symbols or characters using the special ball-point spark pen. The sound of the spark emitted by the pen is picked up by microphones located along the X- and Y-axes of the writing tablet. The time lapse, from spark emission until the sound is picked up by each bank of microphones, is ac-curately measured to provide a digital record of the X- and Y-coordinates of the spark pen location on the paper.

The digitized graphic data is input to a digital computer via the VWA handler for immediate or delayed processing.

The VW01 operates in either of two modes: Single Point or Data Input.

In the Single Point mode of operation, a single spark is generated each time the spark pen is pressed against the writing surface. The spark is initiated by the closure of a microswitch within the spark pen. The Single Point mode is used if the operator desires to plot points. For example, to plot points at four different locations, he positions the pen point at each location. Then, by pressing and releasing the pen at each position, the corresponding X-Y coordi-nate pairs are sensed and digitized.

In the Data Input mode, a continuous series of sparks are generated at a constant rate, under control of clock pulses. The X-Y coordinate pairs are continuously generated and input to the computer. This mode allows the user to draw continu-ous lines, circles, curves, etc., that can be displayed on the CRT.

At the time a spark is generated, X- and Y- clock pulses are initiated which increment X- and Y- hardware registers until the sound of the spark is received by the X- and Y-microphones. As soon as a microphone detects the sound, the associated X- or Y-clock pulses are inhibited, and the register stops increment-ing. The binary numbers contained in the X- and Y-registers will then be directly proportional to the X- and Y- coordinates of the position at which the spark was emitted.

The VWA device handler for the VW01 Sonic Digitizer Writing Tablet provides an interface between the user and the hardware. In general, it conforms to the conventions of the Keyboard Monitor System in either the ADSS or DOS software in DEC manual ADVANCED Monitor Software system. Initialize and input functions are initiated by standard user program commands (system macros). The device handler relieves the user from writing his own device handling subprograms

The Writing Tablet handler makes no tests on incoming X- and Y-coordinates. All coordinates are handled directly back to the user. This means that if the pen stays on the same spot (Data Input mode) or is pushed on at the same spot more than once (Single Point mode) the same X- and Y-coordinates are handled to the user. Repetitive X- and Y-coordinates should not be sent directly to the VT-handler since they could cause a hole to be burned on the display-screen. For this reason it is the user's responsibility to ignore X- and Y-coordinates which are generated on one and the same spot. The number of times the same co-ordinates could be accepted also depends on the intensity.

8.1 .INIT (INITIALIZE) MACRO

The macro .INIT causes the Writing Tablet to be initialized and must be given prior to any other I/O command referencing this device.

The .INIT macro clears one software and two hardware flags. These flags are:

1)	Handler Busy flag	/Software
2)	Data Ready flag	/Hardware
3)	Pen Data flag	/Hardware

The form is:

```
.INIT A,F,R,n
```

where:

A =		Device Assignment Table (.DAT) slot number
F =		Not used
R =		Not used
n =		Not used

The expansion is:

```
LOC     CAL+F(7-2)+A(9-17)
LOC+1   1                        /Function code for .INIT
LOC+2   R
LOC+3   n
```

8.2 .READ MACRO

The .READ macro is used for input point data to the user from the Writing Tablet. The input always consists of one status word and two words containing the X- and Y-point coordinates.

The status word has the following format:

```
0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17
```

    Input .DAT flag   Writing Tablet Identifier Bits

where: means:

    Bit 0 = 0   Input from "DATA READY"
        = 1   Input from "PEN DATA"
    Bit 14=1   Input from Writing Tablet 1
    Bit 15=1   Input from Writing Tablet 2
      16=1   Input from Writing Tablet 3
      17=1   Input from Writing Tablet 4

The form is:

    .READ A,M,L,W

where:

    A = Device Assignment Table (.DAT) Slot Number
    M = Data Mode:
        0 = Single Point
        1 = Single Point multiplexed
        2 = Data Input (not scan!)
        3 = Data Input multiplexed (scan!)
    L = Line buffer address
        Points to a three word data buffer
    W = Writing tablet to be selected (1-4)

The expansion is:

```
LOC       CAL+M(6-8)+A(9-17)
LOC+1     10                      /Function code for .READ
LOC+2     L
LOC+3     W
```

8.3 .WAIT MACRO

The .WAIT macro is used only with respect to the .READ macro. If a .WAIT is given the user program waits until the .READ has completed, that is, when the line buffer is filled and is again available for the user program. If the line buffer is available, control is returned to the user immediately after the .WAIT macro expansion (LOC+2). If the input of data has not yet been completed, control is returned to the .WAIT macro.

The form is:

      .WAIT   A

where: A = Device Assignment Table (.DAT) slot number

The expansion is:

```
LOC        CAL+A(9-17)
LOC+1      12                        /Function Code for .WAIT
```

8.4 .WAITR MACRO

The .WAITR macro is also used only with respect to the .READ. If the previous .READ is done, control is returned to the user immediately after the .WAIT in order to proceed in line. If the input of data has not yet been completed, however, control is given to a location in the user program specified in the .WAITR call.

The form is:

      .WAITR   A,ADDR

where: A = Device Assignment Table (.DAT) slot number
          ADDR = Location in the user program to which control must
                be transferred if input is not completed.

The expansion is:

```
LOC        CAL+1000₈+A(9-17)
LOC+1      12                        /Function code for .WAITR
LOC+2      ADDR
```

The expansion is:

$$LOC \quad CAL+1000_8+A(9-17)$$
$$LOC+1 \quad 12 \quad /Function\ code\ for\ .WAITR$$
$$LOC+2 \quad ADDR$$

8.5 .FSTAT MACRO

The .FSTAT macro checks the status of a file specified by the file entry block. On return the AC will contain zero and bits 0-2 of LOC+2 will also be zero, stating that the device was non-directoried.

The form is:

    .FSTAT A,D

where:

    A = Device Assignment Table (.DAT) slot number
    D = Address of a three word block of storage (directory entry
        block) in user area containing the file name and the ex-
        tension of the file whose presence is to be examined.

The expansion is:

    LOC   CAL+3000$_8$+A(9-17)
    LOC+1   2   /Function code for .FSTAT
    LOC+2   D

8.6 .CLOSE MACRO

Once input has been initiated (.INIT and .READ) it must be terminated by the .CLOSE macro. The hardware flags (Data Ready and Pen Data) are cleared and the Writing Tablet(s) is disabled in order to prevent illegal interrupts.

The form is:

    .CLOSE A

where: A = Device Assignment Table (.DAT) slot number

The expansion is:

    LOC   CAL+A(9-17)
    LOC+1   6   /Function code for .CLOSE

8.7 IGNORED FUNCTIONS

The following macros are ignored by the VWA device handler:

1)   .SEEK
2)   .ENTER
3)   .CLEAR
4)   .MTAPE
5)   .WRITE
6)   .TRAN
7)   .DLETE
8)   .RENAM

CHAPTER 9

TEXT DISPLAY/EDIT FUNCTIONS

The VT15 GRAPHICS software provides the user with a complete text editing program, EDITVT, and a soft copy display feature, CONTROL X.

The EDITVT program has the same command and editing structure as the standard Editor (i.e., EDIT, refer to DEC-15-YWZB-DN) except that the majority of the text presentation takes place on the VT04 display CRT. The Control X (CTRL X) feature enables the user to, essentially, replace the console printer with the display CRT when desired.

9.1 EDITVT

Systems which have a VT15 Graphics Display unit permit the user to employ program EDITVT for editing purposes. Program EDITVT enables the user to perform soft copy editing of files using the VT15 display as a file data display device. Data is displayed in sets of either 56, 72-character lines or 28, 72-character lines. The EDITVT commands and the editing functions performed are essentially the same as those of the standard Editor program (EDIT, refer to DEC-15-YWZB-DN).

9.1.1 Setup Commands

The following command must be issued to the monitor prior to loading EDITVT:

a)	$ VT ON	Enables the VT display unit.
b)	$ HALF ON/OFF	This command is optional; it enables the user to set up a half-screen display (i.e., 28, 72-character lines) condition in which only half the screen is used for display.

The program EDITVT is loaded into core by the command "EDITVT" given to the Monitor. Once loaded, the program announces itself by outputting its name and version number on the console printer. The user must then input the command "TV ON" to initiate the VT15 display operations. VT15 display operations may be stopped at any time by the command "TV OFF".

9.1.2 Controls

The VT-15 Display console contains a horizontal strip of six square push-to-light pushbuttons which are used in display operations. These pushbuttons

are unmarked since their function is determined by software and may vary according to the particular program (system or user) which is in control of the system.

In EDIT operations, only the two rightmost pushbuttons are needed; these switches are referred to as numbers 5 and 6, based on the following numbering scheme:

```
┌─────────────────────────────────────────────────────┐
│                                                       │
│   │1│      │2│      │3│      │4│      │5│      │6│    │
│                                                       │
└─────────────────────────────────────────────────────┘
```
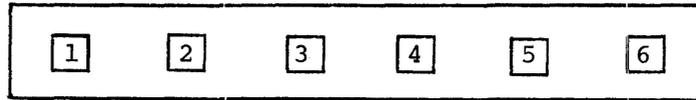
9.1.3 Display Modes

The VT-15 Display operates in two display modes:

a) SCROLL Mode - When the number 5 pushbutton is in the OFF (unlit) position, the display is in the SCROLL mode. In this mode, when the display screen is full, the next line of data to be displayed causes the displayed material to "roll" upwards, line-by-line, with new data displayed at the bottom of the screen.

b) PAGE Mode - When the number 5 pushbutton is in the ON (lit) position, the display is in the PAGE mode. In this mode, when the screen is full, the next entered material for display causes the complete, full-screen display (i.e., PAGE) to be erased; the new material is then displayed starting at the top line of the screen. When a large file is to be displayed in the PAGE mode, the number 6 control pushbutton is used to advance the display through the file page (screen) by page (screen). Each time this pushbutton is actuated, the screen is cleared and the next set (page) of data available is displayed.

9.2 CONTROL X FEATURE

The Control X feature gives the user the ability to change from hard to soft copy at any time during Monitor operation. When Soft copy is desired the user types TV ON when under Monitor Control and then a Control X. The TV ON command sets up the necessary linkage in the teletype handler and also reserves a segment of core to be used for the Display Buffer. The Control X command may be typed during Monitor Control or during System Program Control; it switches output from the device presently being used to the alternate device. (Teletype to display or display to teletype.) When the display is being used, teletype input is echoed on both the teletype and on the display while teletype output appears only on the display.

9.2.1. SCROLL Mode

When text is being output to the display and the display screen is filled (56)
lines, the next incoming line appears on the bottom of the screen and the oldest
or top line on the screen disappears. It appears as if the text is rotating
from screen bottom to screen top. The display screen may be cleared at any
time and new text begins at screen top by changing the position of pushbutton
number 6; and then typing a carriage return.

9.2.2 PAGE Mode

The display may be put in page mode operation. That means that when the dis-
play has 56 lines being presented it stops output to it so the user can inspect
the text and it then waits for the user to advance to the next page. This fea-
ture is useful for doing a PIP transfer of a large file to the display; the
file can be read on the display a page at a time. It is also useful for looking
at Macro Assemblers and FORTRAN compilations on the display. Page Mode opera-
tion is entered by setting pushbutton number 5 to the ON position; for normal
operation (text rotation across screen) pushbutton number 5 should be in the
OFF position. When in page mode, a page is advanced by changing the position
of pushbutton number 6.

9.2.3 TV ON/OFF Monitor Commands

The TV ON command sets up the interface between the VT15 Display System and the
Teletype Handler Section of the Resident Monitor. The Display Interface Code
is moved to a position directly above the Resident Monitor and essentially be-
comes a part of the resident monitor. The TV ON command also reserves a segment
of core for use as the Display Buffer. Once the TV ON command has been issued
the user has the ability to switch his output device from Teletype to display
and from display to teletype. The output device switching is accomplished by
typing a ↑X (Control X); and may be done when under monitor control or user
program control.

The feature gives the user the ability to work from an extremely fast, soft
copy output device; and easily switch to hard copy when it is desired. When ↑X
is typed, an Up-Arrow (↑) is echoed on the device selected for output. The
TV OFF command releases the reserved core segment and it frees the area of core
directly above the Resident Monitor where the Display Interface Code was moved.
The TV ON command remains in effect until TV OFF is issued or the Monitor System
is bootstrapped. If the VT15 Display System is desired as the primary output
device, TV ON may be set at System Generation time. The TV OFF command can over-
ride the System Generation setting, allowing selection of hard copy output.

9.2.4 HALF ON/OFF Monitor Command

The HALF ON/OFF command can be used in ↑X operations.

9.2.5 Differences Between CTRL X in V5A (i.e. ADSS) and in DOS.

Control X   will work slightly differently under DOS15 than under the Advanced
Monitor System (ADSS). The DOS15 Monitor also includes some additional features
associated with ↑X.

The System Generator under ADSS does not ask questions concerning TV ON/OFF
and half buffer ON/OFF settings. Under DOS15 the VT can be set to the ON posi-
tion at system generation time and then it will not be necessary for the user
to type TV ON; the same applies to HALF buffer ON. Under DOS15 the loading of
a system CUSP does not cause the display to be cleared thus requiring another
↑X to be typed. Under DOS15 the display will continue its text presentation
not only when system CUSPs are loaded but also when the Monitor is refreshed.
Control X under ADSS (V5A) is NOT supported but is available to the user.

MNEMONICS COMMONLY USED IN GRAPHICS SUBPROGRAM CALLS

The following mnemonics are commonly used in describing subroutine call statements throughout this manual.

Mnemonic	Definition
1. DELTAX	An integer number or variable which represents in raster units the amount the CRT beam is to be displaced from its current position in a horizontal direction. This quantity is signed to indicate the direction of displacement (i.e., + = move beam right − = move beam left).
2. DELTAY	Same as DELTAX except that the indicated displacement is made on a vertical direction and the directions indicated by the sign are: + = move beam up − = move beam down.
3. INT	This variable is restricted to the Integer values 1 and $\emptyset$ to indicate if the CRT beam movement is to be visible, (INT = 1) to draw a line, or invisible (INT = $\emptyset$).
4. PNAME	The subpicture display files generated by the graphic subpicture calls are stored in dimensioned integer arrays specified by the user. The integer variable PNAME specifies the first element of the array into which commands generated by a particular call are to be stored. PNAME is always represented as a subscripted variable; it will contain the length of the file and is the variable by which the file is referenced in later manipulations. NOTE: The variable PNAME may be dropped from the statement argument lists; if dropped, the last given value for PNAME will be assumed.
5. STR	Identifies the dimensioned real array which contains the string of characters to be displayed in IOPS ASCII (Hollerith) form (five 7-bit characters per word).
6. FEATR	An integer number which identifies a hardware feature(s) to be specified in the call (e.g., 1 = scale, 2 = intensity, 4 = light pen, and 8 = blink).

Mnemonic	Definition

7. VALUE

A single integer variable or constant that indicates the value or setting is specified for a selected display feature.

8. DTA

Contains the set of data points, one per word, in the range 0 to 1023 (Integer).

9. N

Used by GRAPH subprogram to indicate the number of points to graph. Also used by TEXT subprogram to indicate the number of characters to be displayed.

10. A

An integer variable or constant restricted to the values 0 and 1. Indicates which axis to increment for GRAPH subprogram, 0 = increment X, set Y to data values, 1 = increment Y, set X to data values.

11. MAINFL

Similar to PNAME, the value of MAINFL represents the first array element of the dimensioned Integer array specified by the user for storing main display file commands. MAINFL is represented as a subscripted integer variable, it contains the length of the file and is the variable by which the file is referenced.

12. CNAME

An integer variable that identifies the location or first location which contains the display command(s) generated by the call in which CNAME is an output argument.

13. NAMR

An integer which represents the contents of the name register at the time of a light pen hit (restricted to values ranging from 1 to 127).

14. PB

A six-element integer array which will contain a logical .T, or .F, for each of the six pushbuttons.

15. RST

This variable, restricted to the integer values of 1 and 0, indicates whether the hardware SAVE/RESTORE option is to be used when copying subpicture files. The value 0 indicates that the SAVE/RESTORE option is not to be used; the value 1 indicates that it is to be used.

DISPLAY INSTRUCTION GROUPS
Generated By
GRAPHICS SUBPROGRAM CALLS

SUBPROGRAM CALL	NUMBER OF COMMANDS	COMMANDS GENERATED
LINE PLOT(∅,... REPLOT(∅,...	1	If one of the eight basic directions: VN!INCR

	2	If random vector option is used:
		
		      SVX! DELTAX
		      SVY! DELTAY

	N+2	If not one of the above, required line is approximated with a series of basic vectors:
		      SKP
		      (COUNT=N+2)
		      V1
		      V2
		      .
		      .
		      .
		      VN

TEXT
PLOT(3,...
REPLOT(3,...
	3	CHARS* .+2
		    DJMP .+2
		    (FULL 15-BIT ADDRESS)

COPY
PLOT(∅,...
REPLOT(∅,...
	3	When SAVE/RESTORE is not used:
		    DJMS* .+2
		    DJMP .+2
		    (FULL 15-BIT ADDRESS)

	6	When SAVE/RESTORE is specified:
		    SAVE .+4
		    DJMS* .+2
		    DJMP .+3
		    (FULL 15-BIT ADDRESS)
		    (STATUS)
		    RSTR .-1

PRAMTR PLOT(2,... REPLOT(2,...	1-4	Adds from one to four parameter words to the display file, depending on the type of argument list used.

GRAPH	N	Adds N graph plot commands to the display file, where N is equal to the number of points in the data set:
		    GY!Y1 GX!X1
		    GY!Y2 GX!X2
		    . or .
		    . .
		    . .
		    GY!YN GX!XN

SETPT RSETPT	2	PY!Y PX!X

MACRO EXPANSION OF GRAPHICS SUBPROGRAM CALLS

Subpicture Routines

LINE

```
    .GLOBAL    LINE
    JMS*       LINE
    JMP        .+5
    .DSA       DELTAX
    .DSA       DELTAY
    .DSA       INT
    [.DSA      PNAME ]
```

TEXT

```
    .GLOBL     TEXT
    JMS*       TEXT
    JMP        .+4
    .DSA       STR
    .DSA       N
    [.DSA      PNAME ]
```

COPY

```
    .GLOBL     COPY
    JMS*       COPY
    JMP        .+4
    .DSA       RST
    .DSA       PNAME1
    [.DSA      PNAME ]
```

PRAMTR

```
    .GLOBL     PRAMTR
    JMS*       PRAMTR
    JMP        .+N
    .DSA       FEATR
    .DSA       VALUE
    [.DSA      PNAME ]
    where N=2+(Number of Features
          specified)+1 if PNAME
          is given
```

GRAPH

```
    .GLOBL     GRAPH
    JMS*       GRAPH
    JMP        .+5
    .DSA       DTA
    .DSA       N
    .DSA       A
    [.DSA      PNAME ]
```

BLANK

```
    .GLOBL     BLANK
    JMS*       BLANK
    JMP        .+2
    .DSA       PNAME
```

UNBLNK

```
    .GLOBL     UNBLNK
    JMS*       UNBLNK
    JMP        .+2
    .DSA       PNAME
```

CIRCLE

```
    .GLOBL     CIRCLE
    JMS*       CIRCLE
    JMP        .+7
    .DSA       R
    .DSA       THETA
    .DSA       GAMMA
    .DSA       DEG
    .DSA       PNAME
```

ROTATE

```
    .GLOBL     ROTATE
    JMS        ROTATE
    JMP        .+12
    .DSA       ISTR
    .DSA       IA
    .DSA       IB
    .DSA       IC
    .DSA       X
    .DSA       Y
    .DSA       Z
    .DSA       SINA
    .DSA       CSA
```

Input Routines

LTORPB

```
    .GLOBL    LTORPB
    JMS*      LTORPB
    JMP       .+6
    .DSA      IX
    .DSA      IY
    .DSA      NAMR
    .DSA      PB
    .DSA      IWICH
    DAC       I
```

TRACK

```
    .GLOBL    TRACK
    JMS*      TRACK
    JMP       .+5
    .DSA      IX
    .DSA      IY
    .DSA      IOPT
    .DSA      IARRAY
```

Relocating Routines

DYSET

```
    .GLOBL    DYSET
    JMS*      DYSET
    JMP       2*N+.+1
    .DSA      PNAME
    .DSA      ASCII
              .
              .
              .
    .DSA      PNAMEN
    .DSA      ASCIIN
              (where n = number
                        of files)
```

DYLINK

```
    .GLOBL    DYLINK
    JMS*      DYLINK
    JMP       2*N+.+1
    .DSA      PNAME1
    .DSA      ASCII1
              .
              .
              .
    .DSA      PNAMEN
    .DSA      ASCIIN
              (where N = number
                        of files)
```

Main Display File Routines

DINIT

```
    .GLOBL    DINIT
    JMS*      DINIT
    JMP       .+2
    .DSA      MAINFL
```

DCLOSE

```
    .GLOBL    DCLOSE
    JMS*      DCLOSE
```

SETPT

```
    .GLOBL    SETPT
    JMS*      SETPT
    JMP       .+4
    .DSA      X
    .DSA      Y
    [.DSA     CNAME ]
```

PLOT a COPY

```
    .GLOBL    PLOT
    JMS*      PLOT
    JMP       .+5
    .DSA      (Ø
    .DSA      RST
    .DSA      PNAME
    [.DSA     CNAME]
```

PLOT a LINE

```
    .GLOBL    PLOT
    JMS*      PLOT
    JMP       .+6
    .DSA      (1
    .DSA      DELTAX
    .DSA      DELTAY
    .DSA      INT
    [.DSA     CNAME]
```

PLOT a PRAMTR

```
    .GLOBL    PLOT
    JMS*      PLOT
    JMP       .+5
    .DSA      (2
    .DSA      FEATR
    .DSA      VALUE
    [.DSA     CNAME]
```

PLOT a TEXT string

```
    .GLOBL    PLOT
    JMS*      PLOT
    JMP       .+5
    .DSA      (3
    .DSA      STR
    .DSA      N
    [.DSA     CNAME]
```

DELETE

```
    .GLOBL    DELETE
    JMS*      DELETE
    JMP       .+2
    .DSA      CNAME
    DAC       I/ if used as function
```

REPLOT

```
    .GLOBL    REPLOT
    JMS*      REPLOT
    JMP       .+5
    .DSA      (Ø
    .DSA      RST
    .DSA      PNAME
    .DSA      CNAME
    DAC       I/ if used as function
```

REPLOT a LINE

```
    .GLOBL    REPLOT
    JMS*      REPLOT
    JMP       .+6
    .DSA      (1
    .DSA      DELTAX
    .DSA      DELTAY
    .DSA      INT
    .DSA      CNAME
    DAC       I/ if used as function
```

REPLOT a PRAMTR

```
    .GLOBL    REPLOT
    JMS*      REPLOT
    JMP       .+5
    .DSA      (2
    .DSA      FEATR
    .DSA      VALUE
    .DSA      CNAME
    DAC       I/ if used as function
```

REPLOT a TEXT string

```
    .GLOBL    REPLOT
    JMS*      REPLOT
    JMP       .+5
    .DSA      (3
    .DSA      STR
    .DSA      N
    .DSA      CNAME
    DAC       I/ if used as function
```

RSETPT

```
    .GLOBL    RSETPT
    JMS*      RSETPT
    JMP       .+4
    .DSA      X
    .DSA      Y
    .DSA      CNAME
    DAC       I/ if used as function
```

CONDITIONAL ASSEMBLY OF GRAPHICS SUBPROGRAMS

For VT15 configurations that include the Arbitrary Vector
Option, the Graphics Subprogram Package (VTPRIM) can be
conditionally assembled to eliminate coding required for
line approximation. This procedure saves approximately
174_8 locations. The standard procedure for conditional
assembly may be followed; it is only necessary to define
a value for the variable ARBVEC when assembling VTPRIM SRC.

WARNING

In writing MACRO routines, the exclamation point
(!) must not be used in memory reference type in-
structions to separate the Op-code and address
fields. The symbol ! used in this manner causes
the contents of the Op-code and address fields to
be OR'd together resulting in an erroneous 15-bit
address.

HOW TO OBTAIN SOFTWARE INFORMATION

Announcements for new and revised software, as well as programming notes, software problems, and documentation corrections are published by Software Information Service in the following newsletters.

Digital Software News for the PDP-8 & PDP-12
Digital Software News for the PDP-11
Digital Software News for the PDP-9/15 Family

These newsletters contain information applicable to software available from Digital's Program Library, Articles in Digital Software News update the cumulative Software Performance Summary which is contained in each basic kit of system software for new computers. To assure that the monthly Digital Software News is sent to the appropriate software contact at your installation, please check with the Software Specialist or Sales Engineer at your nearest Digital office.

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Maynard, Massachusetts 01754

These forms which are provided in the software kit should be fully filled out and accompanied by teletype output as well as listings or tapes of the user program to facilitate a complete investigation. An answer will be sent to the individual and appropriate topics of general interest will be printed in the newsletter.

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DEC-15-ZFSB-D

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