Contents

To Our Customers . . .

The TRS-80® Computer Graphics package revolutionizes your Model 4 by letting you draw intricate displays from simple program instructions. With the highly defined Graphics Screen, the list of practical applications is nearly endless!

The TRS-80 Computer Graphics package includes a:

- Computer Graphics Diskette
- Computer Graphics Operation Manual

However, before you can use this package, your Model 4 must have 64K of RAM (Random Access Memory) and one disk drive. Your computer must also be modified by a qualified Radio Shack service technician.

Included on the Graphics diskette are:

- TRSDOS Version 6
- Graphics BASIC (BASICG)
- Graphics Subroutine Library (GRPLIB)
- Graphics Utilities
- Sample Programs in BASICG and FORTRAN

To print graphic displays, you can use any Radio Shack printer that has graphic capabilities such as Line Printer VII (26-1167), Line Printer VIII (26-1168), DMP-100 (26-1253), DMP-200 (26-1254), DMP-400 (26-1251), or DMP-500 (26-1252).

You can also utilize the Graphics Subroutine Library with several languages, including, but not limited to, FORTRAN (26-2219).

About This Manual . . .

For your convenience, we've divided this manual into five sections plus appendices:

- Computer Graphics Overview
- Graphics BASIC (BASICG) Language Description
- Graphics Utilities
- FORTRAN Description
- Programming the Graphics Board
- Appendices

This package contains two separate (but similar) methods for Graphics programming:

- Graphics BASIC (BASICG)
- Graphics Subroutine Library

If you're familiar with Model 4 TRSDOS™ and BASIC, you should have little trouble in adapting to Graphics BASIC. If you want to review BASIC statements and syntax, see your ***Model 4 Disk System Owner's Manual.*** Then read Chapters 1, 2 and 3, along with Appendixes A, B, D, and E of this manual.

If it's Graphics applications in FORTRAN you're after, refer to the TRS-80 FORTRAN manual. Then read Chapters 1, 2, 3, and 4 as well as Appendixes C, D, E, and F of this manual.

Note: This manual is written as a reference manual for the TRS-80 Computer Graphics package. It is not intended as a teaching guide for graphics programming.

Notational Conventions

The following conventions are used to show syntax in this manual:

CAPITALS	Any words or characters which are uppercase must be typed in exactly as they appear.
lowercase italics	Fields shown in lowercase italics are variable information that you must substitute a value for.
ENTER	Any word or character contained within a box represents a keyboard key to be pressed.
...	Ellipses indicate that a field entry may be repeated.
filespec	A field shown as filespec indicates a standard TRSDOS file specification of the form: *filename/ext.password:d*
punctuation	Punctuation other than ellipses must be entered as shown.
delimiters	Commands must be separated from their operands by one or more blank spaces. Multiple operands, where allowed, may be separated from each other by a comma, a comma followed by one or more blanks, or by one or more blanks. Blanks and commas may not appear within an operand.

1/ Computer Graphics Overview

Graphics is the presentation of dimensional artwork. With TRS-80 Computer Graphics, the artwork is displayed on a two-dimensional plane — your computer screen. Like an artist's easel or a teacher's blackboard, the screen is a ''drawing board'' for your displays.

TRS-80 Computer Graphics has two colors:

- Black (OFF)
- White (ON)

Graphics programming is different from other types of programming because your ultimate result is a pictorial display (bar graph, pie chart, etc.) rather than textual display (sum, equation, etc.). This is an important distinction. After working with graphics for a while, you'll find yourself thinking ''visually'' as you write programs.

In computer-generated graphics, displays can include tables, charts, graphs, illustrations and other types of artwork. Once they're created, you can ''paint'' displays with a variety of styles and shapes, or even simulate animation.

The Computer Graphics program uses a ''high-resolution'' screen. The more addressable points or dots (called ''pixels'') on a computer's screen, the higher the resolution. A lower resolution screen has fewer addressable pixels.

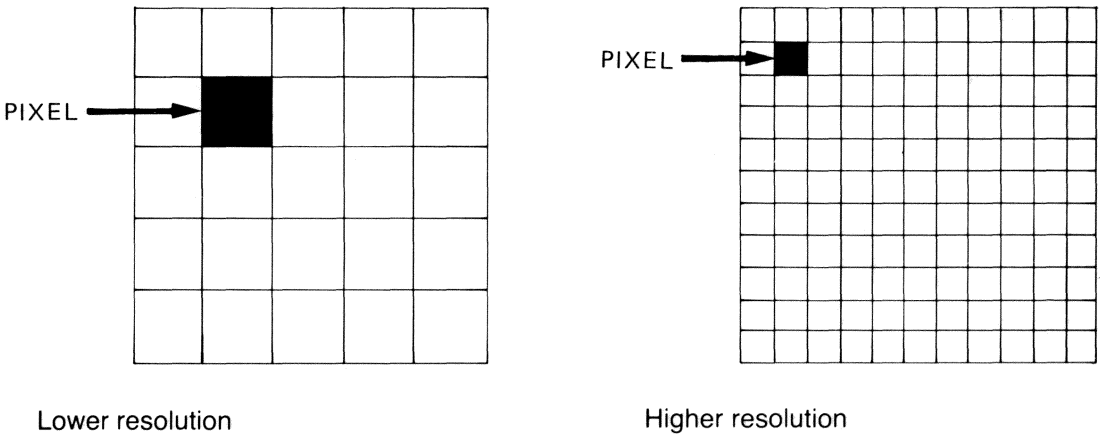


Figure 1. Resolution

Since the TRS-80 has high-resolution — 640 pixels on the X-axis (0 to 639) and 240 pixels on the Y-axis (0 to 239) — you can draw displays that have excellent clarity and detail.

How TRS-80 Computer Graphics Works

The concept of graphics is fairly simple. Each point on the screen can be turned ON (white) or OFF (black).

When you clear the Graphics Screen, all graphic points are turned OFF.

Therefore, by setting various combinations of the pixels (usually with a single command) either ON or OFF, you can generate lines, circles, geometric figures, pictures, etc.

The Graphics Screen

TRS-80 Computer Graphics has two ''screens'' — Text and Graphics. (We'll call them screens, although they are really modes.) Both screens can act independently of each other and make use of the computer's entire display area.

The Text Screen, also referred to as the ''Video Display,'' is the ''normal'' screen where you type in your programs. The Graphics Screen is where graphic results are displayed. Both screens can be cleared independently. Note: The Graphics Screen will not automatically be cleared when you return to TRSDOS. It will be cleared when you re-enter BASICG.

The Graphics Screen cannot be displayed at the same time as the Text Screen.

While working with Computer Graphics, it might be helpful to imagine the screen as a large Cartesian coordinate plane (with a horizontal X- and a vertical Y-axis). However, unlike some coordinate systems, TRS-80 Computer Graphics' coordinate numbering starts in the upper-left corner — (0,0) — and increases toward the lower-right corner — (639,239). The lower-left corner is (0,239) and the upper-right corner is (639,0).

Since the screen is divided into X-Y coordinates (like the Cartesian system), each pixel is defined as a unique position. In TRS-80 Computer Graphics, you can directly reference these coordinates as you draw.

About Ranges...

Some TRS-80 Computer Graphics commands accept values within the Model 4 integer range (−32768 to 32767), instead of just 0 to 639 for X and 0 to 239 for Y. Since most of the points in the integer range are off the screen, these points are part of what is called Graphics ''imaginary'' Cartesian system.

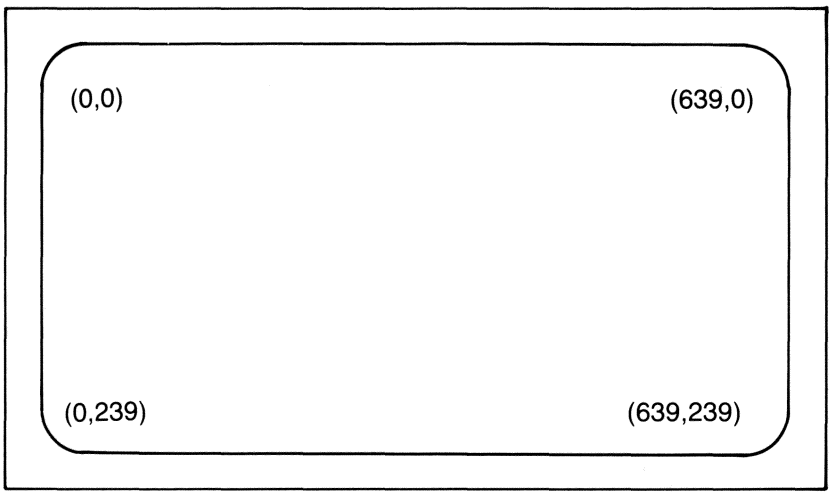


Figure 2. Graphics Visible Screen

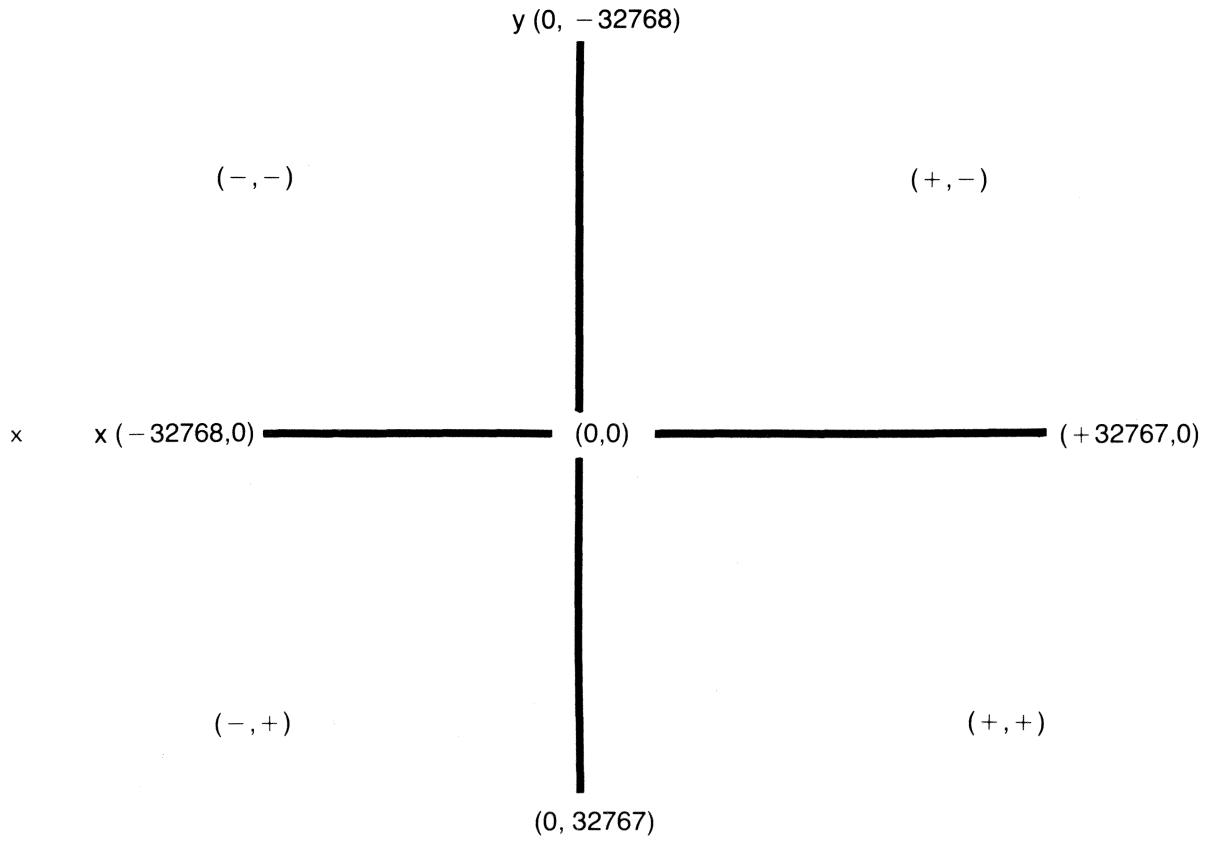


Figure 3. Graphics "Imaginary" Cartesian System

2/ Graphics BASIC

Graphics BASIC (BASICG) vs. BASIC

The Graphics BASIC file on the supplied diskette is named BASICG.

You can load and run a BASIC file from either BASICG or BASIC. You cannot run programs that contain BASICG statements while in BASIC.

Important Note: Because of memory limitations, some programs (i.e., some application programs) will not run in BASICG. BASICG uses approximately 6.6K more memory than BASIC. Some Graphics Commands use Free Memory. This means that the larger your BASIC programs are, the more limitations on your Graphics capabilities.

Each Graphics program statement has a specific syntax and incorporates a Graphics BASIC command or function.

Table 1 gives a brief description of the BASICG commands; Table 2 lists the BASICG functions. This section of the manual will describe each statement and function in detail.

BASICG Commands

Command	Description
CIRCLE	Draws a circle, arc, semicircle, etc.
CLR	Clears the Graphics Screen.
GLOCATE	Sets the Graphics Cursor and the direction for putting characters on the Graphics Screen.
GET	Reads the contents of a rectangle on the Graphics Screen into an array for future use by PUT.
LINE	Draws a line from the startpoint to the endpoint in the specified line style and color. Also creates a box.
PAINT	Paints an area, starting from a specified point. Also paints a specified style.
PRESET	Sets an individual dot (pixel) OFF (or ON).
PRINT #-3	Writes characters to the Graphics Screen.
PSET	Sets an individual dot (pixel) ON (or OFF).
PUT	Stores graphics from an array onto the Graphics Screen.
SCREEN	Selects the Graphics or Text Screen.
VIEW	Creates a viewport which becomes the current Graphics Screen.

Table 1

BASICG Functions	
Function	**Description**
&POINT	Returns the OFF/ON color value of a pixel.
&VIEW	Returns the current viewport coordinates.

Table 2

Starting-Up

Before using the diskette included with this package, be sure to make a "safe copy" of it. See your ***Model 4 Introduction to Your Disk System*** for information on BACKUP.

To load BASICG:

1. Power up your System according to the start-up procedure in your ***Model 4 Introduction to Your Disk System***.
2. Insert the backup diskette into Drive 0.
3. Initialize the System as described in your ***Model 4 Introduction to Your Disk System***.
4. When TRSDOS Ready appears, type:

   BASICG (ENTER)

The Graphics BASIC start-up prompts, followed by the READY prompt appear, and you are in Graphics BASIC. You can now begin BASICG programming.

Remember that Model 4 numeric values are as follows:

Model 4 Numeric Values			
Numeric Type	**Range**	**Storage Requirement**	**Example**
Integer	−32768, 32767	2 bytes	240, 639, −10
Single-Precision	$-1*10^{38}, -1*10^{-38}$ $+1*10^{38}, +1*10^{-38}$ Up to 7 significant digits (Prints six)	4 bytes	22.50,3.14259 −100.001
Double-Precision	$-1*10^{38}, -1*10^{-38}$ $+1*10^{38}, +1*10^{-38}$ Up to 17 significant digits (Prints 16)	8 bytes	1230000.00 3.1415926535897932

Table 3

With each BASICG command or function, there are various options which you may or may not include in a program statement (depending on your needs). Each option is separated from the previous option by a delimiter, usually a comma. When you do not specify an available option (e.g., you use the default value) and you specify subsequent options, you must still enter the delimiter or a Syntax Error will result. (See your ***Model 4 Disk System Owner's Manual*** for more information.)

Because you are dealing with two distinct screens, the Graphics Screen and the Text Screen, we strongly urge you to read the description of the **SCREEN** command before continuing.

CIRCLE
Draws Circle, Semicircle, Ellipse, Arc, Point

CIRCLE *(x,y),r,c,start,end,ar*

(x,y) specifies the centerpoint of the figure. ***x*** and ***y*** are integer expressions.
r specifies the radius of the figure in pixels and is an integer expression.
c specifies the OFF/ON color of the figure and is an integer expression of either 0 (OFF/black) or 1 (ON/white). ***c*** is optional; if omitted, 1 is used.
start specifies the startpoint of the figure and is a numeric expression from 0 to 6.283185. ***start*** is optional; if omitted, 0 is used.
end specifies the endpoint of the figure and is a numeric expression from 0 to 6.283185. ***end*** is optional; if omitted, 6.283185 is used.
ar specifies the aspect ratio of the circle, is a single-precision floating-point number > 0.0 (to $1*10^{38}$) and determines the major axis of the figure. ***ar*** is optional; if omitted, .5 is used and a circle is drawn.

The CIRCLE command lets you draw five types of figures:

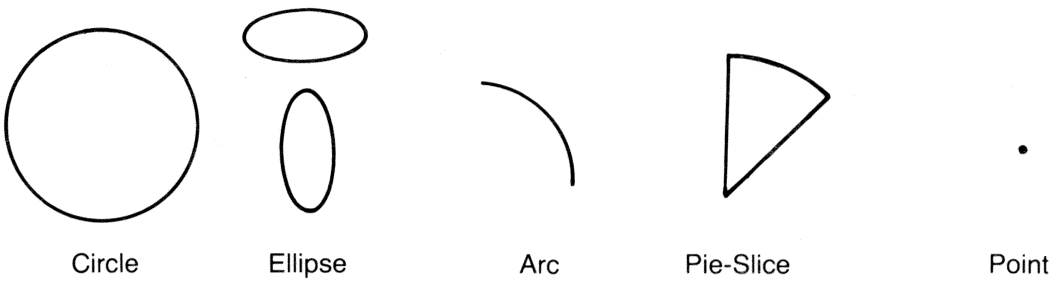


Figure 4. Types of Displays with CIRCLE

With CIRCLE, you can enter values for PI (and 2 x PI) up to 37 significant digits without getting an overflow error. However, only 16 digits are displayed.

3.14159265358979323846264338327950288 41
6.28318530717958647692528676655900576 82

However, you'll probably only be able to visually detect a change in the circle's *start* and *end* when PI is accurate to a few significant digits (e.g., 3.1, 6.28, etc.). The *start* and *end* values can't be more than 2 x PI (e.g., 6.2832 will not work) or an Illegal Function Call error will occur.

(x,y)
Centerpoint

The *(x,y)* coordinates in the CIRCLE statement specify the centerpoint of the figure. *x* and *y* are numeric expressions in the integer number range.

Example

CIRCLE *(x,y),r*

CIRCLE (320,120),*r*

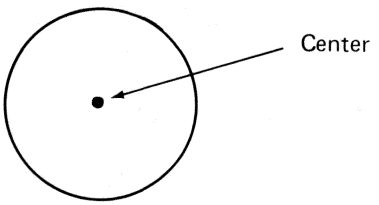


Figure 5. Center of Circle

r
Radius

The radius of a circle is measured in pixels and is a numeric expression in the integer range. Radius is the distance from the centerpoint to the edge of the figure. Although a negative value will be accepted by BASICG, the results of using a negative value are unpredictable.

The radius is either on the X-axis or Y-axis, depending on the aspect ratio (see *ar*). If the aspect ratio is greater than 1, the radius is measured on the Y-axis. If the aspect ratio is less than or equal to 1, the radius is measured on the X-axis.

Example

```
10 CIRCLE(320,120),100
```

This example draws a circle. The radius is 100 and the centerpoint is (320,120).

c
Color

You can get the ON/OFF (white/black) color of a figure's border and radius lines (see chart/end) by specifying a numeric value of 1 or 0.

If you omit color, BASICG uses 1 (ON/white).

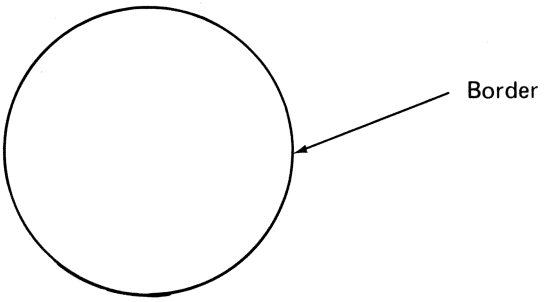


Figure 6. Border of Circle

start/end
Startpoint/Endpoint of Circle

The range for *start* and *end* is 0 to 6.283185 (2 x PI).

If you do not enter *start* and *end*, the default values of 0 and 6.28, respectively, are used.

A negative *start* or *end* value will cause the respective radius to be drawn in addition to the arc (i.e., it will draw a "piece of the pie"). The actual start and endpoints are determined by taking the absolute value of the specified start and endpoints. These values are measured in radians.

Note: Radius will not be drawn if *start* or *end* is -0. To draw a radius with *start* or *end* as 0, you must use $-0.000...01$.

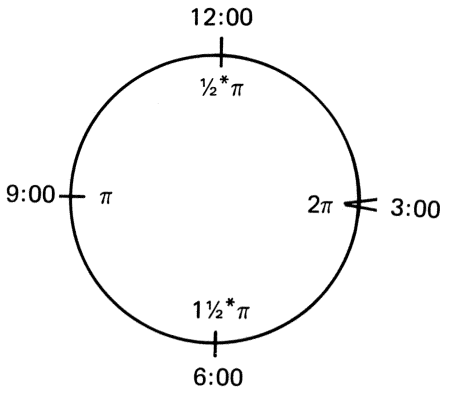


Figure 7. Clock/Radian Equivalents

Degrees	Radians	Clock Equivalent
0	0	3:00
90	1.57	12:00
180	3.14	9.00
270	4.71	6:00
360	6.28	3:00

Table 4. Degree/Radians/Clock Equivalents

You can draw semicircles and arcs by varying *start* and *end*. If *start* and *end* are the same, a point (one pixel) will be displayed instead of a circle.

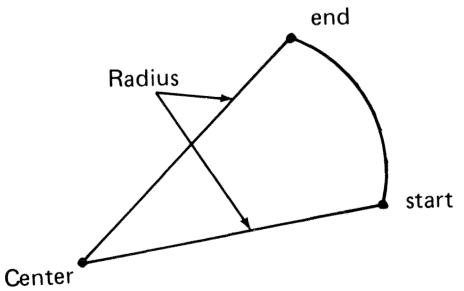


Figure 8. CIRCLE's (−) *start*, (−) *end*

You can have a positive *start* and a negative *end* (or vice versa) as well as negative *starts* and *ends*. In these cases, only one radius line is drawn.

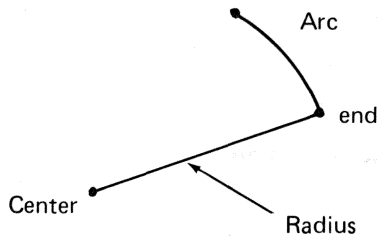


Figure 9. CIRCLE's (+) *start*, (−) *end*

Hints and Tips about *start* and *end*:

- When using the default values for *start* and *end*, you must use commas as delimiters if you wish to add more parameters.
- If you use PI, it is not a reserved word in BASICG and must be defined in your program.

ar
Aspect Ratio

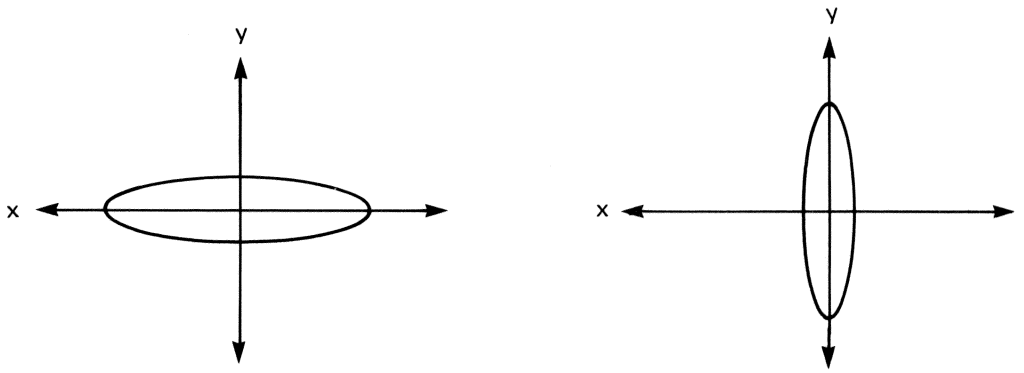
You can draw ellipses by varying the aspect ratio from the default value (.5) for a circle (and semicircle).

Every ellipse has a ''major axis'' which is the ellipse's longer, predominant axis. With an ellipse (as with a circle), the two axes are at right angles to each other.

The mathematical equation for determining the aspect ratio is:

ar = length of Y-axis/length of X-axis

- If the aspect ratio is .5, a circle is drawn.
- If the ratio is less than .5, an ellipse with a major axis on the X-axis is drawn.
- If the ratio is greater than .5, an ellipse with a major axis on the Y-axis is drawn.



X-Axis Ellipse (*ar* < .5) **Y-Axis Ellipse (*ar* > .5)**

Figure 10. CIRCLE's Ellipse

The range for aspect ratio is a single-precision floating-point number greater than 0.0 (to $1*10^{38}$). Although a negative value will be accepted by BASICG, the results of using a negative value are unpredictable.

Hints and Tips about aspect ratio:

- Entering .5 as the ratio produces a circle.
- Numbers between 0 and .5 produce an ellipse with a major axis on X.
- Numbers over .5 generate an ellipse with a major axis on Y.
- Even though you can enter large aspect ratios, large numbers may produce straight lines.

Examples

```
CIRCLE (320,120),90,1
```

This example draws a white-bordered circle with the centerpoint of (320,120) and radius of 90.

```
CIRCLE (320,120),90,1,,,,7
```

This statement draws a white-bordered ellipse with an origin of (320,120) and radius of 90. The major axis is the Y-axis.

```
CIRCLE (320,120),90,1,,-6.2,-5
```

This statement draws an arc with a vertex (''origin'') of (320,120) and radius of 90. *start* is 6.2 and *end* is 5. Radius lines are drawn for *start* and *end*.

```
CIRCLE (320,120),90,1,,-4
```

This example draws an arc with a vertex of (320,120) and radius of 90. *start* is 0 and *end* is 4. A radius line is drawn for *end*.

```
10 PI=3.1415926
20 CIRCLE (320,120),100,1,PI,2*PI,,5
```

A semicircle is drawn.

```
10 CIRCLE (150,100),100,1,-5,-1
20 CIRCLE (220,100),100,1,5,1
```

Two arcs are drawn with the same *start* and *end* point. The arc with the negative *start* and *end* has two radius lines drawn to the vertex. The arc with a positive *start* and *end* has no radius lines.

```
CIRCLE (320,120),140,,-4,6.1
```

This statement draws an arc with a vertex at (320,120) and a radius of 140. *Start* is 4 and *end* is 6.1. A radius line is drawn for *start*.

```
CIRCLE (320,120),140,1,0,1,,5
```

This example draws an arc with a vertex of (320,120) and radius of 140.

Sample Program

```
4 SCREEN 0
5 CLR
10 FOR X =10 TO 200 STEP 10
20 CIRCLE (300,100),X,1,,,,9
30 NEXT X
40 FOR Y=10 TO 200 STEP 10
50 CIRCLE (300,100),Y,1,,,,1
60 NEXT Y
70 FOR Z=10 TO 200 STEP 10
80 CIRCLE (300,100),Z,1,,,,5
90 NEXT Z
100 GOTO 5
```

A set of 20 concentric ellipses is drawn with a major axis on Y, a set of 20 concentric ellipses is drawn with a major axis on X, and a set of 20 concentric circles is drawn. The ellipses and circles in each of the three groups are concentric and the radius varies from 10 to 200.

CLR
Clears the Graphics Screen

CLR

CLR clears the Graphics Screen.

Example

```
10 SCREEN 0
20 CIRCLE(320,120),100,1
```

This program line will draw a circle. Now type:

```
CLR (ENTER)
```

and the Graphics Screen will be cleared but the Text Screen will remain unchanged. This can be seen by typing:

```
SCREEN 1
```

GET
Reads the Contents of Rectangular Pixel Area into Array

GET(*x1,y1*)–(*x2,y2*),*array name*

(x1,y1) are coordinates of one of the opposing corners of a rectangular pixel area. *x1* is an integer expression from 0 to 639. *y1* is an integer expression from 0 to 239.
(x2,y2) are coordinates of the other corner of a rectangular pixel area. *x2* is an integer expression from 0 to 639. *y2* is an integer expression from 0 to 239.
array name is the name you assign to the array that will store the rectangular area's contents. *array name* must be specified.

Important Note: BASICG recognizes two syntaxes of the command GET — the syntax described in this manual and the syntax described in the ***Model 4 Disk System Owner's Manual***. BASIC recognizes only the GET syntax described in the ***Model 4 Disk System Owner's Manual***.

GET reads the graphic contents of a rectangular pixel area into a storage array for future use by PUT (see PUT).

A rectangular pixel area is a group of pixels which are defined by the diagonal line coordinates in the GET statement.

The first two bytes of *array name* are set to the horizontal (X-axis) number of pixels in the pixel area; the second two bytes are set to the vertical (Y-axis) number of pixels in the pixel area. The remainder of *array name* represents the status of each pixel, either ON or OFF, in the pixel area. The data is stored in a row-by-row format. The data is stored 8 pixels per byte and each row starts on a byte boundary.

Array Limits

When the array is created, BASICG reserves space in memory for each element of the array. The size of the array is limited by the amount of memory available for use by your program — each real number in your storage array uses four memory locations (bytes).

The array must be large enough to hold your graphic display and the rectangular area must include all the points you want to store.

Your GET rectangular pixel area can include the entire screen (i.e., GET(0,0)−(639,239),array name), if the array is dimensioned large enough.

To determine the minimum array size:

1. Divide the number of X-axis pixels by 8 and round up to the next higher integer.
2. Multiply the result by the number of Y-axis pixels. When counting the X-Y axis pixels, be sure to include the first and last pixel.
3. Add four to the total.
4. Divide by four (for real numbers) or two (for integers) rounding up to the next higher integer.

The size of the rectangular pixel area is determined by the *(x,y)* coordinates used in GET:

Position: upper-left corner = startpoint = (x1,y1)
lower-left corner = endpoint = (x2,y2)

Size (in pixels): width = x2−x1+1
length = y2−y1+1

Example

```
GET(10,10)-(80,50),V
```

This block is 71 pixels wide on the X-axis (10 through 80) and 41 long on the Y-axis (10 through 50).

- For real: 71/8 = 9 * 41 = 369 + 4 = 373/4 = 94
- For integer: 71/8 = 9 * 41 = 369 + 4 = 373/2 = 187

Depending on the type of array you use, you could set up your minimum-size dimension statement this way:

- Real `DIM V(93)`

or

- Integer `DIM V%(186)`

Examples

```
10 DIM V(249)
20 CIRCLE (65,45),20,1
30 GET (10,10)-(120,80),V
```

An array is created, a circle is drawn and stored in the array via the GET statement's rectangular pixel area's parameters (i.e., (10,10)−(120,80)).

Calculate the dimensions of the array this way:

Rectangular pixel area is 111 × 71. That equals:

$$111/8 = 14 * 71 = 994 + 4 = 998/4 = 250$$

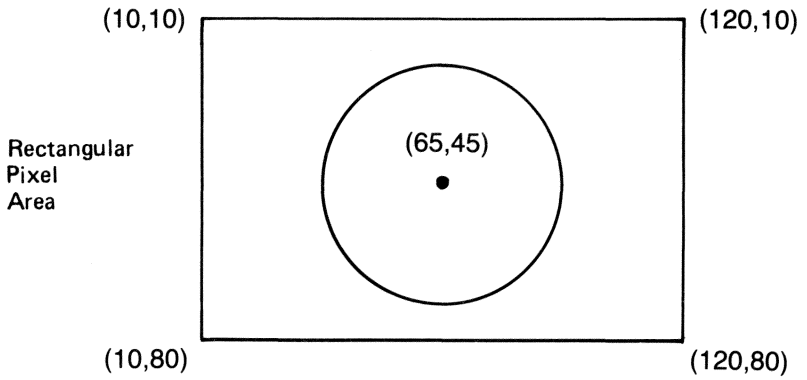


Figure 11

```
10 DIM V(30,30)
20 CIRCLE (50,50),10
30 GET (10,10)-(80,80),V
```

A two-dimensional array is created, a circle is drawn and stored in the array via the GET statement's rectangular pixel area's parameters (i.e., (10,10) – (80,80)).

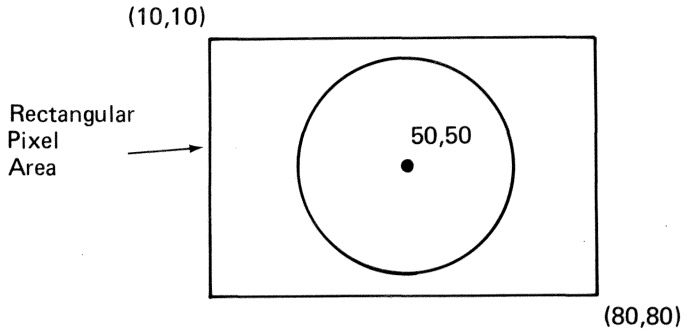


Figure 12

```
10 DIM V%(564)
20 CIRCLE (65,45),50,1,1,3
30 GET(10,10)-(120,80),V%
```

A one-dimensional integer array is created, an arc is drawn and stored in the array via the GET statement's rectangular area's parameters.

GLOCATE
Sets the Graphics Cursor

GLOCATE *(x,y), direction*

(x,y) specifies the location of the Graphics Cursor and is a pair of integer expressions.
direction specifies the direction that the characters will be written to the Graphics Screen and has an integer value of 0, 1, 2, or 3. *direction* is optional; if omitted, 0 is used.

Since the Text Screen and the Graphics Screen cannot be displayed at the same time, you need an easy way to display textual data on the Graphics Screen. GLOCATE provides part of this function by allowing you to specify where on the Graphics Screen to start displaying the data, *(x,y)*, and which direction to display it — *direction*.

The allowable values for *direction* are:

0 — zero degree angle
1 — 90 degree angle
2 — 180 degree angle
3 — 270 degree angle

Examples

```
10 GLOCATE (320,120),0
```

This program line will cause characters to be displayed starting in the center of the screen in normal left-to-right orientation.

```
100 GLOCATE (320,10),1
```

This program line will cause characters to be displayed starting in the center of the top portion of the screen in a vertical orientation, going from the top of the screen to the bottom of the screen.

```
200 GLOCATE (630,120),2
```

This program line will cause characters to be displayed upside down starting at the right of the screen and going towards the left.

```
300 GLOCATE (320,230),3
```

This program line will cause the characters to be displayed vertically, starting at the center of the lower portion of the screen towards the top of the screen.

LINE
Draws a Line or Box

LINE *(x1,y1)*–*(x2,y2)*, *c*, B or BF, *style*

(x1,y1) specifies the starting coordinates of a line and is a pair of integer expressions. *(x1,y1)* is optional; if omitted, the last ending coordinates of any previous command are used as the startpoint. If a command has not been previously specified, (0,0) is used.
(x2,y2) specifies the ending coordinates of a line. *(x2,y2)* is a pair of integer expressions.
c specifies the color and is a numeric expression of either 0 or 1. *c* is optional; if omitted, 1 is used.
B or **BF** specifies drawing and/or shading (solid white or solid black) a box. B draws a box and BF fills a box with shading. B/BF is optional; if omitted, only a line is drawn.
style is the setting for the pattern of a line and is a numeric value in the integer range. *style* is optional; if omitted, –1 (solid line) is used. *style* must be omitted if BF is used.

LINE draws a line from the starting point *(x1,y1)* to the ending point *(x2,y2)*.

If the starting point is omitted, either (0,0) is used if a previous end coordinate has not been specified or the last ending point of the previous command is used. If one or both parameters are off the screen, only the part of the line which is visible is displayed.

With over 65,500 line styles possible, each style is slightly different. You'll find it's almost impossible to detect some of the differences since they are so minute.

LINE with Box Option

The *start* and *end* coordinates are the diagonal coordinates of the box (either a square or rectangle). When you don't specify the B or BF options, the "diagonal" line is drawn. When you specify the B option, the perimeter is drawn but not the diagonal line. When you specify the BF option, the perimeter is drawn, and the area bounded by the perimeter is shaded in the specified color *(c)*.

```
LINE(140,80)-(500,200),1,B
```

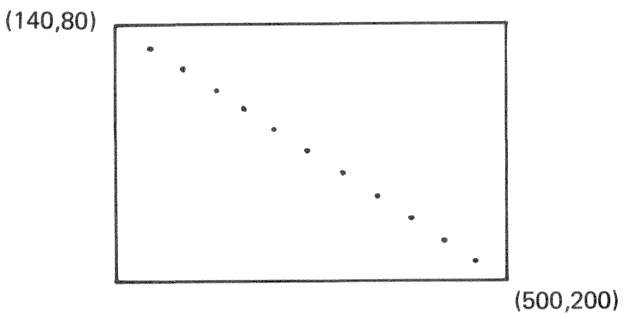


Figure 13

style

style sets the pixel arrangement in 16-bit groups.

For example, 0000 1111 0000 1111 (binary), 0F0F (hex), or 3855 (decimal).

style can be any number in the integer range (negative or positive). Using hexadecimal numbers, you can figure the exact line style you want. There will always be four numbers in the hexadecimal constant.

To use hexadecimal numbers for *style:*

1. Decide what pixels you want OFF (bit = 0) and ON (bit = 1).
2. Choose the respective hexadecimal numbers (from the Base Conversion Chart, Appendix D).

Example

```
0000 1111 0000 1111 = &H0F0F
```

Creates a dashed line.

Type	Binary Numbers	Hex Numbers
Long dash	0000 0000 1111 1111	&H00FF
Short dash	0000 1111 0000 1111	&H0F0F
"Short-short" dash	1100 1100 1100 1100	&HCCCC
Solid line	1111 1111 1111 1111	&HFFFF
OFF/ON	0101 0101 0101 0101	&H5555
"Wide" dots	0000 1000 0000 1000	&H0808
Medium dots	1000 1000 1000 1000	&H8888
Dot-dash	1000 1111 1111 1000	&H8FF8

Table 5. Sample Line Styles

Examples

```
LINE -(100,40)
```

This example draws a line in white (ON) starting at the last endpoint used and ending at (100,40).

```
LINE (0,0)-(319,199)
```

This statement draws a white line starting at (0,0) and ending at (319,199).

```
LINE(100,100)-(200,200),1,,45
```

This example draws a line from (100,100) to (200,200) using line style 45 (&H002D).

```
LINE (100,100)-(300,200),1,,&H00FF
```

This LINE statement draws a line with "long dashes." Each dash is eight pixels long and there are eight blank pixels between each dash.

```
LINE (100,100)-(300,200),1,,-1000
```

This statement draws a line from (100,100) to (300,200) using line style −1000.

```
LINE (200,200)-(-100,100)
```

A line is drawn from the startpoint of (200,200) to (−100,100).

```
10 LINE (30,30)-(180,120)
20 LINE -(120,180)
30 LINE -(30,30)
```

This program draws a triangle.

```
10 LINE -(50,50)
20 LINE -(120,80)
30 LINE -(-100,-100)
40 LINE -(3000,1000)
```

This program draws four line segments using each endpoint as the startpoint for the next segment.

PAINT
Paints Screen

PAINT *(x,y), tiling, border, background*

(x,y) specifies the X-Y coordinates where painting is to begin. *x* is a numeric expression from 0 to 639 and *y* is a numeric expression from 0 to 239.

tiling specifies the paint style and can be a string or a numeric expression. *tiling* is optional; if omitted, 1 is used. *tiling* cannot be a null string (" ") and no more than 64 bytes may be contained in the tiling string.

border specifies the OFF/ON color of the border where painting is to stop and is a numeric expression of either 0 (OFF) or 1 (ON). *border* is optional; if omitted, 1 is used.

background specifies the color of the background that is being painted and is a 1-byte string of either 0 (CHR$(&H00)) or 1 (CHR$(&HFF)). *background* is optional; if omitted, CHR$(&H00) is used.

PAINT shades the Graphics Screen with *tiling* starting at the specified X-Y coordinates, proceeding upward and downward.

x,y
Paint Startpoint

x,y is the coordinate where painting is to begin and must:

- Be inside the area to be painted.
- Be on the working area of the screen.

For example:

```
10 CIRCLE(320,120),80
20 PAINT(320,120),1,1
```

A circle with a centerpoint of (320,120) is drawn and painted in white.

tiling
Paint Style

tiling is the pattern in a graphics display. By specifying each pixel, you can produce a multitude of tiling styles thereby simulating different shades of paint on the screen.

tiling is convenient to use in bar graphs, pie charts, etc., or whenever you want to shade with a defined pattern.

There are two types of *tiling*:

- Numeric expressions
- Strings

Numeric Expressions. There are only two numeric expressions that can be used for the paint style — 0 and 1. 1 paints all pixels ON (solid white) and 0 paints all pixels OFF (solid black).

To use numeric expressions, enter either a 0 or 1. For example:

```
PAINT (320,120),1,1
```

Strings (Point-by-Point Painting). You can paint precise patterns using strings by defining a multi-pixel grid, pixel-by-pixel, on your screen as one contiguous pattern.

String painting is called "pixel" painting because you are literally painting the screen "pixel-by-pixel" in a predetermined order.

You can define the tile length as being one to 64 vertical tiles, depending on how long you want your pattern. Tile width, however, is always eight horizontal pixels (8 pixels representing one 8-bit byte). The dimensions of a tile pattern are length by width. Tile patterns are repeated as necessary to paint to the specified borders. Because of its symmetry, you'll probably find equilateral pixel grids most convenient.

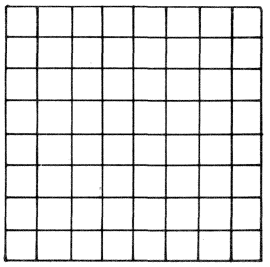


Figure 14. Example of an 8-by-8 Pixel Grid

Strings allow numerous graphic variations because of the many pixel combinations you can define.

Important Note: You cannot use more than two consecutive rows of tiles which match the background or an Illegal Function Call error will occur. For example:

```
PAINT (1,1),CHR$(&HFF)+CHR$(&HFF)+CHR$(&H00)+CHR$(&H00)
+CHR$(&H00)+CHR$(&H00),1,CHR$(&H00)
```

returns an Illegal Function Call error.

Using Tiling

You may want to use a sheet of graph paper to draw a style pattern. This way, you'll be able to visualize the pattern and calculate the binary and hexadecimal numbers needed.

Note: Tiling should only be done on either a totally black or white background; otherwise, results are unpredictable.

To draw an example of a tile on paper:

1. Take a sheet of paper and draw a grid according to the size you want (8 × 8, 24 × 8, etc.). Each boxed area on this grid, hypothetically, represents one pixel on your screen.
2. Decide what type of pattern you want (zigzag, diagonal lines, perpendicular lines, etc.).
3. Fill in each grid in each 8-pixel-wide row of the tile if you want that pixel to be ON, according to your pattern. If you want the pixel to be OFF, leave the grid representing the pixel blank.
4. On your paper grid, count each ON pixel as 1 and each OFF pixel as 0. List the binary numbers for each row to the side of the grid. For example, you might have 0001 1000 on the first row, 0111 0011 on the second row, etc.
5. Using a hexadecimal conversion chart, convert the binary numbers to hexadecimal numbers. (Each row equates to a two-digit hexadecimal number.)
6. Insert the hexadecimal numbers in a tile string and enter the string in your program.

Note: For a listing of commonly used tiling styles, see Appendix E.

Example

For example, if you're working on an 8 × 8 grid and want to draw a plus ("+") sign:

								Binary	Hex
Ø	Ø	Ø	1	1	Ø	Ø	Ø	ØØØ1 1ØØØ	18
Ø	Ø	Ø	1	1	Ø	Ø	Ø	ØØØ1 1ØØØ	18
Ø	Ø	Ø	1	1	Ø	Ø	Ø	ØØØ1 1ØØØ	18
1	1	1	1	1	1	1	1	1111 1111	FF
1	1	1	1	1	1	1	1	1111 1111	FF
Ø	Ø	Ø	1	1	Ø	Ø	Ø	ØØØ1 1ØØØ	18
Ø	Ø	Ø	1	1	Ø	Ø	Ø	ØØØ1 1ØØØ	18
Ø	Ø	Ø	1	1	Ø	Ø	Ø	ØØØ1 1ØØØ	18

Figure 15. 8 × 8 Grid

Tile string:

```
A$=CHR$(&H18)+CHR$(&H18)+CHR$(&H18)+CHR$(&HFF)+CHR$(&HFF)
   +CHR$(&H18)+CHR$(&H18)+CHR$(&H18)
```

b
Border

Border is the OFF/ON color of the border of a graphics design where painting is to stop and is a numeric expression of either 0 or 1. If omitted, 1 (ON) is used and all the pixels on the border are set (solid white).

background
Background Area

Background is a 1-byte character which describes the background of the area you are painting. CHR$(&H00) specifies a black background and CHR$(&HFF) is a totally white background. If background is not specified, BASICG uses CHR$(&H00).

Painting continues until a border is reached or until PAINT does not alter the state of any pixels in a row. However, if pixels in a given row are not altered and the tile that was to be painted in that row matches the background tile, painting will continue on to the next row.

Note: BASICG uses Free Memory for tiling.

Examples

```
10 CIRCLE (300,100),100
20 PAINT (300,100),1,1
```

Paints the circle in solid white.

```
10 CIRCLE (100,100),300
20 PAINT (100,100),1,1
```

Paints the circle. Only the visible portion of the circle is painted on the screen.

```
4 CLR
5 A=1
6 SCREEN 0
10 CIRCLE (320,120),100
20 CIRCLE (100,100),50
30 CIRCLE (400,200),60
40 CIRCLE (500,70),50
50 PAINT (320,120),A,1
60 PAINT (100,100),A,1
70 PAINT (400,200),A,1
80 PAINT (500,70),A,1
```

The tiling style is assigned the value 1 in line 5 (A = 1) for all PAINT statements. Four circles are drawn and painted in solid white.

```
10 LINE (140,80)-(500,200),1,B
20 PAINT (260,120),CHR$(&HEE)+CHR$(&H77)+CHR$(00),1
```

Paints box in specified tiling style using strings.

```
10 CIRCLE (300,100),100
20 PAINT (300,100),"D",1
```

This example uses a character constant to paint the circle in vertical blank and white stripes. The character "D" (0100 0100) sets this vertical pattern: one vertical row of pixels ON, three rows OFF.

```
10 CIRCLE (320,120),200
20 PAINT (320,120),"332211",1
30 PAINT (100,70),"EFEF",1
```

This example draws and paints a circle, then paints the area surrounding the circle with a different paint style (line 30). This PAINT statement's (line 30) startpoint must be outside the border of the circle.

```
10 PAINT (320,120),CHR$(&HFF),1
20 CIRCLE (320,120),100,0
30 PAINT (320,120),CHR$(0)+CHR$(&HFF),0,CHR$(&HFF)
```

Paints the screen white, draws a circle and paints the circle with a pattern.

```
10 PAINT (320,120),CHR$(&HFF),1
20 CIRCLE (320,120),100,0
30 PAINT (320,120),CHR$(0)+CHR$(&HAA),0,CHR$(&HFF)
```

Paints the screen white, draws a circle and paints the circle with a pattern.

```
10 CIRCLE(30080,100),100
20 A$=CHR$(&H00)+CHR$(&H7E)+CHR$(&H18)+CHR$(&H18)+CHR$(&H18)
   +CHR$(&H18)+CHR$(&H18)+CHR$(&H00)
30 PAINT(300,100),A$,1
```

This draws the circle and paints with the letter T within the parameters of the circle.

```
10 A$=CHR$(&H41)+CHR$(&H22)+CHR$(&H14)+CHR$(&H08)+CHR$(&H14)
   +CHR$(&H22)+CHR$(&H41)+CHR$(&H00)
20 PAINT (300,100),A$, 1
```

This paints Xs over the entire screen.

```
1 CLEAR 100
3 CLR
5 SCREEN 0
10 TILE$(0)=CHR$(&H22)+CHR$(&H00)
20 TILE$(1)=CHR$(&HFF)+CHR$(&H00)
30 TILE$(2)=CHR$(&H99)+CHR$(&H66)
40 TILE$(3)=CHR$(&H99)
50 TILE$(4)=CHR$(&HFF)
60 TILE$(5)=CHR$(&HF0)+CHR$(&HF0)+CHR$(&H0F)+CHR$(&H0F)
70 TILE$(6)=CHR$(&H3C)+CHR$(&H3C)+CHR$(&HFF)
80 TILE$(7)=CHR$(&H03)+CHR$(&H0C)+CHR$(&H30)+CHR$(&HC0)
90 A$=TILE$(0)+TILE$(1)+TILE$(2)+TILE$(3)+TILE$(4)
   +TILE$(5)+TILE$(6)+TILE$(7)
100 PAINT(300,100),A$1
```

This example paints the screen with a tiling pattern made up of eight individually defined tile strings (0-7).

&POINT (function) Returns Pixel Value

&POINT*(x,y)*

x specifies an X-coordinate and is an integer expression.
y specifies a Y-coordinate and is an integer expression.
values returned by &POINT are:
0 (pixel OFF)
1 (pixel ON)
−1 (pixel is off the screen)

The &POINT command lets you read the OFF/ON value of a pixel from the screen.

Values for &POINT that are off the screen (i.e., PRINT &POINT (800,500)) return a −1, signifying the pixel is off the screen.

Example

```
10 PSET(300,100),1
20 PRINT &POINT(300,100)
```

Reads and prints the value of the pixel at the point's coordinates (300,100) and displays its value: 1.

```
PRINT &POINT(3000,1000)
```

Since the pixel is off the screen, a −1 is returned.

```
PRINT &POINT(-3000,1000)
```

Since the pixel is off the screen, a −1 is returned.

```
PSET(200,100),0
PRINT &POINT(200,100)
```

Reads and prints the value of the pixel at the point's coordinates (200,100) and displays its value: 0.

```
10 PSET(300,100),1
20 IF &POINT(300,100)=1 THEN PRINT "GRAPHICS BASIC!"
```

Sets the point ON. Since the point's value is 1, line 20 is executed and Graphics BASIC is displayed:

```
GRAPHICS BASIC!
```

```
5 SCREEN 0
10 PSET(RND(640),RND(240)),1
20 IF &POINT(320,120)=1 THEN STOP
30 GOTO 10
```

Sets points randomly until (320,120) is set.

```
5 CLR
10 LINE(50,80)-(120,100),1,BF
20 PRINT &POINT(100,80)
30 PRINT &POINT(110,80)
40 PRINT &POINT(115,90)
50 PRINT &POINT(50,40)
60 PRINT &POINT(130,120)
```

The first three pixels are in the filled box, so the value 1 (one) is displayed for each of the statements in lines 20, 30, and 40. The pixels specified in lines 50 and 60 are not in the shaded box and 0s are returned.

PRESET
Sets Pixel OFF (or ON)

PRESET(*x,y*),*switch*

x specifies an X-coordinate and is an integer expression.
y specifies a Y-coordinate and is an integer expression.
switch specifies a pixel's OFF/ON code and is an integer of either 0 (OFF) or 1 (ON).
switch is optional; if omitted, 0 (OFF) is used.

PRESET sets a pixel either OFF (0) or ON (1), depending on *switch*. If *switch* is not specified, 0 (OFF) is used.

Values for *(x,y)* that are larger than the parameters of the screen (i.e., greater than 639 for *x* and 239 for *y*) are accepted, but these points are off the screen and therefore are not PRESET.

Note: The only choice for *switch* is 0 or 1. If you enter any other number, an Illegal Function Call error will result.

Examples

```
10 PRESET (50,50),1
20 PRESET (50,50),0
```

Turns ON the pixel located at the specified coordinates (in line 10) and turns the pixel OFF (in line 20).

```
5 SCREEN 0
10 PRESET (320,120),1
20 PRESET (300,100),1
30 PRESET (340,140),1
40 FOR I=1 TO 1000: NEXT I
50 PRESET (320,120)
60 PRESET (300,100)
70 PRESET (340,140)
80 FOR I=1 TO 1000: NEXT I
```

Sets the three specified pixels ON (through the three PRESET statements), pauses, and then turns the three pixels OFF.

```
PRESET(3000,1000),1
```

The values for *(x,y)* are accepted, but since the coordinates are beyond the parameters of the screen, the point is not PRESET.

PRINT #–3,
Write Text Characters to the Graphics Screen

PRINT #–3, *item list*

item list may be either string constants (messages enclosed in quotes), string variables, numeric constants (numbers), variables, or expressions involving all of the preceding items. The items to be printed may be separated by commas or semicolons. If commas are used, the Cursor automatically advances to the next print zone before printing the next item. If semicolons are used, a space is not inserted between the items printed on the screen. In cases where no ambiguity would result, all punctuation can be omitted.

PRINT #–3, is used to write text characters to the Graphics Screen. This is the easiest way to display textual data on the Graphics Screen. Characters are displayed starting at the current Graphics Cursor and going in the direction specified by the most recently executed GLOCATE command. If a GLOCATE command was not executed prior to the PRINT #–3, command, a direction of 0 is assumed.

PRINT#–3, will only print text characters (see Appendixes of the ***Model 4 Disk System Owner's Manual***). Each character displayed in the 0 or 2 direction uses an 8 × 8 pixel grid; each character displayed in the 1 or 3 direction uses a 16 × 8 grid. Executing this command will position the Graphics Cursor to the end of the last character that was displayed.

Displaying text in direction 0 engages a wraparound feature. If the end of a line is reached, BASICG will continue the display on the next line. If the end of the screen is reached, BASICG will continue the display at the beginning of the screen without scrolling. If there is not enough room to display at least one character at the current Graphics Cursor, an Illegal Function Call error will result. When displaying text in other directions, an attempt to display text outside of the currently defined screen will cause an Illegal Function Call error to be given.

PSET
Sets Pixel ON (or OFF)

PSET(*x,y*),*switch*

x specifies an X-coordinate and is an integer expression.
y specifies a Y-coordinate and is an integer expression.
switch specifies a pixel's OFF/ON color code and is a numeric expression of 0 (OFF) or 1 (ON). *switch* is optional; if omitted, 1 (ON) is used.

PSET sets a pixel either OFF (0) or ON (1), depending on *switch*. If *switch* is not specified, 1 (ON) is used.

The only choice for *switch* with PSET is 0 and 1. If you enter any other number, an Illegal Function Call will occur.

Values for *(x,y)* that are larger than the parameters of the screen (i.e., greater than 639 for *x* and 239 for *y*) are accepted, but these points are off the screen and therefore are not PSET.

Note: The only distinction between PRESET and PSET in BASICG is the default value for *switch*. The default value for PRESET is 0, while the value for PSET is 1.

Examples

```
10 A=1
20 PSET (50,50),A
```

Turns the pixel located at the specified coordinates ON.

```
10 PSET (RND(640),RND(240)),1
20 GOTO 10
```

Pixels are randomly set to 1 (ON) over the defined area (the entire screen).

```
PSET (-300,-200),1
```

The values for *(x,y)* are accepted, but since it is beyond the parameters of the screen, the pixel is not set.

```
10 PSET (320,120),1
20 A$=INKEY$: IF A$= "" THEN 20
30 PSET(320,120),0
```

Line 10 sets (''turns ON'') a pixel; line 30 resets (''turns OFF'') the same dot.

PUT
Puts Rectangular Pixel Area from Array onto Screen

PUT *(xl,yl), array name, action*

(xl,yl) are coordinates of the upper-left corner of the rectangular pixel area which is to contain a graphic display. *xl* is a numeric expression from 0 to 639 and *yl* is a numeric expression from 0 to 239.

array name is the name of an array (previously specified by GET) that contains the data to be written into the rectangular pixel area.

action determines how the data is written into the rectangular pixel area and is one of the following:

PSET	Sets or resets each point in the specified pixel area to the value in the specified array.
PRESET	Sets or resets each point in the specified pixel area to the inverse of the value in the specified array.
XOR	Performs a logical exclusive-OR between the bits in the specified array and the pixels in the destination area and displays the result.
OR	Performs a logical OR between the bits in the specified array and the pixels in the destination area and displays the result.
AND	Performs a logical AND between the bits in the specified array and the pixels in the destination area and displays the result.

action is optional; if omitted, XOR is used.

Important Note: BASICG recognizes two syntaxes of the command PUT — the syntax described in this manual and the syntax described in the ***Model 4 Disk System Owner's Manual.*** BASIC recognizes only the PUT syntax described in the ***Model 4 Disk System Owner's Manual.***

The PUT function puts a rectangular pixel area stored in an array, and defined by GET, onto the screen. GET and PUT work jointly. Together, they allow you to "get" a rectangular pixel area which contains a graphic display, store it in an array, then "put" the array back on the screen later.

Remember that before you GET or PUT, you have to create an array to store the bit contents of the display rectangular pixel area. The size of the array must match that of the display rectangular pixel area.

PUT moves your GET rectangular pixel area to the startpoint in your PUT statement and the startpoint is the new upper-left corner of the rectangular pixel area.

To illustrate:

```
5 DIM V(3)
10 GET (2,3)-(7,7),V
100 PUT 50,50),V,PSET
```

After GETting, PUT this rectangular pixel area to (50,50). The new coordinates are:

(50,50) (51,50) (52,50) (53,50) (54,50) (55,50)
(50,51) (51,51) (52,51) (53,51) (54,51) (55,51)
(50,52) (51,52) (52,52) (53,52) (54,52) (55,52)
(50,53) (51,53) (52,53) (53,53) (54,53) (55,53)
(50,54) (51,54) (52,54) (53,54) (54,54) (55,54)

The rectangular pixel area ((50,50)−(55,54)) is exactly the same pixel size as (2,3)−(7,7); only the location is different.

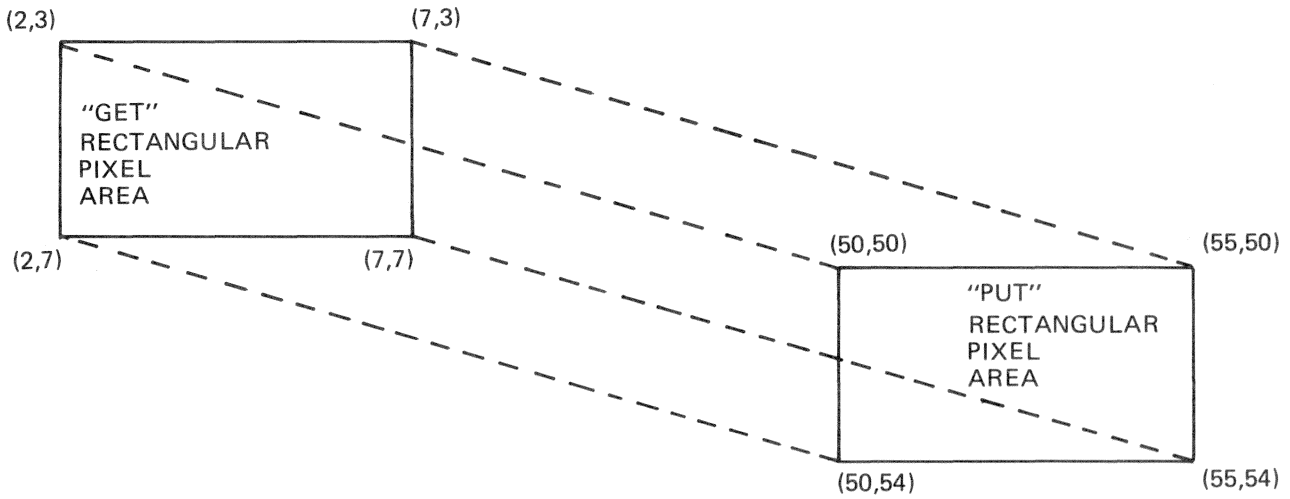


Figure 16

With PUT, action can be PSET, PRESET, OR, AND, or XOR.

These operators are used in BASICG to test the OFF/ON (or 0/1) conditions of a pixel in the original pixel area and the destination pixel area.

For example (using PSET), the pixel is set ON only if the bit in the PUT array is set ON. If the bit is OFF, the pixel is turned OFF (reset).

With PRESET, the pixel is set ON only if the bit in the PUT array is set OFF. If the bit is ON, the pixel is turned OFF (reset).

Using OR, the pixel is set ON if the bit in the PUT array is ON or the corresponding pixel in the destination area is ON. In all other cases, the pixel is turned OFF (reset). In other words:

OR	OFF	ON
OFF	OFF	ON
ON	ON	ON

With AND, the pixel is set ON, if both the bit in the PUT array and the corresponding pixel in the destination area are ON. In all other cases, the pixel is turned OFF (reset). In other words:

AND	OFF	ON
OFF	OFF	OFF
ON	OFF	ON

Using XOR, the pixel is set ON if either the bit in the PUT array or the corresponding pixel in the destination area (but not both) is ON. In all other cases, the pixel is turned OFF (reset). In other words:

XOR	OFF	ON
OFF	OFF	ON
ON	ON	OFF

The following BASICG program will graphically illustrate the differences between the various action options. Since the program will give you a "hard-copy" printout of the action options, you'll need to connect your TRS-80 to a graphic printer. See "Graphics Utilities" later in this manual for more details on using the Computer Graphics package with a printer.

```
 10 DATA "OR", "AND", "PRESET", "PSET", "XOR"
 20 CLR : SCREEN 0
 30 FOR Y= 10 TO 210 STEP  50
 40 FOR X=  0 TO 400 STEP 200
 50 LINE (X+40,Y-5)-(X+100,Y+25),1,B
 60 NEXT X
 70 LINE (50,Y)-(90,Y+10),1,BF
 80 FOR X= 200 TO 400 STEP 200
 90 LINE (X+50,Y)-(X+70,Y+20),1,BF
100 NEXT X
110 NEXT Y
120 DIM V(100)
130 GET (50,10)-(90,30),V
140 FOR N=1 TO 5
150 R= (N-1)*5+1
160 READ A$
165 GLOCATE (136,R*10),0
170 PRINT #-3, A$;
175 GLOCATE (360,R*10),0
180 PRINT #-3, "=";
190 ON N GOTO 200, 210, 220, 230, 240
200 PUT (450,10),  V,OR:     GOTO 250
210 PUT (450,60),  V,AND:    GOTO 250
220 PUT (450,110), V,PRESET: GOTO 250
230 PUT (450,160), V,PSET:   GOTO 250
240 PUT (450,210), V,XOR
250 NEXT N
260 SYSTEM "GPRINT"
270 SCREEN 1
```

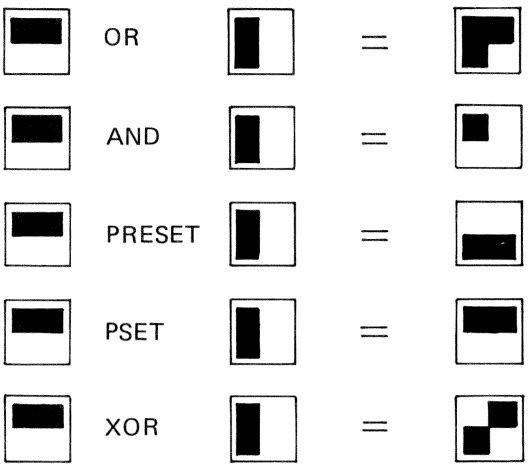


Figure 17

Hints and Tips about PUT:

- An Illegal Function Call error will result if you attempt to PUT a rectangular pixel area to a section of the screen which is totally or partially beyond the parameters of the screen. For example:

```
GET(50,50)-(150,150),V
PUT(200,200),V,PSET
```

  returns an error because the rectangular pixel area cannot be physically moved to the specified rectangular pixel area (i.e., (200,200) – (300,300)).

- If you use PUT with a viewport (see VIEW), all coordinates must be within the parameters of the viewport or you'll get an Illegal Function Call error.

Examples

PUT with PSET

```
10 DIM V%(63)
15 SCREEN 0
17 CLR
20 CIRCLE (30,30),10
30 GET (10,10)-(40,40),V%
40 FOR I=1 TO 500: NEXT I
50 CLR
60 PUT (110,110),V%,PSET
70 FOR I=1 TO 500: NEXT I
```

In this example, the circle is drawn, stored, moved and re-created. First the white-bordered circle appears in the upper left corner of the screen (position (30,30) — program line 20). After a couple of seconds (because of the delay loop), it disappears and then reappears on the screen — (110,110) — program line 60.

What specifically happened is:

1. An array was created (line 10).
2. A circle was drawn (line 20).
3. GET — The circle which was within the source rectangular pixel area, as specified in the GET statement's parameters is stored in the array (line 30).
4. The screen is cleared (line 50).
5. PUT — The circle from the array was PUT into the destination rectangular pixel area as specified in the PUT statement (line 60) with the PSET option.

```
5 SCREEN 0
6 CLR
10 DIM V%(700)
20 LINE (20,20)-(20,80)
30 LINE (80,0)-(80,80)
40 LINE (30,30)-(30,80)
50 LINE (10,5)-(10,80)
60 GET (0,0)-(100,100),V%
70 FOR I=1 TO 1000: NEXT I
80 PUT (180,120),V%,PSET
90 FOR I=1 TO 1000: NEXT I
```

Draws four lines. GET stores the lines in the rectangular pixel area. PUT moves the lines to another rectangular pixel area.

SCREEN
Selects Screen

SCREEN *type*

type specifies which "Screen" to use and is a numeric expression of either 0 or 1.
0 = Graphics Screen
1 = Text Screen

SCREEN lets you set the proper screen. SCREEN 0 selects the Graphics Screen; SCREEN 1 selects the Text Screen. Any value other than 0 or 1 with SCREEN gives an error.

SCREEN is convenient to use when you want to display either a Graphics Screen or a Text Screen. For example, you may have run a program and then added to it. With SCREEN, you can remove the graphics display, add to the program, and then return to the Graphics Screen.

Whenever BASICG tries to display a character on the Text Screen (like in an INPUT or PRINT statement), the screen is automatically set to the Text Screen. If the program is still running after executing the statement, BASICG will revert to the screen that was in effect prior to executing the statement.

Examples

```
10 SCREEN 1
20 LINE (150,150)-(200,200)
```

The computer executes the short program but the Graphics Screen cannot display the graphics because of the SCREEN 1 command. To display the line, type: SCREEN 0 (ENTER)

```
10 CLR
20 SCREEN 1
30 LINE(10,10)-(255,191)
40 LINE(0,191)-(255,0)
50 A$=INKEY$: IF A$=""THEN 50
60 SCREEN 0
70 A$=INKEY$: IF A$="" THEN 70
80 GOTO 10
```

The computer executes the program (draws two intersecting lines) but the screen cannot display the graphics because of SCREEN 1. By pressing any key, the graphics are displayed because of SCREEN 0.

```
5 CLR
10 CIRCLE(200,100),100
20 PAINT (200,100),"44",1
```

Now run the program and type:

```
SCREEN 0 (ENTER)
```

This command turns the Graphics Screen ON. By entering the SCREEN 1 and SCREEN 0 commands, you can alternately turn the Graphics Screen OFF and ON without losing the executed program display.

VIEW (Command)
Redefines the Screen (Creates a Viewport)

VIEW *(xl,yl)*–*(x2,y2)*, *c*, *b*

(xl,yl) are coordinates of the upper-left corner of a rectangular viewport area. *xl* is an integer expression between 0 and 639. *yl* is an integer expression between 0 and 239.

(x2,y2) are coordinates of the lower-right corner of a rectangular viewport area. *x2* is an integer expression >= to *xl* and <= 639. *y2* is an integer expression >= *y1* and <239.

c specifies the color of the interior of the viewport and is an integer expression of either 0 or 1. *c* is optional; if omitted, the viewport is not shaded.

b specifies the border color of the viewport and is a numeric expression of either 0 or 1. *b* is optional; if omitted, a border is not drawn.

VIEW creates a ''viewport'' which redefines the screen parameters (0-639 for X and 0-239 for Y). This defined area then becomes the only place you can draw graphics displays.

If you enter more than one viewport, you can only draw displays in the last defined viewport.

Since VIEW redefines the SCREEN:

- CLR clears the interior of the viewport only.
- If you PSET or PRESET points, draw circles, etc., beyond the parameters of the currently defined viewport, only the portions that are in the viewport will be displayed.
- If you try to read a point beyond the viewport (with POINT), it will return a −1.
- You can only GET and PUT arrays within the viewport.
- You can't PAINT outside the viewport.

The upper-left corner of the viewport is read as (0,0) (the "relative origin") when creating items inside the viewport. All the other coordinates are read relative to this origin. However, the "absolute coordinates" of the viewport, as they are actually defined on the Graphics Cartesian system, are retained in memory and can be read using VIEW as a function.

Every viewport has absolute and relative coordinates and graphic displays are drawn inside using the relative coordinates. For example:

```
10 VIEW (100,100)-(200,200),0,1
20 LINE (30,15)-(80,60),1
```

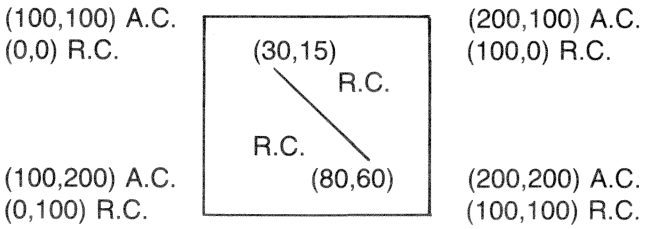


Figure 18

Note: After each of the following examples, you'll have to redefine the entire screen to VIEW (0,0)–(639,239) before performing any other Graphics functions.

Examples

```
VIEW (100,100)-(200,200),0,1
```

Draws a black viewport (pixels OFF) that is outlined in white (border pixels ON).

```
VIEW (100,100)-(200,200),1,1
```

Draws a white viewport (pixels ON) that is outlined in white (border pixels ON).

```
VIEW (50,50)-(100,100),1,0
```

Draws a white viewport (pixels ON) that is outlined in black (border pixels OFF).

```
10 VIEW (10,10)-(600,200),0,1
20 VIEW (50,50)-(100,100),0,1
30 LINE(RND(500),RND(190))-(RND(500),RND(190))
40 GOTO 30
```

First you defined a large viewport that almost covered the entire screen. Next you defined a smaller viewport. The Random command draws lines within the specified parameters but only the segments of the lines that are within the parameters of the smaller viewport are visible since it was specified last.

```
10 VIEW(80,80)-(400,200),0,1
20 VIEW(100,90)-(300,170),0,1
30 VIEW(120,100)-(200,200),0,1
40 VIEW(50,50)-(100,100),0,1
```

Draws four viewports. All further drawing takes place in the last viewport specified.

```
10 VIEW(210,80)-(420,160),0,1
20 CIRCLE(300,120),180,1
30 LINE(15,15)-(60,60),1
40 CIRCLE(90,40),50,1
50 LINE(40,30)-(500,30),1
```

Draws a viewport. Draws a circle but only a portion is within the parameters of the viewport. This circle's centerpoint is relative to the upper left corner of the viewport and not to the absolute coordinates of the graphics Cartesian system. A line is drawn which is totally within the parameters of the viewport. Another circle is drawn which is totally within the parameters of the viewport. Another line is drawn which is only partially within the parameters of the viewport.

```
10 VIEW (190,70)-(440,180),0,1
20 CIRCLE (300,140),170,1
30 CIRCLE (100,230),400,1
40 LINE (10,10)-(500,230),1
```

Draws a viewport. A circle is drawn but only a portion is within the parameters of the viewport. Another circle is drawn and a larger portion is within the parameters of the viewport. A line is drawn but only a segment is within the parameters of the viewport.

&VIEW (function)
Returns Viewport Coordinates

&VIEW *(p)*

(p) specifies a coordinate on the X- or Y-axis and is an integer expression between 0 – 3. 0 returns the left X-coordinate of your viewport. 1 returns the upper Y-coordinate. 2 returns the right X-coordinate. 3 returns the lower Y-coordinate.

&VIEW returns a corner coordinate of a viewport. It is important to note the parentheses are not optional. If you enter the &VIEW function without the parentheses, a Syntax Error will result.

To display one of the four viewport coordinates, you must enter one of the following values for *p*:

- 0 returns the upper left X-coordinate
- 1 returns the upper left Y-coordinate
- 2 returns the lower right X-coordinate
- 3 returns the lower right Y-coordinate

Important Note: When you have defined several viewports, &VIEW only returns the coordinates of the last-defined viewport.

Examples

Set up the following viewport:

```
VIEW(100,80)-(220,150),0,1
```

Now type: `PRINT &VIEW(0)` ENTER

Displays: `100`

Type: `PRINT &VIEW(1)` ENTER

Displays: `80`

Enter: `PRINT &VIEW(2)` ENTER

Displays: `220`

Type: `PRINT &VIEW(3)` ENTER

Displays: `150`

Set up the following viewports:

```
VIEW(100,80)-(220,150),0,1 (ENTER)
VIEW(250,170)-(350,220),0,1 (ENTER)
```

Now enter: `PRINT &VIEW(0)` ENTER

Displays: `250`

Type: `PRINT &VIEW(1)` ENTER

Diplays: `170`

Now type: `PRINT &VIEW(2)` ENTER

Displays: `350`

Type: `PRINT &VIEW(3)` ENTER

Displays: `220`

3/ Graphics Utilities

There are eight utilities included with the TRS-80 Computer Graphics package which are intended to be used as stand-alone programs. However, if you are an experienced programmer, you can use these with BASICG and FORTRAN. The source-code for each utility, that illustrates Graphics programming techniques, is listed later in this section.

The Graphics Utilities let you:

- Save graphic displays to diskette.
- Load graphic displays from diskette.
- Print graphic displays on a graphics printer.
- Turn graphics display OFF or ON.
- Clear graphics memory.

To use these utilities from BASICG, use the SYSTEM command followed by the name of the utility in quotation marks (e.g., `SYSTEM"GCLS"` (ENTER)) and control returns to BASIC Ready. From TRSDOS, enter the utility directly, without quotation marks (e.g., `GCLS` (ENTER)).

To call these routines from FORTRAN, see the Subprogram Linkage section of your ***TRS-80 Model 4 FORTRAN Manual*** (26-2219).

Utilities	
Command	**Action**
GCLS	Clears graphics screen.
GLOAD	Loads graphics memory from diskette.
GPRINT	Lists graphics on the printer.
GPRT2	Prints graphic display on the printer without 90 degree rotation.
GPRT3	Prints graphic display on the printer without 90 degree rotation.
GROFF	Turns Graphic Screen OFF.
GRON	Turns Graphic Screen ON.
GSAVE	Saves graphics memory to diskette.

Table 6

GCLS
Clears Graphics Screen

GCLS

GCLS clears the Graphics Screen by erasing the contents of graphics memory corresponding to the visible Graphics Screen. GCLS erases graphics memory by writing zeroes (OFF) to every bit in memory. GCLS does not clear the Text Screen (video memory).

Examples

When TRSDOS Ready is displayed, type:

```
GCLS (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GCLS" (ENTER)
```

or

```
100 SYSTEM"GCLS"
```

GLOAD
Loads Graphics Memory from Diskette

GLOAD *filename /ext .password :d*

filename consists of a name of up to eight characters; the first character must be a letter.
/ext is an optional name-extension; *ext* is a sequence of up to three numbers or letters.
.password is an optional password; *password* is a name of up to eight characters; the first character must be a letter.
:d is an optional drive specification; *d* is one of the digits 0 through 3.

Note: There cannot be spaces within a file specification. TRSDOS terminates the file specification at the first space.

With GLOAD, you can load TRSDOS files that have graphic contents into graphics memory. These files must have been previously saved to diskette using GSAVE.

Examples

When TRSDOS Ready is displayed, type:

```
GLOAD PROGRAM/DAT.PASSWORD:0 (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GLOAD PROGRAM" (ENTER)
```

or

```
100 SYSTEM "GLOAD PROGRAM"
```

GPRINT
Lists Graphic Display to Printer

GPRINT

GPRINT lets you print graphics memory on a graphics (dot-addressable) printer, such as Radio Shack's DMP-100 (26-1253) or DMP-200 (26-1254). Both of these printers have a 9½″ carriage. However, distortion will occur when

Graphic routines are printed with GPRINT. This is because GPRINT is not a true pixel-by-pixel "Screen Dump" since the pixel size and spacing on the screen is different from the pixel size and spacing on the Printer. GPRINT is a point of departure for you to obtain hard-copy representations of graphics.

To print graphic displays, GPRINT turns the contents of the Graphic Screen clockwise 90 degrees and then prints.

However, FORMS must be used to set printing parameters.

See your ***Model 4 Disk System Owner's Manual*** and printer owner's manual for details on setting printing parameters.

Important Note! Do not press (BREAK) while GPRINT is executing.

Examples

When TRSDOS Ready is displayed, type:

```
GPRINT (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GPRINT" (ENTER)
```

or

```
100 SYSTEM"GPRINT"
```

For a complete GPRINT sample session, see **Appendix D.**

GPRT2
Print Graphics

GPRT2

GPRT2 is similar to GPRINT but is designed for use with wide-carriage (15″) printers such as the DMP-400 and DMP-500.

GPRT2 is different from GPRINT in that the image is not rotated 90 degrees and a different aspect ratio is used.

If GPRT2 does not produce the quality of printout you desire, try GPRT3 or GPRINT.

Important Note! Do not press (BREAK) while GPRT2 is executing.

Examples

When TRSDOS Ready is displayed, type:

```
GPRT2 (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GPRT2" (ENTER)
```

or

```
100 SYSTEM"GPRT2"
```

GPRT3
Print Graphics (Double on the Y-Axis)

GPRT3

GPRT3 is similar to GPRINT but is designed for use with wide-carriage (15″) printers such as the DMP-400 and DMP-500.

GPRT3 is different from GPRINT in that the image is not rotated 90 degrees and a different aspect ratio is used.

If GPRT3 does not produce the quality of print-out you desire, try GPRT2 or GPRINT.

Important Note! Do not press (BREAK) while GPRT3 is executing.

Examples

When TRSDOS Ready is displayed, type:

```
GPRT3 (ENTER)
```

or when the BAISCG READY prompt is displayed, type:

```
SYSTEM"GPRT3" (ENTER)
```

or

```
100 SYSTEM"GPRT3"
```

GROFF
Turns Graphics Display OFF

GROFF

GROFF turns the Graphics Screen OFF. GROFF is different from GCLS since GROFF simply removes the Graphics display without erasing the contents of graphic memory. GCLS completely clears graphics memory by writing zeroes (OFF) to every bit in memory.

Examples

When TRSDOS Ready is displayed, type:

```
GROFF (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GROFF" (ENTER)
```

or

```
100 SYSTEM"GROFF"
```

GRON
Turns Graphics Display ON

GRON

GRON turns the Graphics Screen ON.

Examples

When TRSDOS Ready is displayed, type:

```
GRON (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GRON" (ENTER)
```

or

```
100 SYSTEM"GRON"
```

GSAVE
Saves Graphics Memory to Diskette

GSAVE *filename* /*ext* .*password* :*d*

filename consists of a name of up to eight characters; the first character must be a letter.
/ext is an optional name-extension; *ext* is a sequence of up to three numbers or letters.
.password is an optional password; *password* is a name of up to eight characters; the first character must be a letter.
:d is an optional drive specification; *d* is one of the digits 0 through 3.

Note: There cannot be spaces within a file specification. TRSDOS terminates the file specification at the first space.

With GSAVE, the contents in graphics memory is saved under a specified *filename* which follows the standard TRSDOS format. To load the file back into memory, use GLOAD.

Examples

When TRSDOS Ready is displayed, type:

```
GSAVE PROGRAM/DAT.PASSWORD:0 (ENTER)
```

or when the BASICG READY prompt is displayed, type:

```
SYSTEM"GSAVE PROGRAM" (ENTER)
```

or

```
100 SYSTEM"GSAVE PROGRAM"
```

Graphic Utilities Source Code Listings

```
00001   ; GLOAD --  Save graphics display to disk
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       TRSDOS SVC Equates
00014
00015   @FSPEC: EQU     78              ;Test a filespec
00016   @OPEN:  EQU     59              ;Open an existing file
00017   @READ:  EQU     67              ;Read a record
00018   @CLOSE: EQU     60              ;Close a file
00019   @ERROR: EQU     26              ;Display an error message
00020   @DSPLY: EQU     10              ;Display a message
00021
00022   ;       Port Equates
00023
00024   X:      EQU     80H
00025   Y:      EQU     81H
00026   DATA:   EQU     82H
00027   STATUS: EQU     83H
00028
00029   ;       Main Program
00030
00031   GLOAD:  PUSH    HL              ;Save pointer from command line
00032
00033           LD      A,10H
00034           OUT     (236),A         ;Turn on CRTC ports
00035           LD      BC,1088H        ;Load 16 Regs and point to control port
00036           LD      HL,CRTC+15      ;Load backwards
00037
00038   ;       This code programs the CRTC Chip for 80 x 24 screen
00039   ;       Only required for Model III Graphics Boards
00040
00041   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00042           LD      A,(HL)          ;Get the data
00043           OUT     (137),A         ;Store that in the CRTC
00044           DEC     HL              ;Move to previous entry
00045           DJNZ    FDIV            ;Decrement counter
00046
00047           LD      HL,FCB          ;Point at the FCB
00048           LD      (HL),00H        ;Zero the buffer
00049           LD      DE,HL           ;Build destination pointer
00050           INC     DE              ;Copy first byte to second position
00051           LD      BC,32
00052           LDIR
00053
00054           POP     HL
00055           LD      A,00H
00056           CP      (HL)
```

```
00057            JR       Z,ERROR
00058            LD       DE,FCB
00059            TRSDOS   @FSPEC          ;Move filspec to FCB and do a syntax check
00060            JR       NZ,BOMB
00061
00062            LD       HL,BUFFER
00063            LD       DE,FCB
00064            LD       B,0
00065            TRSDOS   @OPEN           ;Open file if it exists, else create one
00066            JR       NZ,BOMB
00067
00068            LD       A,0B3H          ;status = inc X after write
00069            OUT      (STATUS),A
00070            XOR      A
00071            OUT      (X),A           ;init X & Y to zero
00072            OUT      (Y),A
00073            LD       E,A             ;counter for X values
00074            LD       D,80            ;80 X values
00075            LD       B,75            ;75 disk records for entire screen
00076   NXTREC:  PUSH     DE
00077            LD       DE,FCB
00078            TRSDOS   @READ           ;Read a record from disk
00079            POP      DE
00080            JR       NZ,BOMB
00081            LD       HL,BUFFER
00082            LD       C,B
00083            LD       B,0             ;256 bytes per record
00084   NGRPH:   LD       A,(HL)
00085            OUT      (DATA),A
00086            INC      HL
00087            INC      E
00088            LD       A,E
00089            CP       D
00090            JR       NZ,EGRPH        ;Same row?
00091            XOR      A
00092            LD       E,A
00093            OUT      (X),A           ;Next row. Set X to zero
00094            LD       A,(YPOS)
00095            INC      A
00096            LD       (YPOS),A
00097            OUT      (Y),A
00098   EGRPH:   DJNZ     NGRPH           ;Go get next graphics byte
00099            LD       B,C
00100            DJNZ     NXTREC          ;Go read next disk record
00101
00102   EXIT:    LD       DE,FCB
00103            TRSDOS   @CLOSE
00104            LD       A,0FCH          ;Status = graphics off, no waits, no incs.
00105            OUT      (STATUS),A
00106            LD       A,(EFLAG)
00107            LD       L,A
00108            LD       H,0
00109            CP       H
00110            RET                      ;Return to TRSDOS or BASIC
00111
00112   ;        Error exits
00113
00114   ERROR:   LD       HL,PARM         ;Complain
00115            TRSDOS   @DSPLY
00116            JR       EXIT
```

```
00117
00118   BOMB:   LD      (EFLAG),A
00119           OR      0C0H
00120           LD      C,A
00121           TRSDOS  @ERROR          ;Display error message
00122           JR      EXIT
00123
00124   PARM:   DEFM    'Filespec required~'
00125   EFLAG:  DEFB    0
00126   YPOS:   DEFB    0
00127   FCB:    DEFS    32
00128   BUFFER: DEFS    256
00129
00130   CRTC:   DEFB    99,80,85,8,25,4,24,0,9,0,0,0,0,0,0
00131
00132           END     GLOAD
```

```
00001   ; GSAVE --  Save graphics display to disk
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       TRSDOS SVC Equates
00014
00015   @FSPEC: EQU     78              ;Test a filespec
00016   @INIT:  EQU     58              ;Open an existing file, or create a new one
00017   @WRITE: EQU     75              ;Write a record
00018   @CLOSE: EQU     60              ;Close a file
00019   @ERROR: EQU     26              ;Display an error message
00020   @DSPLY: EQU     10              ;Display a message
00021
00022   ;       Port Equates
00023
00024   X:      EQU     80H
00025   Y:      EQU     81H
00026   DATA:   EQU     82H
00027   STATUS: EQU     83H
00028
00029   ;       Main Program
00030
00031   GSAVE:  PUSH    HL              ;Save pointer from command line
00032
00033           LD      A,10H
00034           OUT     (236),A         ;Turn on CRTC ports
00035           LD      BC,1088H        ;Load 16 Regs and point to control port
00036           LD      HL,CRTC+15      ;Load backwards
00037
00038   ;       This code programs the CRTC Chip for 80 x 24 screen
00039   ;       Only required for Model III Graphics Boards
00040
00041   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00042           LD      A,(HL)          ;Get the data
00043           OUT     (137),A         ;Store that in the CRTC
00044           DEC     HL              ;Move to previous entry
00045           DJNZ    FDIV            ;Decrement counter
00046
00047           LD      HL,FCB          ;Point at the FCB
00048           LD      (HL),00H        ;Zero the buffer
00049           LD      DE,HL           ;Build destination pointer
00050           INC     DE              ;Copy first byte to second position
00051           LD      BC,32
00052           LDIR
00053
00054           POP     HL
00055           LD      A,0DH
00056           CP      (HL)
00057           JR      Z,ERROR
00058           LD      DE,FCB
00059           TRSDOS  @FSPEC          ;Move filspec to FCB and do a syntax check
00060           JR      NZ,BOMB
```

```
00061
00062            LD       HL,BUFFER
00063            LD       DE,FCB
00064            LD       B,0
00065            TRSDOS   @INIT            ;Open file if it exists, else create one
00066            JR       NZ,BOMB
00067
00068            LD       A,0E3H           ;status = inc X after read
00069            OUT      (STATUS),A
00070            XOR      A
00071            OUT      (X),A            ;init X & Y to zero
00072            OUT      (Y),A
00073            LD       E,A              ;counter for X values
00074            LD       D,80             ;80 X values
00075            LD       B,75             ;75 disk records for entire screen
00076   NXTREC:  LD       HL,BUFFER
00077            LD       C,B
00078            LD       B,0              ;256 bytes per record
00079   NGRPH:   IN       A,(DATA)         ;Get next graphics byte
00080            LD       (HL),A           ; and put in buffer
00081            INC      HL
00082            INC      E
00083            LD       A,E
00084            CP       D
00085            JR       NZ,EGRPH         ;Same row?
00086            XOR      A
00087            LD       E,A
00088            OUT      (X),A            ;Next row. Set X to zero
00089            LD       A,(YPOS)
00090            INC      A
00091            LD       (YPOS),A
00092            OUT      (Y),A
00093   EGRPH:   DJNZ     NGRPH            ;Go get next graphics byte
00094            PUSH     DE
00095            LD       DE,FCB
00096            TRSDOS   @WRITE           ;Write a record to disk
00097            POP      DE
00098            JR       NZ,BOMB
00099            LD       B,C
00100            DJNZ     NXTREC           ;Go fill buffer for next record
00101
00102   EXIT:    LD       DE,FCB
00103            TRSDOS   @CLOSE
00104            LD       A,0FCH           ;Status = graphics off, no waits, no incs.
00105            OUT      (STATUS),A
00106            LD       A,(EFLAG)
00107            LD       L,A
00108            LD       H,0
00109            OR       A                ;Test Error byte
00110            RET                       ;Return to TRSDOS or BASIC
00111
00112   ;        Error exits
00113
00114   ERROR:   LD       HL,PARM          ;Complain
00115            TRSDOS   @DSPLY
00116            JR       EXIT
00117
00118   BOMB:    LD       (EFLAG),A
00119            OR       0C0H
00120            LD       C,A
```

```
00121             TRSDOS  @ERROR          ;Display error message
00122             JR      EXIT
00123
00124   PARM:     DEFM    'Filespec required~'
00125   EFLAG:    DEFB    0
00126   YPOS:     DEFB    0
00127   FCB:      DEFS    32
00128   BUFFER:   DEFS    256
00129
00130   CRTC:     DEFB    99,80,85,8,25,4,24,0,9,0,0,0,0,0,0
00131
00132             END     GSAVE
```

```
00001   ; GRON --  Turn on graphics display with waits on
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       Port Equates
00014
00015   STATUS: EQU     83H
00016
00017   ;       Main Program
00018
00019   GRON:   LD      A,10H
00020           OUT     (236),A         ;Turn on CRTC ports
00021           LD      BC,1088H        ;Load 16 Regs and point to control port
00022           LD      HL,CRTC+15      ;Load backwards
00023
00024   ;       This code programs the CRTC Chip for 80 x 24 screen
00025   ;       Only required for Model III Graphics Boards
00026
00027   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00028           LD      A,(HL)          ;Get the data
00029           OUT     (137),A         ;Store that in the CRTC
00030           DEC     HL              ;Move to previous entry
00031           DJNZ    FDIV            ;Decrement counter
00032
00033           LD      A,0FFH
00034           OUT     (STATUS),A
00035           XOR     A
00036           LD      HL,0
00037           RET                     ;Return to TRSDOS or BASIC
00038
00039   CRTC:   DEFB    99,80,85,8,25,4,24,0,9,0,0,0,0,0,0
00040
00041           END     GRON
```

```
00001   ;  GPRINT --  Print graphics screen to graphics printer
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       TRSDOS SVC Equates
00014
00015   @PRT:   EQU     6               ;Print a character on the printer
00016   @PRINT: EQU     14              ;Print a line on the printer
00017   @FLAGS: EQU     101             ;Point to system control flags
00018
00019   ;       Port Equates
00020
00021   X:      EQU     80H
00022   Y:      EQU     81H
00023   DATA:   EQU     82H
00024   STATUS: EQU     83H
00025
00026   ;       Main Program
00027
00028   GPRINT: LD      A,10H
00029           OUT     (236),A         ;Turn on CRTC ports
00030           LD      BC,15
00031           LD      HL,CRTC
00032
00033   ;       This code programs the CRTC Chip for 80 x 24 screen
00034   ;       Only required for Model III Graphics Boards
00035
00036   FDIV:   LD      A,B             ;Program CRTC chip for 80 by 24
00037           OUT     (136),A
00038           LD      A,(HL)
00039           OUT     (137),A
00040           INC     HL
00041           INC     B
00042           LD      A,B
00043           CP      C
00044           JR      NZ,FDIV
00045
00046           LD      A,0DBH          ;Output a Control byte to cause
00047           OUT     (STATUS),A      ; Y to automatically dec. on a read
00048
00049           CALL    INITBF          ;Zero print buffer
00050
00051           XOR     A               ;Set A to 0
00052           OUT     (X),A           ;Initialize the X position
00053           LD      (BPOS),A        ;    "       "  bit position
00054           LD      (XLOC),A        ;    "       "  "  location counter
00055
00056   ;       Set the printer to start graphics mode
00057
00058           LD      C,12H           ;Begin Graphics mode
00059           TRSDOS  @PRT            ;Output Character
00060           JP      NZ,BOMB         ;Printer Not Ready
```

```
00061
00062   ;       Turn off international character set translation
00063
00064           TRSDOS  @FLAGS
00065           LD      A,(IY+8)        ;Get IFLAG$
00066           LD      (OLD),A         ;Save a copy of the current settings
00067           RES     6,(IY+8)        ;Turn off bit 6 (Intl. Translation)
00068
00069   FDIV1:  LD      IX,BUFFER       ;point IX at the printer buffer
00070           LD      B,240           ;go through a whole column of bytes
00071           LD      A,B             ;Put value in A and decrement
00072           DEC     A               ;  so it can be put out as
00073           OUT     (Y),A           ;     the Y position
00074   COLUMN: LD      HL,MASK         ;Point at character mask
00075           IN      A,(DATA)        ;input a graphics byte
00076           AND     (HL)            ;chop off all but proper bit
00077           CALL    PO,SET0         ;if result is odd parity set bit 0
00078                                   ; otherwise bit A is 0
00079           LD      HL,BPOS         ;point HL at the bit position
00080           PUSH    BC              ;save register B (for DJNZ loop)
00081           LD      B,(HL)          ;get count
00082           INC     B               ;increment (in case it is 0)
00083   DECJ:   DEC     B               ;move bit left BPOS number of times
00084           JR      Z,PAST          ;if done, move on...
00085           RLC     A               ;move bit left one position
00086           JR      DECJ            ;repeat loop
00087   PAST:   POP     BC              ;get loop counter back
00088           OR      (IX)            ;merge A with byte of printer buffer
00089           LD      (IX),A          ;put merged result in buffer
00090           INC     IX              ;increment buffer pointer
00091           DJNZ    COLUMN          ;continue loop
00092
00093           LD      A,7             ;See if BPOS has gotten to 8.
00094           INC     (HL)            ;  If it has (printer uses 7 bits)
00095           CP      (HL)            ;     print the buffer and reset
00096           CALL    Z,PRNDRS        ;       BPOS to 0
00097
00098           LD      HL,MASK         ;After getting a vertical row of bits
00099           RRC     (HL)            ; rotate the mask right one position
00100           LD      A,80H           ;Check to see if its back to
00101           CP      (HL)            ; it's original value, if not
00102           JR      NZ,FDIV1        ; go get another row of bits
00103           LD      A,(XLOC)        ;If so, get X pos (to increment it)
00104           CP      79              ;Check to see if we are at the end...
00105           JP      Z,BYE
00106           INC     A               ;otherwise increment the X counter
00107           LD      (XLOC),A        ;and store it back
00108           OUT     (X),A           ;also update the port value
00109           JR      FDIV1           ;now go get another row of bits
00110
00111   SET0:   LD      A,1             ;set A to binary 0000 0001
00112           RET                     ; and return
00113
00114   ;       This routine edits the print buffer to remove trailing blanks
00115   ;       and then sends the data to the printer
00116
00117   PRNDRS: LD      HL,BUFFER+239   ;Set up the
00118           LD      D,0DH           ;Print terminator
00119           LD      B,239           ;Start testing
00120           LD      A,80H           ;Test against nothing
```

```
00121   CLEAN:  CP      (HL)            ;Anything there?
00122           JR      NZ,STOP         ;Found something to print
00123           LD      (HL),D          ;Then get rid of it
00124           DEC     HL
00125           DJNZ    CLEAN           ;Shorten the line as much as possible
00126   STOP:   LD      HL,BUFFER       ;Point to the start of the text
00127           TRSDOS  @PRINT          ;Print the contents of BUFFER and do a C/R
00128           XOR     A               ;clear A
00129           LD      (BPOS),A        ;reset bit position counter
00130
00131   ;       Initialize the Printer Buffer
00132
00133   INITBF: LD      HL,BUFFER       ;Point at the buffer
00134           LD      (HL),80H        ;Fill the buffer with x'80'
00135           LD      DE,HL           ;Build destination pointer
00136           INC     DE              ;Copy first byte to second position
00137           LD      BC,239          ;Zero 240 bytes
00138           LDIR
00139           RET
00140
00141   BYE:    CALL    PRNDRS
00142           LD      C,1EH           ;End Graphics Print Mode
00143           TRSDOS  @PRT
00144
00145   BOMB:   LD      A,0FCH          ;Status = graphics off, no waits, no incs
00146           OUT     (STATUS),A
00147
00148           TRSDOS  @FLAGS          ;Point to system flags again
00149           LD      A,(OLD)         ;Get old contents of IFLAG$
00150           LD      (IY+8),A        ;Set things back the way they were
00151
00152           LD      HL,0            ;Zero Return Code
00153           RET                     ;Return to TRSDOS or BASIC
00154
00155
00156   MASK:   DEFB    80H             ;Mask to use in extracting bits
00157   BUFFER: DEFS    240             ;Printer data buffer
00158           DEFB    0DH             ;Terminator for Print Line
00159   BPOS:   DEFB    0               ;Bit position in printer buffer
00160   XLOC:   DEFB    0               ;Current X location value
00161   OLD:    DEFB    0               ;Old contents of IFLAG$
00162
00163   CRTC:   DEFB    99,80,85,8,25,4,24,24,0,9,0,0,0,0,0,0
00164
00165           END     GPRINT
```

```
00001   ; GCLS -- Clear graphics screen
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       Port Equates
00014
00015   X:      EQU     80H
00016   Y:      EQU     81H
00017   DATA:   EQU     82H
00018   STATUS: EQU     83H
00019
00020   INCY:   EQU     70H
00021   INCXY:  EQU     30H
00022
00023   ;       Main Program
00024
00025   GCLS:   LD      A,10H
00026           OUT     (236),A         ;Turn on CRTC ports
00027           LD      BC,1088H        ;Load 16 Regs and point to control port
00028           LD      HL,CRTC+15      ;Load backwards
00029
00030   ;       This code programs the CRTC Chip for 80 x 24 screen
00031   ;       Only required for Model III Graphics Boards
00032
00033   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00034           LD      A,(HL)          ;Get the data
00035           OUT     (137),A         ;Store that in the CRTC
00036           DEC     HL              ;Move to previous entry
00037           DJNZ    FDIV            ;Decrement counter
00038
00039           LD      A,INCY          ;Set graphics status:
00040           OUT     (STATUS),A      ; Graphics off, waits off, inc Y
00041           XOR     A
00042           OUT     (X),A           ;Set X & Y address to 0
00043           OUT     (Y),A
00044           LD      B,80            ;80 X addresses
00045   OUTER:  LD      C,B
00046           LD      B,239           ;239 Y addresses. 240th done after loop.
00047   INNER:  OUT     (DATA),A        ;Zero graphics memory
00048           DJNZ    INNER           ;Go clear next Y
00049           LD      A,INCXY         ;Set status to inc X & Y after write
00050           OUT     (STATUS),A
00051           XOR     A
00052           OUT     (DATA),A        ;and clear last (240th) Y address
00053           OUT     (Y),A           ;Set Y back to zero
00054           LD      A,INCY          ;Reset status to inc Y only
00055           OUT     (STATUS),A
00056           XOR     A
00057           LD      B,C
00058           DJNZ    OUTER           ;Go clear next X
00059           LD      A,0FCH          ;Set status: graphics off, no waits, no incs
00060           OUT     (STATUS),A
```

```
00061
00062              XOR     A
00063              LD      HL,0
00064              RET                          ;Return to BASIC or TRSDOS
00065
00066   CRTC:      DEFB    99,80,85,8,25,4,24,24,0,9,0,0,0,0,0,0
00067
00068              END     GCLS
```

```
00001   ; GROFF --  Turn graphics display off with waits off
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       Port Equates
00014
00015   STATUS: EQU     83H
00016
00017   ;       Main Program
00018
00019   GROFF:  LD      A,10H
00020           OUT     (236),A         ;Turn on CRTC ports
00021           LD      BC,1088H        ;Load 16 Regs and point to control port
00022           LD      HL,CRTC+15      ;Load backwards
00023
00024   ;       This code programs the CRTC Chip for 80 x 24 screen
00025   ;       Only required for Model III Graphics Boards
00026
00027   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00028           LD      A,(HL)          ;Get the data
00029           OUT     (137),A         ;Store that in the CRTC
00030           DEC     HL              ;Move to previous entry
00031           DJNZ    FDIV            ;Decrement counter
00032
00033           LD      A,0FCH
00034           OUT     (STATUS),A
00035           XOR     A
00036           LD      HL,0
00037           RET                     ;Return to TRSDOS or BASIC
00038
00039   CRTC:   DEFB    99,80,85,8,25,4,24,0,9,0,0,0,0,0,0
00040
00041           END     GROFF
```

```
00001   ;  GPRT2 -- Print graphics X horizontal
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       TRSDOS SVC Equates
00014
00015   @PRT:   EQU     6               ;Print a character on the printer
00016   @PRINT: EQU     14              ;Print a line on the printer
00017   @FLAGS: EQU     101             ;Point to system control flags
00018
00019   ;       Port Equates
00020
00021   X:      EQU     80H
00022   Y:      EQU     81H
00023   DATA:   EQU     82H
00024   STATUS: EQU     83H
00025
00026   ;       Main Program
00027
00028   GPRT2:  LD      A,10H
00029           OUT     (236),A         ;Turn on CRTC ports
00030           LD      BC,1088H        ;Load 16 Regs and point to control port
00031           LD      HL,CRTC+15      ;Load backwards
00032
00033   ;       This code programs the CRTC Chip for 80 x 24 screen
00034   ;       Only required for Model III Graphics Boards
00035
00036   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00037           LD      A,(HL)          ;Get the data
00038           OUT     (137),A         ;Store that in the CRTC
00039           DEC     HL              ;Move to previous entry
00040           DJNZ    FDIV            ;Decrement counter
00041
00042   ;       Set the printer to start graphics mode
00043
00044           LD      C,12H           ;Begin Graphics mode
00045           TRSDOS  @PRT            ;Output Character
00046           JR      NZ,BOMB         ;Printer Not Ready
00047
00048   ;       Turn off international character set translation
00049
00050           TRSDOS  @FLAGS
00051           LD      A,(IY+8)        ;Get IFLAG$
00052           LD      (OLD),A         ;Save a copy of the current settings
00053           RES     6,(IY+8)        ;Turn off bit 6 (Intl. Translation)
00054
00055   ;       Open Video Memory
00056
00057           LD      C,0             ;Graphics Y address
00058           LD      A,0E3H          ;Open RAM with video waits
00059           OUT     (STATUS),A
00060
```

```
00061   ;       Initialize the Printer Buffer
00062
00063   NEWLN:  PUSH    BC              ;Save BC
00064           LD      HL,BUFFER               ;Point at the buffer
00065           LD      (HL),80H        ;Fill the buffer with x'80'
00066           LD      DE,HL           ;Build destination pointer
00067           INC     DE              ;Copy first byte to second position
00068           LD      BC,639          ;Zero 640 bytes
00069           LDIR
00070           POP     BC              ;Restore BC
00071
00072           LD      D,1             ;Bit in buf to set
00073
00074   NEWRW:  LD      A,C
00075           OUT     (Y),A           ;Update Y address
00076           INC     C
00077           LD      HL,BUFFER
00078           XOR     A
00079           OUT     (X),A           ;Restart X address
00080           LD      B,80            ;Get 80 graphics bytes
00081
00082           PUSH    BC              ;Save Y & loop counter
00083   BYTE1:  IN      A,(DATA)
00084           LD      C,A             ;Save graphics byte in C
00085           LD      E,80H           ;Get bits left to right
00086   BIT:    LD      A,C
00087           AND     E
00088           JR      Z,OFF
00089           LD      A,D
00090           OR      (HL)
00091           LD      (HL),A          ;Set bit in buffer
00092   OFF:    INC     HL              ;Next buffer byte
00093           SRL     E               ;Next bit
00094           JR      NZ,BIT
00095           DJNZ    BYTE1
00096           POP     BC
00097
00098           LD      A,240
00099           CP      C               ;Last Y address?
00100           JR      Z,DONE
00101           SLA     D               ;Next bit in buffer
00102           JP      P,NEWRW
00103
00104           CALL    PRINT           ;Print buffer
00105           JR      NZ,BOMB         ;An error occurred.
00106           JR      NEWLN
00107
00108   DONE:   CALL    PRINT
00109
00110   BOMB:   LD      C,1EH           ;End Graphics Print Mode
00111           TRSDOS  @PRT            ;We do not care if this one fails.
00112
00113           LD      A,0FCH          ;Status = graphics off, no waits, no incs
00114           OUT     (STATUS),A
00115
00116           TRSDOS  @FLAGS          ;Point to system flags again
00117           LD      A,(OLD)         ;Get old contents of IFLAG$
00118           LD      (IY+8),A        ;Set things back the way they were
00119
00120           LD      HL,0            ;Zero Return Code
```

```
00121           RET                     ;Return to TRSDOS or BASIC
00122
00123   PRINT:  PUSH    BC
00124           LD      HL,BUFFER+639   ;Point to the end of the buffer
00125           LD      D,0DH           ;Key on the terminator
00126           LD      BC,640          ;Set counter
00127   PFDIV:  LD      A,(HL)          ;Look at a byte
00128           CP      80H             ;Is it a nothing?
00129           JR      NZ,STOP         ;Then stop
00130           DEC     BC              ;Decrement counter
00131           DEC     HL              ;Decrement pointer
00132           LD      A,B             ;See if we are done
00133           OR      C               ;Well?
00134           JR      NZ,PFDIV        ;Loop for more
00135   STOP:   INC     HL              ;Move pointer back one
00136   .       LD      (HL),0DH        ;Load a terminator after last valid byte
00137           LD      HL,BUFFER               ;Point at the text to be printed
00138           TRSDOS  @PRINT          ;Display it
00139           POP     BC
00140           RET                     ;Done, exit
00141
00142   CRTC:   DEFB    99,80,85,8,25,4,24,24,0,9,0,0,0,0,0,0
00143
00144   OLD:    DEFB    0               ;Old contents of IFLAG$
00145   BUFFER: DEFS    640
00146           DEFB    0DH             ;Carriage return
00147
00148           END     GPRT2
```

```
00001   ;  GPRT3 -- Print graphics X horizontal double Y axis
00002
00003           PSECT   2600H           ;Model 4 Overlay area
00004           PRINT   SHORT,NOMAC
00005
00006   ;       Macros
00007
00008   TRSDOS: MACRO   #1
00009           LD      A,#1
00010           RST     28H
00011           ENDM
00012
00013   ;       TRSDOS SVC Equates
00014
00015   @PRT:   EQU     6               ;Print a character on the printer
00016   @PRINT: EQU     14              ;Print a line on the printer
00017   @FLAGS: EQU     101             ;Point to system control flags
00018
00019   ;       Port Equates
00020
00021   X:      EQU     80H
00022   Y:      EQU     81H
00023   DATA:   EQU     82H
00024   STATUS: EQU     83H
00025
00026   ;       Main Program
00027
00028   GPRT3:  LD      A,10H
00029           OUT     (236),A         ;Turn on CRTC ports
00030           LD      BC,1088H        ;Load 16 Regs and point to control port
00031           LD      HL,CRTC+15      ;Load backwards
00032
00033   ;       This code programs the CRTC Chip for 80 x 24 screen
00034   ;       Only required for Model III Graphics Boards
00035
00036   FDIV:   OUT     (C),B           ;Select Data Register in CRTC
00037           LD      A,(HL)          ;Get the data
00038           OUT     (137),A         ;Store that in the CRTC
00039           DEC     HL              ;Move to previous entry
00040           DJNZ    FDIV            ;Decrement counter
00041
00042   ;       Set the printer to start graphics mode
00043
00044           LD      C,12H           ;Begin Graphics mode
00045           TRSDOS  @PRT            ;Output Character
00046           JR      NZ,BOMB         ;Printer Not Ready
00047
00048   ;       Turn off international character set translation
00049
00050           TRSDOS  @FLAGS
00051           LD      A,(IY+8)        ;Get IFLAG$
00052           LD      (OLD),A         ;Save a copy of the current settings
00053           RES     6,(IY+8)        ;Turn off bit 6 (Intl. Translation)
00054
00055   ;       Open Video Memory
00056
00057           LD      C,0             ;Graphics Y address
00058           LD      A,0E3H          ;Open RAM with video waits
00059           OUT     (STATUS),A
00060
```

```
00061   ;       Initialize the Printer Buffer
00062
00063           LD      D,3             ;Bit(s) in buf to set
00064
00065   NEWLN:  PUSH    BC              ;Save BC
00066           PUSH    DE
00067           LD      HL,BUFFER       ;Point at the buffer
00068           LD      (HL),80H        ;Fill the buffer with x'80'
00069           LD      DE,HL           ;Build destination pointer
00070           INC     DE              ;Copy first byte to second position
00071           LD      BC,639          ;Zero 640 bytes
00072           LDIR
00073           POP     DE
00074           POP     BC              ;Restore BC
00075
00076   NEWRW:  LD      A,C
00077           OUT     (Y),A           ;Update Y address
00078           LD      A,40H
00079           CP      D
00080           JR      Z,NEWR1         ;If printing row second time
00081           INC     C               ;       Move to next row
00082   NEWR1:  LD      HL,BUFFER
00083           XOR     A
00084           OUT     (X),A           ;Restart X address
00085           LD      B,80            ;Get 80 graphics bytes
00086           LD      A,4
00087           CP      D
00088           JR      NZ,BYTE
00089           LD      D,6
00090
00091   BYTE:   PUSH    BC              ;Save Y & loop counter
00092   BYTE1:  IN      A,(DATA)
00093           LD      C,A             ;Save graphics byte in C
00094           LD      E,80H           ;Get bits left to right
00095   BIT:    LD      A,C
00096           AND     E
00097           JR      Z,OFF
00098           LD      A,D
00099           OR      (HL)
00100           LD      (HL),A          ;Set bit in buffer
00101   OFF:    INC     HL              ;Next buffer byte
00102           SRL     E               ;Next bit
00103           JR      NZ,BIT
00104           DJNZ    BYTE1
00105           POP     BC
00106
00107           LD      A,240
00108           CP      C               ;Last Y address?
00109           JR      Z,DONE
00110           SLA     D               ;Next bit in buffer
00111           SLA     D
00112           JR      Z,ENDRW
00113           JP      P,NEWRW
00114           LD      A,7FH
00115           AND     D
00116           LD      D,A
00117           JR      NZ,NEWRW
00118           LD      D,3
00119           JR      ENDR2
00120
```

```
00121   ENDRW:  LD      D,1
00122   ENDR2:  PUSH    DE
00123           CALL    PRINT           ;Print buffer
00124           POP     DE
00125           JR      NZ,BOMB         ;Printer Error
00126           JR      NEWLN
00127
00128   DONE:   CALL    PRINT
00129
00130   BOMB:   LD      C,1EH           ;End Graphics Print Mode
00131           TRSDOS  @PRT            ;We do not care if this one fails.
00132
00133           LD      A,0FCH          ;Status = graphics off, no waits, no incs
00134           OUT     (STATUS),A
00135
00136           TRSDOS  @FLAGS          ;Point to system flags again
00137           LD      A,(OLD)         ;Get old contents of IFLAG$
00138           LD      (IY+8),A        ;Set things back the way they were
00139
00140           LD      HL,0            ;Zero Return Code
00141           RET                     ;Return to TRSDOS or BASIC
00142
00143   PRINT:  PUSH    BC
00144           LD      HL,BUFFER+639   ;Point to the end of the buffer
00145           LD      D,0DH           ;Key on the terminator
00146           LD      BC,640          ;Set counter
00147   PFDIV:  LD      A,(HL)          ;Look at a byte
00148           CP      80H             ;Is it a nothing?
00149           JR      NZ,STOP         ;Then stop
00150           DEC     BC              ;Decrement counter
00151           DEC     HL              ;Decrement pointer
00152           LD      A,B             ;See if we are done
00153           OR      C               ;Well?
00154           JR      NZ,PFDIV        ;Loop for more
00155   STOP:   INC     HL              ;Move pointer back one
00156           LD      (HL),0DH        ;Load a terminator after last valid byte
00157           LD      HL,BUFFER       ;Point at the text to be printed
00158           TRSDOS  @PRINT          ;Display it
00159           POP     BC
00160           RET                     ;Done, exit
00161
00162   CRTC:   DEFB    99,80,85,8,25,4,24,24,0,9,0,0,0,0,0,0
00163
00164   OLD:    DEFB    0               ;Old contents of IFLAG$
00165   BUFFER: DEFS    640
00166           DEFB    0DH             ;Carriage return
00167
00168           END     GPRT3
```

4/ Graphics Subroutine Library (FORTRAN)

The Graphics Subroutine Library included on the Computer Graphics diskette lets you use the functions of TRS-80 Computer Graphics while programming in Model 4 FORTRAN (26-2219). This library (GRPLIB/REL) must be linked to any FORTRAN program that accesses the Graphics Subroutines.

BASICG vs. the Graphics Subroutine Library

The Graphics Subroutine Library contains subroutines which provide the same capabilities as the Graphics commands and functions in BASICG. The Graphics subroutines have basically the same names and parameters as the BASICG commands. The major differences between the Library subroutines and the BASICG commands are:

- The BASICG command LINE has three corresponding library subroutines: LINE, LINEB, and LINEBF. LINEB and LINEBF provide the functions of the BASICG command LINE with the parameters B and BF respectively.
- The BASICG command PAINT has two corresponding library subroutines: PAINT and PAINTT. PAINT is for painting solid black or white, and PAINTT is for painting with tiling.
- The Library subroutines that correspond to BASICG commands that use (x,y) coordinates (except for VIEW) use (x,y) coordinates that have been previously set. The subroutines used to set the coordinates are SETXY and SETXYR.

Setting Points using SETXY and SETXYR

The coordinates specified by SETXY or SETXYR will be called the "current" and "previous" coordinates. Subroutines that use one (x,y) coordinate pair use the "current" coordinates and subroutines that use two (x,y) pairs use both the "current" and the "previous" coordinates. Each call to SETXY or SETXYR sets the coordinates as follows:

1. Assign the values of the "current" (x,y) coordinates to the "previous" (x,y) coordinates, (discarding the old "previous" coordinates).
2. Assign new values for the "current" (x,y) coordinates as specified by the arguments supplied. SETXY simply sets the "current" coordinates to the values of its arguments. SETXYR adds the values of its arguments to the "current" coordinates to obtain the new coordinates.

Initialization

Before any calls are made to Graphics, the Graphics library and board must be initialized. A special initialization routine (GRPINI) is included in the library. A call to GRPINI must be made as the first access to the Graphics library.

Example

```
00100  C  SAMPLE INITIALIZATION
00150     DIMENSION V(30,30)
00200     CALL GRPINI (0)
```

Linking

The Library (GRPLIB/REL) must be linked to any programs that access the Graphics Subroutines. You must use the linker (L80) to generate the load module.

Example

```
L80 (ENTER)
*SAMPLE:1-N
*GRPHSAM,GRPLIB-S,FORLIB-S,-U
*-E
```

This example links both the Graphics Library and the FORTRAN Subroutine Library to the relocatable file GRPHSAM/REL. In this example, SAMPLE:1–N is the file name, drive specification, and switch, respectively; GRPHSAM, GRPLIB–S, FORLIB–S, and –U are the names of the relocatable modules to be linked and their respective switches. –E ends the routine and creates the executable program SAMPLE. The *'s in the example are prompts for the user — not data to be entered.

Note: If there are unresolved external references, the FORTRAN Library may need to be scanned a second time.

Errors

If you enter incorrect parameters for any of the Graphics Subroutines, your screen will display:

```
GRAPHICS ERROR
```

and return program control to TRSDOS Ready. This is the only error message you'll get when executing the Subroutines.

Important Note: Free memory is utilized by the Graphic Routine for temporary storage. Extreme care should be exercised if your program accesses this memory.

Routines/Functions

Most of the FORTRAN Subroutines and functions described in this section have a corresponding command in the **Graphics BASIC Language Reference** section of this manual.

FORTRAN Routines	
Routine	**Action**
CIRCLE	Draws a circle, arc, semicircle, or ellipse.
CLS	Clears the Graphics Screen.
GET	Reads the contents of a rectangular pixel area into an array.
GPRINT	Displays textual data on the Graphics Screen.
GRPINI	Graphics initialization routine.
LINE	Draws a line.
LINEB	Draws a box.
LINEBF	Draws a filled box.
LOCATE	Sets the direction for displaying textual data on the Graphics Screen.
PAINT	Paints the screen in specified OFF/ON color.
PAINTT	Paints the screen in a specified pattern.
PRESET	Sets pixel OFF/ON.
PSET	Sets pixel OFF/ON.
PUT	Puts the stored array on the screen.
SCREEN	Selects the screen.
SETXY	Sets (x,y) coordinates (absolute).
SETXYR	Sets (x,y) coordinates (relative).
VIEW	Sets up a viewport where graphics is displayed.

Table 7

FORTRAN Functions	
Function	**Action**
POINT	Reads a pixel's value at a specified coordinate.
FVIEW	Reads a viewport's parameters.

Table 8

CIRCLE
Draws a Circle, Arc, Semicircle, Point or Ellipse

CIRCLE *(radius,color,start,end,ar)*

radius is of INTEGER type and specifies the radius of the circle.
color is of LOGICAL type, specifies the OFF/ON color of the border of the circle and is an integer expression of either 0 or 1.
start is of REAL type and specifies the startpoint of the circle.
end is of REAL type and specifies the endpoint of the circle.
ar is the aspect ratio, is of REAL type and determines the major axis of the circle. If *ar* is 0, 0.5 is used.

CIRCLE draws a circle. By varying *start, end,* and aspect ratio, you can draw arcs, semicircles, or ellipses using current X- and Y-coordinates as the centerpoint (set by SETXY or SETXYR).

If *start* and *end* are 0.0, a circle is drawn starting from the center right side of the circle. Note: In the CIRCLE statement, *end* is read as 2 x PI even though you have entered 0.0. If you enter 0.0 for aspect ratio, a symmetric circle is drawn.

Example

```
CALL CIRCLE(100,1,0.0,0.0,0.0)
```

Sample Program

This example draws and paints a circle.

```
00010  C     SAMPLE PROGRAM FOR CIRCLE
00020        LOGICAL COLOR,OPTION
00030        COLOR=1
00040        OPTION=0
00050        CALL GRPINI(OPTION)
00060        CALL CLS
00070        CALL SETXY(300,100)
00080        CALL CIRCLE(100,COLOR,0.0,0.0,0.0)
00090        CALL PAINT(COLOR,COLOR)
00100        END
```

CLS
Clears Graphics Screen

CLS

Example

```
CALL CLS
```

Sample Program (see CIRCLE)

GET
Reads Contents of a Rectangular Pixel Area into an Array

GET *(array,size)*

array is any type and is the name of the array you specify.
size is of INTEGER type and specifies the size of the *array* in terms of bytes.

GET reads the contents of a rectangular pixel area into an *array* for future use by PUT. The pixel area is a group of pixels which are defined by the current x and y, and the previous X- and Y-coordinates specified by the SETXY call. The first two bytes of *array* are set to the horizontal (X-axis) number of pixels in the pixel area; the second two bytes are set to the vertical (Y-axis) number of pixels in the pixel area. The remainder of *array* represents the status of each pixel (either ON or OFF) in the pixel area. The data is stored in a row-by-row format. The data is stored eight pixels per byte and each row starts on a byte boundary.

Array Limits

When the *array* is defined, space is reserved in memory for each element of the *array*. The size of the *array* is limited by the amount of memory available for use by your program — each real number in your storage *array* uses four memory locations (bytes).

The *array* must be large enough to hold your graphic display and the rectangular area defined must include all the points you want to store.

To determine the minimum *array* size:

1. Divide the number of X-axis pixels by 8 and round up to the next higher integer.
2. Multiply the result by the number of Y-axis pixels.

   When counting the X-Y axis pixels, be sure to include the first and last pixel.
3. Add four to the total.
4. Divide by four (for real numbers) and two (for integers) rounding up to the next higher integer. (Note: If you're using a LOGICAL *array*, the result of Step #3 above will produce the desired array size.)

When using *arrays* the position and size of the rectangular pixel area is determined by the current and previous (x,y) coordinates.

Position:	upper left corner = startpoint = (xl,yl) lower left corner = endpoint = (x2,y2)
Size (in pixels):	Width = x2 − xl + 1 length = y2 − y1 + 1

Example

```
CALL GET(A,4000)
```

Sample Program

This example draws a circle, saves the circle into an *array*, then restores the *array* to the graphics video.

```
00050  C     SAMPLE FOR GET AND PUT
00100        LOGICAL V(128),ACTION
00150                ACTION=1
00200        CALL GRPINI(0)
00300        CALL CLS
00350  C     DRAW A CIRCLE
00400        CALL SETXY(30,30)
00500        CALL CIRCLE(10,1,0.0,0.0,0.0,0.0)
00550  C     SET COORDINATES FOR GET ARRAY
00600        CALL SETXY(10,10)
00700        CALL SETXY(40,40)
00750  C     STORE GRAPHICS INTO ARRAY WITH GET
00800        CALL GET(V,128)
00900        DO 10 I=1,5000
01000  10    CONTINUE
01050  C     CLEAR SCREEN AND RESTORE GRPH FROM ARRAY
01100        CALL CLS
01200        CALL SETXY(110,110)
01300        CALL PUT(V,ACTION)
01400        DO 20 I=1,5000
01500  20    CONTINUE
01600        END
```

GPRINT
Write Text Characters to the Graphics Screen

GPRINT *(cnt,array)*

cnt is of INTEGER type and specifies the number of characters to display.
array is a one dimensional LOGICAL array containing the characters to be displayed.

GPRINT is used to write text characters to the Graphics Screen. This is the easiest way to display textual data on the Graphics Screen. Characters are displayed starting at the current (x,y) coordinates and going in the direction specified by the most recently executed LOCATE call. If no LOCATE call was executed prior to the GPRINT call, a direction of 0 is assumed.

GPRINT will only print text characters (see the ***Model 4 Disk System Owner's Manual***). Each character displayed in the 0 or 2 direction uses an 8 x 8 pixel grid; each character displayed in the 1 or 3 direction uses a 16 x 8 grid. Executing this command will set the current (x,y) coordinates to the end of the last character that was displayed.

Displaying text in the direction 0 engages a wraparound feature. If the end of a line is reached, the display will be continued on the next line. If the end of the screen is reached, the display will be continued at the beginning of the screen without scrolling. If there is not enough room to display at least one character at the current (x,y) coordinates, a GRAPHICS ERROR will result. When displaying text in other directions, an attempt to display text outside the currently defined screen will cause a GRAPHICS ERROR to be given.

GRPINI
Graphics Initialization Routine

GRPINI*(option)*

option is of LOGICAL type; 0 clears the Graphics Screen, non-zero does not clear the Graphics Screen.

GRPINI is the graphics initialization routine. This function must be called before any other graphics calls are made in FORTRAN.

Example

```
CALL GRPINI(1)
```

Sample Program (see CIRCLE)

LINE
Draws Line

LINE *(color, style)*

color is of LOGICAL type, specifies the OFF/ON color of a line and is an integer expression of either 0 (OFF, black) or 1 (ON, white).
style is of INTEGER type, specifies the pattern of the line and is a number in the integer range. –1 indicates a solid line.

LINE draws a line between the previous and current coordinates. These coordinates are set by the SETXY or SETXYR subroutines.

Example

```
CALL LINE (1,-1)
```

Sample Program

This example draws a diagonal line connected to a box, which is connected to a filled box.

```
00010  C     SAMPLE FOR LINE LINEB LINEBF
00020        LOGICAL COLOR
00030        COLOR=1
00040        CALL GRPINI(0)
00050        CALL CLS
00060        CALL SETXY(1,1)
00070        CALL SETXY(210,80)
00080        CALL LINE(COLOR,-1)
00090        CALL SETXY(420,160)
00100  C     COORDINATES ARE NOW (210,80) (420,160)
00110        CALL LINEB(COLOR,-1)
00120        CALL SETXY(639,239)
00130  C     COORDINATES ARE NOW (420,160) (639,239)
00140        CALL LINEBF(COLOR)
00150        END
```

LINEB
Draws Box

LINEB *(color, style)*

color is of LOGICAL type, specifies the OFF/ON color of a line and is an integer expression of either 0 (OFF, black) or 1 (ON, white).
style is of INTEGER type, and specifies the pattern of the line. −1 indicates a solid line.

LINEB is the same as LINE except LINEB draws a box between the two sets of coordinates set by the SETXY or SETXYR subroutines.

Example

```
CALL LINEB(1,-1)
```

Line Program (see LINE)

LINEBF
Draws Painted Box

LINEBF *(color)*

color is of LOGICAL type, specifies the OFF/ON color of a line and is an integer expression of either 0 (OFF, black) or 1 (ON, white).

LINEBF is the same as LINEB except LINEBF fills the box (colors in the box) and the argument style is not used.

Example

```
CALL LINEBF (1)
```

Sample Program (see LINE)

LOCATE
Sets the Direction for Displaying Text on the Graphics Screen

LOCATE *(direction)*

direction is of LOGICAL type, specifies the direction that GLOCATE will use to display textual data and is an integer expression of 0-3.

LOCATE sets the direction that GPRINT will use to display textual data. The allowable values for *direction* are:

0 - zero degree angle
1 - 90 degree angle
2 - 180 degree angle
3 - 270 degree angle

Examples

```
CALL LOCATE (Ø)
```

This program line will cause characters to be displayed at the current (x,y) coordinates in normal left to right orientation.

```
CALL LOCATE (1)
```

This program line will cause characters to be displayed at the current (x,y) coordinates in a vertical orientation going from the top of the screen to the bottom of the screen.

```
CALL LOCATE (2)
```

This program line will cause characters to be displayed upside down starting at the right of the screen and going towards the left.

```
CALL LOCATE (3)
```

This program line will cause the characters to be displayed vertically starting at the lower portion of the screen going towards the top of the screen.

PAINT
Paints Screen in Specified Color

PAINT *(color, border)*

color is of LOGICAL type, specifies the OFF/ON color of painting and is an integer expression of either 0 (OFF, black) or 1 (ON, white).
border is of LOGICAL type, specifies the OFF/ON color of the border and is an integer expression of either 0 (OFF, black) or 1 (ON, white).

PAINT paints the screen in the specified OFF/ON *color* (black or white). It uses the current X- and Y- coordinates (see SETXY) as its startpoint.

Example

```
CALL PAINT(1,1)
```

Sample Program (see CIRCLE)

PAINTT
Paints Screen in Specified Pattern

PAINTT *(arrayT, border, arrayS)*

arrayT is a byte array which defines a multi-pixel pattern to be used when painting (tiling). The first byte of *arrayT* indicates the length of the "tile" (number of bytes).
border is of LOGICAL type and specifies the color of the border. *border* is an integer expression of either 0 (black) or 1 (white).
arrayS is a byte array that is used to define the background. The first byte is always set to 1; the second byte describes the background you are painting on (X'FF' = white, X'00' = black).

PAINTT lets you paint a precisely defined pattern using a graphics technique called "tiling." You can paint with tiling by defining a multi-pixel grid in an array and then using that array as the paint pattern.

Example

```
CALL PAINTT (A,1,V)
```

Sample Program

```
00100  C     EXAMPLE FOR PAINT WITH TILE
00150        LOGICAL A,B,BORDER
00200        DIMENSION A(9)
00300        DIMENSION B(2)
00350  C     DEFINE TILE ARRAY HERE
00400        DATA A(1), A(2), A(3) / 8, X'81', X'42'/
00500        DATA A(4),A(5),A(6)/X'24',X'18',X'18'/
00600        DATA A(7),A(8),A(9)/X'24',X'42',X'81'/
00650  C     DEFINE BACKGROUND ARRAY HERE
00700        DATA  B(1),B(2)/1,0/
00800        CALL GRPINI(0)
00900        CALL CLS
01000        CALL SETXY(300,100)
01100        CALL CIRCLE(150,1,0.0,0.0,0.0)
01200        BORDER=1
01300        CALL PAINTT(A,BORDER,B)
01400        END
```

PRESET
Sets Pixel ON/OFF

PRESET ***(color)***

color is of LOGICAL type, specifies whether a pixel is to be set ON or OFF and is an integer expression of either 0 (OFF) or 1 (ON).

PRESET sets the pixel defined by the current (x,y) coordinates either ON or OFF.

Example

```
CALL PRESET(0)
```

Sample Program

```
00100  C     PRESET EXAMPLE
00200        LOGICAL COLOR
00300        COLOR=1
00400        CALL GRPINI(0)
00500        CALL CLS
00600  C     SET PIXEL TO ON
00700        CALL SETXY(300,120)
00800        CALL PRESET(COLOR)
00900  C     TEST PIXEL WHETHER ON OR OFF
01000        K=POINT(M)
01100  30    WRITE (3,35)K
01200  35    FORMAT ('2',`PIXEL VALUE IS',I4)
01300        END
```

PSET
Sets Pixel ON/OFF

PSET *(color)*

color is of LOGICAL type, specifies whether a pixel is to be set ON or OFF and is an integer expression of either 0 (OFF) or 1 (ON).

PSET sets the pixel defined by the current (x,y) coordinates either ON or OFF.

Example

```
CALL PSET(0)
```

Sample Program

```
00100  C     PSET EXAMPLE
00200        LOGICAL COLOR
00300        LOGICAL POINT
00400        COLOR=1
00500        CALL GRPINI(0)
00600        CALL CLS
00700  C     SET PIXEL TO ON
00800        CALL SETXY(300,120)
00900        CALL PSET(COLOR)
01000  C     TEST PIXEL WHETHER ON OR OFF
01100        K=POINT(M)
01200        WRITE (3,35)K
01300  35    FORMAT ('2','PIXEL VALUE IS',I4)
01400        END
```

PUT
Puts Stored Array onto Screen

PUT *(array, action)*

array is usually LOGICAL type, although any type is permissible. Specifies the array (stored with GET) to be restored.

action is of LOGICAL type and specifies how the data is to be written to the video. Action may be one of the following:

1 = OR	3 = PRESET
2 = AND	4 = PSET
	5 = XOR

PUT takes a rectangular pixel area that has been stored by GET and puts it on the screen at current x and y coordinates set by calling SETXY.

Example

```
CALL PUT (V,1)
```

Sample Program (see GET)

SCREEN
Selects Screen

SCREEN *(switch)*

switch is of LOGICAL type and specifies the type of screen display and may be one of the following:

0 = Graphics Screen
1 = Text Screen

SCREEN lets you select the proper screen.

Example

```
CALL SCREEN(0)
```

Sample Program

This example turns off the graphics display, draws a circle, then turns on the graphics display. The circle is then visible.

```
00010  C     EXAMPLE FOR SCREEN
00020        LOGICAL CMD
00040        CMD=1
00050        CALL GRPINI(0)
00060        CALL CLS
00070        CALL SCREEN(CMD)
00080        CALL SETXY(300,120)
00090        CALL CIRCLE(100,1,0,0,0,0,0,0)
00100        CALL PAINT(1,1)
00110        DO 20 I=1,10000
00120  20    CONTINUE
00130        CMD=0
00140        CALL SCREEN(CMD)
00150        END
```

SETXY
Sets Coordinates

SETXY *(x,y)*

(x,y) are INTEGER type and represent coordinates on the Graphics Screen.

SETXY sets and holds both current and previous X- and Y- coordinates. When a new coordinate is given, it is designated as the "current coordinate" and the last coordinate is designated as the "previous coordinate." If a new coordinate is specified, the "previous coordinate" is lost and the "current coordinate" becomes the "previous coordinate."

Example

```
CALL SETXY(100,100)
```

Sample Program (see LINE)

SETXYR
Sets Relative Coordinates

SETXYR *(p1,p2)*

(p1,p2) are INTEGER type and represent Relative Coordinates on the Graphics Screen.

SETXYR sets the current (x,y) coordinates relative to the previously set (x,y) coordinates. For example, if the "current" coordinates are (100,100), CALL SETXYR(10,10) will set the "current" coordinates to (110,110); the "previous" coordinates will then be (100,100).

Example

```
CALL SETXYR(30,30)
```

Sample Program

```
00010  C     DRAW TWO INTERSECTING CIRCLES
00020        CALL GRPINI(1)
00030        CALL CLS
00040        CALL SETXY(100,100)
00050        CALL CIRCLE(50,1,0,0,0,0,0,0)
00060  C     DRAW SECOND CIRCLE WITH CENTER 20
00070  C     PIXELS TO THE RIGHT OF FIRST CIRCLE
00080        CALL SETXYR(20,0)
00090        CALL CIRCLE(50,1,0,0,0,0,0,0)
00100        END
```

VIEW
Sets Viewport

VIEW *(leftX,leftY,rightX,rightY,color,border)*

leftX, leftY, rightX, rightY are INTEGER type and specify the viewport's parameters.
left X* and *rightX are numeric expressions from 0 to 639 and specify viewport's corner X-coordinates. *leftY* and *rightY* are numeric expressions from 0 to 239 and specify the viewport's corner Y-coordinates.
color is of LOGICAL type, specifies the OFF/ON color code and is a numeric expression of either 0 (OFF, black), 1 (ON, white), or −1 (viewport is not shaded).
border is of LOGICAL type, specifies the border color for the viewport and is an integer expression of either 0 (OFF, black), 1 (ON, white), or −1 (border is not drawn).

VIEW draws viewports on your screen. Graphics is displayed only in the last defined viewport.

The upper-left corner of viewport is read as (0,0) (the "relative origin") when creating items inside the viewport. All the other coordinates are read relative to this origin. However, the "absolute coordinates" of the viewport, as they are actually defined on the Graphics Cartesian system, are retained in memory and can be read using VIEW as a function.

Example

```
CALL VIEW(100,100,200,200,0,1)
```

Sample Program

```
00100  C     SAMPLE VIEW PROGRAM
00200        LOGICAL COLOR,BORDER,K
00300        INTEGER FVIEW
00400        CALL GRPINI(1)
00500        CALL CLS
00600  C     SET UP VIEW PORT
00700        COLOR=0
00800        BORDER=1
00900        CALL VIEW(210,80,420,160,COLOR,BORDER)
01000  C     DRAW MULTIPLE CIRCLES
01100        CALL SETXY(105,40)
01200        DO 20 I=10,150,10
01300        CALL CIRCLE(I,1,0.0,0.0,0)
01400  20    CONTINUE
01500  C     DISPLAY VIEWPORT COORDINATES
01600        DO 40 I=1,4
01700        K=I-1
01800        J=FVIEW(K)
01900        WRITE (3,35)I,J
02000  35    FORMAT ('2','VIEW PORT COORDINATE ',I4,' IS AT',I4)
02100  40    CONTINUE
02200  C     PRINT EMPTY LINES
```

```
02300          DO 60 I=1,6
02400          WRITE (3,50)
02500    50    FORMAT (1H1)
02600    60    CONTINUE
02700          END
```

The following two descriptions are functions in the Graphics Subroutine Library and must be declared as LOGICAL and INTEGER, respectively, in any routine that uses them.

Functions

POINT
Reads Pixel Value at Current Coordinates

V= POINT(*X*)

X is a dummy variable needed to set up the proper FORTRAN linkage to the POINT routine.

POINT returns the OFF/ON pixel value at current x and y coordinate as specified by SETXY or SETXYR. If the point is not in the current viewport, POINT returns −1.

Example

```
K=POINT(M)
```

Sample Program (see PSET)

FVIEW
Reads Viewport's Parameters

FVIEW *(n)*

n is of LOGICAL type and is an integer expression from 0 to 3.

FVIEW returns the specified viewport parameter:

0 = returns the left X-coordinate
1 = returns the left Y-coordinate
2 = returns the right X-coordinate
3 = returns the right Y-coordinate

Example

```
I=FVIEW(0)
```

Sample Program (see VIEW)

5/ Programming the Graphics Board

The Graphics Board provides 640 × 240 byte addressable pixels on a TRS-80 Model 4. The Graphics Board contains 32K of screen RAM to store video data consisting of four 64K RAMs which are double accessed for 8 bytes of data. Regular alphanumeric data is stored in the static RAM on the Video Board. The Graphics Board uses separate hardware to generate a 640 × 240 display, so only one screen may be displayed at a time. If the video is switched from Text to Graphics Screen very rapidly, the Video display may lose horizontal/vertical synchronization.

I/O port mapping is used to read and write data to the board. The Board is addressable at 80 – 83 Hex.

There are four internal registers which can be written to or read on the board. They are as follows:

1. X-Position — X-address (0 to 127) for data write only. (0 to 79 for display.)
2. Y-Position — Y-address (0 to 255) for data write only. (0 to 238 for display.)
3. Data — Graphics data in "byte" form. Each byte turns on or off 8 consecutive horizontal dots.
4. Options — 8 flags which turn on or off the user programmable options (Write only).

The I/O port mapping of the board is:

- *x*0 — X-Register Write. (80)
- *x*1 — Y-Register Write. (81)
- *x*2 — Video data read or write. (82)
- *x*3 — Options write. (83)

where *x* denotes the upper nibble of the I/O boundary as set by the DIP Switches. They are set by the factory at 80H.

The Graphics Board uses X-Y addressing to locate the start of a Graphics data byte. The upper-left of the screen is (0,0) while the lower-right is (079,239). If the bit is a 1, the dot will be ON. For example, if you wanted to turn on the 5th dot on the top row, the registers would contain: X POSITION = 0, Y POSITION = 0, DATA = (00001000) = 08H. Note that in calculating points to plot, the Y-position is correct for a single dot. Only the X-position must be corrected to compensate for the byte addressing. This can be accomplished in a simple subroutine.

Line Drawing Options

There are two 8-bit counters which act as latches for the X- and Y-address. You may select, through the options register, if they are to automatically count after a read or write to graphic memory. Also, the counters may increment or decrement independently. These counters do not count to their respective endpoints and reset. Instead, they will overflow past displayable video addresses. Therefore, the software should not allow the counters to go past 79 and 239. However, these extra memory locations may be used for data storage.

Examples

The following are brief examples on how to use the Graphics Board.

Read the video byte at X=0, Y=0

```
        XOR     A               ;CLEAR A
        OUT     (80H),A         ;OUTPUT X ADDRESS
        OUT     (81H),A         ;OUTPUT Y ADDRESS
        IN      A,(82H)         ;READ VIDEO BYTE
```

Draw a line from X=0,Y=0 to X=639, Y=0 using the hardware line drawing

```
        LD      B,79            ;B HAS CHARACTER COUNT
        LD      A,0B1H          ;OPTIONS:INCREMENT X AFTER WRITE
                                ;10110001 Binary
        OUT     (83H),A
        XOR     A
        OUT     (80H),A         ;OUT X ADDRESS STARTING
        OUT     (81H),A         ;OUTPUT Y ADDRESS
        LD      A,0FFH          ;LOAD A WITH ALL DOTS ON
LOOP    OUT     (82H),A         ;OUTPUT DOTS
        DJNZ    LOOP            ;OUTPUT NUMBER IN B REGISTER
```

Options Programming

No.	Option	Description
0	GRAPHICS/ALPHA*	Turns graphics ON and OFF. "1" turns graphics ON.
1	NOT USED	
2	XREG DEC/INC*	Selects whether X decrements or increments. "1" selects decrement.
3	YREG DEC/INC*	Selects whether Y decrements or increments. "1" selects decrement.
4	X CLK RD*	If address clocking is desired, a "0" clocks the X address up or down AFTER a Read depending on the status of BIT 2.
5	Y CLK RD*	If address clocking is desired, a "0" clocks the Y address up or down AFTER a Read depending on the status of BIT 3.
6	X CLK WR*	A "0" clocks AFTER a Write.
7	Y CLK WR*	A "0" clocks AFTER a Write.

Table 9. Options Programming

Appendix A/BASICG/Utilities Reference Summary

Argument ranges are indicated below by special letters and words:

ar is a single-precision floating point number > 0.0 (to $1* 10^{38}$).

b	is an integer expression of either 0 or 1.
B	specifies a box.
BF	specifies a shaded box.
c	is an integer expression of 0 or 1.
n	is an integer expression from 0 to 2.
p	is an integer expression from 0 to 3.
r	is an integer expression from 0 to 639.
x	is an integer expression from 0 to 639.
y	is an integer expression from 0 to 239.
action	is either AND, PSET, PRESET, OR, or XOR.
background	is a string of either 0 or 1.
border	is an integer expression of either 0 or 1.
end	is an expression from −6.283185 to 6.283185.
start	*f029is an expression from −6.283185 to 6.283185.*
switch	is an integer expression of 0 or 1.
tiling	is a string or an integer expression of 0 or 1.
type	is an integer expression of 0 or 1.

CIRCLE*(x,y)r,c,start,end,ar* Draws a circle, ellipse, semicircle, arc, or point.

```
CIRCLE(100,100),25,1              CIRCLE(150,150),40,1,,,,,6
CIRCLE(100,100),100,PI,2*PI,5     CIRCLE(-50,-50),200
```

CLS Clears the Text Screen and video memory.

```
CLS                    SYSTEM"CLS"
```

CLR Clears the Graphics Screen.

```
CLR
```

GCLS Clears the Graphics Screen and memory.

```
GCLS                   SYSTEM"GCLS"            100 SYSTEM"GCLS"
```

GET*(x1,y1)–(x2,y2),array name* Reads the contents of a rectangular pixel area into an array.

```
GET(10,10)-(50,50),V
```

GLOAD *filename/ext.password:d* Loads graphics memory.

```
GLOAD PROG             SYSTEM"GLOAD PROG"
```

GLOCATE *(x,y),direction* Sets the Graphics Cursor

```
GLOCATE (320,120),0
```

GPRINT Dumps graphic display on the printer.

```
GPRINT                SYSTEM"GPRINT"          100 SYSTEM"GPRINT
```

GPRT2 Dumps graphic display on the printer without rotating 90 degrees.

```
GPRT2                 SYSTEM"GPRT2"           100 SYSTEM"GPRT2"
```

GPRT3 Dumps graphics display on the printer without rotating 90 degrees.

```
GPRT3                 SYSTEM"GPRT3"           100 SYSTEM"GPRT3"
```

GROFF Turns Graphics Display OFF.

```
GROFF    SYSTEM"GROFF"
```

GRON Turns Graphics Display ON.

```
GRON    SYSTEM"GRON"
```

GSAVE ***filename/ext.password:d*** Saves graphics memory.

```
GSAVE PROG            SYSTEM"GSAVE PROG"
```

LINE*(x1,y1)–(x2,y2),c,B* or *BF, style* Draws a line/box.

```
LINE -(100,100)              LINE(100,100)-(200,200),1,B,45
LINE(0,0)-(100,100),1,BF          LINE(-200,-200)-(100,100)
```

PAINT ***(x,y),tiling,border,background*** Paints the screen.

```
PAINT(320,120),1,1  PAINT(320,120),"DDDDD",1
PAINT(320,120),A$,1
PAINT(320,120),CHR$(0)+CHR$(&HFF),0,CHR$(&H00)
PAINT(320,120),CHR$(E)+CHR$(77)+CHR$(3)
```

&POINT*(x,y)* A function. Tests graphics point.

```
PRINT &POINT(320,120)   IF &POINT(320,120)=1)THEN...
PRINT &POINT(320,120),-1
```

PRESET ***(x,y),switch*** Sets pixel OFF or ON.

```
PRESET(100,100),0
```

PRINT #–3, ***item list*** Write text characters to the Graphics Screen.

```
PRINT #-3,"MONTHLY"
```

PSET ***(x,y),switch*** Sets pixel ON or OFF.

```
PSET(100,100),1
```

PUT ***(x1,y1),array name,action*** Puts graphics from an array onto the screen.

```
PUT(100,100),A,PSET      PUT(100,100),A,AND
PUT(A,B),B
```

SCREEN ***type*** Selects the screen.

```
SCREEN 0
```

VIEW ***(x1,y1)–(x2,y2),c,b*** Redefines the screen and creates a viewport.

```
VIEW(100,100)-(150,150)   VIEW(100,100)-(150,150),0,1
```

&VIEW(*p*) A function. Returns viewport's coordinates.

```
PRINT &VIEW(1)
```

Appendix B/ BASIC Error Codes and Messages

Code	Number	Message
NF	1	NEXT without FOR A variable in a NEXT statement does not correspond to any previously executed, unmatched FOR statement variable.
SN	2	Syntax error BASIC encountered a line that contains an incorrect sequence of characters (such as unmatched parenthesis, misspelled statement, incorrect punctuation, etc.). BASIC automatically enters the edit mode at the line that caused the error.
RG	3	Return without GOSUB BASIC encountered a RETURN statement for which there is no matching GOSUB statement.
OD	4	Out of data BASIC encountered a READ statement, but no DATA statements with unread items remain in the program.
FC	5	Illegal function call A parameter that is out of range was passed to a math or string function. An FC error may also occur as the result of: a. A negative or unreasonably large subscript. b. A negative or zero argument with LOG. c. A negative argument to SQU. d. A negative mantissa with a noninteger exponent. e. A call to a USR function for which the starting address has not yet been given. f. An improper argument to MID$, LEFT$, RIGHT$, PEEK, POKE, TAB, SPC, STRING$, SPACE$, INSTR, or ON...GOTO.
OV	6	Overflow The result of a calculation was too large to be represented in BASIC numeric format. If underflow occurs, the result is zero and execution continues without an error.

OM	7	Out of memory A program is too large, or has too many FOR loops or GOSUBs, too many variables, or expressions that are too complicated.
UL	8	Undefined line number A nonexistent line was referenced in a GOTO, GOSUB, IF...THEN...ELSE, or DELETE statement.
BS	9	Subscript out of range An array element was referenced either with a subscript that is outside the dimensions of the array, or with the wrong number of subscripts.
DD	10	Redimensioned Array Two DIM statements were given for the same array, or a DIM statement was given for an array after the default dimension of 10 has been established for that array.
/O	11	Division by zero An expression includes division by zero, or the operation of involution results in zero being raised to a negative power. BASIC supplies machine infinity with the sign of the numerator as the result of the division, or it supplies positive machine infinity as the result of the involution. Execution then continues.
ID	12	Illegal direct A statement that is illegal in direct mode was entered as a direct mode command.
TM	13	Type mismatch A string variable name was assigned a numeric value or vice versa. A numeric function was given a string argument or vice versa.
OS	14	Out of string space String variables have caused BASIC to exceed the amount of free memory remaining. BASIC allocates string space dynamically, until it runs out of memory.
LS	15	String too long An attempt was made to create a string more than 255 characters long.
ST	16	String formula too complex A string expression is too long or too complex. The expression should be broken into smaller expressions.

CN	17	Can't continue An attempt was made to continue a program that: a. Has halted due to an error. b. Has been modified during a break in execution. c. Does not exist.
UF	18	Undefined user function A USR function was called before providing a function definition (DEF) statement.
	19	No RESUME An error-handling routine was entered without a matching RESUME statement.
	20	RESUME without error A RESUME statement was encountered prior to an error-handling routine.
	21	Undefined error An error message is not available for the error that occurred.
	22	Missing operand An expression contains an operator with no operand.
	23	Line buffer overflow. An attempt was made to input a line with too many characters.
	26	FOR without NEXT A FOR statement was encountered without a matching NEXT.
	29	WHILE without WEND A WHILE statement does not have a matching WEND.
	30	WEND without WHILE A WEND statement was encountered without a matching WHILE.
	Disk Errors	
	50	Field overflow A FIELD statement is attempting to allocate more bytes than were specified for the record length of a direct-access file.

51	Internal error An internal error malfunction has occurred in BASIC. Report to Radio Shack the conditions under which the message appeared.
52	Bad file number A statement or command references a file with a buffer number that is not OPEN or is out of the range of file numbers specified at initialization.
53	File not found A LOAD, KILL, or OPEN statement references a file that does not exist on the current disk.
54	Bad file mode An attempt was made to use PUT, GET, or LOF with a sequential file, to LOAD a direct file, or to execute an OPEN statement with a file mode other than I, O, R, E or D.
55	File already open An OPEN statement for sequential output was issued for a file that is already open; or a KILL statement was given for a file that is open.
57	Device I/O error An Input/Output error occurred. This is a fatal error; the operating system cannot recover it.
58	File already exists The filespec specified in a NAME statement is identical to a filespec already in use on the disk.
61	Disk full All disk storage space is in use.
62	Input past end An INPUT statement was executed after all the data in the file had been INPUT, or for a null (empty) file. To avoid this error, use the EOF function to detect the end-of-file.
63	Bad record number In a PUT or GET statement, the record number is either greater than the maximum allowed (65,535) or equal to zero.

64	Bad file name An illegal filespec (file name) was used with a LOAD, SAVE, KILL, or OPEN statement (for example, a filespec with too many characters).
66	Direct statement in file A direct statement was encountered while LOADing an ASCII-format file. The LOAD is terminated.
67	Too many files An attempt was made to create a new file (using SAVE or OPEN) when all directory entries are full.

Appendix C/ Subroutine Language Reference Summary

CIRCLE (*radius, color,start,end,ar*) Draws circle, ellipse, semicircle, arc, or point. (*x,y*) coordinates set by SETXY.

```
CALL CIRCLE (100,1,0,0,0)
```

CLS Clears Screen.

```
CALL CLS(2)
```

FVIEW (*n*) Returns viewport parameter.

```
I=FVIEW(0)
```

GET (*array,size*) Reads the contents of a rectangular pixel area into an array for future use by PUT.

```
CALL GET(A,4000)
```

GPRINT (*size,array*) Displays textual data.

```
CALL GPRINT (28,ARRAY1)
```

GRPINI (*option*) Graphics initialization routine.

```
CALL GRPINI(0)
```

LINE (*color,style*) Draws a line.
Coordinates set by SETXY or SETXYR.

```
CALL LINE (1,-1)
```

LINEB (*color,style*) Draws a box.
Coordinates set by SETXY or SETXYR.

```
CALL LINEB (1,-1)
```

LINEBF (*color*) Draws a filled box.
Coordinates set by SETXY or SETXYR.

```
CALL LINEBF (1)
```

LOCATE (*n*) Sets the direction for displaying textual data.

```
CALL LOCATE
```

PAINT (*color,border*) Paints screen.

```
CALL PAINT(1,1)
```

PAINTT (*arrayT,border,arrayS*) Paints screen with defined paint style.

```
CALL PAINTT (A,1,V)
```

POINT Returns pixel value at current coordinates.

```
K=POINT(M)
```

PRESET (*color*) Sets pixel ON or OFF.

```
CALL PRESET (0)
```

PSET (*color*) Sets pixel ON or OFF.

```
CALL PSET (0)
```

SCREEN (*type*) Sets Screen/graphics speed.

```
CALL SCREEN (1)
```

SETXY (*X,Y*) Sets coordinates (absolute).

```
CALL SETXY(100,100)
```

SETXYR(*X,Y*) Sets coordinates (relative).

```
CALL SETXYR(50,50)
```

VIEW (*leftX,leftY,rightX,rightY,color,border*) Sets viewport.

```
CALL VIEW(100,100,200,200,0,1)
```

Appendix D/ Sample Programs

```
10 '
20 ' Pie Graph Program ("PECANPIE/GRA")
30 '
40 ' Object
50 '     The object of this program is to draw a pie graph of the
60 '     expenses for a given month of eight departments of a company,
70 '     along with the numerical value of each pie section
80 '     representation.
90 '
100 '
110 ' Running the program
120 '     The month and the amounts spent by each department are input,
130 '     and the program takes over from there.
140 '
150 ' Special features
160 '     The amounts spent by each account as well as the total
170 '     amount spent are stored in strings.  The program will
180 '     standardize each string so that it is 9 characters long
190 '     and includes two characters to the right of the decimal
200 '     point.  This allows for input of variable length and an
210 '     optional decimal point.
220 '
230 '     The various coordinates used in the program are found
240 '     based on the following equations:
250 '
260 '             x = r * cos(theta)
270 '             y = r * sin(theta)
280 '
290 '     where x and y are the coordinates, r is the radius, and theta
300 '     is the angle.  (Note:  The y-coordinates are always multiplied
310 '     by 0.5.  This is because the y pixels are twice the size of the
320 '     x pixels.)
330 '
340 '     If an angle theta is generated by a percent less than 1%, the
350 '     section is not graphed, and the next theta is calculated.
360 '     However, the number will still be listed under the key.
370 '
380 ' Variables
390 '     ACCT$(i)        Description of the account
400 '     BUD$(i)         Amount spent by the account
410 '     DS$             Dollar sign (used in output)
420 '     HXCOL           Column number for the pie section number
430 '     HYRW            Row number for the pie section number
440 '     I               Counter
```

```
450 '     MN$               Month
460 '     PER(i)            Percent value of BUD$(i)
470 '     R                 Radius of circle
480 '     T0                Angle value line to be drawn
490 '     T1                Angle value of the next line
500 '     TBUD$             Total of all the BUD$(i)'s
510 '     THALF             Angle halfway between T1 and T0 (used for
520 '                       location position for section number)
530 '     TILE$(i)          Paint style for each section
540 '     TWOPI             Two times the value of pi
550 '     X0                X-coordinate for drawing the line represented
560 '                       by T0
570 '     XP                X-coordinate for painting a section
580 '     Y0                Y-coordinate for drawing the line represented
590 '                       by T0
600 '     YP                Y-coordinate for painting a section
610 '
620 ' Set initial values
630 '
640 CLEAR 1000    '10-JAN-84
650 DIM THALF(15),BUD$(15),ACCT$(15),PER(16)
660 TWOPI=2*3.14159
670 R=180
680 DS$="$"
690 ACCT$(1) = "Sales"
700 ACCT$(2) = "Purchasing"
710 ACCT$(3) = "R&D        "
720 ACCT$(4) = "Accounting"
740 ACCT$(5) = "Advertising "
750 ACCT$(6) = "Utilities  "
760 ACCT$(7) = "Security "
770 ACCT$(8) = "Expansion"
780 TILE$(0)=CHR$(&H22)+CHR$(&H0)
790 TILE$(1)=CHR$(&HFF)+CHR$(&H0)
800 TILE$(2)=CHR$(&H99)+CHR$(&H66)
810 TILE$(3)=CHR$(&H99)
820 TILE$(4)=CHR$(&HFF)
830 TILE$(5)=CHR$(&HF0)+CHR$(&HF0)+CHR$(&HF)+CHR$(&HF)
840 TILE$(6)=CHR$(&H3C)+CHR$(H3C)+CHR$(&HFF)
850 TILE$(7)=CHR$(&H3)+CHR$(&HC)+CHR$(&H30)+CHR$(&HC0)
860 '
870 ' Enter values to be graphed, standardize them, and calculate
880 ' the percent they represent
890 '
900 CLR
910 CLS
920 SCREEN 1
930 PRINT @80,"Enter month "
940 PRINT @240,"Enter amount spent by"
```

```
950 PRINT @320,"$"
960 PRINT @0,""
970 LINE INPUT "Enter month ";MN$
980 FOR I=1 TO 8
990 PRINT @265,ACCT$(I);"
1000 PRINT @320,"$"
1010 PRINT @240,""
1020 LINE INPUT "$";BUD$(I)
1030 IF INSTR(BUD$(I),".") =0 THEN BUD$(I)=BUD$(I)+".00"
1040 IF LEN(BUD$(I))<9 THEN BUD$(I)=" "+BUD$(I):GOTO 1040
1050 TBUD$=STR$(VAL(TBUD$)+VAL(BUD$(I)))
1060 NEXT I
1070 IF INSTR(TBUD$,".")=0 THEN TBUD$=TBUD$+".00"
1080 IF LEN(TBUD$)<9 THEN TBUD$=" "+TBUD$:GOTO 1080
1090 FOR I=1 TO 8
1100 PER(I)=VAL(BUD$(I))/VAL(TBUD$)*100
1110 NEXT I
1120 SCREEN 0
1130 '
1140 ' Draw the circle and calculate the location of the lines and
1150 ' the line numbers
1160 '
1170 CIRCLE(425,120),R
1180 FOR I=0 TO 8
1190 T0=TWOPI/100*PER(I)=T0
1200 X0=425+R*COS(T0)
1210 Y0=120-R*SIN(T0)*.5
1220 T1=TWOPI/100*PER(I+1)+T0
1230 THALF(I)=(T0+T1)/2
1240 HXCOL=(425+R*1.15*COS(THALF(I)))-10
1250 HYRW=INT(120-R*1.15*SIN(THALF(I))*.5)
1260 IF PER(I)>1 THEN LINE (425,120)-(X0,Y0)
1270 GLOCATE (HXCOL,HYRW),0
1280 IF I<8 and PER(I+1)>1 THEN PRINT #-3,I+1
1290 NEXT I
1300 '
1310 ' Paint the appropriate sections of the pie
1320 '
1330 FOR I=0 TO 7
1340 XP=425+R*.5*COS(THALF(I)
1350 YP=120-R*.5*SIN(THALF(I))*.5
1360 IF PER(I+1)<=1 THEN 1380
1370 PAINT (XP,YP),TILE$(I),1
1380 NEXT I
1390 '
1400 ' Print the key for the graph
1410 '
1420 GLOCATE(0,10),0
```

```
1430 PRINT #-3,"Expenditures for"
1440 GLOCATE(0,25),0
1450 PRINT #-3,MN$
1460 GLOCATE(0,40),0
1470 PRINT #-3,"#    Description    Amount"
1480 FOR I=1 TO 8
1490 GLOCATE(0,(4+I)*15),0
1500 PRINT #-3,I
1510 GLOCATE(40,(4+I)*15),0
1520 PRINT #-3,ACCT$(I)
1530 GLOCATE(130,(I+4)*15),0
1540 PRINT #-3,DS$;BUD$(I)
1550 DS$=" "
1560 NEXT I
1570 GLOCATE(0,195),0
1580 PRINT #-3,STRING$(26,"-")
1590 GLOCATE(40,210),0
1600 PRINT #-3,"Total        ";TBUD$
1610 FOR I=1 TO 10000
1620 NEXT I
1630 SCREEN 1
1640 END
```

```
10 ' "THREEDEE/GRA"
20 '
30 ' Object
40 '    The object of this program is to produce a three
50 ' dimensional bar graph representation of the gross
60 ' income for a company over a one year period.
70 '
80 ' Variables
90 '    A        Vertical alphanumeric character
100 '   BMSG$    Bottom message
110 '   CHAR$    Disk file input field
120 '   GI$      Gross income
130 '   I        Counter
140 '   J        Counter
150 '   MN$      Month
160 '   REC      Record number of vertical character
170 '   S1$      Single character of vertical message
180 '   TILE$    Tile pattern for painting
190 '   TTINC    Total income for the year
200 '   X        X-coordinate of bar
210 '   Y(i)     Y-coordinate of bar
220 '
230 'Input/output
240 '   The program prompts you to enter the gross income, in millions,
250 'for each month.  The program requires these values to be between one
260 'and nine.
270 '
280 'Set initial values
290 '
300 CLS
310 DIM Y(12),A(8),MN$(12)
320 DEFINT A
330 VMSG$=" Millions of dollars "
340 TMSG$="G r o s s  I n c o m e  F o r  1 9 8 3 "
350 BMSG$="M o n t h"
360 MN$(1)="January"
370 MN$(2)="February"
380 MN$(3)="March"
390 MN$(4)="April"
400 MN$(5)="May"
410 MN$(6)="June"
420 MN$(7)="July"
430 MN$(8)="August"
440 MN$(9)="September"
450 MN$(10)="October"
460 MN$(11)="November"
470 MN$(12)="December"
480 TILE$=CHR$(&H99)+CHR$(&H66)
```

```
490 X=-10
500 '
510 ' Input gross income, and calculate the Y-coordinate
520 '
530 FOR I=1 TO 12
540 CLS
550 PRINT "Enter gross income in millions (1-9) for ";MN$(I)
560 LINE INPUT "$";GI$
570 Y(I)=205-20*VAL(GI$)
580 TTINC=TTINC+VAL(GI$)
590 NEXT I
600 CLR
610 SCREEN 0
620 '
630 ' Draw the graph and bars
640 '
650 FOR I=1 TO 12
660 CLS
670 X=X+50
680 LINE (X,Y(I))-(X+20,205),1,BF
690 LINE -(X+40,195)
700 LINE -(X+40,Y(I)-10)
710 LINE -(X+20,Y(I)-10)
720 LINE -(X,Y(I))
730 LINE (X+20,Y(I))-(X+40,Y(I)-10)
740 PAINT(X+21,Y(I)+2),TILE$,1
750 NEXT I
760 GLOCATE(40,215),0
770 PRINT #-3,"Jan  Feb  Mar  Apr  May  June  July  Aug  Sept  Oct  Nov
780 GLOCATE(290,230),0
790 PRINT #-3,BMSG$
800 FOR I=1 TO 10
810 IF I>9 THEN C=1 ELSE C=2
820 GLOCATE((C*10)-5,(20-I*2)*10),0
830 PRINT #-3,STR$(I);"-"
840 NEXT I
850 LINE (35,0)-(35,205)
860 LINE -(639,205)
870 GLOCATE(0,180),3
880 PRINT #-3,VMSG$
890 GLOCATE(220,0),0
900 PRINT #-3,TMSG$
910 GLOCATE(260,10),0
920 PRINT #-3,"(Total income is";TTINC:" million)"
930 FOR I=1 TO 10000
940 NEXT I
950 SCREEN 1
960 END
```

Printing Graphics Displays

There are many ways to use the stand-alone utilities (described in Graphic Utilities). The following discussion demonstrates one way to use the utilities with graphic displays generated under BASICG.

To print graphics, follow these steps:

1. When TRSDOS Ready appears, set FORMS to allow 255 characters per line and 60 lines per page. (See your ***Model 4 Disk System Owner's Manual.***)
2. Set the printer into Graphic Mode, if possible, and set the printer's other parameters (elongation, non-elongated, etc.), if applicable, according to instructions in your printer owner's manual.
3. Write, run and save your program as a BASICG program file.
4. Save the graphics memory to diskette using GSAVE.
5. Load the file into memory using GLOAD.
6. Enter the print command GPRINT.

Example

1. Set FORMS with your printer's printing parameters.
2. Load BASICG and type in this program:

```
  5 SCREEN 0
 10 DEFDBL Y
 20 CLR
 30 LINE (0,120)-(640,120)
 40 LINE (320,0)-(320,240)
 50 FOR X=0 TO 640
 60 PI=3.141259
 70 X1=X/640*2*PI-PI
 80 Y=SIN(X1)*100
 90 IF Y>100 THEN X=X+7
100 PSET (X,-Y+120)
110 NEXT X
120 GLOCATE(0,0),0
130 PRINT #-3, "THIS IS A SINE WAVE."
```

3. RUN the program.

   The program draws a sine wave on the Graphics Screen (graphics memory) and prints the statement in line 130 (''THIS IS A SINE WAVE.'') on the Graphics Screen.

4. SINE (for sine wave) is the name we are giving this TRSDOS file. To save the contents of the graphics memory (which now includes the converted video memory) to diskette, type: `SYSTEM"GSAVE SINE"` **ENTER**.
5. The graphics memory is saved as a TRSDOS file on your diskette.
6. Exit BASIC by typing: `SYSTEM` **ENTER**

7. Type: `GCLS` (ENTER)

   The graphics memory is now cleared.

8. To load the file back into memory, type:

   `GLOAD SINE` (ENTER)

   The display is now on the Graphics Screen.

9. To print, type: `GPRINT` (ENTER).

FORTRAN Sample Programs

```
ØØ1ØØ   C       HIGH RESOLUTION GRAPHICS TEST - MAIN PROGRAM
ØØ2ØØ   C
ØØ3ØØ           CALL GRPINI(Ø)
ØØ4ØØ           CALL SCREEN(Ø)
ØØ5ØØ   C
ØØ6ØØ   C       CIRCLE TEST
ØØ7ØØ   C
ØØ8ØØ           CALL CTEST
ØØ9ØØ   C
Ø1ØØØ   C       LINE TEST
Ø11ØØ   C
Ø12ØØ           CALL LTEST
Ø13ØØ   C
Ø14ØØ   C       LINEB TEST
Ø15ØØ   C
Ø16ØØ           CALL LBTST
Ø17ØØ   C
Ø18ØØ   C       LINEBF TEST
Ø19ØØ   C
Ø2ØØØ           CALL LBFTST
Ø21ØØ   C
Ø22ØØ   C       PAINTT TEST
Ø23ØØ   C
Ø24ØØ           CALL PTTTST
Ø25ØØ   C
Ø26ØØ   C       GET AND PUT TEST
Ø27ØØ   C
Ø28ØØ           CALL GPTST
Ø29ØØ   C
Ø3ØØØ   C       PSET/POINT TEST
Ø31ØØ   C
Ø32ØØ           CALL PPTST
Ø33ØØ   C
Ø34ØØ   C       PRESET/POINT TEST
Ø35ØØ   C
Ø36ØØ           CALL PRETST
Ø37ØØ   C
```

```
Ø38ØØ    C        SCREEN TEST
Ø39ØØ    C
Ø4ØØØ             CALL SCRTST
Ø41ØØ    C
Ø42ØØ    C        VIEW/FVIEW TEST
Ø43ØØ    C
Ø44ØØ             CALL VTEST
Ø45ØØ             CALL CLS(2)
Ø46ØØ             END
```

```
ØØ1ØØ            SUBROUTINE CTEST
ØØ2ØØ    C
ØØ3ØØ    C       THIS SUBROUTINE TESTS CIRCLE, SETXY, AND PAINT
ØØ4ØØ    C
ØØ5ØØ            LOGICAL MSG(29)
ØØ6ØØ            CALL CLS
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ    1ØØ     FORMAT('TEST CIRCLE, SETXY, AND PAINT')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(29,MSG)
Ø12ØØ            CALL WAIT
Ø13ØØ            CALL VIEW(Ø,3Ø,639,239,Ø,Ø)
Ø14ØØ            DO 1Ø I=1,1ØØ
Ø15ØØ            IX=MOD(I*17,64Ø)
Ø16ØØ            IY=MOD(I*13,21Ø)
Ø17ØØ            IR=I*1.5
Ø18ØØ            START=MOD(I,13)-6.Ø
Ø19ØØ            END=MOD(I*3,13)-6.Ø
Ø2ØØØ            IF (START.LT.END) GOTO 1
Ø21ØØ            T=START
Ø22ØØ            START=END
Ø23ØØ            END=T
Ø24ØØ    1       CONTINUE
Ø25ØØ            RATIO=MOD(I*3,1ØØ)
Ø26ØØ            IF (RATIO.GT.Ø) RATIO=RATIO/4Ø.
Ø27ØØ            CALL SETXY(IX,IY)
Ø28ØØ            CALL CIRCLE(IR,1,START,END,RATIO)
Ø29ØØ    1Ø      CONTINUE
Ø3ØØØ    C
Ø31ØØ    C       RANDOMLY FILL IN THE AREAS
Ø32ØØ    C
Ø33ØØ            DO 11 I=1,5Ø
Ø34ØØ            IX=MOD(I*23,64Ø)
Ø35ØØ            IY=MOD(I*11,21Ø)
Ø36ØØ            CALL SETXY(IX,IY)
Ø37ØØ            CALL PAINT(1,1)
Ø38ØØ    11      CONTINUE
Ø39ØØ            CALL WAIT
Ø4ØØØ            CALL VIEW(Ø,Ø,639,239,-1,-1)
Ø41ØØ            RETURN
Ø42ØØ            END
```

```
ØØ1ØØ            SUBROUTINE LTEST
ØØ2ØØ     C
ØØ3ØØ     C      THIS ROUTINE EXERCISES LINE
ØØ4ØØ     C
ØØ5ØØ            LOGICAL MSG(19)
ØØ6ØØ            CALL CLS(Ø)
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ     1ØØ    FORMAT('LINE AND PAINT TEST')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(19,MSG)
Ø12ØØ            CALL WAIT
Ø13ØØ            J=1ØØ
Ø14ØØ            DO 1Ø I=1,639,2
Ø15ØØ            CALL SETXY(I,15)
Ø16ØØ            CALL SETXY(I,239)
Ø17ØØ            CALL LINE(1,J)
Ø18ØØ            J=J-1
Ø19ØØ     1Ø     CONTINUE
Ø2ØØØ            CALL WAIT
Ø21ØØ            CALL VIEW(Ø,15,639,239,Ø,Ø)
Ø22ØØ            CALL CLS
Ø23ØØ     C
Ø24ØØ     C      DRAW WHITE LINES AND FILL IN RANDOMLY
Ø25ØØ     C
Ø26ØØ            IX=MOD(I*19,639)
Ø27ØØ            IY=MOD(I*17,223)
Ø28ØØ            CALL SETXY(IX,IY)
Ø29ØØ            DO 11 I=1,1ØØ
Ø3ØØØ            IX=MOD(I*23,639)
Ø31ØØ            IY=MOD(I*29,223)
Ø32ØØ            CALL SETXY(IX,IY)
Ø33ØØ            CALL LINE(1,-1)
Ø34ØØ     11     CONTINUE
Ø35ØØ            DO 12 I=1,5Ø
Ø36ØØ            IX=MOD(I*31,639)
Ø37ØØ            IY=MOD(I*37,223)
Ø38ØØ            CALL SETXY(IX,IY)
Ø39ØØ            CALL PAINT(1,1)
Ø4ØØØ     12     CONTINUE
Ø41ØØ            CALL WAIT
Ø42ØØ     C
Ø43ØØ     C   WHITE OUT SCREEN, DRAW BLACK LINES, PAINT BLACK RANDOMLY
Ø44ØØ     C
Ø45ØØ            CALL VIEW(Ø,15,639,239,1,1)
Ø46ØØ            DO 15 I=1,1ØØ
Ø47ØØ            IX=MOD(I*11,639)
Ø48ØØ            IY=MOD(I*13,223)
Ø49ØØ            CALL SETXY(IX,IY)
Ø5ØØØ            CALL LINE(Ø,-1)
Ø51ØØ     15     CONTINUE
Ø52ØØ            DO 16 I=1,5Ø
Ø53ØØ            IX=MOD(I*17,639)
```

```
Ø54ØØ            IY=MOD(I*19,223)
Ø55ØØ            CALL SETXY(IX,IY)
Ø56ØØ            CALL PAINT(Ø,Ø)
Ø57ØØ    16      CONTINUE
Ø58ØØ            CALL WAIT
Ø59ØØ            CALL VIEW(Ø,Ø,639,239,Ø,Ø)
Ø6ØØØ            RETURN
Ø61ØØ            END
```

```
ØØ1ØØ            SUBROUTINE LBFTST
ØØ2ØØ    C
ØØ3ØØ    C       LINEBF TEST
ØØ4ØØ    C
ØØ5ØØ            LOGICAL MSG(11)
ØØ6ØØ            CALL CLS
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ    1ØØ     FORMAT('LINEBF TEST')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(11,MSG)
Ø12ØØ            CALL WAIT
Ø13ØØ            IXP=639
Ø14ØØ            ICLR=1
Ø15ØØ            DO 1Ø IX=Ø,12Ø
Ø16ØØ            CALL SETXY(IX*2,IX+3Ø)
Ø17ØØ            CALL SETXY(IXP,IXP-4ØØ)
Ø18ØØ            CALL LINEBF(ICLR)
Ø19ØØ            IXP=IXP-3
Ø2ØØØ            ICLR=ICLR-1
Ø21ØØ            IF (ICLR.LT.Ø) ICLR=1
Ø22ØØ    1Ø      CONTINUE
Ø23ØØ            CALL WAIT
Ø24ØØ            RETURN
Ø25ØØ            END
```

```
ØØ1ØØ            SUBROUTINE PTTTST
ØØ2ØØ     C
ØØ3ØØ     C      PAINT WITH TILES TEST
ØØ4ØØ     C
ØØ5ØØ            LOGICAL A(65),B(4),IS(16),MSG(23)
ØØ6ØØ            DATA A(1)/8/
ØØ7ØØ     C      X
ØØ8ØØ            DATA A(2),A(3),A(4),A(5)/X'41',X'22',X'14',X'Ø8'/
ØØ9ØØ            DATA A(6),A(7),A(8),A(9)/X'14',X'22',X'41',X'ØØ'/
Ø1ØØØ     C      FINE HORIZONTAL LINES
Ø11ØØ            DATA A(1Ø),A(11),A(12)/2,X'FF',X'ØØ'/
Ø12ØØ     C      MEDIUM HORIZONTAL LINES
Ø13ØØ            DATA A(13)/4/
Ø14ØØ            DATA A(14),A(15),A(16),A(17)/X'FF',X'FF',X'ØØ',X'ØØ'/
Ø15ØØ     C      DIAGONAL LINES
Ø16ØØ            DATA A(18)/4/
Ø17ØØ            DATA A(19),A(2Ø),A(21),A(22)/X'Ø3',X'ØC',X'3Ø',X'CØ'/
Ø18ØØ     C      LEFT TO RIGHT DIAGONALS
Ø19ØØ            DATA A(23)/4/
Ø2ØØØ            DATA A(24),A(25),A(26),A(27)/X'CØ',X'3Ø',X'ØC',X'Ø3'/
Ø21ØØ     C      FINE VERTICAL LINES
Ø22ØØ            DATA A(28),A(29)/1,X'AA'/
Ø23ØØ     C      MEDIUM VERTICAL LINES
Ø24ØØ            DATA A(3Ø),A(31)/1,X'CC'/
Ø25ØØ     C      COARSE VERTICAL LINES
Ø26ØØ            DATA A(32),A(33)/1,X'FØ'/
Ø27ØØ     C      ONE PIXEL DOTS
Ø28ØØ            DATA A(34),A(35),A(36)/2,X'22',X'ØØ'/
Ø29ØØ     C      TWO PIXEL DOTS
Ø3ØØØ            DATA A(37),A(38),A(39)/2,X'99',X'66'/
Ø31ØØ     C      PLUSES
Ø32ØØ            DATA A(4Ø),A(41),A(42),A(43)/3,X'3C',X'3C',X'FF'/
Ø33ØØ     C      SOLID
Ø34ØØ            DATA A(44),A(45)/1,X'FF'/
Ø35ØØ     C      BROAD CROSS HATCH
Ø36ØØ            DATA A(46),A(47),A(48),A(49)/3,X'92',X'92',X'FF'/
Ø37ØØ     C      THICK CROSS HATCH
Ø38ØØ            DATA A(5Ø)/4/
Ø39ØØ            DATA A(51),A(52),A(53),A(54)/X'FF',X'FF',X'DB',X'DB'/
Ø4ØØØ     C      FINE CROSS HATCH
Ø41ØØ            DATA A(54),A(55),A(56)/2,X'92',X'FF'/
Ø42ØØ     C      ALTERNATING PIXELS
Ø43ØØ            DATA A(57),A(58),A(59)/2,X'55',X'AA'/
Ø44ØØ            DATA B(1),B(2),B(3),B(4)/1,Ø,1,X'FF'/
Ø45ØØ            DATA IS(1),IS(2),IS(3),IS(4),IS(5),IS(6)/1,1Ø,13,18,23,28/
Ø46ØØ            DATA IS(7),IS(8),IS(9),IS(1Ø),IS(11)/3Ø,32,34,37,4Ø/
Ø47ØØ            DATA IS(12),IS(13),IS(14),IS(15),IS(16)/44,46,5Ø,54,57/
Ø48ØØ            CALL CLS
Ø49ØØ            ENCODE(MSG,1ØØ)
Ø5ØØØ     1ØØ    FORMAT('PAINTT AND SETXYR TESTS')
Ø51ØØ            CALL SETXY(Ø,Ø)
Ø52ØØ            CALL LOCATE(Ø)
Ø53ØØ            CALL GPRINT(23,MSG)
```

```
Ø54ØØ            CALL WAIT
Ø55ØØ    C
Ø56ØØ    C       PAINT ON A BLACK BACKGROUND
Ø57ØØ    C
Ø58ØØ            DO 1Ø I=1,16
Ø59ØØ            CALL SETXY(Ø,4Ø)
Ø6ØØØ            CALL SETXYR(639,199)
Ø61ØØ            CALL LINEB(1,-1)
Ø62ØØ            CALL SETXYR(-3ØØ,-1ØØ)
Ø63ØØ            ITMP=IS(I)
Ø64ØØ            CALL PAINTT(A(ITMP),1,B)
Ø65ØØ            CALL WAIT
Ø66ØØ            CALL VIEW(Ø,4Ø,639,239,Ø,Ø)
Ø67ØØ            CALL VIEW(Ø,Ø,639,239,-1,-1)
Ø68ØØ    1Ø      CONTINUE
Ø69ØØ    C
Ø7ØØØ    C       PAINT ON A WHITE BACKGROUND
Ø71ØØ    C
Ø72ØØ            DO 11 I=1,16
Ø73ØØ            IF(I.EQ.12) GOTO 11
Ø74ØØ            CALL VIEW(Ø,4Ø,639,239,Ø,Ø)
Ø75ØØ            CALL VIEW(Ø,Ø,639,239,-1,-1)
Ø76ØØ            CALL SETXY(Ø,4Ø)
Ø77ØØ            CALL SETXYR(639,199)
Ø78ØØ            CALL LINEBF(1)
Ø79ØØ            CALL SETXYR(-3ØØ,-1ØØ)
Ø8ØØØ            ITMP=IS(I)
Ø81ØØ            CALL PAINTT(A(ITMP),Ø,B(3))
Ø82ØØ            CALL WAIT
Ø83ØØ    11      CONTINUE
Ø84ØØ            RETURN
Ø85ØØ            END
```

```
ØØ1ØØ            SUBROUTINE GPTST
ØØ2ØØ    C
ØØ3ØØ    C       GET AND PUT TEST
ØØ4ØØ    C
ØØ5ØØ            LOGICAL A(1ØØØ),MSG(16)
ØØ6ØØ            CALL CLS
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ    1ØØ     FORMAT('GET AND PUT TEST')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(16,MSG)
Ø12ØØ            CALL VIEW(Ø,3Ø,639,239,Ø,Ø)
Ø13ØØ            CALL SETXY(1ØØ,1ØØ)
Ø14ØØ            CALL SETXYR(3Ø,3Ø)
Ø15ØØ            CALL LINEBF(1)
Ø16ØØ            CALL GET(A,1ØØØ)
Ø17ØØ            CALL CLS
Ø18ØØ            CALL WAIT
Ø19ØØ            CALL SETXY(1ØØ,1ØØ)
Ø2ØØØ            CALL PUT(A,1)
Ø21ØØ            CALL WAIT
Ø22ØØ            CALL VIEW(Ø,Ø,639,239,Ø,-1)
Ø23ØØ            RETURN
Ø24ØØ            END
```

```
ØØ1ØØ            SUBROUTINE PPTST
ØØ2ØØ    C
ØØ3ØØ    C       PSET AND POINT TEST
ØØ4ØØ    C
ØØ5ØØ            LOGICAL POINT,MSG(21)
ØØ6ØØ            CALL CLS
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ    1ØØ     FORMAT('PSET AND POINT TEST')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(19,MSG)
Ø12ØØ            CALL WAIT
Ø13ØØ            CALL CLS
Ø14ØØ    C
Ø15ØØ    C       SET AND CHECK ALL PIXELS
Ø16ØØ    C
Ø17ØØ            DO 1Ø I=Ø,639
Ø18ØØ            DO 11 J=Ø,239
Ø19ØØ            CALL SETXY(I,J)
Ø2ØØØ            CALL PSET(1)
Ø21ØØ            K=POINT(L)
Ø22ØØ            IF(K.EQ.Ø) GOTO 999
Ø23ØØ    11      CONTINUE
Ø24ØØ    1Ø      CONTINUE
Ø25ØØ    C
Ø26ØØ    C       RESET AND CHECK ALL PIXELS
Ø27ØØ    C
Ø28ØØ            DO 12 I=Ø,639
Ø29ØØ            DO 13 J=Ø,239
Ø3ØØØ            CALL SETXY(I,J)
Ø31ØØ            CALL PSET(Ø)
Ø32ØØ            K=POINT(L)
Ø33ØØ            IF (K.EQ.1) GOTO 999
Ø34ØØ    13      CONTINUE
Ø35ØØ    12      CONTINUE
Ø36ØØ            CALL CLS
Ø37ØØ            ENCODE(MSG,1Ø1)
Ø38ØØ    1Ø1     FORMAT('PSET AND POINT PASSED')
Ø39ØØ            CALL SETXY(Ø,Ø)
Ø4ØØØ            CALL LOCATE(Ø)
Ø41ØØ            CALL GPRINT(21,MSG)
Ø42ØØ            GOTO 1ØØØ
Ø43ØØ    999     CALL CLS
Ø44ØØ            ENCODE(MSG,1Ø2)
Ø45ØØ    1Ø2     FORMAT('PSET AND POINT FAILED')
Ø46ØØ            CALL SETXY(Ø,Ø)
Ø47ØØ            CALL LOCATE(Ø)
Ø48ØØ            CALL GPRINT(21,MSG)
Ø49ØØ    1ØØØ    CALL WAIT
Ø5ØØØ            RETURN
Ø51ØØ            END
```

```
ØØ1ØØ            SUBROUTINE PRETST
ØØ2ØØ    C
ØØ3ØØ    C       PRESET AND POINT TEST
ØØ4ØØ    C
ØØ5ØØ            LOGICAL POINT,MSG(23)
ØØ6ØØ            CALL CLS
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ    1ØØ     FORMAT('PRESET AND POINT TEST')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(23,MSG)
Ø12ØØ            CALL WAIT
Ø13ØØ            CALL CLS
Ø14ØØ    C
Ø15ØØ    C       SET AND CHECK ALL PIXELS
Ø16ØØ    C
Ø17ØØ            DO 1Ø I=Ø,639
Ø18ØØ            DO 11 J=Ø,239
Ø19ØØ            CALL SETXY(I,J)
Ø2ØØØ            CALL PRESET(1)
Ø21ØØ            K=POINT(L)
Ø22ØØ            IF(K.EQ.Ø) GOTO 999
Ø23ØØ    11      CONTINUE
Ø24ØØ    1Ø      CONTINUE
Ø25ØØ    C
Ø26ØØ    C       RESET AND CHECK ALL PIXELS
Ø27ØØ    C
Ø28ØØ            DO 12 I=Ø,639
Ø29ØØ            DO 13 J=Ø,239
Ø3ØØØ            CALL SETXY(I,J)
Ø31ØØ            CALL PRESET(Ø)
Ø32ØØ            K=POINT(L)
Ø33ØØ            IF (K.EQ.1) GOTO 999
Ø34ØØ    13      CONTINUE
Ø35ØØ    12      CONTINUE
Ø36ØØ            CALL CLS
Ø37ØØ            ENCODE(MSG,1Ø1)
Ø38ØØ    1Ø1     FORMAT('PRESET AND POINT PASSED')
Ø39ØØ            CALL SETXY(Ø,Ø)
Ø4ØØØ            CALL LOCATE(Ø)
Ø41ØØ            CALL GPRINT(23,MSG)
Ø42ØØ            GOTO 1ØØØ
Ø43ØØ    999     CALL CLS
Ø44ØØ            ENCODE(MSG,1Ø2)
Ø45ØØ    1Ø2     FORMAT('PRESET AND POINT FAILED')
Ø46ØØ            CALL SETXY(Ø,Ø)
Ø47ØØ            CALL LOCATE(Ø)
Ø48ØØ            CALL GPRINT(23,MSG)
Ø49ØØ    1ØØØ    CALL WAIT
Ø5ØØØ            RETURN
Ø51ØØ            END
```

```
ØØ1ØØ            SUBROUTINE SCRTST
ØØ2ØØ    C
ØØ3ØØ    C       SCREEN TEST
ØØ4ØØ    C
ØØ5ØØ            LOGICAL MSG(11)
ØØ6ØØ            CALL CLS
ØØ7ØØ            ENCODE(MSG,1ØØ)
ØØ8ØØ    1ØØ     FORMAT('SCREEN TEST')
ØØ9ØØ            CALL SETXY(Ø,Ø)
Ø1ØØØ            CALL LOCATE(Ø)
Ø11ØØ            CALL GPRINT(11,MSG)
Ø12ØØ            CALL WAIT
Ø13ØØ            CALL SETXY(3ØØ,12Ø)
Ø14ØØ            CALL CIRCLE(1ØØ,1,Ø.Ø,6.28,Ø.5)
Ø15ØØ            CALL CIRCLE(1ØØ,1,Ø.Ø,6.28,Ø.25)
Ø16ØØ            CALL CIRCLE(5Ø,1,Ø.Ø,6.28,Ø.5)
Ø17ØØ            CALL PAINT(1,1)
Ø18ØØ    C
Ø19ØØ    C       GRAPHICS SCREEN
Ø2ØØØ    C
Ø21ØØ            CALL SCREEN(Ø)
Ø22ØØ            CALL WAIT
Ø23ØØ            CALL WAIT
Ø24ØØ            CALL WAIT
Ø25ØØ    C
Ø26ØØ    C       TEXT SCREEN
Ø27ØØ    C
Ø28ØØ            CALL SCREEN(1)
Ø29ØØ            CALL WAIT
Ø3ØØØ            CALL WAIT
Ø31ØØ            CALL WAIT
Ø32ØØ    C
Ø33ØØ    C       GRAPHICS SCREEN
Ø34ØØ    C
Ø35ØØ            CALL SCREEN(Ø)
Ø36ØØ            CALL WAIT
Ø37ØØ            CALL WAIT
Ø38ØØ            CALL WAIT
Ø39ØØ            RETURN
Ø4ØØØ            END
```

```
ØØ1ØØ            SUBROUTINE VTEST
ØØ2ØØ    C
ØØ3ØØ    C       VIEW AND FVIEW TEST
ØØ4ØØ    C
ØØ5ØØ            INTEGER FVIEW
ØØ6ØØ            LOGICAL MSG(19)
ØØ7ØØ            CALL CLS
ØØ8ØØ            ENCODE(MSG,1ØØ)
ØØ9ØØ    1ØØ     FORMAT('VIEW AND FVIEW TEST')
Ø1ØØØ            CALL SETXY(Ø,Ø)
Ø11ØØ            CALL LOCATE(Ø)
Ø12ØØ            CALL GPRINT(19,MSG)
Ø13ØØ            CALL WAIT
Ø14ØØ    C
Ø15ØØ    C       DRAW VIEWPORT AND CIRCLES
Ø16ØØ    C
Ø17ØØ            CALL VIEW(Ø,4Ø,639,239,Ø,1)
Ø18ØØ            CALL DCIRCL(1)
Ø19ØØ    C
Ø2ØØØ    C       DRAW VIEWPORT AND LINES
Ø21ØØ    C
Ø22ØØ            CALL VIEW(2Ø,5Ø,619,229,1,Ø)
Ø23ØØ            CALL DLINE(Ø)
Ø24ØØ    C
Ø25ØØ    C       DRAW VIEWPORT AND CIRCLES
Ø26ØØ    C
Ø27ØØ            CALL VIEW(4Ø,6Ø,599,2Ø9,Ø,Ø)
Ø28ØØ            CALL DCIRCL(1)
Ø29ØØ    C
Ø3ØØØ    C       DRAW VIEWPORT AND LINES
Ø31ØØ    C
Ø32ØØ            CALL VIEW(6Ø,7Ø,579,199,1,1)
Ø33ØØ            CALL DLINE(Ø)
Ø34ØØ    C
Ø35ØØ    C       CLEAR SCREEN
Ø36ØØ    C
Ø37ØØ            IX1=FVIEW(Ø)
Ø38ØØ            IY1=FVIEW(1)
Ø39ØØ            IX2=FVIEW(2)
Ø4ØØØ            IY2=FVIEW(3)
Ø41ØØ            CALL VIEW(6Ø-IX1,7Ø-IY1,6Ø+IX2,4Ø+IY2,Ø,1)
Ø42ØØ            CALL CLS
Ø43ØØ            RETURN
Ø44ØØ            END
```

```
Ø45ØØ            SUBROUTINE DCIRCL(ICLR)
Ø46ØØ            CALL SETXY(1ØØ,1ØØ)
Ø47ØØ            DO 1Ø I=5,3ØØ,5
Ø48ØØ            CALL CIRCLE(I,ICLR,Ø.Ø,6.28,Ø.5)
Ø49ØØ    1Ø      CONTINUE
Ø5ØØØ            CALL WAIT
Ø51ØØ            RETURN
Ø52ØØ            END

Ø53ØØ            SUBROUTINE DLINE(ICLR)
Ø54ØØ            DO 11 I=2,2ØØ,4
Ø55ØØ            CALL SETXY(-1Ø,-1Ø)
Ø56ØØ            CALL SETXY(I+2ØØ,I)
Ø57ØØ            CALL LINE(ICLR,-1)
Ø58ØØ    11      CONTINUE
Ø59ØØ            CALL WAIT
Ø6ØØØ            RETURN
Ø61ØØ            END
```

```
ØØ1ØØ            SUBROUTINE WAIT
ØØ2ØØ     C
ØØ3ØØ     C      THIS SUBROUTINE INTRODUCES A TIME DELAY
ØØ4ØØ     C
ØØ5ØØ            DO 11 J=1,2Ø
ØØ6ØØ            DO 1Ø I=1,1ØØØØ
ØØ7ØØ     1Ø     CONTINUE
ØØ8ØØ     11     CONTINUE
ØØ9ØØ            RETURN
Ø1ØØØ            END
```

Appendix E/ Base Conversion Chart

DEC.	HEX.	BINARY	DEC.	HEX.	BINARY
0	00	00000000	40	28	00101000
1	01	00000001	41	29	00101001
2	02	00000010	42	2A	00101010
3	03	00000011	43	2B	00101011
4	04	00000100	44	2C	00101100
5	05	00000101	45	2D	00101101
6	06	00000110	46	2E	00101110
7	07	00000111	47	2F	00101111
8	08	00001000	48	30	00110000
9	09	00001001	49	31	00110001
10	0A	00001010	50	32	00110010
11	0B	00001011	51	33	00110011
12	0C	00001100	52	34	00110100
13	0D	00001101	53	35	00110101
14	0E	00001110	54	36	00110110
15	0F	00001111	55	37	00110111
16	10	00010000	56	38	00111000
17	11	00010001	57	39	00111001
18	12	00010010	58	3A	00111010
19	13	00010011	59	3B	00111011
20	14	00010100	60	3C	00111100
21	15	00010101	61	3D	00111101
22	16	00010110	62	3E	00111110
23	17	00010111	63	3F	00111111
24	18	00011000	64	40	01000000
25	19	00011001	65	41	01000001
26	1A	00011010	66	42	01000010
27	1B	00011011	67	43	01000011
28	1C	00011100	68	44	01000100
29	1D	00011101	69	45	01000101
30	1E	00011110	70	46	01000110
31	1F	00011111	71	47	01000111
32	20	00100000	72	48	01001000
33	21	00100001	73	49	01001001
34	22	00100010	74	4A	01001010
35	23	00100011	75	4B	01001011
36	24	00100100	76	4C	01001100
37	25	00100101	77	4D	01001101
38	26	00100110	78	4E	01001110
39	27	00100111	79	4F	01001111

DEC.	HEX.	BINARY	DEC.	HEX.	BINARY
80	50	01010000	120	78	01111000
81	51	01010001	121	79	01111001
82	52	01010010	122	7A	01111010
83	53	01010011	123	7B	01111011
84	54	01010100	124	7C	01111100
85	55	01010101	125	7D	01111101
86	56	01010110	126	7E	01111110
87	57	01010111	127	7F	01111111
88	58	01011000	128	80	10000000
89	59	01011001	129	81	10000001
90	5A	01011010	130	82	10000010
91	5B	01011011	131	83	10000011
92	5C	01011100	132	84	10000100
93	5D	01011101	133	85	10000101
94	5E	01011110	134	86	10000110
95	5F	01011111	135	87	10000111
96	60	01100000	136	88	10001000
97	61	01100001	137	89	10001001
98	62	01100010	138	8A	10001010
99	63	01100011	139	8B	10001011
100	64	01100100	140	8C	10001100
101	65	01100101	141	8D	10001101
102	66	01100110	142	8E	10001110
103	67	01100111	143	8F	10001111
104	68	01101000	144	90	10010000
105	69	01101001	145	91	10010001
106	6A	01101010	146	92	10010010
107	6B	01101011	147	93	10010011
108	6C	01101100	148	94	10010100
109	6D	01101101	149	95	10010101
110	6E	01101110	150	96	10010110
111	6F	01101111	151	97	10010111
112	70	01110000	152	98	10011000
113	71	01110001	153	99	10011001
114	72	01110010	154	9A	10011010
115	73	01110011	155	9B	10011011
116	74	01110100	156	9C	10011100
117	75	01110101	157	9D	10011101
118	76	01110110	158	9E	10011110
119	77	01110111	159	9F	10011111

Appendix E/ Base Conversion Chart

DEC.	HEX.	BINARY	DEC.	HEX.	BINARY
160	A0	10100000	200	C8	11001000
161	A1	10100001	201	C9	11001001
162	A2	10100010	202	CA	11001010
163	A3	10100011	203	CB	11001011
164	A4	10100100	204	CC	11001100
165	A5	10100101	205	CD	11001101
166	A6	10100110	206	CE	11001110
167	A7	10100111	207	CF	11001111
168	A8	10101000	208	D0	11010000
169	A9	10101001	209	D1	11010001
170	AA	10101010	210	D2	11010010
171	AB	10101011	211	D3	11010011
172	AC	10101100	212	D4	11010100
173	AD	10101101	213	D5	11010101
174	AE	10101110	214	D6	11010110
175	AF	10101111	215	D7	11010111
176	B0	10110000	216	D8	11011000
177	B1	10110001	217	D9	11011001
178	B2	10110010	218	DA	11011010
179	B3	10110011	219	DB	11011011
180	B4	10110100	220	DC	11011100
181	B5	10110101	221	DD	11011101
182	B6	10110110	222	DE	11011110
183	B7	10110111	223	DF	11011111
184	B8	10111000	224	E0	11100000
185	B9	10111001	225	E1	11100001
186	BA	10111010	226	E2	11100010
187	BB	10111011	227	E3	11100011
188	BC	10111100	228	E4	11100100
189	BD	10111101	229	E5	11100101
190	BE	10111110	230	E6	11100110
191	BF	10111111	231	E7	11100111
192	C0	11000000	232	E8	11101000
193	C1	11000001	233	E9	11101001
194	C2	11000010	234	EA	11101010
195	C3	11000011	235	EB	11101011
196	C4	11000100	236	EC	11101100
197	C5	11000101	237	ED	11101101
198	C6	11000110	238	EE	11101110
199	C7	11000111	239	EF	11101111

DEC.	HEX.	BINARY
240	F0	11110000
241	F1	11110001
242	F2	11110010
243	F3	11110011
244	F4	11110100
245	F5	11110101
246	F6	11110110
247	F7	11110111
248	F8	11111000
249	F9	11111001
250	FA	11111010
251	FB	11111011
252	FC	11111100
253	FD	11111101
254	FE	11111110
255	FF	11111111

Appendix F/ Pixel Grid Reference

The following hexadecimal numbers include commonly used tiling designs.

Important Note: You cannot use more than two empty rows of tiles when tiling or you'll get an Illegal Function Call error.

Example (four rows of empty tiles):

```
CHR$(&HFF)+CHR$(&HFF)+CHR$(&H00)+CHR$(&H00)+CHR$(&H00)+CHR$(&H00)
```

gives you an Illegal Function Call error.

1. "X"

```
CHR$(&H41)+CHR$(&H22)+CHR$(&H14)+CHR$(&H08)+CHR$(&H14)
+CHR$(&H22)+CHR$(&H41)+CHR$(&H00)
```

								Hex	Decimal
0	1	0	0	0	0	0	1	41	65
0	0	1	0	0	0	1	0	22	34
0	0	0	1	0	1	0	0	14	20
0	0	0	0	1	0	0	0	08	8
0	0	0	1	0	1	0	0	14	20
0	0	1	0	0	0	1	0	22	34
0	1	0	0	0	0	0	1	41	65
0	0	0	0	0	0	0	0	00	0

2. "Fine" horizontal lines

```
CHR$(&HFF)+CHR$(&H00)
```

								Hex	Decimal
1	1	1	1	1	1	1	1	FF	255
0	0	0	0	0	0	0	0	00	0

3. "Medium" horizontal lines

```
CHR$(&HFF)+CHR$(&HFF)+CHR$(&H00)+CHR$(&H00)
```

								Hex	Decimal
1	1	1	1	1	1	1	1	FF	255
1	1	1	1	1	1	1	1	FF	255
0	0	0	0	0	0	0	0	00	0
0	0	0	0	0	0	0	0	00	0

4. Diagonal lines

(Right to left)

```
CHR$(&H03)+CHR$(&H0C)+CHR$(&H30)+CHR$(&HC0)
```

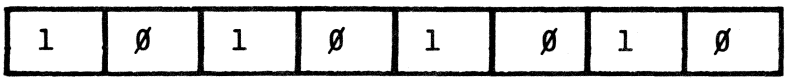
								Hex	Decimal
0	0	0	0	0	0	1	1	03	3
0	0	0	0	1	1	0	0	0C	12
0	0	1	1	0	0	0	0	30	48
1	1	0	0	0	0	0	0	C0	192

(Left to right)

```
CHR$(&HC0)+CHR$(&H30)+CHR$(&H0C)+CHR$(&H03)
```

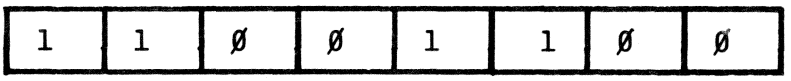
								Hex	Decimal
1	1	0	0	0	0	0	0	C0	192
0	0	1	1	0	0	0	0	30	48
0	0	0	0	1	1	0	0	0C	12
0	0	0	0	0	0	1	1	03	3

5. "Fine" vertical lines
   `CHR$(&HAA)`



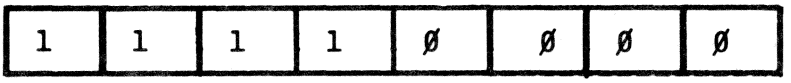
Hex	Decimal
AA	170

6. "Medium" vertical lines
   `CHR$(&HCC)`



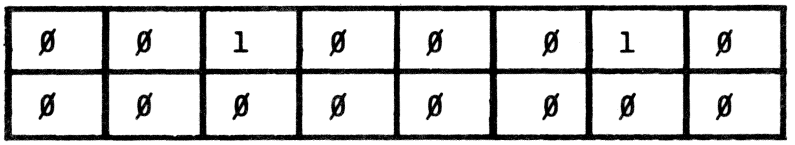
Hex	Decimal
CC	204

7. "Coarse" vertical lines
   `CHR$(&HF0)`



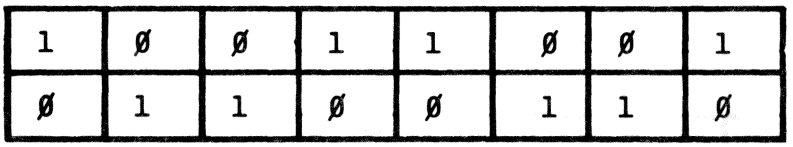
Hex	Decimal
F0	240

8. One-pixel dots
   `CHR$(&H22)+CHR$(&H00)`



Hex	Decimal
22	34
00	0

9. Two-pixel dots
   `CHR$(&H99)+CHR$(&H66)`



Hex	Decimal
99	153
66	102

10. Pluses ("+")

```
CHR$(&H3C)+CHR$(&H3C)+CHR$(&HFF)
```

Ø	Ø	1	1	1	1	Ø	Ø
Ø	Ø	1	1	1	1	Ø	Ø
1	1	1	1	1	1	1	1

Hex	Decimal
3C	60
3C	60
FF	255

11. Solid (all pixels ON)

```
CHR$(&HFF)
```

1	1	1	1	1	1	1	1

Hex	Decimal
FF	255

12. "Broad" cross-hatch

```
CHR$(&H92)+CHR$(&H92)+CHR$(&HFF)
```

1	Ø	Ø	1	Ø	Ø	1	Ø
1	Ø	Ø	1	Ø	Ø	1	Ø
1	1	1	1	1	1	1	1

Hex	Decimal
92	146
92	146
FF	255

13. "Thick" cross-hatch

```
CHR$(&HFF)+CHR$(&HFF)+CHR$(&HDB)+CHR$(&HDB)
```

1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	Ø	1	1	Ø	1	1
1	1	Ø	1	1	Ø	1	1

Hex	Decimal
FF	255
FF	255
DB	219
DB	219

14. "Fine" cross-hatch

```
CHR$(&H92)+CHR$(&HFF)
```

1	ø	ø	1	ø	ø	1	ø
1	1	1	1	1	1	1	1

Hex	Decimal
92	146
FF	255

15. Alternating pixels

```
CHR$(&H55)+CHR$(&HAA)
```

ø	1	ø	1	ø	1	ø	1
1	ø	1	ø	1	ø	1	ø

Hex	Decimal
55	85
AA	170

Appendix F/ Line Style Reference

Type	Binary Numbers	Hex	Decimal
Long dash	0000 0000 1111 1111	&H00FF	255
Short dash	1111 0000 1111 0000	&HF0F0	-3856
"Short-short" dash	1100 1100 1100 1100	&HCCCC	-13108
Solid line	1111 1111 1111 1111	&HFFFF	-1
OFF/ON	0101 0101 0101 0101	&H5555	21845
"Wide" dots	0000 1000 0000 1000	&H0808	2056
"Medium" dots	1000 1000 1000 1000	&H8888	-30584
"Dot-dash"	1000 1111 1111 1000	&H8FF8	-28680

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