J Vens.

TEKTRONIX®

4655

PLOT 10

TERMINAL CONTROL SYSTEM

USER'S MANUAL

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† See Section 1.1 for an explanation.

1. INTRODUCTION

In order to allow the user to deal with many computer environments both for timesharing and mini computers, TEKTRONIX has developed the Terminal Control System software package. The package is a comprehensive set of subroutines which allows terminal-independent graphic programming; the user needs only to select the proper subroutines at load time. The design is basically system and computer independent and enables the experienced programmer to work at the terminal level and also provides the facilities for the occasional user to operate easily at the conceptual level. The Terminal Control System consists of those subroutines which support the TEKTRONIX 4006, 4010, 4012/13*, and 4014/15* Computer Display Terminals.

RELEASE 3 AND EARLIER RELEASES

1.1 THIS MANUAL IS DESIGNED FOR ALL USERS OF ANY RELEASE AND VERSION OF THE TERMINAL CONTROL SYSTEM. THE CURRENT RELEASE (RELEASE 3) IS COVERED IN THE MAIN SECTIONS OF THE MANUAL; ANY USER WHO OBTAINS THE PACKAGE AFTER THE DATE OF THIS MANUAL CAN PRESUME THAT HE HAS RELEASE 3.

PREVIOUS RELEASES OF THE TERMINAL CONTROL SYSTEM ARE ALSO COVERED IN THE MAIN SECTIONS WITH THE FOLLOWING EXCEPTIONS:

†(1) ALL ROUTINES OR HEADINGS OF SECTIONS MARKED WITH A DAGGER (†) BELONG EXCLUSIVELY TO RELEASE 3. FOR INFORMATION REGARDING EARLIER VERSIONS OF THESE ROUTINES, TURN TO APPENDIX B. IF THE ROUTINE IS NOT LISTED IN APPENDIX B, IT IS ORIGINAL WITH RELEASE 3.

(2) ROUTINES EXCLUSIVELY FOR THE TEKTRONIX 4002A TERMINAL CAN BE FOUND IN APPENDIX B.

(3) DESCRIPTIONS OF COMMON VARIABLES AND SYSTEM ROUTINES IN APPENDIX B APPLY ONLY TO RELEASES OF THE TERMINAL CONTROL SYSTEM PRIOR TO RELEASE 3.

(4) THOSE USER'S WHO RUN THE TERMINAL CONTROL SYSTEM ON MINI COMPUTERS (PDP-11) SHOULD ALSO CHECK APPENDIX B FOR SPECIAL OPERATING INSTRUCTIONS.

(5) USER'S WHO ARE CHANGING TO RELEASE 3 FROM EARLIER RELEASES OF THE TERMINAL CONTROL SYSTEM WILL FIND THE NEW PACKAGE INCOMPATIBLE WITH OLDER APPLICATIONS PROGRAMS IF AND ONLY IF THE COMMON VARIABLES HAVE BEEN ACCESSED (e.g., FOR THE TAB AND MARGIN ROUTINES OR FOR ROUTINES RSCALE AND RROTAT). UNPREDICTABLE RESULTS CAN OCCUR.

---

* The notation 4014/15 refers to either the 4014 or the 4015 terminals, the notation 4012/13 refers to either the 4012 or the 4013 terminal. The 4015 and 4013 terminals are in all ways the same as their counterparts, but offer in addition an APL character set.

THE TEKTRONIX TERMINALS

1.2 The 4006, 4010, 4012/13, and 4014/15 Computer Display Terminals are capable of displaying both alphanumeric characters and graphic data. Once written, the display remains visible until it is erased, and it is not necessary to continually refresh the information put up on the screen. The 4012 is an upper and lower case ASCII Terminal. The 4013 is an APL Terminal which also has the ASCII character set of the 4012. The 4014 and 4015 Terminals offer upper and lower case ASCII, with the 4015 also having APL capabilities.

The 4014/15* Terminals offer in addition a write-through capability, in which both stored and refreshed information may be displayed. The 4014/15 Terminals have a display area of 14.5 inches by 10.9 inches, and the user has the option of four character sizes. The 4014/15 Terminals with Enhanced Graphics Module** offer hardware dashed lines and point plotting as well as incremental point plotting. The user may also address a grid of 1024 by 1024 points or a grid of 4096 by 4096 points.

A TERMINAL CONTROL SYSTEM OVERVIEW

1.3 The ideal that the Terminal Control System strives for is to make the Terminal as easy to use as a pencil and a piece of paper. The detailed programming and general I/O handling are contained within the system; as a result the basic Terminal capabilities are made available to the user in a natural and practical manner.

The Terminal Control System subroutines communicate with each other primarily through the Terminal Status Area, a set of common variables which continuously represent the current state of the Terminal and maintain the data and flags necessary to generate output according to the user's level of need. Terminal status cannot accurately be kept when output to the Terminal is generated by other means than through the appropriate Terminal Control System routine or whenever the user changes status locally (e.g., uses the PAGE or RESET key).

The package gives many graphing conveniences to the user. Bright and dark vectors (line segments) as well as points may be displayed on the Terminal screen. A bright vector which can be seen on the screen, is caused by one of the "draw" routines. A "move" routine will cause a dark vector, the invisible equivalent of a bright vector; a "point" routine causes the display of a bright spot or point. Also included in the package are a choice of linear, logarithmic, or polar coordinate systems, automatic scaling of graphic data, and buffered input and output for faster, more efficient character handling.

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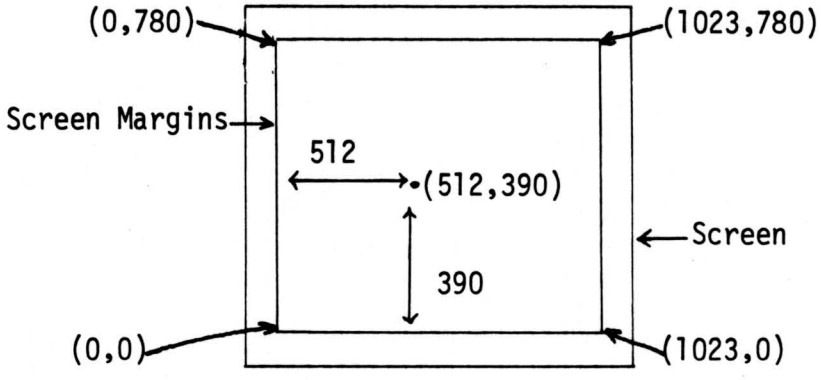
* The notation 4014/15 refers to the 4014 or the 4015 Terminal. The notation 4012/13 refers to either the 4012 or the 4013 Terminal.

** The Terminal Control System does not support special point plotting for the Enhanced Graphics Module.

The following section deals with some of the subroutines which output bright and dark vectors (draws and moves, respectively) and points using Terminal screen coordinates. The values of these coordinates should be from Ø to 1023 unless a 4014/15 Terminal with the Enhanced Graphic Module is used (in which case addressing from Ø through 4095 points is available). The Y-axis coordinates should not exceed 780 (or 3120 for the Enhanced Graphics Module) to remain visible on the screen.



Screen Coordinates*

Figure 1.3

* The Screen Margins indicate the initial settings for alphanumeric line limits on the Terminal Screen.

2. INTRODUCTORY DRAWING

INITIALIZATION:

Subroutine INITT

2.1 Initialization of the Terminal and the Terminal Status Area must be accomplished as the first step in the use of Terminal Control System routines. This may be done by calling the initializing routine, INITT. When INITT is called the following events occur:

(a) The screen is erased and the cursor (the small floating square which indicates the position where writing will occur) moves to the HOME position in the upper left hand corner of the screen .

(b) The Terminal is set to alphanumeric mode.

(c) The margin values are set to the left and right screen extremes.

(d) The window is defined so that the portion of virtual space will be displayed which is equivalent in coordinates with the screen [i.e., (275, 763) in user coordinates is equivalent to (275, 763) in screen coordinates]. See Sections 3.0 through 3.2 for a description of virtual graphics.

INITT requires the rate of character transmission from the computer to the Terminal as an input parameter in order that appropriate delays may be produced during screen erasure and hardcopy generation. This will prevent loss of data on remotely connected Terminals while they are not ready.

CALLING SEQUENCE:

```
CALL INITT (IBAUD)
```

Parameter Entered:

IBAUD - the transmission (baud) rate in characters per second.

TERMINATION: Subroutine FINITT

2.2 When terminating a program which uses the Terminal Control System, it may be desirable to return the Terminal to alphanumeric mode and move the cursor to a point that will not interfere with any previous output. In the present release (Release 3) all output to the Terminal is buffered, or stored, until the user calls a routine that dumps the buffer, or until the buffer is full.

FINITT automatically performs these functions. It terminates the program and outputs the contents of the buffer. Its arguments designate the position of the alphanumeric cursor upon program termination. FINITT should be used, depending on the computer system, either in conjunction with or in place of a FORTRAN STOP statement.

CALLING SEQUENCE:

```
CALL FINITT (IX, IY)
```

Parameters Entered:

IX - the screen x-coordinate of the position to which the beam is moved before program termination.

IY - the screen y-coordinate of the beam termination position.

ABSOLUTE LINE DRAWING IN SCREEN COORDINATES

2.3 The three functions which do line drawing by referring to screen coordinate locations are MOVABS, DRWABS, and PNTABS. "ABS" stands for absolute; the drawing is called absolute because it is measured from a fixed point, the origin (Ø,Ø). The arguments of these routines are always in integer format.

Subroutine MOVABS

2.4 The argument of MOVABS is the pair of coordinates of the point to which a move is desired. Output starts at the stored current beam position. This position is updated after every line draw or other output command. In addition, all drawings are buffered for Release 3.

CALLING SEQUENCE:

```
CALL MOVABS (IX, IY)
```

Example:

```
CALL MOVABS (1ØØ, 15Ø)
```

This call generates a move to (1ØØ, 15Ø) so that drawing can proceed from there.

Subroutine DRWABS

2.5 DRWABS generates a bright vector from the current beam position to the coordinates given and updates the appropriate variables in the Terminal Status Area.

CALLING SEQUENCE:

```
CALL DRWABS (IX, IY)
```

Example:

```
CALL MOVABS (1ØØ, 5Ø)
CALL DRWABS (3ØØ, 5Ø)
```

These calls cause a move to (1ØØ, 5Ø) and a subsequent line to be drawn from (1ØØ, 5Ø) to (3ØØ, 5Ø).

Example:

PROGRAM TO DRAW A TRIANGLE

```
CALL INITT(30)
CALL MOVABS(100,100)
CALL DRWABS(300,100)
CALL DRWABS(200,187)
CALL DRWABS(100,100)
CALL FINITT(0,767)
```

Figure 2.5

Subroutine PNTABS

2.6 PNTABS similarly moves to the coordinates given as arguments and displays a point there.

CALLING SEQUENCE:

```
CALL PNTABS (IX, IY)
```

Example:

```
CALL INITT(30)
CALL MOVABS(300,200)
CALL DRWABS(500,200)
CALL DRWABS(500,400)
CALL DRWABS(300,400)
CALL DRWABS(300,200)
CALL PNTABS(400,300)
CALL FINITT(0,767)
```

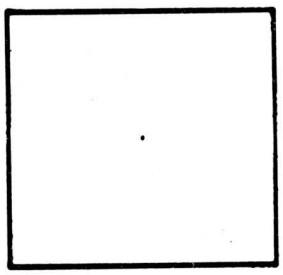


Figure 2.6

RELATIVE LINE DRAWING IN SCREEN COORDINATES

2.7 It is often easier to draw lines by indicating how many horizontal and vertical screen units to move relative to the last beam position. Negative relative movement is to the left or down, while positive movement is to the right or up. DRWREL, MOVREL, and PNTREL perform relative drawing in screen units. They have the same syntax as DRWABS, MOVABS, and PNTABS.

Example:

Draw the same box as in Figure 2.6 with relative vectors.

```
CALL INITT(30)
CALL MOVABS(300,200)
CALL DRWREL(200,0)
CALL DRWREL(0,200)
CALL DRWREL(-200,0)
CALL DRWREL(0,-200)
CALL PNTREL(100,100)
CALL FINITT(0,767)
```

SCREEN GRAPHICS

(Integer Arguments)

ACTION	*ABSOLUTE*	*RELATIVE*
MOVE	*MOVABS*	*MOVREL*
DRAW	*DRWABS*	*DRWREL*
POINT	*PNTABS*	*PNTREL*

Figure 2.7

3. VIRTUAL AND SCREEN GRAPHICS

This part deals with the most important relationships in the Terminal Control System, the translation of the User's data to a physical location on the screen. With an understanding of this relationship between the data area and the Terminal screen the User can freely manipulate the display on the screen to reflect his need. For example, he can plot three different sets of data in the same screen display.

The first group of sections in this part (1 through 6) discusses the display of the User's data area. This area may be conceived of as existing virtually within the computer, and is analogous to the sheet of paper on which graphic data is usually drawn. The data area is called virtual space. The unit of measurement in virtual space is arbitrary and representative of any unit the User wishes, from milligrams to light years.

The second group of sections in this part (7 and 8) discusses how virtual data may be displayed by screen graphics in designated portions of the Terminal screen (the screen window). Sections 9 and 10 deal specifically with the inter-dependence of virtual space graphics and screen graphics. Sections 11 and 12 discuss the drawing of dashed lines with both virtual space graphics and screen space graphics.

THE VIRTUAL WINDOW:

3.1 All or any portion of virtual space may be viewed at any time through the technique of windowing. The User defines in user units a rectangle, the virtual window, which utilizes that part of virtual space he wishes to view. Graphic lines (vectors) and portions of lines which lie outside the virtual window are automatically eliminated or clipped by the graphic routines, while those which lie within or pass through the window are scaled and fitted into the appropriate portion of the screen.

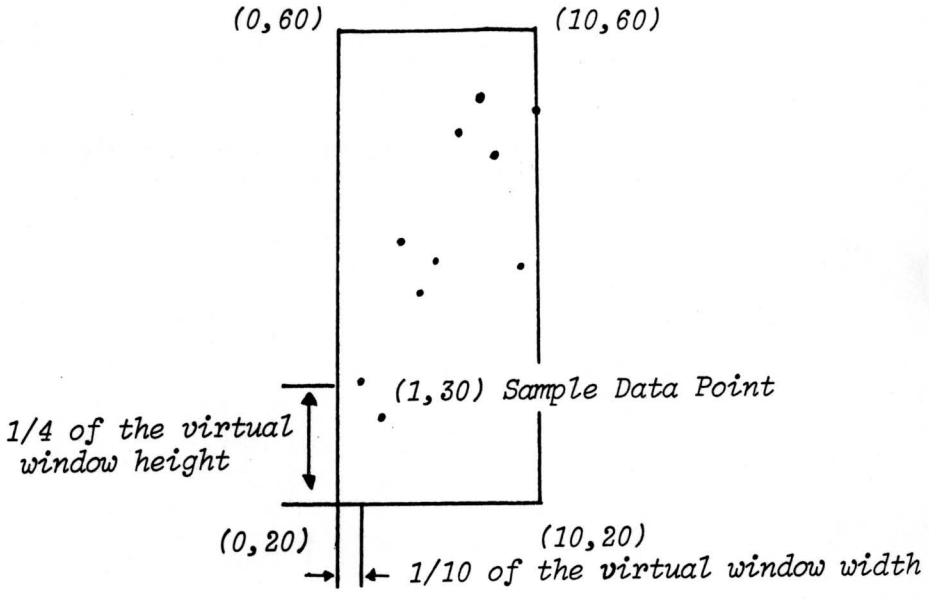
A VIEWABLE AREA IN USER UNITS: (THE VIRTUAL WINDOW)

3.2 Examine a graph as conceived in days and dollars and the method that will be used to display it on the screen. Suppose the following raw data is to be plotted:

DAY	PROFIT
1	$ 30
2	26
3	42
4	38
5	40
6	50
7	54
8	48
9	40
10	52

A virtual window is defined in virtual space with the lower lefthand corner at (Ø days, 2Ø dollars). It is to extend horizontally on the X-axis for 1Ø days and vertically on the Y-axis for 4Ø dollars. One way of defining a rectangular window is to specify the lower lefthand corner and the horizontal and vertical dimensions.

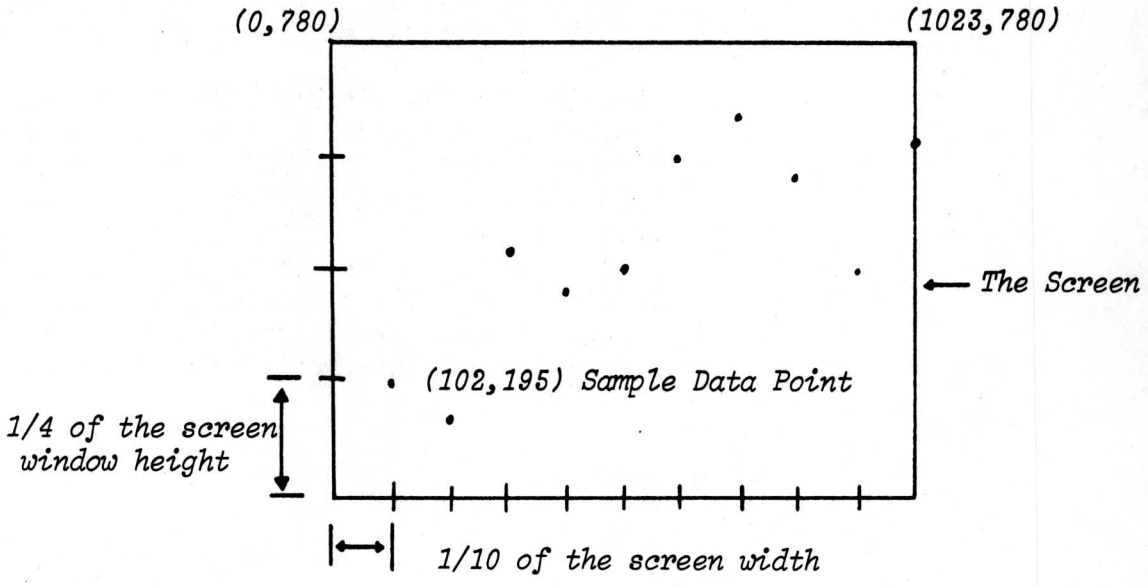
When the data is displayed on the screen, it is scaled in proportion to distances in the virtual window. Since the screen is 1024 units wide, it will be displayed (1/1Ø) x 1Ø24=1Ø2 units from left to right on the screen. The point (1,3Ø) is 1/4 of the distance, bottom to top, on the virtual window. The screen is 781 units high, so the point is displayed (1/4) x 781=195 units from the bottom of the screen (Figure 3.2). Every point on the virtual window is similarly translated to a point on the screen.



THE VIRTUAL WINDOW

Figure 3.2

(Figure 3.2 is continued on the following page.)



The Data of Figure 3.2 as Displayed on the Screen *

* The code used to display Figure 3.2 may be seen on page 15.

DEFINING THE VIRTUAL WINDOW: Subroutine VWINDO

3.3 The Terminal Control System uses one of two subroutines to define the virtual window. The first is VWINDO.

CALLING SEQUENCE:

CALL VWINDO (XMIN, XRANGE, YMIN, YRANGE)

Parameters Entered:

XMIN - the minimum horizontal user coordinate.

XRANGE - the horizontal extent of the rectangle.

YMIN - the minimum vertical user coordinate.

YRANGE - the vertical extent of the rectangle.

In the example of Figure 3.2, the calling sequence would be:

CALL VWINDO (Ø.,1Ø.,2Ø.,4Ø.)

†*Subroutine DWINDO*

3.4 A second method of defining a virtual window may be employed by using the subroutine DWINDO. DWINDO uses a calling sequence similar to that of VWINDO.

CALLING SEQUENCE:

CALL DWINDO (XMIN, XMAX, YMIN, YMAX)

Parameters Entered:

XMIN - the minimum horizontal user coordinate

XMAX - the maximum horizontal user coordinate

YMIN - the minimum vertical user coordinate

YMAX - the maximum vertical user coordinate

In the example of Figure 3.2, the calling sequence would be:

CALL DWINDO (Ø.,1Ø.,2Ø.,6Ø.)

LINE DRAWING IN USER (VIRTUAL) UNITS: Absolute Line Drawing

3.5 MOVEA, DRAWA, and POINTA are analogous to MOVABS, DRWABS, and PNTABS, but they allow points outside the virtual window to be referenced. Only those points or portions of bright vectors (line segments) which fall within the window boundaries, however, will be displayed; this is known as "clipping".

CALLING SEQUENCE:

```
CALL MOVEA (X, Y)
CALL DRAWA (X, Y)
CALL POINTA (X, Y)
```

Parameters Entered:

X - the horizontal virtual (real) coordinate to which a bright or dark vector is drawn or at which a point is displayed.

Y - the vertical virtual (real) coordinate to which a bright or dark vector is drawn or at which a point is displayed.

Using subroutine POINTA, we will display the data of Figure 3.2:

```
      CALL INITT(30)
      CALL UWINDO(0 ,10 ,20 ,40 )
      DIMENSION X(10),Y(10)
      DATA X/1.,2.,3.,4.,5.,6.,7.,8.,9.,10./
      DATA Y/30.,26.,42.,38.,40.,50.,54.,48.,40.,52./
      DO 100 I=1,10
100   CALL POINTA(X(I),Y(I))
      CALL FINITT(0,767)
```

To work in user units on the screen, one could set up a virtual window that measures eight by six units. The following code will draw a three by three unit rectangle with the lefthand corner at (1.,1.) and a point in the middle.

```
CALL INITT(30)
CALL VWINDO(0.,8.,0.,6.)
CALL MOVEA(1.,1.)
CALL DRAWA(1.,4.)
CALL DRAWA(4.,4.)
CALL DRAWA(4.,1.)
CALL DRAWA(1.,1.)
CALL POINTA(2.5,2.5)
CALL FINITT(0,707)
```

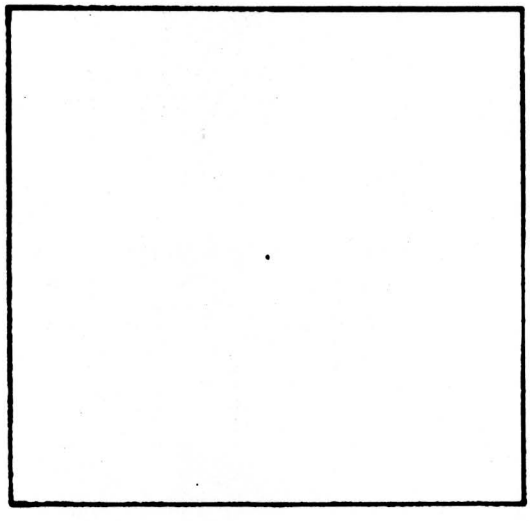


Figure 3.5

RELATIVE VIRTUAL COORDINATE SUBROUTINES

3.6 MOVER, DRAWR, and POINTR draw straight lines, move, and display points respectively, relative to the current beam position. They are analogous to MOVREL, DRWREL, and PNTREL, (Section 2.7) except that they deal with user rather than screen units and clipping, as described above, may occur.

The following code will produce the same rectangle as that of Figure 3.5.

```
CALL INITT(30)
CALL VWINDO(0 ,8 ,0 ,6 )
CALL MOVEA(1 ,1 )
CALL DRAWR(0 ,3 )
CALL DRAWR(3 ,0 )
CALL DRAWR(0 ,-3 )
CALL DRAWR(-3 ,0 )
CALL POINTR(1.5,1.5)
CALL FINITT(0,767)
```

	SCREEN GRAPHICS (*Integer Arguments*)		*VIRTUAL GRAPHICS* (*Real Arguments*)	
ACTION	*ABSOLUTE*	*RELATIVE*	*ABSOLUTE*	*RELATIVE*
MOVE	*MOVABS*	*MOVREL*	*MOVEA*	*MOVER*
DRAW	*DRWABS*	*DRWREL*	*DRAWA*	*DRAWR*
POINT	*PNTABS*	*PNTREL*	*POINTA*	*POINTR*

Figure 3.6

THE SCREEN WINDOW

3.7 So far, to display a drawing in virtual space the entire screen has been used. But any rectangular portion of the screen can be used as a display area. This display area is called the screen window, and it is defined by the subroutines SWINDO and TWINDO. The two subroutines stand in the same relation to each other as do VWINDO and DWINDO (see Sections 3.3 and 3.4); like all arguments in screen terms, the arguments of SWINDO and TWINDO are in integer format.

Subroutine SWINDO

3.7.1 CALLING SEQUENCE:

```
CALL SWINDO (MINX, LENX, MINY, LENY)
```

Parameters Entered:

MINX - the minimum horizontal screen coordinate.

LENX - the horizontal extent of the rectangle.

MINY - the minimum vertical screen coordinate.

LENY - the vertical extent of the rectangle.

† *Subroutine TWINDO*

3.7.2 CALLING SEQUENCE:

```
CALL TWINDO (MINX, MAXX, MINY, MAXY)
```

Parameters Entered:

MINX - the minimum horizontal screen coordinate.

MAXX - the maximum horizontal screen coordinate.

MINY - the minimum vertical screen coordinate.

MAXY - the maximum vertical screen coordinate.

SCALING AND STRETCHING THE SCREEN WINDOW:

3.8 The points of the virtual window are scaled to fit into the screen window in the same manner as they previously fitted into the entire screen. Consider again the data of Figure 3.2.

The following program illustrates how the size and shape of the screen window can be manipulated by changing the dimensions of TWINDO. Note that all of the virtual data is displayed in each case.

```
C * DEMONSTRATION OF SCALING AND STRETCHING
      CALL INITT (30)
      CALL DWINDO (0.,10.,20.,60.)
C * DRAW THE SAME GRAPH IN FOUR TERMINAL WINDOWS
      CALL TWINDO (0,200,550,700)
      CALL GRAFIT
      CALL TWINDO (300,900,550,700)
      CALL GRAFIT
      CALL TWINDO (0,200,0,450)
      CALL GRAFIT
      CALL TWINDO (300,900,0,450)
      CALL GRAFIT
C * MAKE HARDCOPY
      CALL HDCOPY
      CALL FINITT(0,760)
      END

C * SUBROUTINE TO DRAW GRAPH WHICH FILLS TERMINAL WINDOW
      SUBROUTINE GRAFIT
      DIMENSION X(10),Y(10)
      DATA X/1.,2.,3.,4.,5.,6.,7.,8.,9.,10./
      DATA Y/30.,26.,42.,38.,40.,50.,54.,48.,40.,52./
      CALL MOVEA(X(1),Y(1))
      DO 100 I=1,10
100   CALL DRAWA(X(I),Y(I))
      CALL MOVEA(0.,20.)
      CALL DRAWA(10.,20.)
      CALL DRAWA(10.,60.)
      CALL DRAWA(0.,60.)
      CALL DRAWA(0.,20.)
      RETURN
      END
```

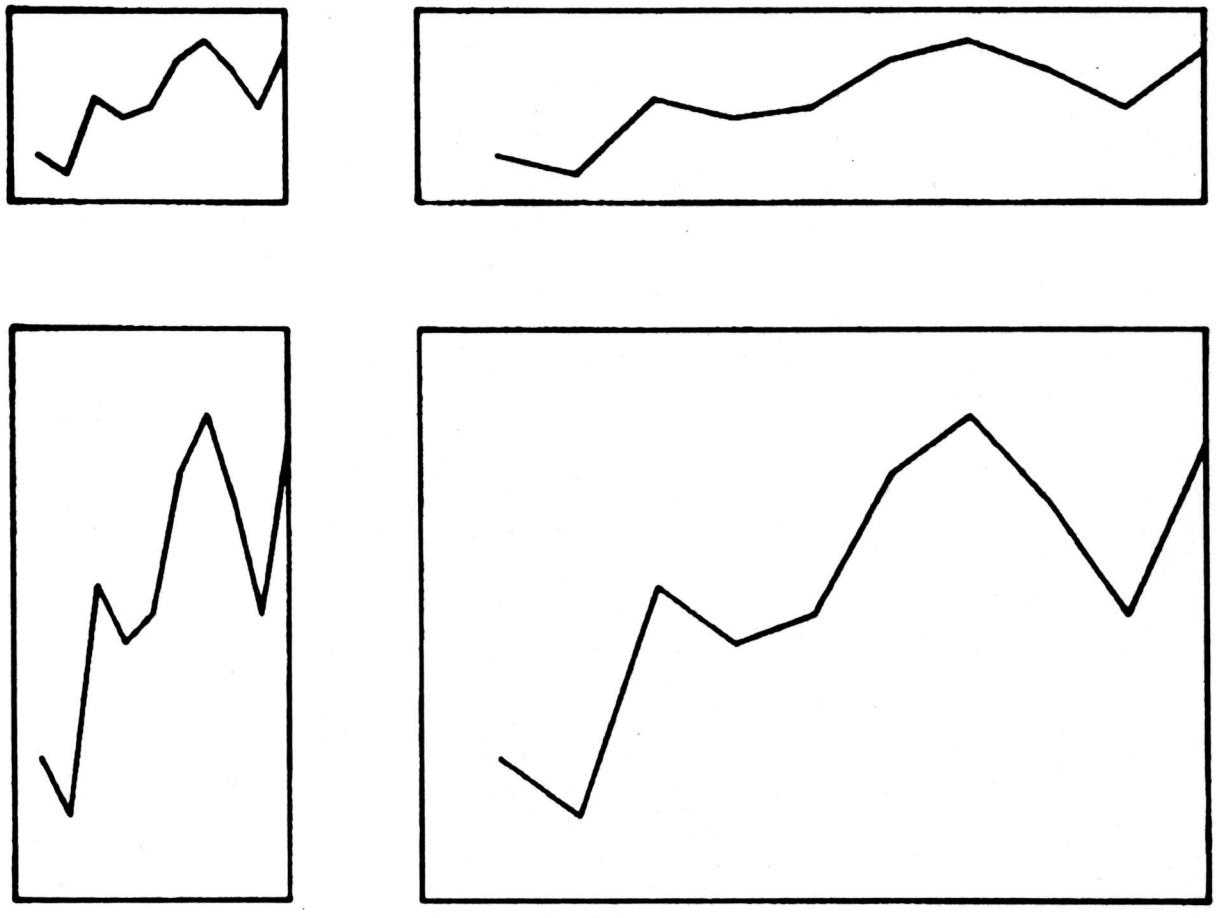


Figure 3.8

CLIPPING IN VIRTUAL SPACE:

3.9 To see only a portion of the data, the user can change VWINDO/DWINDO to include only the desired section. When drawing is done in user (virtual) units, that portion of the drawing is clipped which occurs outside the present virtual window. Clipping occurs in <u>all</u> virtual graphics:

```
      DIMENSION X(10),Y(10)
      DATA X/1.,2.,3.,4.,5.,6.,7.,8.,9.,10./
      DATA Y/30.,26.,42.,38.,40.,50.,54.,48.,40.,52./
      CALL INITT(30)
      CALL SWINDO(400,300,200,400)
      CALL VWINDO(3.,5.,40.,15.)
      CALL MOVEA(X(1),Y(1))
      DO 100 I=1,10
100   CALL DRAWA(X(I),Y(I))
      CALL MOVABS(400,200)
      CALL DRWABS(700,200)
      CALL DRWABS(700,600)
      CALL DRWABS(400,600)
      CALL DRWABS(400,200)
      CALL FINITT(0,767)
      STOP
      END
```

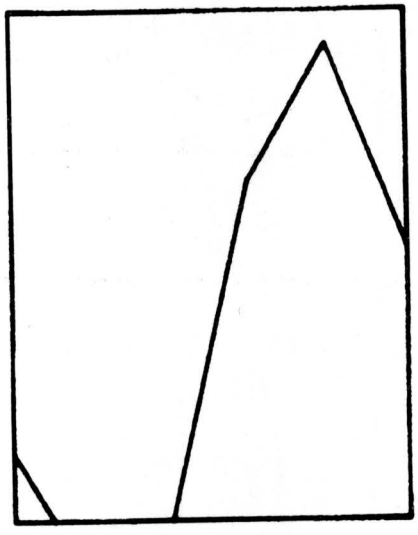


Figure 3.9

INTERCHANGEABILITY OF VIRTUAL AND SCREEN GRAPHICS:

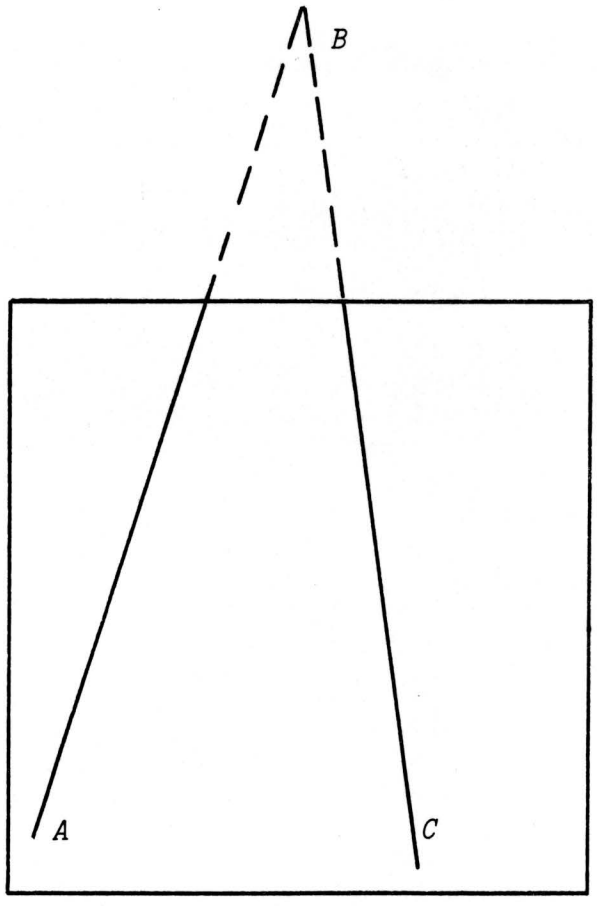
3.10 The user may locate a point in virtual space which is not within the limits of the virtual window. He may draw to and from this point with no difficulty since the drawing will automatically be scaled and clipped by the window definition. The same is not true of screen space, which is defined entirely by the limits of the screen.

Therefore, a transition from screen to virtual space can always be accomplished, but the reverse is not true. If a point in virtual space is designated which does not appear on the screen window, a draw using screen coordinates will originate at the beam's last visible position within the screen window and not at the expected virtual point. In addition the user must be aware of wrap-around if he addresses a point which is off the screen.

Example:

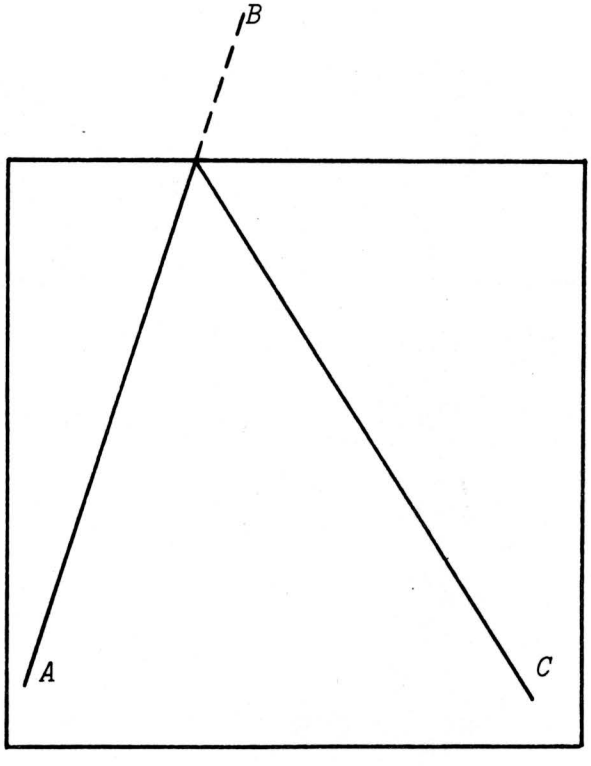
The screen coordinates (1500,0) will cause wrap-around (e.g., A relative draw to the above coordinates will result in a vector on the X-axis drawn (1500-1024) raster units from the current beam position.)

See Figure 3.10



Screen Window

A line drawn in user (virtual) coordinates from point A to point B and back to point C



A line drawn in virtual coordinates from A to B and in screen coordinates back to C. B is a point outside the screen window, but within the screen limits.

<u>This draw reflects a user error</u>

Figure 3.10

DASHED LINE DRAWING

3.11 Dashed lines of nearly infinite variety may be drawn through the use of the Terminal Control System in both virtual and screen space. The four basic dashed line subroutines are DSHABS, DSHREL, DASHA, and DASHR. These routines are analogous to DRWABS, DRWREL (Sections 2.5 and 2.7), DRAWA, and DRAWR (Sections 3.5 and 3.6); each dashed line subroutine, however, has a third, integer-format argument. This third argument controls the type of dashed line displayed, and it can take any integer value from -1 to the largest integer the computer can accept.

CALLING SEQUENCES:

```
CALL DSHABS (IX, IY, L)
CALL DSHREL (IX, IY, L)
CALL DASHA (X, Y, L)
CALL DASHR (X, Y, L)
```

IX, IY (integer) and X, Y (real) are the coordinates the dashed line is drawn to and L is the dash type specification.

* † *DASHED LINE SPECIFICATIONS: Parameter L*

3.12 Software dashed lines may be specified on any TEKTRONIX graphics display terminal with a concatenation of the following code numbers:

```
1 - 5 raster units, visible
2 - 5 raster units, invisible
3 - 10 raster units, visible
4 - 10 raster units, invisible
5 - 25 raster units, visible
6 - 25 raster units, invisible
7 - 50 raster units, visible
8 - 50 raster units, invisible
```

Example:

```
CALL DSHABS (2ØØ, 7ØØ, 3454)
```

The software also uses single digits to specify (L):

-1 causes a move

0 causes a draw

9 alternate visible and invisible segments between data points.

Example:

```
CALL DSHABS (2ØØ, 7ØØ, -1)
```

---

* User's of the Terminal Control System with earlier releases than Release 3 may use software dash codes 1 through 9. See Appendix B.

Four types of hardware dashed lines are available on the 4014/15 Terminal with Enhanced Graphic Module (see TERM, Section 5.1). The hardware dashed line specifications are fast and efficient and may be used by any TEKTRONIX Graphic Display Terminal. If the terminal hardware is not capable of generating the hardware dash, then the software will approximate the type according to the following key:

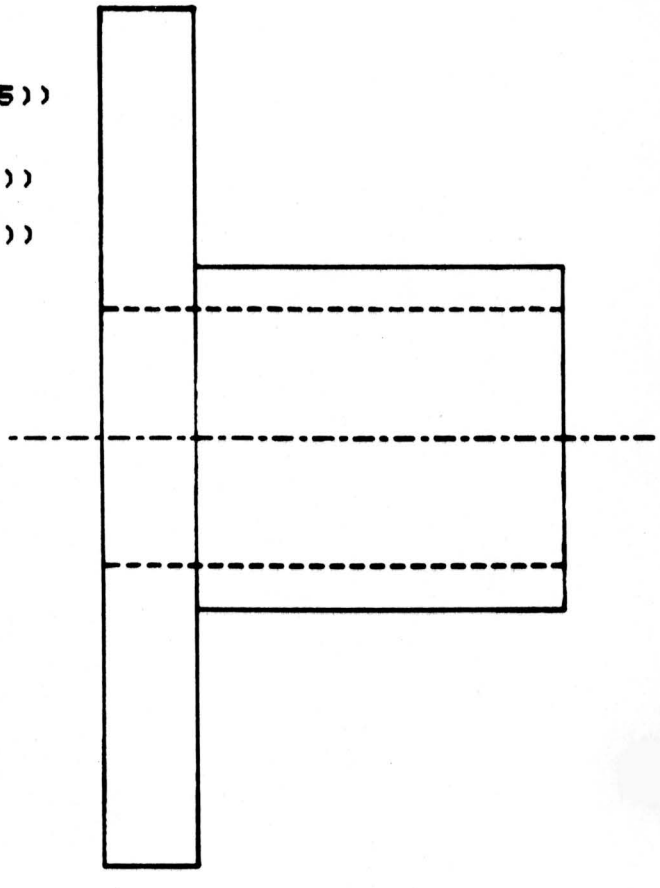
1 - a dotted line
2 - a dash-dot line
3 - a short-dashed line
4 - a long-dashed line

Example:

```
CALL DSHABS (200, 700, 2)
```

The following example illustrates two software-simulated, hardware dash types (2 and 3). Function KIN (Section 4.13), which converts inches to screen units, is used here to make relative draws:

```
C * SAMPLE DRAWING OF A FLANGE
      CALL INITT(30)
      CALL MOVABS(100,50)
      CALL DRWREL(0,KIN(5.))
      CALL DRWREL(KIN(0.5),0)
      CALL DRWREL(0,-KIN(5.))
      CALL DRWREL(-KIN(0.5),0)
      CALL MOVREL(KIN(0.5),KIN(1.5))
      CALL DRWREL(KIN(2.0),0)
      CALL DRWREL(0,KIN(2.0))
      CALL DRWREL(-KIN(2.0),0)
      CALL MOVREL(KIN(2.0),-KIN(0.25))
C * DRAW DASHED 'HIDDEN' LINES
      CALL DSHREL(-KIN(2.5),0,3)
      CALL MOVREL(KIN(2.5),-KIN(1.5))
      CALL DSHREL(-KIN(2.5),0,3)
      CALL MOVREL(KIN(3.0),KIN(0.75))
C * DRAW DASHED 'CENTER LINE'
      CALL DSHREL(-KIN(3.5),0,2)
      CALL FINITT(0,0)
      END
```



	SCREEN GRAPHICS (*Integer Arguments*)		*VIRTUAL GRAPHICS* (*Real Arguments*)	
ACTION	*ABSOLUTE*	*RELATIVE*	*ABSOLUTE*	*RELATIVE*
MOVE	*MOVABS*	*MOVREL*	*MOVEA*	*MOVER*
DRAW	*DRWABS*	*DRWREL*	*DRAWA*	*DRAWR*
POINT	*PNTABS*	*PNTREL*	*POINTA*	*POINTR*
DASH	*DSHABS*	*DSHREL*	*DASHA*	*DASHR*

Figure 3.12

ALPHANUMERIC OUTPUT

4.1 By allowing the Terminal Control System to monitor alphanumeric (A/N) output rather than using FORTRAN READ and WRITE statements, it is possible to maintain Terminal status, especially the tracking of the beam position. This tracking is required for tab and margin control as well as for facilitating the mixture of A/N and graphic output. As with graphic output in Release 3.0 alphanumeric output is buffered, or stored, until a routine is called to dump the buffer, or until the buffer is full.

ENTERING A/N MODE: Subroutine ANMODE

4.2 At times the user may wish to output A/N data other than through the Terminal Control System. In such cases it is the user's responsibility to insure that the Terminal is in A/N mode. This can be done by using ANMODE. It is not necessary to call ANMODE when using the Terminal Control System routines as they will automatically call it whenever necessary. ANMODE can be used to dump the output buffer.*

CALLING SEQUENCE:

```
CALL ANMODE
```

*A/N CHARACTER OUTPUT: Subroutine ANCHO***

4.3 Non-control alphanumeric characters are monitored when output through ANCHO. A/N mode will be entered if necessary and the Terminal Status Area representation of the screen beam position is updated as characters are output. If the outputting of the character advances the beam beyond the right margin setting, a new line is automatically generated.

The input argument is assumed to be a 7-bit ASCII, non-control character which is right-adjusted within an integer word. ANCHO does not check this input variable. Any but the expected input will result in erroneous beam status information.

ANCHO updates the beam according to the character size set. All character sizes are correctly updated in 4Ø96 grid space. In 1Ø24 space, however, only the large size characters are correctly updated; the other sizes are fractional screen units in width, forcing the beam update to be an approximation to within 1/2 a screen unit of the true beam position.

---

* If you have Terminal Control System, Release 3.0 or greater, the positioning on the Terminal screen of mixed non-Terminal Control System output (such as a FORTRAN WRITE) with Terminal Control System output is dependent upon the way in which the software package is implemented on your computer. See Section 7.11.1 for details. If all output is through the Terminal Control System, no such implementation dependencies exist.

** This routine is also discussed in Section 7.3.

CALLING SEQUENCE:

CALL ANCHO (ICHAR)

Parameter Entered:

ICHAR - An integer which represents a 7-bit ASCII character, right-adjusted. NOT a control character.

For an example of ANCHO, see Section 5.4.

A/N STRING OUTPUT

† *Subroutine ANSTR**

4.3.1 ANSTR functions in all respects like ANCHO above, except that it allows the user to output an alphanumeric string instead of a single character. The arguments of ANSTR are NCHAR, the number of characters to be output, and NADE, the array of ASCII decimal equivalent integers which represents the string to be output.

CALLING SEQUENCE:

CALL ANSTR (NCHAR, NADE)

Parameters Entered:

NCHAR the number of characters to be output.

NADE An array containing the ASCII decimal integer equivalents for the characters to be output.

4.4 A/N CHARACTER HANDLING

Subroutine NEWLIN Generates a line feed and carriage return.

CALL NEWLIN

Subroutine LINEF Generates a line feed.

CALL LINEF

---

* This routine is also discussed in Section 7.4.

Subroutine CARTN

Generates a carriage return

```
CALL CARTN
```

Subroutine HOME

Moves the alphanumeric cursor to the upper left corner of the screen.

```
CALL HOME
```

*Subroutine BAKSP**

Generates a backspace.

```
CALL BAKSP
```

Subroutine NEWPAG

Erases the Terminal screen and returns the alphanumeric cursor to the HOME position.

```
CALL NEWPAG
```

† *USING THE SCREEN CURSOR:*

*Subroutine SCURSR***

4.5 The graphic cursor may be used to specify screen coordinates directly. Calling SCURSR will activate the graphic cursor, allowing the user to position it. The cursor position is transmitted to the computer when a keyboard character is struck. This character along with the input position is returned as arguments by SCURSR. The Terminal Control System compensates for effects on the beam position caused by the graphic cursor.

CALLING SEQUENCE:

```
CALL SCURSR (ICHAR, IX, IY)
```

Parameters Returned:

ICHAR - a keyboard character, 7-bit ASCII right-adjusted.

IX - the screen x-coordinate of the graphic cursor.

IY - the screen y-coordinate of the graphic cursor.

The following example (Figure 4.5) demonstrates a use of the screen cursor. ANMODE (Section 4.2) is called to print out the coordinates of the screen cursor.

*Subroutine DCURSR***

(Covers all Terminal Control System Releases)

4.5.1 DCURSR accomplishes the same function as SCURSR above. It's calling sequence and arguments are also the same.

---

* Not supported on the 4006 Terminal. To achieve a backspace, substitute the following:

```
CALL MOVREL(-LINWDT(1),Ø)
```

** Not supported on the 4006 Terminal.

```
      CALL INITT (30)
10    CALL SCURSR (ICHAR,IX,IY)
      CALL PNTABS (IX,IY)
      CALL ANMODE
      WRITE (5,20) IX,IY
20    FORMAT (1H+,$,I5,I4)*
      IF (ICHAR.NE.83) GO TO 10
      CALL FINITT (0,0)
      END
```

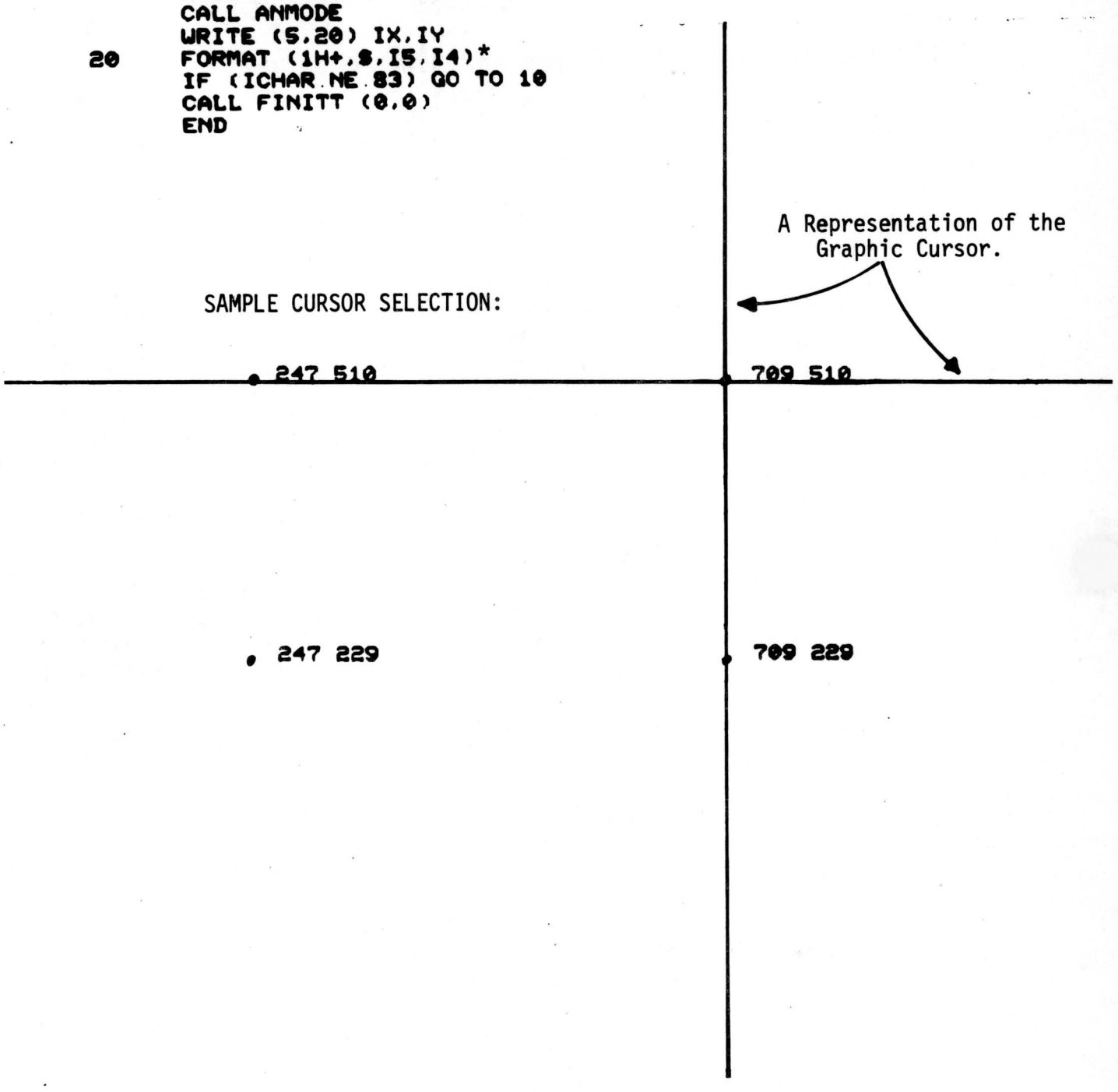


Figure 4.5

* 1H+, $ is the PDP-10 processor's carriage-return suppression format. (See Implementation Notes)

*USING THE VIRTUAL CURSOR: Subroutine VCURSR**

4.6 It is often useful to be able to retrieve virtual rather than screen coordinates with the graphic cursor. The routine VCURSR allows the user to enable the graphic cursor. After the cursor has been positioned, its screen coordinates may be transmitted to the computer by striking a keyboard character. VCURSR transforms the input data into virtual coordinates according to the current window definition. The virtual cursor does not affect the beam position.

The transformation which VCURSR effects assumes that all of the screen is a continuation of virtual space with the scale implied by the current window.

CALLING SEQUENCE:

```
CALL VCURSR (ICHAR, X, Y)
```

Parameters Returned:

ICHAR - a keyboard character, 7-bit ASCII, right-adjusted.

X - the virtual x-coordinate of the graphic cursor.

Y - the virtual y-coordinate of the graphic cursor.

The following example of VCURSR allows the user the capability of interactive line drawing. When a character is struck, a line segment is drawn or a move is made from the current beam position to the coordinates specified by the graphic cursor.

* Not supported on the 4006 Terminal.

```
      DIMENSION FRAME(8)
      DATA FRAME/1.,0.,1.,1.,0.,1.,0.,0./
      CALL INITT(120)
C *   SPECIFY MINIMUMS AND EXTENTS OF WINDOWS
      CALL SWINDO(250,500,150,500)
      CALL VWINDO(0.,1.,0.,1.)
C *   FRAME THE SCREEN WINDOW
      CALL MOVEA(0.,0.)
      DO 100 I=1,8,2
100   CALL DRAWA(FRAME(I),FRAME(I+1))
C *   SAMPLE THE CURSOR REPEATEDLY
150   CALL ANMODE
      CALL VCURSR(IBR,X,Y)
C *   A "P" IS STRUCK
      IF(IBR.EQ.80)GO TO 200
C *   A "D" IS STRUCK
      IF(IBR.EQ.68)GO TO 300
C *   AN "M" IS STRUCK
      IF(IBR.EQ.77)GO TO 400
C *   AN "S" IS STRUCK
      IF(IBR.EQ.83)GO TO 500
      GO TO 150
200   CALL POINTA(X,Y)
      GO TO 150
300   CALL DRAWA(X,Y)
      GO TO 150
400   CALL MOVEA(X,Y)
      GO TO 150
500   CALL ANMODE
      CALL FINITT(0,767)
      END
```

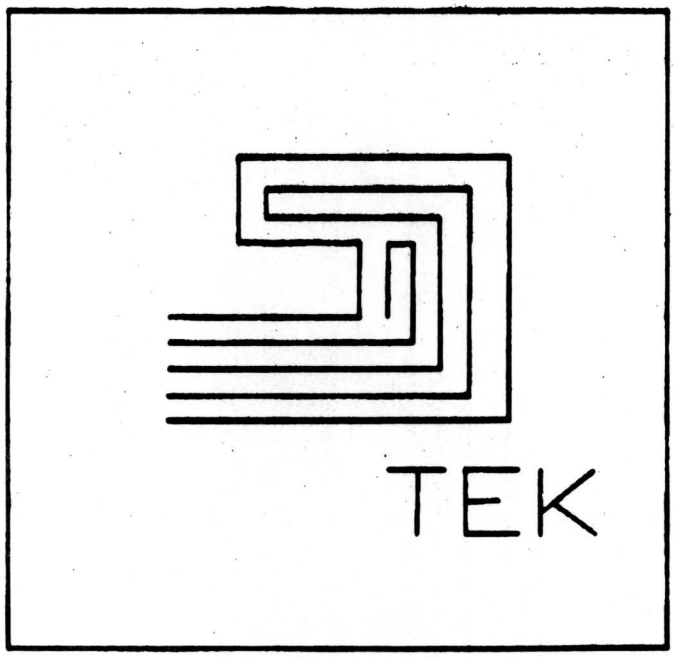


Figure 4.6

TERMINAL STATUS AREA:

4.7 The Terminal Status Area is a set of variables which are kept in a common block and represent the current state of the Terminal. The Terminal Control System allows the user to save the current Terminal status and return to it at a later time.

Although it does not save the displayed data, this facility does allow the user to interrupt his processing, move to another location, do other processing there or interact with the user, and then return to his original processing.

Since the user allocates the save areas, he may easily save more than one level of status and may restore any of his saved states at any time.

Subroutine SVSTAT

4.7.1 The current status of the Terminal may be saved by providing the status saving routine with a 60-word real array in which the Terminal Status Area may be stored.

WARNING: The status of dashed lines cannot be saved and used again reliably.

CALLING SEQUENCE:

```
CALL SVSTAT (RARRAY)
```

Parameter Entered:

RARRAY - a 60-word real array

Subroutine RESTAT

4.7.2 The Terminal may be restored to any previously saved state at any time by providing the status restoring routine with the 60-word real array in which the previous Terminal Status Area was stored.

CALLING SEQUENCE:

```
CALL RESTAT (RARRAY)
```

Parameter Entered:

RARRAY - the 60-word array containing previously stored terminal state.

```
      CALL INITT(30)
      DIMENSION IBOX(8),ITIME(8),B(60),T(60)
      DATA IBOX/200,0,0,200,-200,0,0,-200/
      DATA ITIME/80,0,-80,120,80,0,-80,-120/
      CALL MOVABS(400,300)
C     SAVE CURRENT TERMINAL STATUS
      CALL SVSTAT(B)
      CALL MOVABS(460,340)
      CALL SVSTAT(T)
      DO 100 N=1,7,2
      CALL DRWREL(ITIME(N),ITIME(N+1))
      CALL SVSTAT(T)
C     RESTORE STATUS
      CALL RESTAT(B)
      CALL DRWREL(IBOX(N),IBOX(N+1))
      CALL SVSTAT(B)
100   CALL RESTAT(T)
C     OPTIONAL HARDCOPY
      CALL HDCOPY
      CALL FINITT(0,767)
      STOP
      END
```

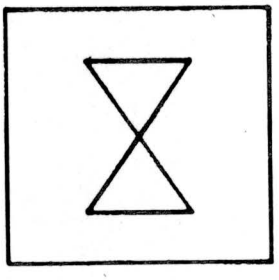


Figure 4.7

† *RESCALING A GRAPHIC OUTPUT:*

*Subroutine RSCALE**

4.8 A graphic figure drawn with relative coordinates may be rescaled by any virtual, relative factor which is compatible with the virtual window definition; that is, a figure will be clipped if its dimensions exceed the limits of the virtual window.

CALLING SEQUENCE:

CALL RSCALE (FACTOR)

Parameter Entered:

FACTOR - the rescaling factor relative to the original size of the display.

† *ROTATING GRAPHIC OUTPUT:*

*Subroutine RROTAT**

4.9 A graphic figure drawn with relative coordinates may be rotated at any angle relative to its original display position.

CALLING SEQUENCE:

CALL RROTAT (DEG)

Parameter Entered:

DEG - the angle of rotation relative to the position of the original display.

The following example draws a triangle, then rescales it by a factor of 2 and rotates it by 90° to obtain the second triangle.

```
      CALL INITT(30)
      CALL TRIANG(200 ,200 )
C     DOUBLE SCALE SIZE
      CALL RSCALE(2 )
      CALL RROTAT(90 )
C     ROTATED 90 DEGREES AND REDRAW
      CALL TRIANG(700 ,400 )
      CALL TINPUT(K)
      CALL FINITT(10,10)
      STOP
      END

      SUBROUTINE TRIANG(X,Y)
      CALL MOVEA(X,Y)
      CALL MOVER(-100 ,-100 )
      CALL DRAWR(200 ,0 )
      CALL DRAWR(-100 ,200 )
      CALL DRAWR(-100 ,-200 )
      CALL POINTR(100 ,100 )
      RETURN
      END
```

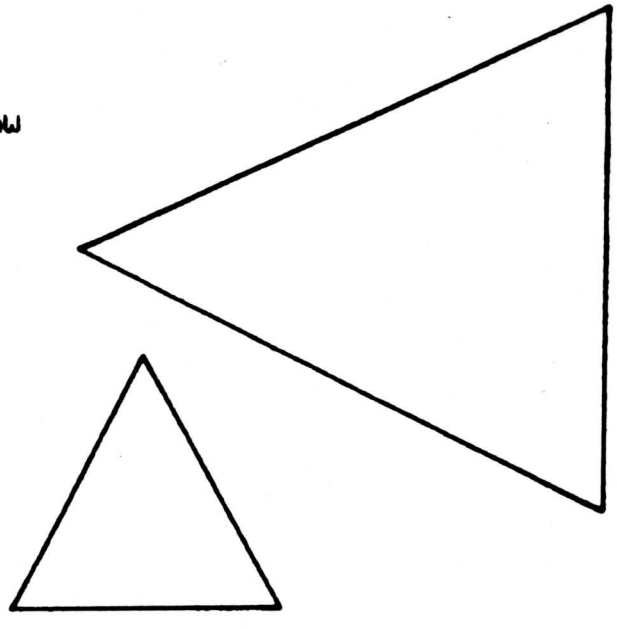


Figure 4.9

---

* Those user's who run the TEKTRONIX Character Generator (Part No. 062-1494-00) should delete the above programs from their Character Generator software and use these subroutines in their place.

† *Subroutine RESET*

4.10 This routine accomplishes the same function as INITT (see Section 2.1), but it does not call for a new page.

CALLING SEQUENCE:

```
CALL RESET
```

† *Subroutine RECOVR*

4.11 RECOVR updates the Terminal hardware to match the Terminal Status Area variables. It is useful following output to the Terminal which is outside the realm of the Terminal Control System (e.g., a FORTRAN WRITE).

CALLING SEQUENCE:

```
CALL RECOVR
```

MISCELLANEOUS UTILITY ROUTINES: Subroutine HDCOPY

4.12 The user who is equipped with the TEKTRONIX hardcopy unit appropriate to his terminal may have the computer generate a hardcopy of the screen contents at any time. This may be accomplished while in any mode and does not affect the Terminal Control System status. The system will prevent generation of additional output until the hardcopy is completed.

CALLING SEQUENCE:

```
CALL HDCOPY
```

Subroutine ERASE

The terminal screen may be erased without changing the mode or beam position. The Terminal Control System will prevent generation of additional output until the erase is completed.

CALLING SEQUENCE:

```
CALL ERASE
```

Subroutine BELL

An audible tone may be output at any time to call the user's attention to a particular event. Often a sustained audible output, which may be generated by a series of calls to the bell routine is used for an alarm. The "bell" may be sounded while in any mode except GIN (Graphic Input) mode and has no affect on Terminal status.

CALLING SEQUENCE:

```
CALL BELL
```

† *Subroutine SEETW* Returns the current values of the screen window.

CALLING SEQUENCE:

```
CALL SEETW (MINX, MAXX, MINY, MAXY)
```

Parameters Returned:

MINX - the minimum horizontal screen coordinate.
MAXX - the maximum horizontal screen coordinate.
MINY - the minimum vertical screen coordinate.
MAXY - the maximum vertical screen coordinate.

† *Subroutine SEEDW* Returns the current values of the virtual window limits.

CALLING SEQUENCE:

```
CALL SEEDW (XMIN, XMAX, YMIN, YMAX)
```

Parameters Returned:

XMIN - the minimum horizontal user coordinate.
XMAX - the maximum horizontal user coordinate.
YMIN - the minimum vertical user coordinate.
YMAX - the maximum vertical user coordinate.

† *Subroutine SEEREL* Returns the values of the common variables used by the relative virtual routines to scale and rotate vectors.

CALLING SEQUENCE:

```
CALL SEEREL (RCOS, RSIN, SCALE)
```

Parameters Returned:

RCOS - the cosine of the rotation angle
RSIN - the sine of the rotation angle
SCALE - the multiplier used for scaling

† *Subroutine SEETRN* Returns the value of the common variables set by the window and transformation routines.

CALLING SEQUENCE:

```
CALL SEETRN (XFAC, YFAC, KEY)
```

Parameters Returned:

XFAC - the x scale factor
YFAC - the y scale factor
KEY - the transformation key
1 = line
2 = log
3 = polar

CONVERSION OF INCHES TO SCREEN UNITS:

Function KIN

4.13 The function routine KIN transforms inches to screen units. It provides the number of raster units in (RI) inches.

CALLING SEQUENCE:

Variable = KIN (RI)

Parameter Entered:

RI - the number of inches

Parameter Returned:

KIN - the number of raster units in (RI) inches

Example:

KIN is a means of determining a screen position when the user wishes to work with virtual units.

```
IX = KIN (1.4)

CALL DRWREL (IX ,0)
```

CONVERSION OF CENTIMETERS TO SCREEN UNITS:

Function KCM

4.14 The function routine KCM transforms centimeters to screen units. It provides the number of raster units in (RC) centimeters.

CALLING SEQUENCE:

Variable = KCM (RC)

Parameter Entered:

RC - the number of centimeters

Parameter Returned:

KCM - the number of raster units in (RC) centimeters

Example:

KCM is a means of determining a screen position when the user wishes to work with virtual units.

```
IX = KCM (3.5)

CALL DRWREL (IX ,0)
```

MEASURING THE WIDTH OF CHARACTERS:

† *Function LINWDT*

4.15 LINWDT provides the width in raster units as an accurate measure of the horizontal size of a given number of adjacent characters. The context is the current screen coordinate system (1024 addressable points vs. 4096 addressable points).

CALLING SEQUENCE:

Variable = LINWDT (NUMCHR)

Parameter Entered:

NUMCHR - the number of adjacent characters for which the width in raster units is desired

Parameter Returned:

LINWDT - the width in raster units of NUMCHR characters in the current character size

MEASURING THE HEIGHT OF LINES:

† *Function LINHGT*

4.16 LINHGT provides in raster units the accurate measure of the height of a given number of lines.

CALLING SEQUENCE:

Variable = LINHGT (NUMLIN)

Parameter Entered:

NUMLIN - the integer number of lines for which the height in raster units is desired

Parameter Returned:

LINHGT - the height in raster units of NUMLIN lines in the current character size (see CHRSIZ, Figure 5.3).

TABS AND MARGINS

4.17 The Terminal Control System allows the user to set and reset tabs and margins to facilitate format layout. The tab and margin settings are software generated and as such are useful only for A/N output through Terminal Control System routines. All tab and margin values are in screen coordinates. Both horizontal and vertical tabs and left and right margins are available; both horizontal and vertical tabs are limited to ten positions each.

† *SETTING THE TAB TABLE:*

Subroutine TTBLSZ

4.17.1 Tab settings for both horizontal and vertical tabs are kept in two ten-word integer arrays. The settings are ordered with ascending screen coordinates, the first zero value indicating the end of the settings. TTBLSZ sets up the size of the integer array. The horizontal and vertical arrays must be equal in size.

CALLING SEQUENCE:

```
CALL TTBLSZ (ITBLSZ)
```

Parameter Entered:

ITBLSZ - the size of the tab table (horizontal and vertical) expressed as an integer from 1 to 10.

TAB SETTING:

† *Subroutine SETTAB*

4.17.2 The routine SETTAB takes a given tab setting in screen coordinates and inserts it into the given tab table. If the tab is full, the maximum setting will be lost in order that a lessor tab setting may be inserted. Although duplicate tab settings are not inserted, SETTAB does not generally check the tab setting for validity nor does it know whether the given tab table is horizontal or vertical.*

CALLING SEQUENCE:

```
CALL SETTAB (ITAB, ITBTBL)
```

Parameters Entered:

ITAB - tab setting in either X or Y coordinates.

ITBTBL - the horizontal or vertical tab table (Array Name).

---

* SETTAB expects ITBTBL to be initialized to zero. If the system does not do this automatically, the user should do it with a DATA statement.

REMOVING A TAB:

† *Subroutine RSTTAB*

4.17.3 To remove a tab selectively, its position in screen coordinates (ITAB) must be entered along with the proper tab table. Non-zero values which do not correspond to a current tab setting are ignored. If the value of the tab position is Ø, the entire tab table will be removed.

CALLING SEQUENCE:

CALL RSTTAB (ITAB, ITBTBL)

Parameters Entered:

ITAB - the X or Y screen coordinate of the tab to be removed. If the number is Ø, all tabs in the tab table designated will be removed.

ITBTBL - the horizontal or vertical tab table (Array Name).

THE HORIZONTAL TAB:

† *Subroutine TABHOR*

4.17.4 Calling the horizontal tab routine will cause the alphanumeric cursor to be moved with a constant Y-value to the position specified by the first non-zero entry in the horizontal tab table, IHORZ, which is greater than the current screen X-coordinate of the cursor or beam position. If the horizontal tab table is empty, no action will occur. If the tab table is not empty and no entry exists which is greater than the current screen X-coordinate of the cursor or beam position, or if the first non-zero entry greater than the screen X-coordinate is also greater than the right margin setting, a new line will be generated.

CALLING SEQUENCE:

CALL TABHOR (ITBTBL)

Parameter Entered:

ITBTBL - the name of the horizontal table.

THE VERTICAL TAB:

† *Subroutine TABVER*

4.17.5 Vertical tabbing will cause the alphanumeric cursor to be moved with a constant X-value to the position specified by the last non-zero entry in the vertical tab table which is less than the current Y-coordinate of the cursor on beam position. If no such entry exists, then no action is taken.

CALLING SEQUENCE:

```
CALL TABVER (ITBTBL)
```

Parameter Entered:

ITBTBL - the name of the vertical tab table (see SETTAB, Section 4.17.2).

The following example sets the tabs and resets them, putting out characters with the help of subroutine ANCHO (Section 4.3).

```
      DIMENSION IHORZ(4),IVERT(4)
      CALL INITT (30)
      CALL TTBLSZ (4)
      CALL SETTAB (20,IHORZ)
      CALL SETTAB (50,IHORZ)
      CALL SETTAB (250,IHORZ)
      CALL SETTAB (400,IHORZ)
      CALL SETTAB (750,IVERT)
      CALL SETTAB (600,IVERT)
      CALL SETTAB (500,IVERT)
      CALL SETTAB (233,IVERT)
      DO 100 IVTAB=1,4
      IF (IVTAB.EQ.3) CALL RSTTAB (250,IHORZ)
      IF (IVTAB.EQ.3) CALL SETTAB (150,IHORZ)
      CALL TABVER (IVERT)
      DO 50 IHTAB=1,4
      CALL TABHOR (IHORZ)
      LTR=64+IHTAB+4*(IVTAB-1)
      CALL ANCHO (LTR)
50    CONTINUE
      CALL NEWLINE
100   CONTINUE
      CALL FINITT (0,0)
      END
```

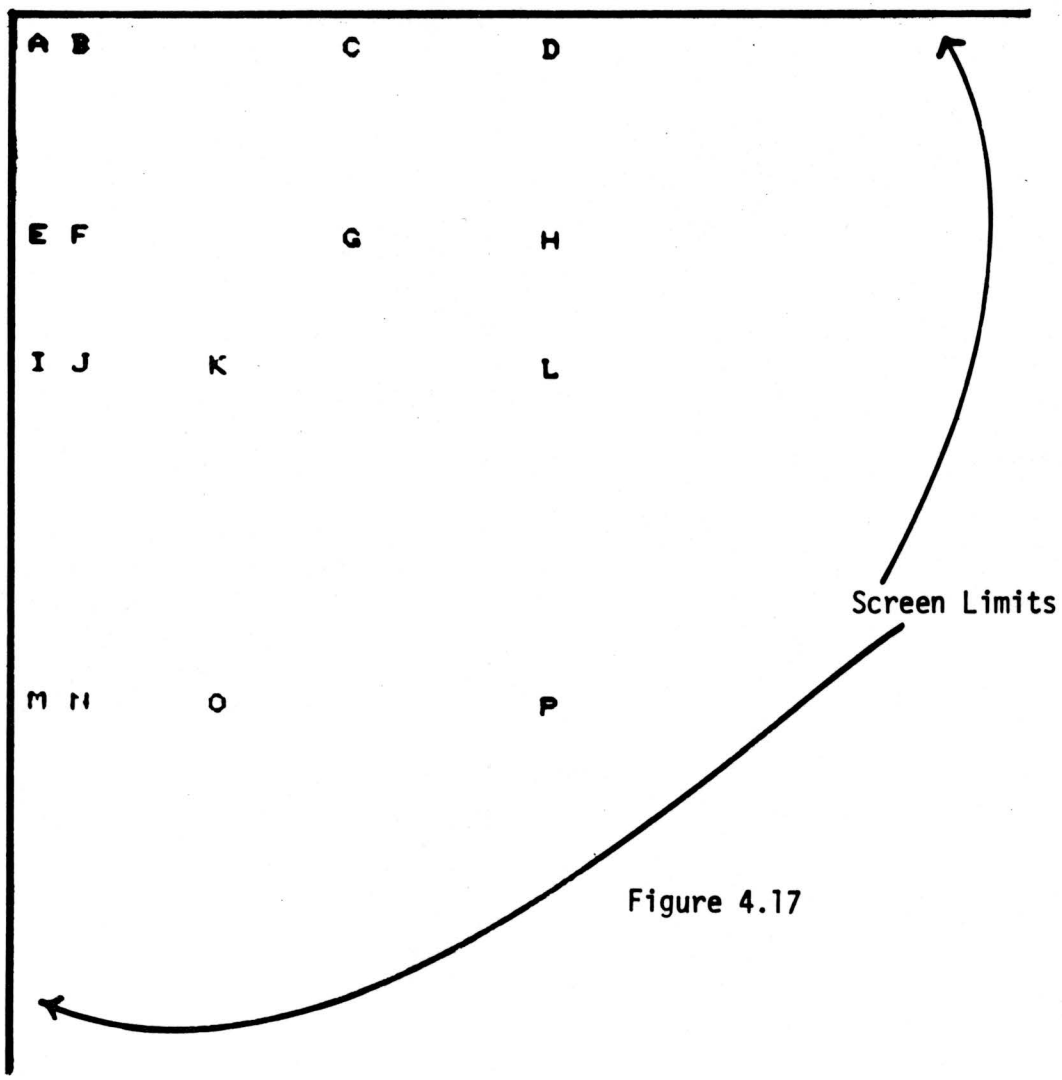


Figure 4.17

† *SETTING THE MARGINS:*

Subroutine SETMRG

4.17.6 This routine sets the left and right margins to be used by Carriage Return (CARTN), HOME, and NEWPAG (see Section 4.4).

CALLING SEQUENCE:

```
CALL SETMRG (MLEFT, MRIGHT)
```

Parameters Entered:

MLEFT - the screen coordinate at which a line of alphanumeric output starts. Its value should always be greater than Ø and less than the maximum screen coordinate (1023 or 4095) or the right margin value.

MRIGHT - the screen coordinate at which a line of A/N output ends. Its value should always be greater than MLEFT and less than the maximum screen coordinate (1023 or 4095).

† *LEVEL CHECKING:*

Subroutine TCSLEV

4.18 This routine returns the last date of modification for the Terminal Control System as well as the release number.

CALLING SEQUENCE:

```
CALL TCSLEV (LEVEL)
```

Parameter Returned:

LEVEL - a seven digit number of the form YYDDDRR.

YY = the year of modification.
DDD = the julian day.
RR = the release number. A decimal point is implied between the first and second integers.

Example:

7530033 = 1975, day 300, Release 3.3

5. ROUTINES WHICH SUPPORT THE 4014 or 4015* TERMINAL

The following routines specifically support the 4014 Display Terminal and the 4014/15 with the Enhanced Graphics Module.** The Terminal Control System is compatible in its entirety with the 4014/15 Terminal, but the special routines allow the Terminal to utilize its extra capabilities.

The 4014/15 Enhanced Terminals have an addressable range of points from Ø through 4095 on each axis, although its normal range is from Ø through 1023 points. The address character sequences used by both address ranges are compatible with all TEKTRONIX Graphic Display Terminals; however, when using the 4096 range of addressable points on the 4006, 4010, 4012, or 4013 Terminals, the resolution is only to every fourth address point.

That a 4014 or a 4015 is being used, with or without the Enhanced Graphics Module, is specified by the first parameter of Subroutine TERM (Section 5.1).

† *IDENTIFYING THE 4014/15 TERMINAL:*

Subroutine TERM

5.1 In order to take advantage of the extra features of the TEKTRONIX 4014/15 Terminal, the user must inform the Terminal Control System that he has the capability. He does this by specifying his Terminal with Subroutine TERM. If he does not use TERM before calling 4014/15 routines, the Terminal Control System will treat his Terminal as a 4010 or a 4012/13 Terminal. TERM needs to be called only once, however, after each initialization (i.e., call to INITT).

CALLING SEQUENCE:

```
CALL TERM (ITERM, ISCAL)
```

Parameters Entered:

ITERM - an integer from 1 to 3 where:

- 1 - indicates 4006, 4010, 4012/13
- 2 - indicates 4014/15
- 3 - indicates 4014/15 with Enhanced Graphics Module

ISCAL - either 1024 (addressable points) or 4096 (addressable points)

---

* The 4015 Terminal and 4013 Terminal offer an APL character set as well as the ASCII character set available on the 4014 and 4012 Terminals. The notation 4014/15 refers to either the 4014 or the 4015 Terminal; the notation 4012/13 refers to either the 4012 or 4013 Terminal.

** The Terminal Control System does not support Special Point Plotting for the Enhanced Graphics Module.

† *MODIFYING THE Z-AXIS OF THE 4014/15 TERMINAL: Subroutine CZAXIS*

5.2 Vectors on the 4014 or 4015 Terminal cannot only vary in X and Y position; they also vary in brightness and storage properties. This third type of variation is called the Z-axis capability. The 4014/15 Terminal has four Z-axis capabilities.

Normal Z-Axis - This is the same storage tube mode which is available on the 4010 Terminal. The display is bright and sharp. It is also stored on the screen until it is erased by a call to NEWPAG or ERASE (Sections 4.4 and 4.12). Normal Z-axis is the default mode and is used at all times unless a call to CZAXIS is made.

Defocused Z-Axis - This mode is in all respects similar to normal mode, except that the display is results in broader lines and is slightly brighter.

Enabled Write Through Mode - This mode allows a stored display and refreshed information to coexist on the Terminal screen. For example, the user may wish to display a graph, yet add moving vectors to the original graph. These vectors must be refreshed.

CALLING SEQUENCE:

```
CALL CZAXIS (ICODE)
```

Parameter Entered:

ICODE - an integer from Ø through 3 calls the Z-axis mode

- Ø - normal Z-axis
- 1 - defocused Z-axis
- 2 - enabled write-through mode

† *CHANGING THE CHARACTER SIZE ON THE* 4014/15 *TERMINAL:*

Subroutine CHRSIZ

5.3 The 4014/15 Terminal has four different available character sizes which range from a very small 133 characters per line size to a very large 74 characters per line size. CHRSIZ changes both the current character size and the variables associated with the change. The default size is size 1 (see below).

CALLING SEQUENCE:

X

CALL CHRSIZ (ICHAR)

Parameter Entered:

ICHAR - an integer which has one of the following values representing the number of characters per line (c.p.l.) of the selected size.

CHARACTER SIZE	CHARACTERS/LINE	NO. of LINES
1	74	35
2	81	38
3	121	58
4	133	64

MEASURING THE SIZE OF A CHARACTER:

Subroutine CSIZE

5.4 CSIZE provides the current character height and width in raster units. The characters are measured in the screen coordinate system in use, either 1024 or 4096. This subroutine is useful for imposing alphanumeric characters on graphic displays, primarily in the case of labeling. It allows the user to see where his label ought to be placed to coincide with grid lines and tic marks. When dealing with the multiple character sizes available on the 4014 Terminal, this routine is especially helpful.

CALLING SEQUENCE:

X

CALL CSIZE (IHORZ, IVERT)

Parameters Returned:

IHORZ - the horizontal character dimension, including inter-character space; the horizontal distance between two periods.

IVERT - the vertical distance, as above, including interline spacing.

The following example demonstrates a use of CSIZE and CHRSIZ. Subroutine ANCHO (Section 4.3) is used to output the alphanumeric character.

```
C * DEMONSTRATION OF CHRSIZ AND CSIZE
      CALL INITT (30)
C * USE A SUBROUTINE TO DO THE WORK
      CALL TERM (3,1024)
      CALL SUB1 (0,400,1)
      CALL SUB1 (500,400,2)
      CALL SUB1 (0,0,3)
      CALL SUB1 (500,0,4)
      CALL FINITT (0,0)
      END

C * SUBROUTINE TO CHANGE AND MEASURE CHARACTER SIZE
C * AND POSITION OUTPUT
      SUBROUTINE SUB1 (IX,IY,ICHRSZ)
C * SET UP THE MESSAGE ARRAY
      DIMENSION IMSG (55)
      DATA IMSG /67,72,65,82,65,67,84,69,82,32,83,73,90,69,
     &           32,73,83,32,0,0,32,88,32,0,0,32,84,69,75,80,79,73,
     &           78,84,83,44,0,0,32,88,32,0,0,32,77,73,78,73,80,79,
     &           73,78,84,83,46/
C * DRAW A BOX FOR OUTPUT
      CALL MOVABS (IX,IY)
      CALL DRWREL (310,0)
      CALL DRWREL (0,310)
      CALL DRWREL (-310,0)
      CALL DRWREL (0,-310)
C * SET AND MEASURE CHARACTER SIZE IN 4096 SPACE
      CALL TERM (3,4096)
      CALL CHRSIZ (ICHRSZ)
      CALL CSIZE (IHORZ,IVERT)
      IMSG(37)=IHORZ/10+48
      IMSG(38)=IHORZ-IHORZ/10*10+48
      IMSG(42)=IVERT/10+48
      IMSG(43)=IVERT-IVERT/10*10+48
C * SET AND MEASURE CHARACTER SIZE IN 1024 SPACE
      CALL TERM (3,1024)
      CALL CHRSIZ (ICHRSZ)
      CALL CSIZE (IHORZ,IVERT)
      IMSG(19)=IHORZ/10+48
      IMSG(20)=IHORZ-IHORZ/10*10+48
      IMSG(24)=IVERT/10+48
      IMSG(25)=IVERT-IVERT/10*10+48
C * POSITION AND PUT OUT MESSAGE
      CALL MOVABS (IX,IY)
      CALL MOVREL (20,200)
      DO 100 I=1,15
100   CALL ANCHO (IMSG(I))
      CALL ANCHO (ICHRSZ+48)
      I2LNDN=-2*IVERT
      CALL MOVREL (-16*IHORZ,I2LNDN)
      DO 200 I=16,36
200   CALL ANCHO (IMSG(I))
      CALL MOVREL (-21*IHORZ,I2LNDN)
      DO 310 I=37,55
310   CALL ANCHO (IMSG(I))
      RETURN
      END
```

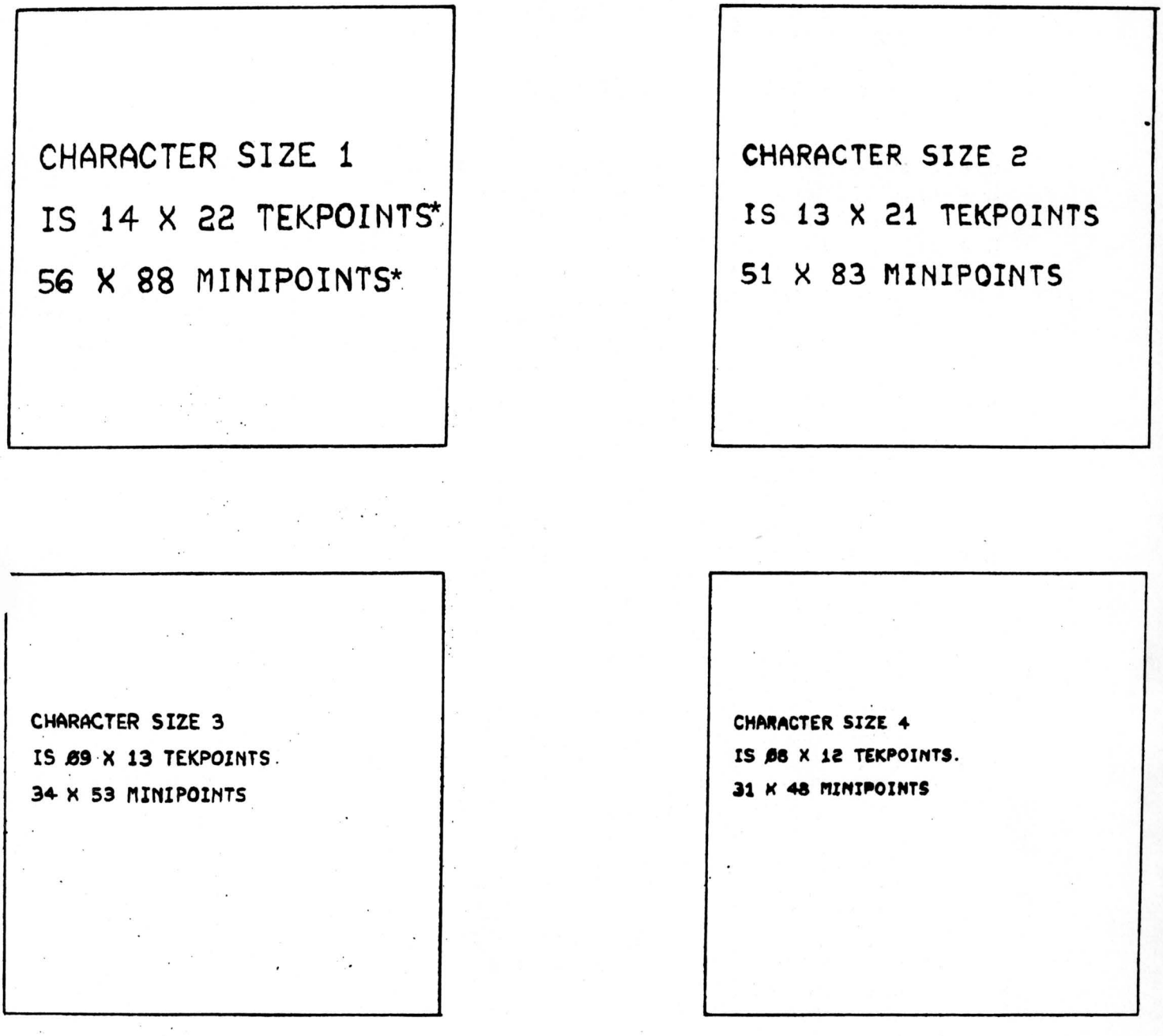


Figure 5.4

* TEKPOINTS means addressable points in 1024 x 1024 space;

* MINIPOINTS means addressable points in 4096 x 4096 space.

† *INCREMENTAL PLOTTING:*

Subroutine INCPLT

5.5 INCPLT is used to perform incremental plotting. Each incremental plot character will move the beam one raster unit in the given direction. The user specifies the direction, whether it is to be visible or invisible and whether he wishes this plot character to be output. The user must have a 4014 or 4015 with the Enhanced Graphics Module and have specified a 4096 grid in his call to TERM (Section 5.1).

CALLING SEQUENCE:

CALL INCPLT (IONOFF, IDIR, NO)

Parameters Entered:

IONOFF — Ø = Beam off (invisible)
1 = Beam on (visible)

IDIR — Direction Code

NO — the number of times the plot character is to be repeated.

Direction Code:

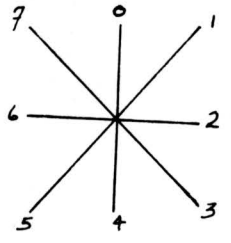
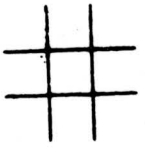


Figure 5.5

Example:

```
CALL INITT (30)
CALL TERM (3,4096)
CALL MOVABS (200,200)
CALL INCPLT (1,0,300)
CALL INCPLT (0,2,100)
CALL INCPLT (1,4,300)
CALL INCPLT (0,1,100)
CALL INCPLT (1,6,300)
CALL INCPLT (0,0,100)
CALL INCPLT (1,2,300)
CALL FINITT (0,0)
END
```



CHECK TERMINAL MODES:

† *Subroutine SEEMOD*

5.6 SEEMOD returns the value of common variables indicating the status of the hardware dashed line type, Z-axis mode, and Terminal mode. (See Sections 3.12 and 5.2.)

CALLING SEQUENCE:

```
CALL SEEMOD (LINE, IZAXIS, MODE)
```

Parameters Returned:

LINE - the hardware line type in effect

IZAXIS - the hardware Z-axis mode

MODE - the software mode:

Ø = alphanumeric
1 = vector
2 = point plot
3 = incremental plot
4 = dash

CHECK TERMINAL:

† *Subroutine SEETRM*

5.7 SEETRM returns the common variables which identify terminal speed, type, character size, and the maximum range of addressable points (4096 or 1024).

CALLING SEQUENCE:

```
CALL SEETRM (ISPEED, ITERM, ISIZE, MAXSR)
```

Parameters Returned:

ISPEED - the baud rate in characters per second which has been set in INITT (Section 2.1).

ITERM - the terminal type set in TERM (Section 5.1).

ICSIZE - the character size set in CHRSIZ (Section 5.3).

MAXSR - the screen address range set in TERM (Section 5.1).

6. TRANSFORMATIONS*

The transformation routines in the Terminal Control System allow the user to define any of three coordinate systems; linear, logarithmic, or polar. The default transformation (LINTRN) is linear, and it remains in effect until one of the transformations is called. LINTRN returns the user to a linear window.

The logarithmic transformation, LOGTRN, allows the user to express data as logarithms with reference to either the X or Y-axis or both.

The polar transformation, POLTRN, allows the user to define his coordinates as radius and degrees.

Each transformation occurs automatically before the drawing of a vector; each remains in effect until another transformation routine is called or until the system is re-initialized.

TRANSFORM: Alter the coordinate system in which data is specified.

Example:

POLTRN	radius, angle	1Ø,Ø°	1Ø,9Ø°	1Ø,18Ø°
LINTRN	X, Y	1Ø,Ø	Ø,1Ø	-1Ø,Ø

Figure 6, produced by the following codes, draws a grid by means of a user-written subroutine, GRID**; this gridwork is displayed in five different coordinate systems. Grid (a) is linear. Grids (b), (c), and (d) demonstrate the three different types of logarithmic transformations; respectively, they are (log-x, linear-y), (linear-x, log-y), and (log-x, log-y). Grid (e) demonstrates a call to the polar transformation, POLTRN. All five grids use the same virtual data. The difference between them is the result of the transformation through which they are viewed.

---

* The System Manual for the Terminal Control System explains how the user may write his own transformation routines by means of user hooks provided in internal routines of the package.

** See page 55 for the coding of GRID.

```
      CALL INITT(30)
C * DEFINE THE DATA WINDOW
      CALL DWINDO(10.,100.,10.,100.)
C * DEFINE SCREEN WINDOW (A)
      CALL TWINDO(0,250,500,750)
C * DRAW A GRID SHOWING A LINEAR TRANSFORMATION
      CALL GRID
C * DEFINE SCREEN WINDOW (B)
      CALL TWINDO(0,250,0,250)
      CALL LOGTRN(1)
C * DRAW A GRID SHOWING A LOG-X, LINEAR-Y TRANSFORMATION
      CALL GRID
C * DEFINE SCREEN WINDOW (C)
      CALL TWINDO(750,1000,500,750)
      CALL LOGTRN(2)
C * DRAW A GRID SHOWING A LINEAR-X, LOG-Y TRANSFORMATION
      CALL GRID
C * DEFINE SCREEN WINDOW (D)
      CALL TWINDO(750,1000,0,250)
      CALL LOGTRN(3)
C * DRAW A GRID SHOWING A LOG-X, LOG-Y TRANSFORMATION
      CALL GRID
C * DEFINE SCREEN WINDOW (E)
      CALL TWINDO(375,625,250,500)
      CALL POLTRN(10.,100.,0.)
C * DRAW A GRID SHOWING A POLAR TRANSFORMATION
      CALL GRID
      CALL FINITT (0,0)
      END
*
```

```
C * DRAW A GRID WITH LINES FROM 10 TO 100 AT INTERVALS OF 10
      SUBROUTINE GRID
      DMIN=10.
      DMAX=100.
      X=DMIN
C * DRAW GRID LINES ALONG X-AXIS
      DO 100 I=1,10
      CALL MOVEA(X,DMIN)
      CALL DRAWSA(X,DMAX)
100   X=X+10.
      Y=10.
C * DRAW GRID LINES ALONG Y-AXIS
      DO 200 J=1,10
      CALL MOVEA(DMIN,Y)
      CALL DRAWSA(DMAX,Y)
200   Y=Y+10.
      RETURN
      END
```

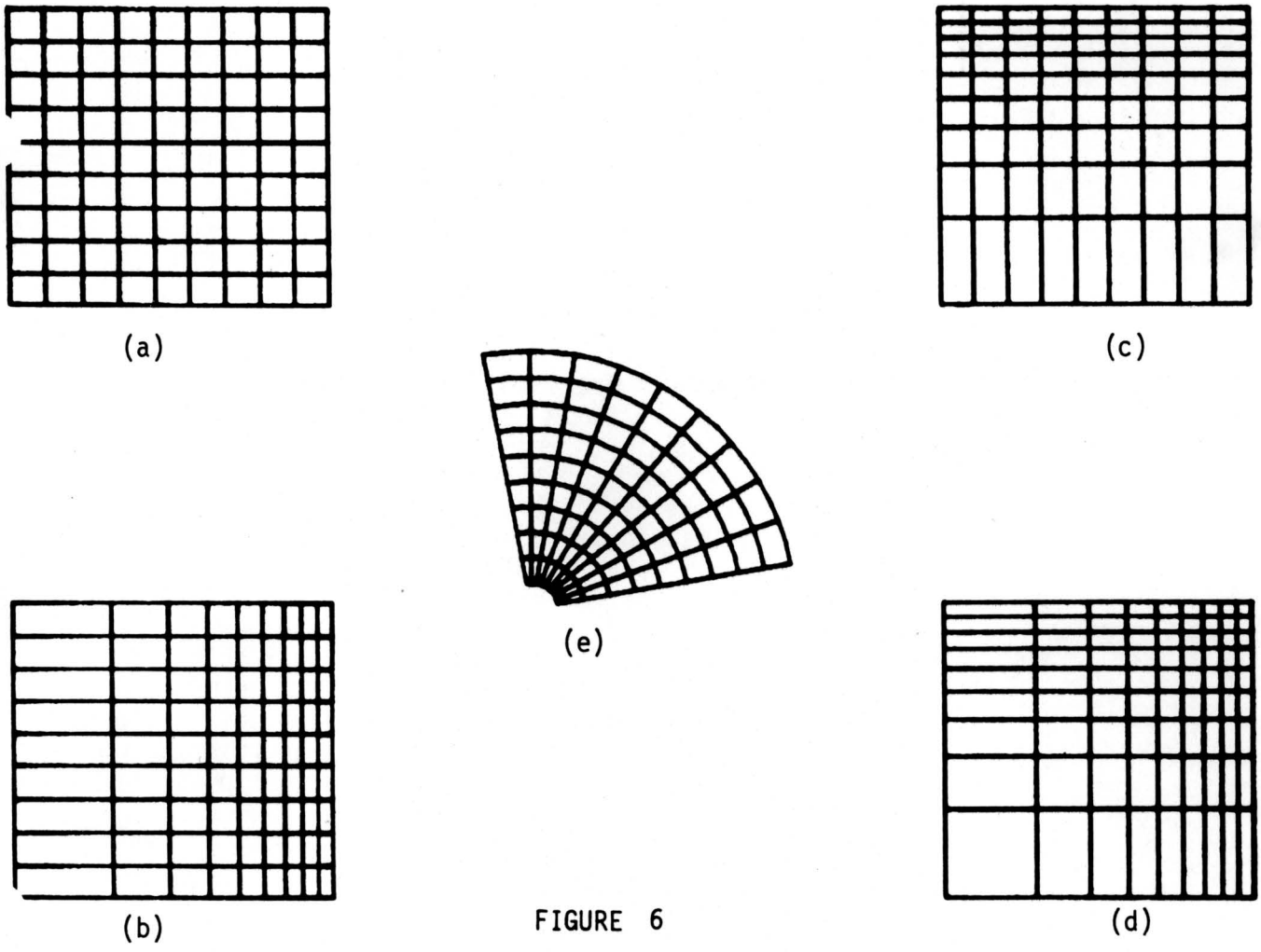


FIGURE 6

† *THE LINEAR TRANSFORMATION:*

Subroutine LINTRN

6.1 LINTRN returns a user from either a logarithmic or a polar window and establishes linear scaling. A linear window is assumed for all Terminal Control System routines until log or polar definitions are requested; it is, therefore, not necessary to call LINTRN upon initializing a program.

CALLING SEQUENCE:

```
CALL LINTRN
```

† *THE LOGARITHMIC TRANSFORMATION:*

Subroutine LOGTRN

6.2 LOGTRN defines either the X or Y axis or both as logarithmically scaled to fit the user's screen window. The extent of the logarithmic definition is determined by the parameter KEY.

CALLING SEQUENCE:

```
CALL LOGTRN (KEY)
```

Parameter Entered:

KEY - 1 - x-axis logarithmic
y-axis linear

2 - x-axis linear
y-axis logarithmic

3 - x-axis logarithmic
y-axis logarithmic

† *THE POLAR TRANSFORMATION:*

Subroutine POLTRN

6.3 POLTRN allows the user to define his virtual graphic data to the Terminal Control System in polar coordinates. Polar coordinates are specified by radius and angle. The angle is represented in degrees, counter-clockwise from a horizontal line to the right of the origin. The arguments of POLTRN control the shape of the screen window in which the virtual data is displayed. The virtual window is scaled and transformed to fit into the screen area between arguments ANGMIN and ANGMAX. The third argument, RSUPRS, is subtracted from the virtual radius. If ANGMIN and ANGMAX do not equal the data window (DWINDO) minimum and maximum (YMIN and YMAX), or if RSUPRS is not equal to zero, a distortion of the virtual polar data will occur (see Figures 6.7 and 6.8). The user can adapt this distortion to emphasize any features he wishes. The polar origin is automatically located to obtain the largest possible display area within the user's screen window.

CALLING SEQUENCE:

CALL POLTRN (ANGMIN, ANGMAX, RSUPRS)

Parameters Entered:

ANGMIN - the minimum angle relative to the horizontal from which the display will appear on the screen

ANGMAX - the maximum angle relative to the horizontal from which the display will appear on the screen.

RSUPRS - the radius suppression factor.

DRAWING SEGMENTS USING THE POLAR TRANSFORMATION:

† *Subroutine DRAWSA*

† *Subroutine DRAWSR*

6.4 In order to draw the grid used in (e) of Figure 6, a call to Subroutine DRAWSA was used in the construction of GRID. This call was substituted for a call to DRAWA (Section 3.5). DRAWSA is analogous to DRAWA, except that it enables the user to draw the curved line segments that are necessary when a polar transformation is in effect. Subroutine DRAWSR is analogous to DRAWR (Section 3.6), but again it is used for a polar transformation.

CALLING SEQUENCE:

CALL DRAWSA (X, Y)

Where X and Y are the virtual coordinates to which the line segment is drawn.

CALL DRAWSR (X, Y)

Where X and Y are the virtual coordinates relative to the current beam position.

DRAWING DASHED LINE SEGMENTS USING THE POLAR TRANSFORMATION:

† *Subroutine DASHSA*

† *Subroutine DASHSR*

6.5 DASHSA and DASHSR are analogous to Subroutines DASHA and DASHR (Section 3.11), respectively. They too are used for a polar transformation.

CALLING SEQUENCES:

CALL DASHSA (X, Y, L)

Where X and Y are the virtual coordinates to which the dashed line segment is to be drawn. L is the dashed line type (see Section 3.12).

CALL DASHSR (X, Y, L)

Where X and Y are the virtual coordinates to which the dashed line is drawn relative to the current beam position. L is the dashed line type. (See Section 3.12.)

	SCREEN GRAPHICS (Integer Arguments)		*VIRTUAL GRAPHICS (Real Arguments)*	
ACTION	*ABSOLUTE*	*RELATIVE*	*ABSOLUTE*	*RELATIVE*
MOVE	*MOVABS*	*MOVREL*	*MOVEA*	*MOVER*
DRAW	*DRWABS*	*DRWREL*	*DRAWA*	*DRAWR*
POINT	*PNTABS*	*PNTREL*	*POINTA*	*POINTR*
DASH	*DSHABS*	*DSHREL*	*DASHA*	*DASHR*
SEGMENTED DRAW	*none*	*none*	*DRAWSA*	*DRAWSR*
SEGMENTED DASH	*none*	*none*	*DASHSA*	*DASHSR*

TERMINAL CONTROL SYSTEM

Release 3

DRAWING ROUTINES

Figure 6.5

USING THE POLAR TRANSFORMATION:

6.6 Given the polar grid*(e) of Figure 6, examine the capabilities of Subroutine POLTRN; the first example demonstrates a dashed line segment which connects thirty different radii, with lengths between 90. and 100., at increments of three degrees; they are displayed between an ANGMIN of 10° and an ANGMAX of 100°. Radius suppression is 0.

```
      DIMENSION RDATA(30)
      DATA RDATA /90.3,92.4,94.5,95.2,96.1,96.9,98.2,98.7,99.1,99.4,
     & 99.7,100.0,99.5,99.0,98.5,98.0,97.5,97.0,96.5,96.0,95.5,95.0,
     & 94.0,93.0,92.0,93.0,97.0,94.3,91.0,92.8/
      CALL INITT (30)
C * DEFINE THE TERMINAL WINDOW
      CALL TWINDO(100,900,100,600)
C * DEFINE THE DATA WINDOW WITH RADIUS FROM 10 TO 100
      CALL DWINDO(10.,100.,10.,100.)
C * SPECIFY A POLAR WINDOW DISPLAYED BETWEEN 10 AND 100 DEGREES
C * WITH RADIUS SUPPRESSION OF ZERO
      CALL POLTRN(10.,100.,0.)
C * DRAW A GRID SHOWING THE WINDOW
      CALL GRID
C * PLOT THE DATA STEPPING THE ANGLE FROM 10 TO 100 DEGREES
C * WITH INCREMENT OF 3
      CALL MOVEA(RDATA(1),10.)
      DO 10 I=1,30
      DEGREE=10+I*3
10    CALL DASHSA(RDATA(I),DEGREE,12)
      CALL FINITT(0,0)
      STOP
      END
```

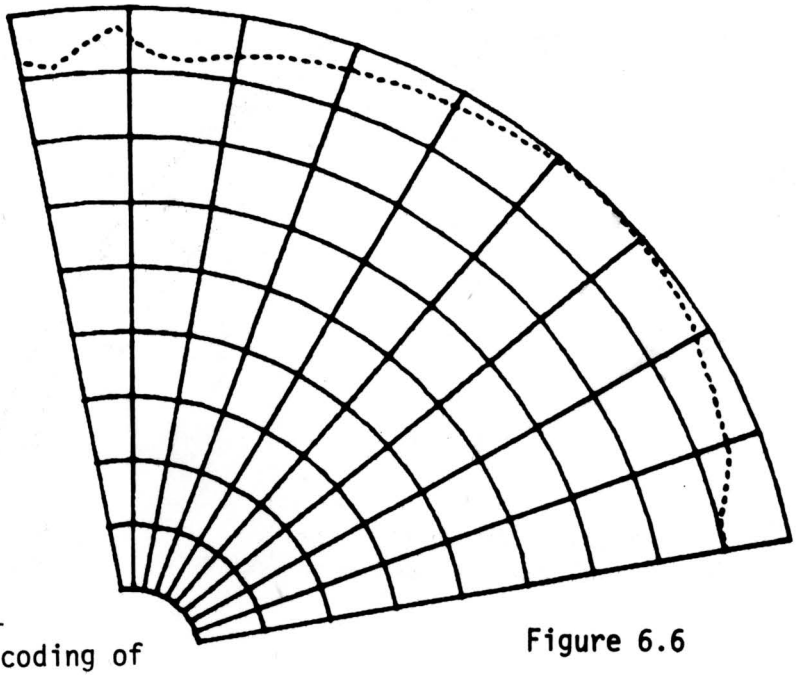


Figure 6.6

* See page 55 for the coding of Subroutine GRID.

The second example demonstrates how the same plot would look if it were displayed with a virtual (data) window with a radius between 9Ø. and 1ØØ. Again the radius suppression is Ø. Notice that all grid lines specified below 9Ø. are clipped.

```
      CALL INITT (30) *
C * DEFINE THE TERMINAL WINDOW
      CALL TWINDO(100,900,100,600)
C * DEFINE THE DATA WINDOW WITH RADIUS FROM 90 TO 100
      CALL DWINDO(90.,100.,10.,100.)
C * SPECIFY A POLAR WINDOW DISPLAYED BETWEEN 10 AND 100 DEGREES
C * WITH RADIUS SUPPRESSION OF ZERO
      CALL POLTRN(10.,100.,0.)
C * DRAW A GRID SHOWING THE WINDOW
      CALL GRID
C * PLOT THE DATA STEPPING THE ANGLE FROM 10 TO 100 DEGREES
C * WITH INCREMENT OF 3
      CALL MOVEA(RDATA(1),10.)
      DO 10 I=1,30
      DEGREE=10+I*3
10    CALL DASHSA(RDATA(I),DEGREE,12)
      CALL FINITT(0,0)
      STOP
      END
```

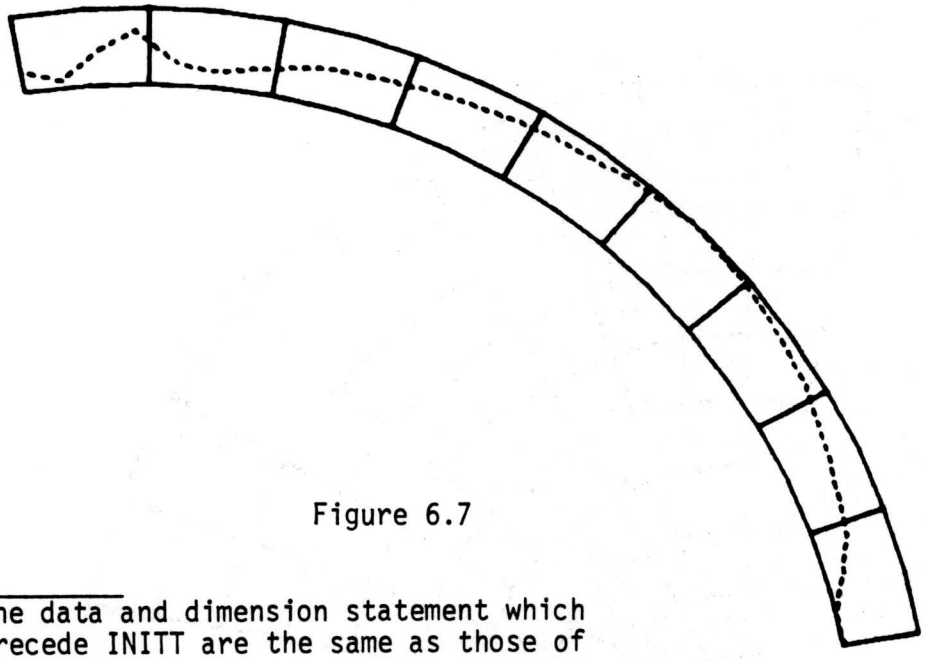


Figure 6.7

* The data and dimension statement which precede INITT are the same as those of Figure 6.6.

The third example, using the same data points and the same virtual (data) window as those of example 2 (Figure 6.7), demonstrates how the graph is displayed with a radius suppression factor of 90. from each of the thirty radii, causing the data to be displayed between an ANGMIN of 10° and an ANGMAX of 100° and between a radius minimum of 0 and maximum of 10.

```
      CALL INITT (30) *
C * DEFINE THE TERMINAL WINDOW
      CALL TWINDO(100,900,100,600)
C * DEFINE THE DATA WINDOW WITH RADIUS FROM 90 TO 100
      CALL DWINDO(90.,100.,10.,100.)
C * SPECIFY A POLAR WINDOW DISPLAYED BETWEEN 10 AND 100 DEGREES
C * WITH RADIUS SUPPRESSION OF 90
      CALL POLTRN(10.,100.,90.)
C * DRAW A GRID SHOWING THE WINDOW
      CALL GRID
C * PLOT THE DATA STEPPING THE ANGLE FROM 10 TO 100 DEGREES
C * WITH INCREMENT OF 3
      CALL MOVEA(RDATA(1),10.)
      DO 10 I=1,30
      DEGREE=10+I*3
10    CALL DASHSA(RDATA(I),DEGREE,12)
      CALL FINITT(0,0)
      STOP
      END
```

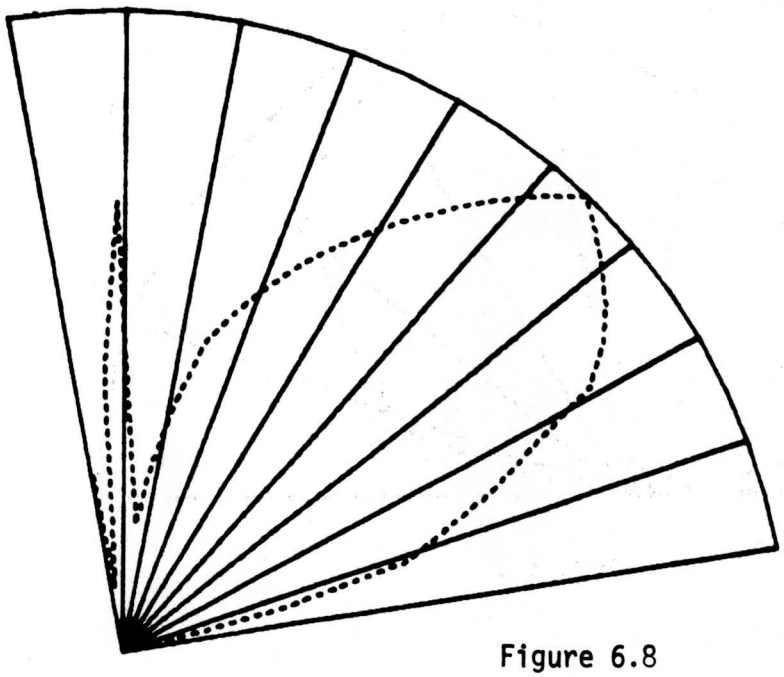


Figure 6.8

* See note, page 60.

The fourth example uses the same information as example 3. In this case, however, the polar window is displayed between an ANGMIN of Ø° and an ANGMAX of 18Ø°. Radius suppression is again 9Ø.

```
      CALL INITT (30)*
C * DEFINE THE TERMINAL WINDOW
      CALL TWINDO(100,900,100,600)
C * DEFINE THE DATA WINDOW WITH RADIUS FROM 90 TO 100
      CALL DWINDO(90.,100.,10.,100.)
C * SPECIFY A POLAR WINDOW DISPLAYED BETWEEN ZERO AND 180 DEGREES
C * WITH RADIUS SUPPRESSION OF 90
      CALL POLTRN(0.,180.,90.)
C * DRAW A GRID SHOWING THE WINDOW
      CALL GRID
C * PLOT THE DATA STEPPING THE ANGLE FROM 10 TO 100 DEGREES
C * WITH INCREMENT OF 3
      CALL MOVEA(RDATA(1),10.)
      DO 10 I=1,30
      DEGREE=10+I*3
10    CALL DASHSA(RDATA(I),DEGREE,12)
      CALL FINITT(0,0)
      STOP
      END
```

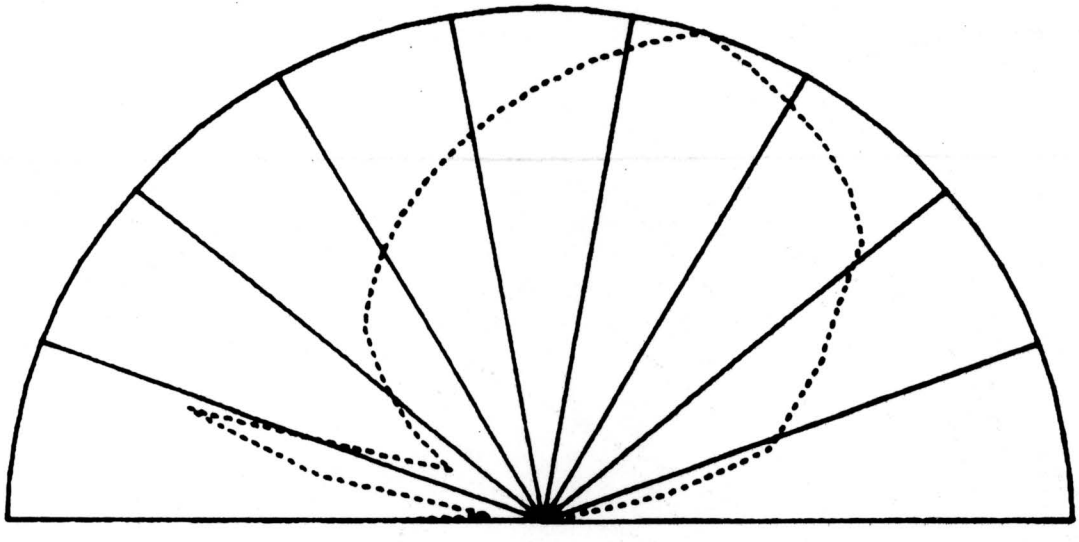


Figure 6.9

* See note, page 60.

7. INPUT/OUTPUT ROUTINES

The user's program may perform three types of Input/Output with Terminal Control System subroutines: graphic, alphanumeric, and Terminal/peripheral control. All the output from the package routines is funnelled through the basic subroutine, TOUTST, while all input comes in through subroutine TINSTR. The graphic and control I/O use these two subroutines directly as well as their single character counterparts, TOUTPT and TINPUT. Alphanumeric I/O can be accomplished through the more versatile set of routines described below. The user should be aware that some of the following routines may be implementation dependent (see Implementation Notes).

For output the Terminal Control System translates all characters to be sent to the Terminal into ASCII decimal equivalent (ADE)*form and packs them into an output buffer. When the buffer is full or the system or user calls subroutine TSEND, this buffer is dumped, translated into system dependent code, and sent to the Terminal.

For input the Terminal Control System accepts system dependent code received from the Terminal, translates it into ADE*(see above) form, and distributes it to the subroutine which called for it, if necessary translating it again into alphanumeric format.

From the point of view of the user's program, alphanumeric I/O may be accomplished more efficiently using direct methods, such as FORTRAN READ and WRITE statements. However, output through the Terminal Control System updates the graphic beam position, except where noted, and allows control over the exact positioning of characters anywhere on the Terminal screen, while input through the Terminal Control System provides correct formatting of data for later output or internal processing. It is the user's responsibility to call ANMODE to dump the output buffer before doing FORTRAN I/O. (See RECOVR, Section 4.11.) Positioning of mixed FORTRAN and Terminal Control System output is implementation dependent. See Section 7.11.1 for details.

Three formats are allowed for both input and output:

1. ADE (ASCII decimal equivalents)*
2. A1 (where A1 represents one word with one alphanumeric character in it)
3. Am (where Am represents one word with m alphanumeric characters in it. M is usually the number of alphanumeric characters that one word can contain)

* ADE code is simply the integer representation of the ASCII character set. The ADE characters are the numbers from Ø to 127, with 48 representing Ø, 65 "A", 90 "Z", etc.

** An ASCII decimal equivalent chart may be found at the end of this manual.

OUTPUT:
†Subroutine TOUTST

7.1 TOUTST outputs an array of ADE* characters. This routine does not update the graphic beam position within the Terminal Control System, nor does it put the Terminal in alphanumeric mode. TOUTST should be used only when outputting control characters which are not otherwise handled by the Terminal Control System.

CALLING SEQUENCE:

```
CALL TOUTST(NCHAR,IARRAY)
```

PARAMETERS ENTERED:

NCHAR	the length of IARRAY,i.e., the number of characters to be output.
IARRAY	the array containing ADE characters to be output.

Subroutine TOUTPT

7.2 TOUTPT outputs a single ADE*character. This routine does not update the graphic beam position within the Terminal Control System, nor does it put the Terminal into alphanumeric mode. TOUTPT should be used only when outputting a control character which is not otherwise handled by the Terminal Control System.

CALLING SEQUENCE:

```
CALL TOUTPT(ICHAR)
```

PARAMETER ENTERED:

ICHAR	an ADE*character to be output.

Subroutine ANCHO

7.3 ANCHO outputs a single ADE*character. This routine places the Terminal in alphanumeric mode, outputs the character, and then updates the position of the beam. For a complete description of ANCHO see Section 4.3.

† For Terminal Control System, Release 3 and later, only.

* ADE code is simply the integer representation of the ASCII character set. The ADE characters are the numbers from Ø to 127, with 48 representing Ø, 65 "A", 90 "Z", etc.

CALLING SEQUENCE:

```
CALL ANCHO(ICHAR)
```

PARAMETER ENTERED:

ICHAR	the non-control ADE character to be output.

†*Subroutine ANSTR*

7.4 ANSTR accomplishes the same function as ANCHO, except that it outputs an array of non-control ADE characters. ANSTR also places the Terminal in alphanumeric mode and updates the graphic beam position within the Terminal Control System. For complete description of ANSTR see Sections 4.3 and 4.3.1.

CALLING SEQUENCE:

```
CALL ANSTR(NCHAR,IARRAY)
```

PARAMETERS ENTERED:

NCHAR	the number of characters to be output.
IARRAY	the array containing the ASCII decimal integer equivalents for the characters to be output.

†*Subroutine A1OUT*

7.5 A1OUT outputs an array of A1 FORTRAN format characters. This routine puts the Terminal in alphanumeric mode and updates the graphic beam position in the Terminal Control System.

CALLING SEQUENCE:

```
CALL A1OUT(NCHAR,IARRAY)
```

PARAMETERS ENTERED:

NCHAR	the length of IARRAY; the number of characters to be output.
IARRAY	the array of A1 FORTRAN format characters to be output.

†*Subroutine AOUTST*

7.6 AOUTST outputs an array of Am format characters. In this format m represents the number of alphanumeric characters in one word. This routine also updates the graphic beam position in the Terminal Control System.

CALLING SEQUENCE:

CALL AOUTST(NCHAR,IARRAY)

PARAMETERS ENTERED:

NCHAR	the number of characters to be output, m times the length (number of words) of IARRAY.
IARRAY	the array of Am format characters to be output. If IARRAY is shorter than NCHAR, it is padded with blanks.

INPUT:

†Subroutine TINSTR

7.7 TINSTR accepts input from the Terminal and puts it into an ADE array. These characters are in a form ready to be output by ANCHO (Sections 4.3) or ANSTR (Section 4.3.1).

CALLING SEQUENCE:

CALL TINSTR(LEN,IARRAY)

PARAMETER ENTERED:

LEN	the number of characters expected. If fewer than LEN are received, IARRAY is padded with blanks, and if more than LEN are received, the next call to TINSTR will input the excess characters.

PARAMETER RETURNED:

IARRAY	the ADE array into which the input characters are placed.

Subroutine TINPUT

7.8 TINPUT accepts one ADE character from the Terminal.

CALLING SEQUENCE:

CALL TINPUT(ICHAR)

PARAMETER RETURNED:

ICHAR	the ADE character received from the Terminal. Since TINPUT calls TINSTR, a null record (entering only a carriage return at the Terminal) becomes a blank, while more than one character entered is stored for later access by any call to TINSTR.

†*Subroutine A1IN*

7.9 A1IN accepts an array of characters from the Terminal in integer A1 FORTRAN format. The array is in the correct format to be output by subroutine A1OUT (Section 7.5)

CALLING SEQUENCE:

```
CALL A1IN(NCHAR,IARRAY)
```

PARAMETER ENTERED:

NCHAR	the number of characters expected from the Terminal. Since A1IN calls TINSTR (Section 7.7) if fewer than NCHAR characters are received, IARRAY is padded with blanks; if more characters than NCHAR are received, they are stored for later access by any call to TINSTR.

PARAMETER RETURNED:

IARRAY	the array in which the A1 format characters are placed.

†*Subroutine AINST*

7.10 AINST accepts an array of characters from the Terminal in Am format. This array can then be output by subroutine AOUTST (Section 7.6).

CALLING SEQUENCE:

```
CALL AINST (NCHAR,IARRAY)
```

PARAMETER ENTERED:

NCHAR	the number of characters expected from the Terminal. Since AINST calls TINSTR (Section 7.7), if fewer than NCHAR characters are received, IARRAY is padded with blanks; if more than NCHAR are received, they are stored for later access by any call to TINSTR.

PARAMETERS RECEIVED:

IARRAY	the array in which the Am format characters are placed.

Utility I/O Routines

7.11 The following routines aid the user of the Terminal Control System in outputting or inputting data. These routines, however, should be used carefully and in most cases will not need to be called.

Setting the Output Buffer Format: †Subroutine SETBUF

7.11.1 The user will find it necessary to control his output format after implementation of the package only when changing to a different Terminal type (e.g., from a 4Ø1Ø to a 4Ø14) or when transferring to a different computer system. The output format must be changed in these cases in order to avoid interline character problems (see the Implementation Notes). Interline characters, particularly carriage return (CR), line feed (LF), and timing characters (NUL or SYN), need to be suppressed to make graphic input possible. If the user's implementation doesn't suppress interline characters, the user will need to call SETBUF as well as TERM when changing from a 4Ø1Ø or 4Ø12 Terminal to a 4Ø14 Terminal.

CALLING SEQUENCE

```
CALL SETBUF(KFORM)
```

PARAMETER ENTERED:

KFORM — the format of the output buffer, after the following code:*

1 - For 4010 and 4012 Terminals. This format is for systems on which interline characters cannot be suppressed. Characters necessary to generate a move back to the current beam position are stored at the beginning of each buffer. Graphic cursor input is not possible. With buffer Type 1, the move back to the current stored beam position happens before every Terminal Control System buffer output. For example, CALL CHRSIZ(2). CALL ANMODE moves the alphanumeric cursor to the location at which it was after the previous buffer was transmitted. The subsequent system-supplied interline characters may move the cursor to the left and down one line, so any non-Terminal Control System output that follows will begin there.

---

* The following discussion is important for users who:
(a) Wish to mix Terminal Control System output with other types of output (e.g., FORTRAN).
(b) Wish to run programs on different computer systems, or
(c) wish to change Terminal types (e.g., from a 4012 to a 4014 Terminal).

2 - For 4014 Terminals. This format is for systems on which interline characters cannot be suppressed. Thus interline characters follow each output buffer transmission to the Terminal. However, a flag character (ESC) is sent where necessary, and the 4014 hardware ignores the interline characters. Graphic cursor input is possible. In all other respects Buffer Types 1 and 2 are identical, including their behavior when non-Terminal Control System output is mixed with Terminal Control System output.

3 - Used for all Terminals on systems where interline characters may be suppressed. Graphic cursor input is possible. With Buffer Type 3, no carriage returns or other interline characters are appended to Terminal Control System output by the computer. All output begins at the position of the alphanumeric or graphic cursor on the Terminal screen. This position agrees with the stored beam position even after ANMODE or TSEND is called. However, non-Terminal Control System output causes a discrepancy between the stored and the actual beam position.

4 - Like Buffer Type 3, except that output is unbuffered; i.e., each call to TOUTST results in direct output.

Example:

A program follows to illustrate the Buffer Type dependent results that occur when FORTRAN and Terminal Control System output are mixed.

NOTE

Buffer types 1 and 2 are not available in the TSO version of the Terminal Control System.

```
      DIMENSION ITHE(1)
      DATA ITHE/5HTHE    /
      CALL INITT(3Ø)
      CALL SETBUF(2)
      CALL TERM(3,1)
      CALL CHRSIZ(1)
      CALL MOVABS(Ø,45Ø)
      CALL DRWABS(1ØØ,45Ø)
      CALL ANMODE
      WRITE(5,1ØØ)
1ØØ   FORMAT(1X,9HTEKTRONIX)
      CALL CHRSIZ(2)
      CALL ANMODE
      WRITE(5,2ØØ)
2ØØ   FORMAT(1X,15H           4014)
      CALL CHRSIZ(3)
      CALL AOUTST(5,ITHE)
      CALL FINITT(Ø,2ØØ)
      END
```

Results with Buffer Types 1 and 2:

Results with Buffer Types 3 and 4:

On this computer system, the FORTRAN WRITE carriage control character "space" (1X) results in a line feed (LF) before FORTRAN output and a carriage return (CR) after output. A carriage return and a line feed follow each Terminal Control System output. On your computer system results of this program may differ from those shown due to different carriage control characters.

Detailed Explanation of the Example:

PROGRAM STEP	PLACEMENT OF OUTPUT	
	Buffer Type 1 and 2	Buffer Type 3 and 4
MOVABS (0,450) DRWABS (100,450) ANMODE WRITE "TEKTRONIX"	Interline characters following ANMODE and the LF preceding "TEKTRONIX" place "TEKTRONIX" two lines below (100,450).	The line feed preceding "TEKTRONIX" places it one line below (100,450).
CHRSIZ(2) ANMODE WRITE "4014"	The software MOVE to (100,450) and similar carriage control characters to the above place "TEKTRONIX" and "4014" on the same line.	The CR following "TEKTRONIX" and the LF preceding "4014" place "4014" beginning at the left margin two lines below (100,450).
CHRSIZ(3) AOUTST(5,ITHE) FINITT	The software MOVE to (100,450) places "THE" there.	The CR following "4014" places "THE" on the same line as "4014" but at the left margin. NOTE: The software assumes the cursor position to agree with the stored beam position. No MOVE to the stored beam position occurs.

Examine the Output Format:
† *Subroutine SEEBUF*

7.11.2 SEEBUF allows the user to examine the format of his output buffer (see SETBUF, Section 7.11.1, and the Implementation Notes).

CALLING SEQUENCE:

```
CALL SEEBUF(JFORM)
```

PARAMETER RETURNED:

KFORM	the output buffer format presently in use. For a 4Ø1Ø or 4Ø12 Terminal KFORM should return either 1 (for systems which do not allow interline characters to be suppressed) 3, or 4 (for systems where interline characters may be suppressed). For a 4Ø14 Terminal KFORM should return 2, 3, or 4.

Examining the Useable Space in the Input or Output Buffer:
†*Function LEFTIO*

7.11.3 LEFTIO returns the number of characters remaining in the Input buffer or the amount of space (in characters) remaining in the Output buffer. In cases where the amount of input is variable, for example, the user may wish to see how many characters need to be processed before a given input.

CALLING SEQUENCE:

```
K=LEFTIO(IBUFF)
```

PARAMETER ENTERED:

IBUFF	indicates which buffer is to be examined: 1 Input buffer Ø Output buffer

PARAMETER RETURNED:

K	the number of characters left in the buffer indicated by IBUFF.

Locating the Position of the Graphic Beam:

† *Subroutine SEELOC*

7.11.4 SEELOC allows the user to locate on the screen the last position of the graphic beam if he has generated output outside the Terminal Control System (e.g., a FORTRAN READ or WRITE or a call to TOUTSTR or TOUTPT (Sections 7.1 and 7.2, respectively)). Thus, he may update the beam position himself.

CALLING SEQUENCE:

```
CALL SEELOC (IX,IY)
```

PARAMETERS RETURNED:

IX	the screen X-coordinate of the beam.
IY	the screen Y-coordinate of the beam.

Dumping the Output Buffer:

Subroutine TSEND

7.12 TSEND dumps the output buffer constructed by the Terminal Control System output routines. Whenever the output buffer becomes full, it is transmitted; but TSEND may be called any time the user wishes to have all stored output displayed. (It is customary to call ANMODE, as TSEND may leave the Terminal in graphics mode.)

If you have Terminal Control System, Release 3.0 or greater, the positioning on the Terminal screen of mixed non-Terminal Control System output (such as a FORTRAN WRITE) with Terminal Control System output is dependent upon the way in which the software package is implemented on your computer. See Section 7.11.1 for details. If all output is through the Terminal Control System, no such implementation dependencies exist.

CALLING SEQUENCE:

```
CALL TSEND
```

APPENDIX A

I. An Advanced Use of the Terminal Control System:
Circuit Drawing A2

II. Terminal Control System (Release 3)
Common Variables A7

III. Glossary A9

The combination of simple Terminal Control System routines can result in sophisticated usages. The following example demonstrates how the graphic cursor can be used in combination with simple moves and draws to create electrical circuit drawings interactively.

The main program calls the virtual cursor. The user can position it anywhere on the screen and, by punching different terminal keys, move and draw or call subroutines which draw symbols at that position.

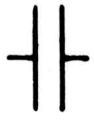
```
C * PROGRAM TO DRAW CIRCUITS INTERACTIVELY
      DATA IDRAW/68/,IMOVE/77/,IERASE/69/,IQUIT/81/,IHCOPY/72/
      DATA IRESIS/82/,ICAP/67/,ITRANS/84/,IGRND/71/
      CALL INITT(30)
C * SET TERMINAL SCREEN WINDOW
      CALL TWINDO(0,1000,0,750)
C * SET VIRTUAL SPACE DATA WINDOW
      CALL DWINDO(0.,500.,0.,375.)
      CALL MOVEA(0.,0.)
C * CALL FOR THE GRAPHIC CURSOR
100   XFROM=XTO
      YFROM=YTO
105   CALL VCURSR(KEY,XTO,YTO)
      IF(KEY .NE. IDRAW)GO TO 110
      CALL DRAWA(XTO,YTO)
      GO TO 100
110   IF(KEY .NE. IMOVE)GO TO 120
      CALL MOVEA(XTO,YTO)
      GO TO 100
120   IF(KEY .NE. IERASE)GO TO 130
      CALL ERASE
      GO TO 105
130   IF(KEY .NE. IQUIT)GO TO 140
      CALL FINITT(0,0)
140   IF(KEY .NE. IHCOPY)GO TO 150
      CALL HDCOPY
      GO TO 105
C * DETERMINE ROTATION OF SYMBOL
150   RANGLE=ATAN2(YTO-YFROM,XTO-XFROM)*57.2957795131
      CALL RROTAT(RANGLE)
      IF(KEY .NE. IRESIS)GO TO 160
      CALL RESIST
      CALL DRAWA(XTO,YTO)
      GO TO 100
160   IF(KEY .NE. ICAP)GO TO 170
      CALL CAP
      CALL DRAWA(XTO,YTO)
      GO TO 100
170   IF(KEY .NE. ITRANS)GO TO 180
      CALL TRANS
      CALL MOVEA(XFROM,YFROM)
C * BEAM LEFT AT START POINT FOR TRANSISTOR
      GO TO 105
180   IF(KEY .NE. IGRND)GO TO 100
      CALL GROUND
      CALL MOVEA(XFROM,YFROM)
C * BEAM LEFT AT START POINT FOR GROUND SYMBOL
      GO TO 105
      END
```

The subprograms draw four different symbols:

Symbol	Keyboard Character
resistor	R
capacitor	C
transistor	T
ground	G

```
C * ROUTINE TO DRAW A RESISTOR
      SUBROUTINE RESIST
      CALL DRAWR(10.,0.)
      CALL DRAWR(3.,10.)
      CALL DRAWR(6.,-20.)
      CALL DRAWR(6.,20.)
      CALL DRAWR(6.,-20.)
      CALL DRAWR(6.,20.)
      CALL DRAWR(6.,-20.)
      CALL DRAWR(3.,10.)
      RETURN
      END
```

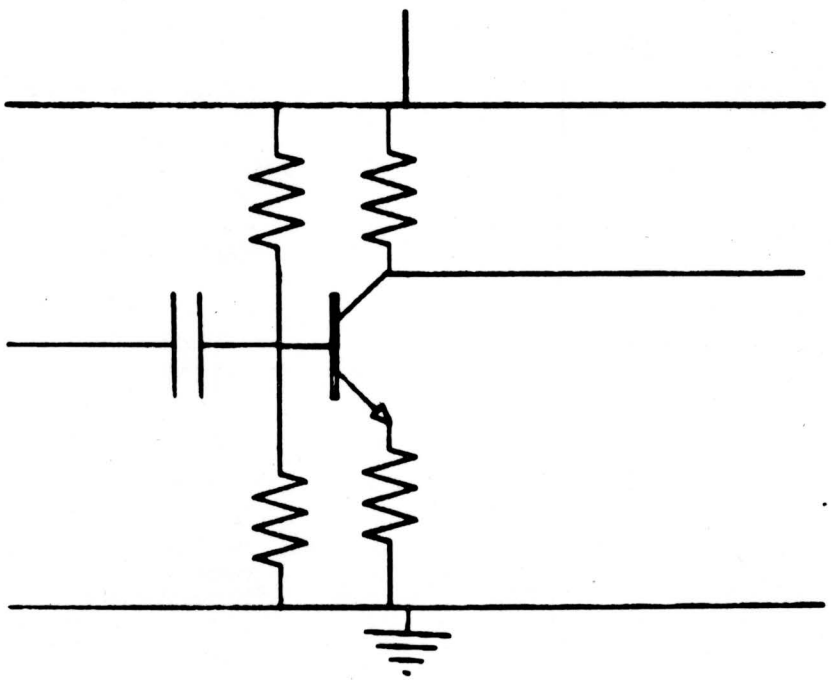
```
C * SUBROUTINE TO DRAW A CAPACITOR
      SUBROUTINE CAP
      CALL DRAWR(10.,0.)
      CALL MOVER(0.,20.)
      CALL DRAWR(0.,-40.)
      CALL MOVER(10.,40.)
      CALL DRAWR(0.,-40.)
      CALL MOVER(0.,20.)
      RETURN
      END
```



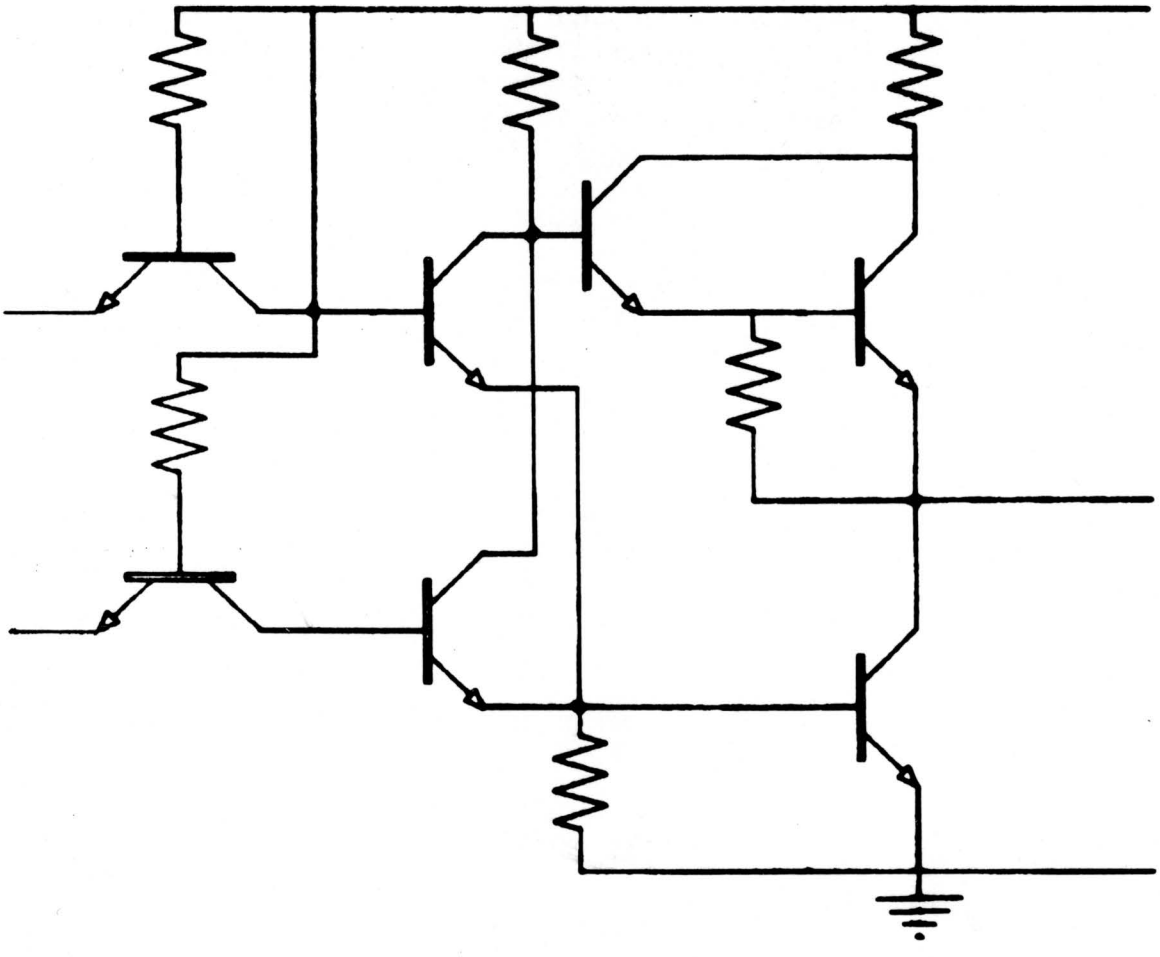
```
C * ROUTINE TO DRAW A TRANSISTOR
      SUBROUTINE TRANS
      CALL DRAWR(20.,0.)
      CALL DRAWR(0.,20.)
      CALL DRAWR(2.,0.)
      CALL DRAWR(0.,-40.)
      CALL DRAWR(-2.,0.)
      CALL DRAWR(0.,20.)
      CALL MOVER(2.,10.)
      CALL DRAWR(20.,20.)
      CALL MOVER(-20.,-40.)
      CALL DRAWR(15.,-15.)
      CALL DRAWR(2.,2.)
      CALL DRAWR(3.,-7.)
      CALL DRAWR(-7.,3.)
      CALL DRAWR(2.,2.)
      CALL MOVER(5.,-5.)
      RETURN
      END
```

```
C * ROUTINE TO DRAW A GROUND SYMBOL
      SUBROUTINE GROUND
      CALL DRAWR(10.,0.)
      CALL MOVER(0.,-16.)
      CALL DRAWR(0.,32.)
      CALL MOVER(5.,-27.)
      CALL DRAWR(0.,22.)
      CALL MOVER(5.,-17.)
      CALL DRAWR(0.,12.)
      CALL MOVER(5.,-7.)
      CALL DRAWR(0.,2.)
      RETURN
      END
```

Examples of circuits which can be drawn using the above program:



A transistor amplifier



A logic gate

II. TERMINAL CONTROL SYSTEM (RELEASE 3) COMMON VARIABLES

All functions and subroutines which required users of earlier releases of the Terminal Control System to access the /TKTRNX/ common area are now supported by Release 3 routines; therefore, conversion of programs which used earlier releases to those which use Release 3 is fairly simple. The conversion consists of deleting the /TKTRNX/ common area from these earlier programs and changing the code lines which set the common variables, so that the appropriate subroutines are called, as follows:

Variables in /TKTRNX/ common	Subroutines in Release 3
TRSINF, TRCOSF	RROTAT
TRSCAL	RSCALE
KLMRGN, KRMRGN	SETMRG

The tab routines are somewhat different in Release 3 than in earlier versions in that no tab tables are provided in the common area in Release 3. The user must insert a dimension statement for KHORZT and KVERTT in his older programs using the tab routines.

A list of Release 3 common variables follows.

†RELEASE 3 VARIABLE NAMES IN ALPHABETICAL ORDER

Note: These variables apply to Release 3. Users with earlier releases of the Terminal Control System should see the description in APPENDIX B.

Except where noted with a dagger (†), variables in Release 3 perform the same functions as their identically named counterparts in earlier releases.

	Name	Use	Description
	KBAUDR	General	Characters per Second
	KBEAMX	Screen Graphics	Beam X-coordinate
	KBEAMY	Screen Graphics	Beam Y-Coordinate
	KDASHT	Virtual Graphics	Dash Specification
†	KEYCON	Virtual Graphics	Transformation Key
†	KFACTR	Screen Graphics	Addressing Factor
†	KGNFLG	General	General Error Flag
	KGRAFL	General	Graphic Level Flag
	KHOMEY	General	Home Y-Value
	KHORSZ	A/N	Character Horizontal Size
†	KINLFT	I/O	Characters Left in Input Buffer
	KKMODE	General	Mode
†	KLINE	Graphics	Vector Type
	KLMRGN	A/N	Left Margin
	KMAXSX	Virtual Graphics	Screen Window Maximum X
	KMAXSY	Virtual Graphics	Screen Window Maximum Y
	KMINSX	Virtual Graphics	Screen Window Minimum X
	KMINSY	Virtual Graphics	Screen Window Minimum Y
†	KMOFLG	Unused	Future Expansion
	KMOVEF	Screen Graphics	Move Flag
†	KOTLFT	I/O	Characters Left in Output Buffer
†	KPAD2	General	Padding Size
	KPCHAR	Screen Graphics	Previous Plot Characters
	KRMRGN	A/N	Right Margin
†	KSIZEF	A/N	Character Size
	KTBLSZ	A/N	Tab Table Size
†	KTERM	General	Type of Terminal
†	KUNIT	I/O	Output Buffer Format
†	KVERSZ	A/N	Character Vertical Size
†	KZAXIS	General	Vector Intensity
	TIMAGX	Virtual Graphics	Imaginary Beam X
	TIMAGY	Virtual Graphics	Imaginery Beam Y
	TMAXVX	Virtual Graphics	Virtual Window Maximum X
	TMAXVY	Virtual Graphics	Virtual Window Maximum Y
	TMINVX	Virtual Graphics	Virtual Window Minimum X
	TMINVY	Virtual Graphics	Virtual Window Minimum Y
	TRCOSF	Virtual Graphics	Relative Vector Cosine Factor
	TREALX	Virtual Graphics	Real Beam X
	TREALY	Virtual Graphics	Real Beam Y
†	TRFACX	Virtual Graphics	Transformation Parameter
†	TRFACY	Virtual Graphics	Transformation Parameter
†	TRPAR1	Virtual Graphics	Transformation Parameter
	.	.	.
	.	.	.
	.	.	.
†	TRPAR6	Virtual Graphics	Transformation Parameter
	TRSCAL	Virtual Graphics	Relative Vector Scale Factor
	TRSINF	Virtual Graphics	Relative Vector Sine Factor

III. TERMINAL CONTROL SYSTEM

Glossary

ABSOLUTE VECTOR — A directed line segment from a given starting point to a given end point. In screen graphics, the start point is defined by the beam position, and the end point is an absolute screen coordinate. In virtual graphics the start point is the virtual beam position and the end point is an absolute virtual coordinate.

ADE — ASCII decimal equivalent. The integer representation of the ASCII character set. (See ASCII Code Chart.)

ALPHANUMERIC CURSOR — A rectangular, non-stored, moveable marker which indicates the next position at which a character will be displayed.

ALPHANUMERIC MODE — The Terminal mode in which ASCII output will be interpreted as characters to be displayed.

A/N — Abbreviation for "alphanumeric."

ASCII — American Standard Code for Information Interchange: A standard code consisting of 7-bit elements for information interchange among data processing communications systems.

BUFFERING — Storing input or output in an array (in the Terminal Control System an array of 72 characters) which is transmitted or dumped when it is full or when a command to dump is given.

CLIPPING — The modification of virtual graphics vectors so that the portion of those vectors which lies outside of the virtual window will not be displayed on the screen.

COORDINATE — An ordered pair (X, Y) of numbers uniquely represent a point either on the screen or in virtual space. The ordered pair of numbers used in the normal coordinate system (Cartesian coordinates) represent the point according to its distance from the origin (0,0) along the X and Y-axis respectively.

CURSOR — A moveable marker used as a reference.

DEFOCUS MODE	Causes broader lines in the screen display; for the 4014/15 Terminal.
DRAW	The display command which causes a bright vector to appear.
ERASE	The procedure of clearing the Terminal screen.
GRAPHIC CURSOR	A cross-hair cursor used to specify positional input.
HARDCOPY	A permanent copy of a display on the Terminal screen which is made by a remote hardcopy unit.
HOME POSITION	The upper-left corner screen location at which the first character of a page is normally printed.
INPUT	Data sent from the Terminal to the computer. Also, data provided to a subroutine.
KEYBOARD	The portion of the Terminal which allows the user to enter A/N data into the computer.
LEFT MARGIN	The screen X-coordinate which represents the starting position of a line of alphanumeric output.
MOVE	The display command which causes a dark vector to be drawn.
NEW LINE	The operation which causes the alphanumeric cursor to go to the left margin and down one line.
NEW PAGE	The operation which erases the screen and moves the alphanumeric cursor to the HOME position.
ORIGIN	The coordinate represented by (Ø,Ø). The origin of the screen is located at the lower-left corner. Virtual space, by definition, has its origin at its center.

POINT — The display command which causes a point to be drawn.

RASTER UNIT — The distance between two adjacent points on the screen; the basic resolution element of the Terminal.

REFRESH — To renew a display. If a Terminal (i.e., a 4014/15 Terminal) is in non-store mode, this display must be refreshed by the user's program to remain visible.

RELATIVE VECTOR — A means of describing an absolute vector which is drawn relative to the current beam position.

RIGHT MARGIN — The screen X-coordinate which represents the rightmost limit of alphanumeric output. Any attempt to write to the screen beyond the right margin using an A/N output routine will cause a NEW LINE to be generated.

SCREEN — The portion of the Terminal on which output from the computer is displayed.

SCREEN COORDINATES — The set of points which constitutes the screen. These points form a discrete two-dimensional space and range from (Ø,Ø) to (1Ø23, 1Ø23) inclusive; the 4014/15 Terminal with Enhanced Graphic Module offers in addition a range from (Ø,Ø) to (4Ø95 to 4Ø95) inclusive. SCREEN COORDINATES MUST ALWAYS BE INTEGERS.

SCREEN WINDOW — The section of the screen into which the virtual window is scaled and translated.

SOFTWARE — The programs and routines used to operate a computer.

STORAGE BEAM — The electron beam which is directed by the output to draw characters and vectors on the Terminal Screen.

STORAGE TUBE — A cathode ray tube (CRT) which will maintain a display, once written, for an indefinite period until an erasure is made.

TERMINAL — A console which accepts data from or sends data to a computer. The term is used here with reference to a TEKTRONIX 4010, 4012/13, or 4014/15 Display Terminal.

TERMINAL STATUS — The current state of the Terminal.

TERMINAL STATUS AREA — The set of common variables which represent the current Terminal status.

TIMESHARING — The use of a computer to serve a number of individuals in an essentially simultaneous fashion. Communication with a timesharing computer is usually through an interactive terminal.

TRANSFORMATION — The relationship between the virtual and screen windows. It may include a scaling, a translation, and/or a change of coordinate systems.

USER COORDINATES — A coordinate system in which the units of measurement are defined by the user. See Virtual Coordinates.

VECTOR — A line segment. A vector may be either bright (visible) or dark (invisible). The former is generated by a DRAW routine, the latter by a MOVE routine.

VIRTUAL COORDINATES — The set of points which consitute virtual space.

VIRTUAL CURSOR — Allows the user to locate coordinates in virtual space with the graphic cursor.

VIRTUAL SPACE — A user-defined, data-structured display area which is Terminal independent.

VIRTUAL WINDOW — The portion of virtual space which is displayed in the Terminal area defined by the screen window. Only that portion of virtual space which is contained in the virtual window will be displayed.

WRITE-THROUGH MODE — Allows refreshed information to be displayed along with stored information on the 4014/15 Terminal.

Z-AXIS — Allows variations in the storage and brightness capabilities on the 4014/15 Terminal.

ROUTINES COVERED IN APPENDIX B

NOTE: These routines are not compatible with the present release (Release 3) of the Terminal Control System, but instead cover earlier releases. Also listed are routines designed for the 4002A Terminal and for mini-computer (PDP-11).

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APPENDIX B

TERMINAL CONTROL SYSTEM

Routines for

RELEASE 2.0 AND EARLIER;

4002A Terminal Support; IBM/TSO;

and for PDP-11 Users

The following section documents those routines which are not compatible with the present release of the Terminal Control System (Release 3).

Those users who have Release 3 should disregard this section. SEE SECTION 1.1 FOR FURTHER EXPLANATION.

APPENDIX B

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SCALING AND ROTATING:

B.Ø Relative vectors are used primarily to construct objects or entities which must be displayed at a number of different locations in Virtual Space. However, the size and orientation of these objects is not always the same. For this reason, relative vectors are automatically scaled and rotated by the relative vector routines according to the scaling factor, TRSCAL, and the rotation factors, TRCOSF and TRSINF. TRSCAL, TRCOSF, and TRSINF are all Terminal Status Area variables. All input arguments to the relative vector routines are unscaled and unrotated. The input arguments define the normal size and orientation for a relative vector. Scaling and rotation will not effect absolute vectors.

SETTING THE SCALE:

The relative vector scale factor, TRSCAL, can be used to alter the length of a relative vector. All relative vectors are scaled according to the current value. For example, if a section of relative vector coding will construct a given object and you require the object to be constructed again at twice the normal size, then set TRSCAL to 2.Ø and re-execute the code which will construct the object.

The relative scale factor may be set in the same fashion that any variable is set. It is necessary, however, that the Terminal Status Area be defined as a set of COMMON variables for reference. If no scaling is desired, TRSCAL should be assigned the value 1.Ø which is the initial value of TRSCAL set by INITT.

SETTING THE ROTATION:

Relative vectors may also have their direction altered through the relative vector rotation factors, TRCOSF and TRSINF. TRCOSF represents the cosine value of the rotation and TRSINF represents the sine value. It should be noted that if the sum of the squares of the cosine and sine values do not equal 1.Ø, then there will be a distortion in length.

All relative factors are rotated according to the values of the current rotation factors. If the user wishes to construct an object defined by relative vectors at an angle different from the normal orientation, he sets the rotation factors to the cosine and sine values of the angle and executes the code for the object.

The relative vector scale factors may be set in the same fashion that any variable is set, as long as the Terminal Status Area be defined as a set of COMMON variables for reference. If no rotation from the normal orientation of the relative vector is desired, the rotation factors should be set to: TRCOSF = 1.Ø; TRSINF = Ø.Ø. These are also the initial values set by INITT.

DASHED LINES:

Subroutine DASHA

B.1 A dashed line may be drawn from the last point at which the Beam was positioned to a specified point with DASHA. Only that portion, if any, which passes through the Virtual Window will be visible. On return from this routine, the Beam will be positioned at the given Virtual Coordinate.

CALLING SEQUENCE:

CALL DASHA (X, Y, L)

Where:

X - Virtual X-coordinate of the point

Y - Virtual Y-coordinate of the point

L - Dashed line specification

Subroutine DASHR

A dashed line may be drawn in Virtual Space from the current Beam location to a point displaced by X and Y with DASHR. Only that portion, if any, of the line which passes through the Virtual Window will be displayed.

CALLING SEQUENCE:

CALL DASHR (X, Y, L)

Where:

X - X-value of the displacement

Y - Y-value of the displacement

L - Dashed line specification

Subroutine DSHABS

A dashed line may be drawn from the current beam position to any point on the screen with DSHABS. On return from this routine, the beam position is at the given Screen Coordinate.

CALLING SEQUENCE:

CALL DSHABS (IX, IY, L)

Where:

IX - Screen X-coordinate of the given point

IY - Screen Y-coordinate of the given point

L - Dashed line specification

Subroutine DSHREL

A dashed line may be drawn on the Screen relative to the current beam position according to a given X and Y displacement with a DSHREL.

CALLING SEQUENCE:

```
CALL DSHREL (IX, IY, L)
```

Where:

IX - X-displacement in screen coordinates

IY - Y-displacement in screen coordinates

L - Dashed line specification

A dashed line is specified by concatenating integers describing the line segment length and visibility. All codes except 9 should have 2 or more integers.

1 - 5 raster units, visible
2 - 5 raster units, invisible
3 - 10 raster units, visible
4 - 10 raster units, invisible
5 - 25 raster units, visible
6 - 25 raster units, invisible
7 - 50 raster units, visible
8 - 50 raster units, invisible
9 - alternate bright and dark between points.

TABS AND MARGINS

B.2 The Terminal Control System allows the user to set and reset tabs and margins to facilitate format layout. The tab and margin settings are software generated and as such are only useful for A/N data output through Terminal Control System routines. All tab and margin values are in Screen Coordinates.

Both horizontal and vertical tabs and left and right margins are available. Horizontal and vertical tabs are limited to ten positions each.

TAB SETTINGS

Tab settings for both horizontal and vertical tabs are kept in two ten-word integer arrays. The settings are ordered with ascending Screen Coordinates with the first zero value indicating the end of the settings.

SET TAB ROUTINES

The routine SETTAB takes a given tab setting in Screen Coordinates and inserts it into the given tab table. If the tab table is full, the maximum setting will be lost in order that a lesser tab setting may be inserted. When this occurs, the general error flag, KERROR, is set. Although duplicate tab settings are not inserted, SETTAB does not generally check the tab setting for validity and does not check if the given tab table is KHORZT or KVERTT, the horizontal and vertical tab tables respectively.

CALLING SEQUENCE:

```
CALL SETTAB (ITAB, ITABLE)
```

Where:

ITAB - Tab setting in either X or Y Screen Coordinates.

ITABLE - Horizontal or vertical tab table (i.e., KHORZT, KVERTT).

SETTING THROUGH COMMON

Both the horizontal and vertical tab table (KHORZT(1Ø) and KVERTT(1Ø) respecitively) can be set directly if the Terminal Status Area is available as a set of common variables. If set directly, the user must insure that the tabs are in increasing order with the first zero value following the valid tab settings. Negative values should never be used.

TAB RESETTING: RESET SINGLE TAB

To selectively reset a tab, its position in Screen Coordinates must be input to the tab resetting routine with the given tab table. Non-zero values which do not correspond to a current tab setting are ignored.

CALLING SEQUENCE:

```
CALL RSTTAB (ITAB, ITABLE)
```

Where:

ITAB - X or Y Screen Coordinate of tab to be reset

ITABLE - Horizontal or vertical tab table (i.e., KHORZT, KVERTT).

RESET ALL TABS

An entire tab table may be reset by using a zero for the tab position to be reset.

CALLING SEQUENCE

```
CALL RSTTAB (Ø, ITABLE)
```

Where:

ITABLE - Horizontal or vertical tab table (i.e., KHORZT, KVERTT).

HORIZONTAL TAB

Calling the horizontal tab routine will cause the alphanumeric cursor to be moved with a constant Y-value to the position specified by the first non-zero entry in the horizontal tab table, KHORZT, which is greater than the current Screen X-Coordinate of the cursor or beam position. If the horizontal tab table is empty, no action will occur. If the tab table is not empty and no entry exists which is greater than the current Screen X-Coordinate of the cursor or beam position, or if the first non-zero entry greater than the Screen X-Coordinate is also greater than the right margin setting, a new line will be generated.

CALLING SEQUENCE:

```
CALL TABHOR
```

VERTICAL TAB

Vertical tabbing will cause the alphanumeric cursor to be moved with a constant X-value to the position specified by the last non-zero entry in the vertical tab table, KVERTT, which is less than the current Y-coordinate of the cursor or beam position. If no entry in the vertical tab table exists which is non-zero and yet less than the current Y-coordinate, then no action occurs.

CALLING SEQUENCE:

CALL TABVER

MARGINS:

LEFT MARGIN

The left margin is the Screen X-Coordinate at which a line of A/N output starts. The Carriage Return, Home, and New Page routines cause the A/N cursor to move to the current left margin.

The left margin setting is contained in the Terminal Status Area variable, KLMRGN. KLMRGN may be set in the same manner as any other variable. However, its value should always be greater than Ø and less than the right margin value. The initial value of the left margin as set by INITT is Ø.

RIGHT MARGIN

The right margin is the rightmost position at which A/N output may be output. Any attempt to output beyond the right margin using the A/N output routine will cause a new line to be generated.

The right margin value is a Screen X-Coordinate and is contained in the Terminal Status Area variable, KRMRGM. KRMRGN may be set in the same manner as any other variable.

However, its value should always be less than 1Ø23 and greater than the left margin variable. The initial value as set by INITT is 1Ø1Ø.

B.3 4002A Terminal Routines

SCRATCHPAD SUPPORT

One of the major features of the 4002A terminal is the computer-addressable scratchpad. Some basic routines are included in the 4002A version of the Terminal Control System to assist in the use of the scratchpad. These are described below.

NOTE: It is firmly recommended that status be saved before using the scratchpad and restored after use.

ENTER SCRATCHPAD MODE

This routine enters scratchpad mode. Future output will be directed to the scratchpad until this mode is left. Display of data output to the scratchpad will not occur until scratchpad mode is exited (see ENLCM and EDITSP below).

CALLING SEQUENCE:

```
CALL ENSPM
```

CLEAR SCRATCHPAD

The scratchpad is cleared and the scratchpad cursor is set to the beginning of the buffer.

CALLING SEQUENCE:

```
CALL CLRSP
```

ENTER LOCAL COMPOSE MODE

Scratchpad mode is exited, the scratchpad data is displayed, and local compose mode is entered. The user may now modify the output or clear and enter his own data. When he presses the SEND button while still in local compose mode, the entire buffer will be sent to the computer. After calling this routine, the program should be set for input as all output will be ignored until a reply from the user has been received.

CALLING SEQUENCE:

```
CALL ENLCM
```

B.4 Character Types

ITALIC MODE (Restricted to 4002A Terminals)

This routine will output the proper control character to enter italic mode. This routine does not enter alphanumeric mode automatically.

CALLING SEQUENCE:

```
CALL ITALIC
```

ITALIC MODE RESET (Restricted to 4002A Terminals)

Resets to non-italic mode and enters alphanumeric mode. Double size mode is not affected by this routine.

CALLING SEQUENCE:

```
CALL ITALIR
```

DOUBLE SIZE MODE (Restricted to 4002A Terminals)

This routine will output the proper control character to enter double size mode. This routine does NOT enter alphanumeric mode automatically.

CALLING SEQUENCE:

```
CALL DBLSIZ
```

NORMAL SIZE MODE (Restricted to 4002A Terminals)

Resets to normal size characters and enters alphanumeric mode. Italic mode is not affected by this routine.

CALLING SEQUENCE:

```
CALL NRMSIZ
```

NOTE: Italic and double size modes are set and reset only by the above routines. Entering graphic, point plot, or incremental plot modes will not affect these settings.

INCREMENTAL PLOTTING (Restricted to 4002A Terminals)

This routine is used to perform incremental plotting. The user specifies the direction, whether it is to be visible or invisible, and the number of times he wishes this plot character to be output.

CALLING SEQUENCE:

```
CALL INCPLT (IONOFF, IDIR, NO)
```

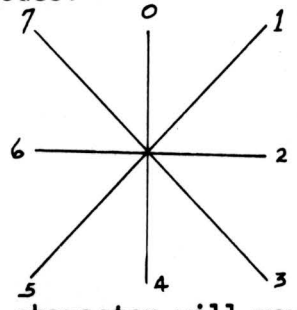
Where:

IONOFF = Ø; Beam off (invisible)
= 1; Beam on (visible)

IDIR = Direction code (0-7; see below)

NO = Number of times plot character is to be repeated.

Direction Codes:



Each incremental plot character will move the beam one raster unit in the given direction.

B.5 A/N INPUT/OUTPUT

Subroutine TINPUT

A/N characters may be input one at a time through the general input routine, TINPUT. Characters input will be in 7-bit ASCII and right-adjusted. TINPUT will not cause an echo* to be generated and no beam movement will occur. This allows the user to interact with his program while in vector mode.**

CALLING SEQUENCE:

```
CALL TINPUT (ICHAR)
```

Where:

ICHAR - 7-bit ASCII character right-adjusted

NOTE: If the user wishes to input data other than through the Terminal Control System routines, he should position the beam at an appropriate position, and enter A/N mode before requesting his input. Also he should expect a non-monitored echo of his input data to occur. (IBM/TSO users see Section 7.5.1.)

OUTPUT ON IBM/TSO:

Subroutine TOUTPT

For user's of IBM/TSO only Subroutine TOUTPT is necessary to place a character in the output buffer. The output buffer is automatically dumped when full. TOUTPT does not update common; the routine should not, therefore, be used to send characters which affect Terminal status. The user may update common to match the status of the hardware after using TOUTPT by performing a move.

CALLING SEQUENCE:

```
CALL TOUTPT (ICODE)
```

Parameter Entered:

ICODE - an integer representing a 7-bit ASCII character, right-adjusted.

Example: The following code outputs an A at (500, 500).

```
      :
CALL MOVABS (500,500)
CALL ANMODE
CALL TOUTPT (65)
CALL MOVABS (0,0)
      :
```

---

* Check the Terminal Control System Implementation Notes for more information regarding this matter.

** IBM/TSO user's should make a call to ANMODE before a call to TINPUT.

Subroutine TSEND

TSEND dumps the output buffer constructed by TOUTPT. TOUTPT calls TSEND, but TSEND may be called anytime the user wishes to have all output generated by the Terminal Control System to be displayed. TSEND may be called, for example, before input to the Terminal. This routine is also automatically called by FINITT, HDCOPY, NEWPAG, ANMODE, and DCURSR.

CALLING SEQUENCE:

```
CALL TSEND
```

B.6 Terminal Control System Common (Global) Variables

TERMINAL STATUS AREA

The Terminal Control System maintains a representation of the current state of the terminal and the user's output mode and level with a set of common (or global) variables referred to as the Terminal Status Area. The Terminal Status Area should be set up in each implementation of the Terminal Control System as a block of common storage, easily accessible to all user routines.

Some of the information contained within the Terminal Status Area, such as character width (KHORSZ) and height (KVERSZ), provide a significant aid for all and increase the ability to program in a terminal independent fashion. Other variables, such as the relative vector scale (TRSCAL) and rotation factors (TRCOSF, TRSINF), and the margin variables (KLMRGN, KRMRGN), must be available to the routines which require use of these facilities. The sophisticated user of the Terminal Control System will also find that the information in, and the appropriate use of, the other variables will significantly increase his programming capability.

All of the Terminal Status Area variables are not used in all implementations. However, in order to retain consistency and increase the ease of transference of application software from one system to another, it is required that the standard Terminal System Area layout indicated below be used by all.

Two names have been assigned to each Terminal Status Area variable and appear in the upper left of the description paragraph. The first is the normal 6-character name. The second is a 4-character name to be used for those implementations which do not permit a full 6-character name. In all Terminal Control System documentation, the Terminal Status Area variables will be referenced by the 6-character name.

COMMON LAYOUT

The Terminal Status Area is defined below as a labeled COMMON block as used in FORTRAN IV implementations. The name of the COMMON block is TKTRNX for all such implementations. The order of the variables in the COMMON block for all implementations is the same as that described in the Floating Point COMMON below, with the only difference being that which exists for Fixed Point COMMON, also described below.

COMMON LAYOUT (continued)

All Terminal Status Area variables for implementation which utilize floating point will be integer or real according to the implicit FORTRAN definition associated with their names. Although, the same names will be retained (with the exception of TRSCAL), all Terminal Status Area variables will be integers for those implementations with processing restricted to integer arithmetic.

Floating Point COMMON:

```
      COMMON /TKTRNX/ KBAUDR,KERROR,KGRAFL,KHOMEY,KKMODE,
     1  KHORSZ,KVERSZ,KITALC,KSIZEF,KLMRGN,KRMRGN,
     2  KTBLSZ,KHORZT(10),KVERTT(10),
     3  KBEAMX,KBEAMY,KMOVEF,KPCHAR(4),KDASHT,
     4  KMINSX,KMINSY,KMAXSX,KMAXSY,TMINVX,TMINVY,TMAXVX,TMAXVY,
     5  TREALX,TREALY,TIMAGX,TIMAGY,TRCOSF,TRSINF,TRSCAL
```

Fixed Point COMMON:

Same as Floating Point COMMON (with all variables defined as integers) except for line 5:

```
     5  TREALX,TREALY,TIMAGX,TIMAGY,TRCOSF,TRSINF,KUPSCA,KDWNSC
```

where the two-variable integer scale factor replaces the real single variable scale factor.

GENERAL VARIABLES

The following variables are generally used throughout the Terminal Control System.

Baud Rate — KBAUDR, KBDR

The number of characters per second which can be transmitted to the terminal. For directly connected terminals, this variable will have a zero value.

General Error Flag — KERROR , KERR

The flag set or reset by various Terminal Control System routines to indicate whether or not certain anomalistic conditions occurred.

Graphic Level Flag — KGRAFL, KGFL

Flag which indicates the user is currently in Virtual Graphics mode when set. When reset, user is assumed to be at Direct Graphic Level.

Home Y-Value — KHOMEY, KHMY

Screen Y-Coordinate of the terminal home position.

Mode — KKMODE, KMOD

Status variable indicating current terminal mode:

Ø - Alphanumeric
1 - Vector
2 - Point Plot
3 - Incremental Plot*
4 - Dash

A/N VARIABLES

The following variables are used primarily in the processing of A/N data of the Terminal Control System.

Character Horizontal Size — KHORSZ, KHSZ

Number of Screen Coordinates that the beam is horizontally displaced when a hardware-generated character is output.

Character Vertical Size — KVERSZ, KVSZ

Number of Screen Coordinates that the beam is vertically displaced when a hardware-generated line feed is output.

Italic Flag* — KITALC, KITL

Flag set to indicate the enabling of italic output.

Size Flag* — KSIZEF, KSIZ

Flag set to indicate the enabling of double size alpha-numeric output.

*Used with implementations supporting the Tektronix 4002A Graphic Computer Terminal.

Left Margin — KLMRGN, KLMG

Left margin setting as a Screen X-Coordinate.

Right Margin — KRMRGN, KRMG

Right margin setting as a Screen X-Coordinate.

Tab Table Size — KTBLSZ, KTBS

The number of words in each of the tab tables.

Horizontal Tab Table — KHORZT, KHOT

Ten word integer array containing the current horizontal tab settings. The entries must be Screen X-Coordinate values in ascending order. The first zero value is used to indicate the end of the tab settings.

Vertical Tab Table — KVERTT, KVET

Ten word integer array containing current vertical tab settings. The entries must be Screen Y-Coordinate values in ascending order. The first zero value is used to indicate the end of the tab settings.

SCREEN GRAPHIC VARIABLES

The following variables are used at the basic graphic output level.

Beam X-Coordinate — KBEAMX, KBMX

The Screen X-Coordinate of the current storage beam position. Updated whenever beam is moved through output to the terminal.

Beam Y-Coordinate — KBEAMY, KBMY

The Screen X-Coordinate of the current storage beam position. Updated whenever beam is moved through output to the terminal.

Move Flag — KMOVEF, KMVF

Flag set to indicate terminal is primed for a blank vector when in vector mode.

Previous Plot Characters — KPCHAR, KPCH

Four word integer array containing the plot characters which define the last vector or point plot output.

Dashed Line Specification — KDASHT, KDST

Defines the lengths of the visible and invisible portions of a dashed line.

VIRTUAL GRAPHIC VARIABLES

The following variables are used in conjunction with Direct Graphic output.

Screen Window Minimum X — KMINSX, KSX1

Minimum Screen X-Coordinate of the current Screen Window.

Screen Window Minimum Y — KMINSY, KSY1

Minimum Screen Y-Coordinate of the current Screen Window.

Screen Window Maximum X — KMAXSX, KSX2

Maximum Screen X-Coordinate of the current Screen Window.

Screen Window Maximum Y — KMAXSY, KSY2

Maximum Screen Y-Coordinate of the current Screen Window.

Virtual Window Minimum X — TMINVX, TVX1

Minimum Virtual X-Coordinate of the current Virtual Window.

Virtual Window Minimum Y — TMINVY, TVY1

Minimum Virtual Y-Coordinate of the current Virtual Window.

Virtual Window Maximum X — TMAXVX, TVX2

Maximum Virtual X-Coordinate of the current Virtual Window.

Virtual Window Maximum Y — TMAXVY, TVY2

Maximum Virtual Y-Coordinate of the Virtual Window.

Real Beam X — TREALX, TRLX

Virtual X-Coordinate of the current Real Beam position.

Real Beam Y — TREALY, TRLY

Virtual Y-Coordinate of the current Real Beam position.

Imaginary Beam X — TIMAGX, TIMX

Virtual X-Coordinate of the current Imaginary Beam position.

Imaginary Beam Y — TIMAGY, TIMY

Virtual Y-Coordinate of the current Imaginary Beam position.

Relative Vector Cosine Factor — TRCOSF, TRCF

Cosine value used for rotation of relative vectors in Virtual Space.

Relative Vector Sine Factor — TRSINF, TRSF

Sine value used for rotation of relative vectors in Virtual Space.

Relative Vector Scale Factor — TRSCAL, TRSC

Value used for the scaling of relative vectors in Virtual Space. (For implementations utilizing floating point.)

Relative Vector Up Scale Factor — KUPSCA, KUPS

Numerator value of scaling factor for relative vectors in Virtual Space. (For implementations where only integer arithmetic is available.

Relative Vector Down Scale Factor — KDWNSC, KDWN

Denominator value of scaling factor for relative vectors in Virtual Space. (For implementations where only integer arithmetic is available.)

B.7 VARIABLE NAMES IN ALPHABETICAL ORDER

Name	Use	Description
KBAUDR	General	Characters per Second
KBEAMX	Direct Graphics	Beam X-Coordinate
KBEAMY	Direct Graphics	Beam Y-Coordinate
KDASHT	Virtual Graphics	Dash Specification
KDWNSC*	Virtual Graphics	Relative Vector Down Scale Factor
KERROR	General	General Error Flag
KGRAFL	General	Graphic Level Flag
KHOMEY	General	Home Y-Value
KHORSZ	A/N	Character Horizontal Size
KHORZT	A/N	Horizontal Tab Table
KITALC**	A/N	Italic Flag
KKMODE	General	Mode
KLMRGN	A/N	Left Margin
KMAXSX	Virtual Graphics	Screen Window Maximum X
KMAXSY	Virtual Graphics	Screen Window Maximum Y
KMINSX	Virtaul Graphics	Screen Window Minimum X
KMINSY	Virtual Graphics	Screen Window Minimum Y
KMOVEF	Direct Graphics	Move Flag
KPCHAR	Direct Graphics	Previous Plot Characters
KRMRGN	A/N	Right Margin
KSIZEF**	A/N	Size Flag
KTBLSZ	A/N	Tab Table Size
KUPSCA*	Virtual Graphics	Relative Vector Up Scale Factor
KVERSZ	A/N	Character Vertical Size
KVERTT	A/N	Vertical Tab Table
TIMAGX	Virtual Graphics	Imaginary Beam X
TIMAGY	Virtual Graphics	Imaginary Beam Y
TMAXVX	Virtual Graphics	Virtual Window Maximum X
TMAXVY	Virtual Graphics	Virtual Window Maximum Y
TMINVX	Virtual Graphics	Virtual Window Minimum X
TMINVY	Virtual Graphics	Virtual Window Minimum Y
TRCOSF	Virtual Graphics	Relative Vector Cosine Factor
TREALX	Virtual Graphics	Real Beam X
TREALY	Virtual Graphics	Real Beam Y
TRSCAL	Virtual Graphics	Relative Vector Scale Factor
TRSINF	Virtual Graphics	Relative Vector Sine Factor

*Used only for implementation where only integer arithmetic is available.

**Used with implementations supporting the Tektronix 4002A Graphic Computer Terminal.

B.8 Other Terminal Control System Routines

GENERAL

The Terminal Control System consists of a set of highly modular routines in order that implementation and applicability would cover a number of terminals, systems, and users. A number of support routines not described in the main portion of this manual exist. These routines and a brief explanation of their function are described below.

BASIC I/O ROUTINES

Output Character — TOUTPT

Sets parity if necessary and outputs given character to terminal.

X,Y Conversion — XYCNVT

Screen X,Y Coordinates are translated to the minimum set of plot characters required for vector or point plot output. This routine performs the point plot simulation required for 4Ø1Ø implementations.

Forced I/O Delay — IOWAIT

Timesharing and remote temrinals will lose any output sent while a hard copy is being generated or the screen is being erased. The IOWAIT routine forces an appropriate delay in output to allow these events to occur without loss of information.

Output Dashed Line — TKDASH

Draws a dashed line as specified in KDASHT.

MODE CONTROL ROUTINES

Enter Vector Mode — VECMOD

Causes the terminal to enter the vector mode.

Enter Point Plot Mode PNTMOD

Signals the X,Y Conversion routine to simulate point plotting for the 4Ø1Ø.

Enter Dash Mode DSHMOD

Sets the dash type specification and enters dash mode.

Mode Check MODCHK

Determines present system mode.

GRAPHIC TRANSFORM ROUTINES

Virtual Graphics to Screen Transformation V2ST

Transforms a Virtual Space vector or point into output according to the current window definition. The General Error Flag is set whenever the given vector or point is outside the current window, and no output is generated. This routine maintains the Beam positions in Virtual Graphics.

Clip CLIPT

Clips Virtual Space vectors according to the current window definition. Returns start and end points of the visible segment of the vector. If vector does not pass through the window at all, the General Error Flag is raised.

Parallel Clip PARCLT

Clips horizontal and vertical vectors in Virtual Space according to the current window definition. Assumes vector passes through window and returns start and end points of the visible segment of the vector.

Point Clip PCLIPT

Determines if given point is within the current window. Sets the General Error Flag if point is not within the current window.

Window Coordinate Transform WINCOT

Scales and outputs a given Virtual Space vector or point according to the current window definition.

Reverse Window Coordinate Transform REVCOT

Transforms a given Screen Coordinate into a Virtual Coordinate according to the current window definition.

Graphic Level Check LVLCHT

Checks the current graphic level. If in Direct Level on entry, this routine resets the Beam and enters Virtual Graphics.

Relative to Absolute Conversion REL2AB

Scales and rotates relative vectors in Virtual Space and converts them to absolute vectors.

COMMON

Common is the same order as in the earlier standard release (see B.6). One word is used for each integer and two for each real number.

Two FORTRAN routines present in Release 3 but not found in the standard earlier releases are included in this version.

Subroutine RSCALE

Set relative vector scale factor.

CALLING SEQUENCE:

```
CALL RSCALE (SCALE)
     or
JSR R5,RSCALE
BR .+4
.WORD SCALE
```

Where SCALE is the address of a real variable containing the scale factor.

Subroutine RROTAT

Set relative vector rotate factors.

CALLING SEQUENCE:

```
CALL RROTAT (ROT)
     or
JSR R5,RROTAT
BR .+4
.WORD ROT
```

Where ROT is the address of a real variable containing the angle of rotation desired in degrees.

Four routines which may be called from assembly level only are unique to this version.

Subroutine TYPSTR

Outputs a string of ASCII characters to the terminal. Note that for this implementation, TOUTPT calls TYPSTR.

CALLING SEQUENCE:

```
JSR R5,TYPSTR
.WORD BUFFER
  .
  .
  .
```

Buffer:

```
.BYTE n
.BYTE n
.BYTE n
  .
  .
  .
.BYTE 377
```

Where n is the desired ASCII character to be output. The string of characters may be of any length as long as it is terminated by a 377_8 character.

Subroutine INPSTR

Inputs a string of ASCII characters from the terminal. Note that for this implementation, TINPUT calls INPSTR. INPSTR does not echo input back to the screen.

CALLING SEQUENCE:

```
JSR R5,INPSTR
.WORD BUFFER
  .
  .
  .
```

Buffer:

```
.WORD n
.=.+n
.EVEN
```

Where n is the number of characters to be input. The incoming characters are packed one character per byte. Input is terminated when the buffer is filled or when a carriage return (CR) character is transmitted, in this case the remaining characters in the buffer are set to spaces. INPSTR does not echo to the screen.

Subroutine ECHOST

Inputs a string of ASCII characters from the terminal, echoing them back to the screen one by one as they are entered. This entry was added for convenience in debugging this package. It is not currently used by any of the TCS routines.

CALLING SEQUENCE:

```
JSR R5,ECHOST
.WORD BUFFER
   .
   .
   .
Buffer:

.WORD n
.=.+n
.EVEN
```

Where n is the number of characters to be input. The incoming characters are packed one character per byte. Input is terminated when the buffer is filled or when a carriage return (CR) character is transmitted, in this case the remaining characters in the buffer are set to spaces. ECHOST does echo to the screen.

Subroutine CNTRL

This routine performs several basic control functions such as PAGE, ALPHA, etc., by calling TYPSTR with the appropriate string.

CALLING SEQUENCE:

```
JSR R5,CNTRL
.WORD n
```

Where n is the number of the function to be performed:

n	Function	
0	Page	
1	Alpha Mode	
2	Graphic Input Initialize (Crosshair Cursor)	
3	Hardcopy	
4	Double Size	Dummy Functions for 4010 Applications
5	Italic	
6	Double Size and Italic Reset	
7	ASCII Character Set	
8	APL Character Set	
9	Point Plot Mode	
10	Rotate Characters	

11	Bell
12	Horizontal Tab
13	Vertical Tab
14	Line Feed
15	Carriage Return
16	Carriage Return and Line Feed
17	Backspace
18	Graphic Mode
19	Return Status Trigger

The argument list to subroutine INITT is ignored. No argument need be sent.

I. SUBROUTINE AND FUNCTION INDEX

ROUTINES WHICH ARE COMPATIBLE WITH ALL RELEASES OF THE TERMINAL CONTROL SYSTEM.

NOTE: Users who possess an earlier release than the present (Release 3.0) should check APPENDIX B if they are seeking information about a routine not listed here.

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ASCII CODE CHART

CONTROL				HIGH X & Y GRAPHIC INPUT				LOW X				LOW Y			
NUL	ø	DLE	16	SP	32	ø	48	@	64	P	8ø	`	96	p	112
SOH	1	DC1	17	!	33	1	49	A	65	Q	81	a	97	q	113
STX	2	DC2	18	"	34	2	5ø	B	66	R	82	b	98	r	114
ETX	3	DC3	19	#	35	3	51	C	67	S	83	c	99	s	115
EOT	4	DC4	2ø	$	36	4	52	D	68	T	84	d	1øø	t	116
ENQ	5	NAK	21	%	37	5	53	E	69	U	85	e	1ø1	u	117
ACK	6	SYN	22	&	38	6	54	F	7ø	V	86	f	1ø2	v	118
BEL BELL	7	ETB	23	'	39	7	55	G	71	W	87	g	1ø3	w	119
BS BACK SPACE	8	CAN	24	(	4ø	8	56	H	72	X	88	h	1ø4	x	12ø
HT	9	EM	25	)	41	9	57	I	73	Y	89	i	1ø5	y	121
LF LINE FEED	1ø	SUB	26	*	42	:	58	J	74	Z	9ø	j	1ø6	z	122
VT	11	ESC	27	+	43	;	59	K	75	[	91	k	1ø7	{	123
FF	12	FS	28	,	44	<	6ø	L	76	\	92	l	1ø8	¦	124
CR RETURN	13	GS	29	-	45	=	61	M	77	]	93	m	1ø9	}	125
SO	14	RS	3ø	.	46	>	62	N	78	^	94	n	11ø	~	126
SI	15	US	31	/	47	?	63	O	79	_	95	o	111	127 RUBOUT (DEL)	

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