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TRS-80®

Computer Graphics

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A Special Note on Model III Computer Graphics...

Be sure to use the GCLS command ("clear the Graphics Screen") at TRSDOS READY when you first turn on your computer. Otherwise, random graphics may appear on the Screen.

Thank You

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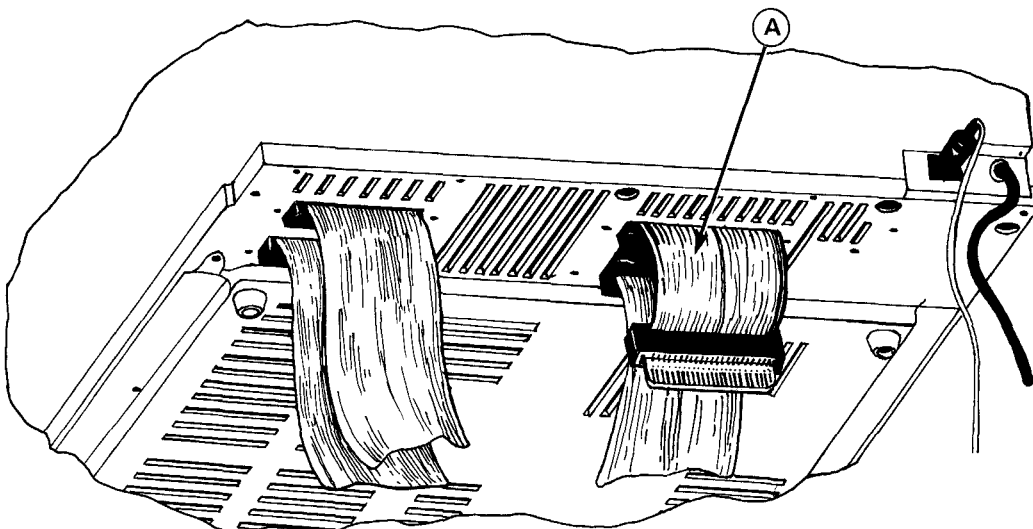
To Our Customers . . .

The TRS-80® Computer Graphics package revolutionizes your Model III 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 III must have 48K of RAM (Random Access Memory) and one disk drive. Your computer must also be modified by a qualified Radio Shack service technician. The only difference you'll notice is a cable which protrudes from the bottom of the Model III case. Do not attempt to disconnect this cable! This cable is provided to allow you to attach peripheral devices (such as a hard disk) to the I/O Bus Jack of the Model III. The cable connector which is attached directly to the I/O Bus Jack (see Point A in the figure below) must be firmly attached for the Computer Graphics package to work.



Included on the Graphics diskette are:

- . TRSDOS 1.3
- . Disk BASIC
- . 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 (26-2200).

About This Manual . . .

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

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

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

- . Graphics BASIC (BASICG)
- . Graphics Subroutine Library

If you're familiar with Model III 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 III Operation and BASIC Language Reference Manual** and **Model III Disk System Owner's Manual**. Then read Chapters 1, 2 and 3, along with Appendixes A, B, E, and F 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 underline

Fields shown in lowercase underline are variable information that you must substitute a value for.

<ENTER>

Any word or character contained within brackets 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
Note that with TRSDOS 1.3, d (Drive) can be any number from 0-3.

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.

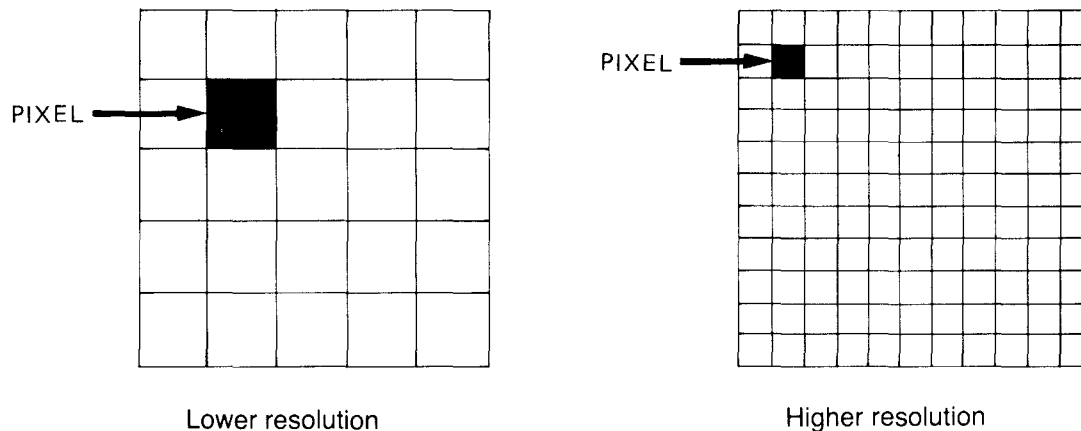


Figure 1. Resolution

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 Subroutine Library, which is part of the Computer Graphics package, contains subroutines which provide the same capabilities, as well as similar names and parameters, as the commands and functions in Graphics BASIC. The main difference between the Subroutine Library and BASICG is the manner in which coordinates are specified (e.g., BASICG coordinates are specified as arguments for each command while the Subroutine Library specifies coordinates with a separate subroutine call). Another difference concerns the names of a few routines (e.g., LINE vs. LINEB vs. LINEBF, etc.). All of these differences will

be described in detail in the appropriate sections of this manual.

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 III 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.

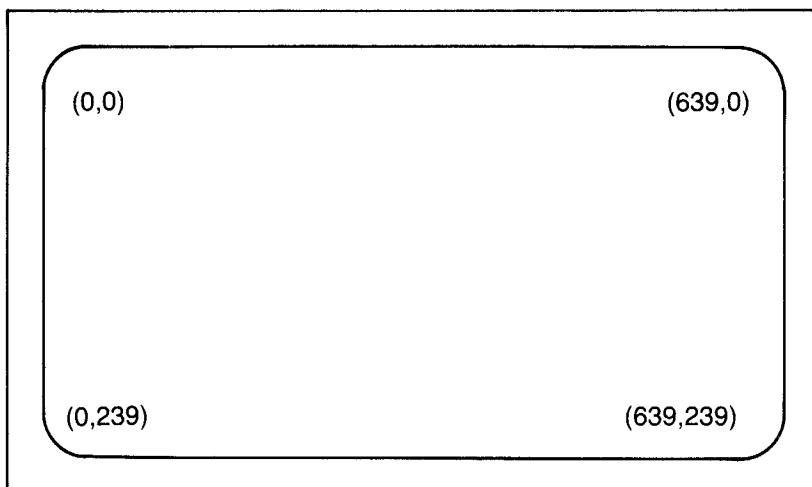


Figure 2. Graphics Visible Screen

TRS-80[®]

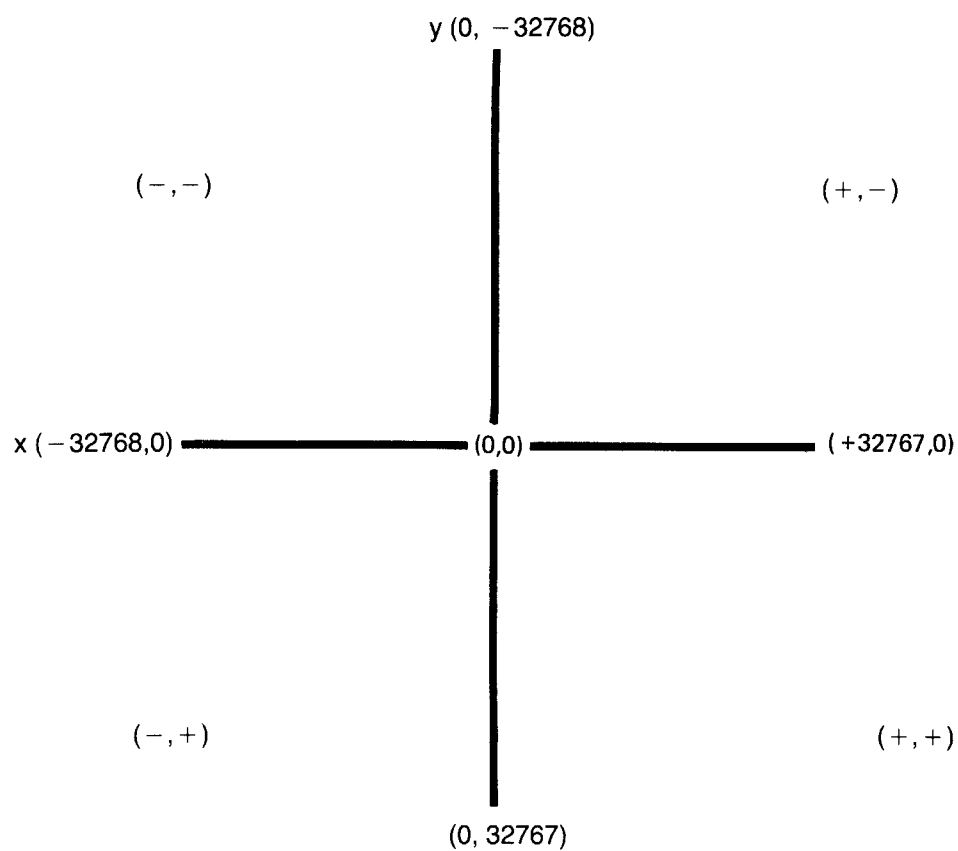


Figure 3. Graphics "Imaginary" Cartesian System

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2/ Graphics BASIC

Graphics BASIC (BASICG) vs. BASIC

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

Program files created under BASICG are not directly loadable with BASIC files (and vice versa). If you attempt to load a BASIC file in compressed format from BASICG (and vice versa), an NB error may occur. See Appendix B for a list of BASICG error messages.

If you want to load a file from one BASIC to the other to the other, we recommend that you first save the file in ASCII format (**SAVE"filename/ext",A**).

You can then 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 6.5K more memory than BASIC. When you enter BASIC with 0 files, there are 39,282 bytes free. When you enter BASICG with 0 files, there are 32,675 bytes free. 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 III Disk System Owner's Manual** for information on BACKUP.

To load BASICG:

1. Power up your System according to the start-up procedure in your **Model III Disk System Owner's Manual**.
2. Insert the backup diskette into Drive 0.
3. Initialize the System as described in the "Operation" section of the **Model III Disk System Owner's Manual**.
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 III numeric values are as follows:

Model III Numeric Values			
Numeric Type	Range	Storage Requirement	Example
Integer	-32768, 32767	2 bytes	240, 639, -10
Single-Precision	-1×10^{38} , -1×10^{-38} $+1 \times 10^{38}$, $+1 \times 10^{-38}$ Up to 7 significant digits (Prints six)	4 bytes	22.50, 3.14259 -100.001
Double-Precision	-1×10^{38} , -1×10^{-38} $+1 \times 10^{38}$, $+1 \times 10^{-38}$ 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 III Operation and BASIC Language Reference 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 a 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:

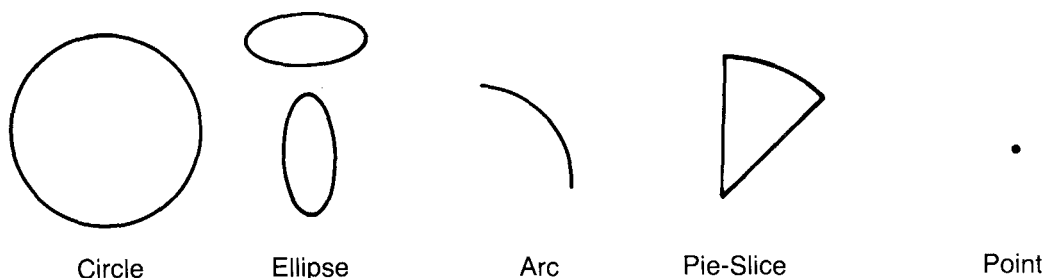


Figure 4. Types of Displays with CIRCLE

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

3.1415926535897932384626433832795028841
6.2831853071795864769252867665590057682

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
```

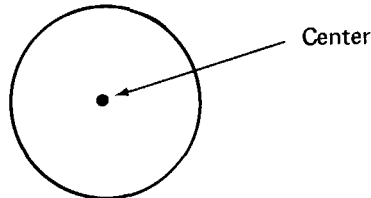


Figure 5. Center of Circle

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

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

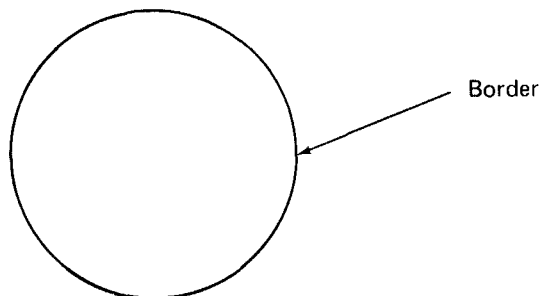


Figure 6. Border of Circle

**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.

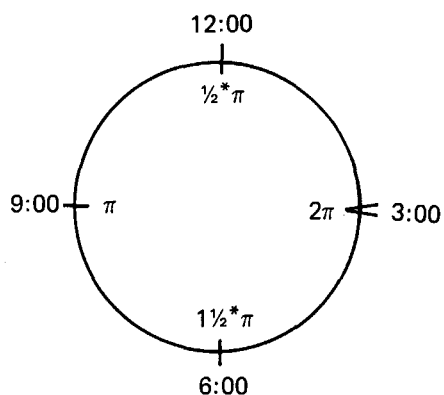
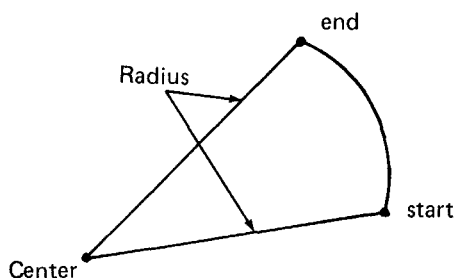


Figure 7. Clock/Radian Equivalents

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.

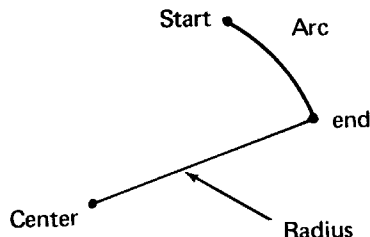


Figure 9. CIRCLE's (+) start, (-) end

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:

$$\underline{ar} = \underline{\text{length of Y-axis} / \text{length of X-axis}}$$

- . 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.

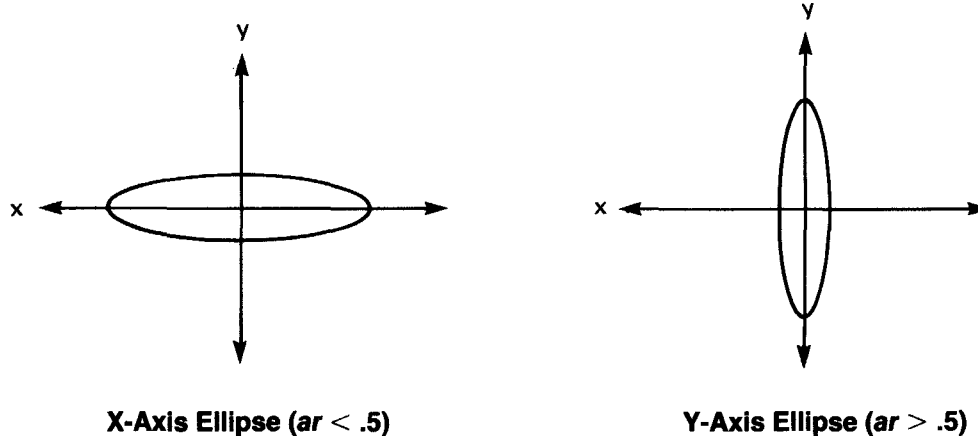


Figure 10. CIRCLE's Ellipse

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 III Operation and BASIC Language Reference Manual. BASIC recognizes only the GET syntax described in the Model III Operation and BASIC Language Reference 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 x 71. That equals:

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

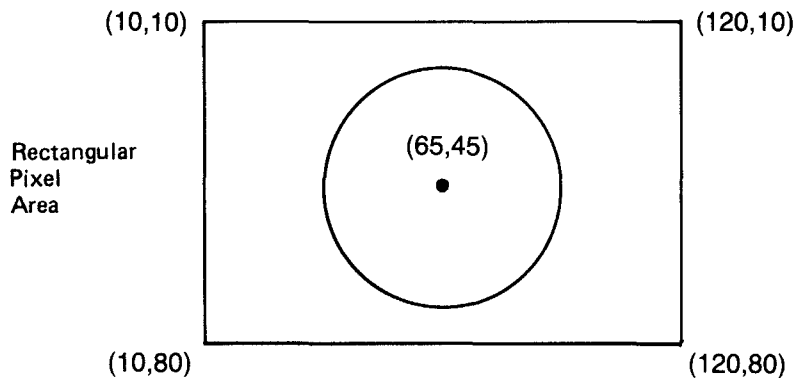


Figure 11

```
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)).

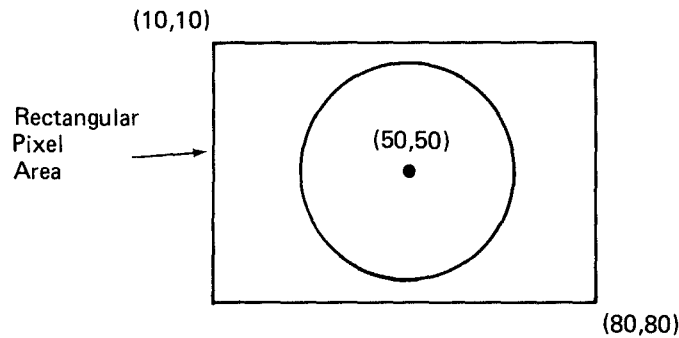


Figure 12

```

1Ø DIM V%(564)
2Ø CIRCLE (65,45),5Ø,1,1,3
3Ø GET(1Ø,1Ø)-(12Ø,8Ø),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 going 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
```

(140,80)

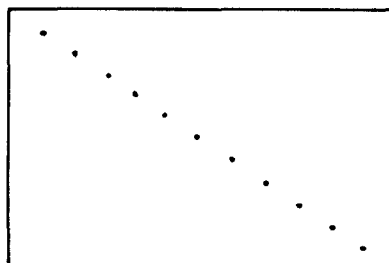


Figure 13

(500,200)

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 E).

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.

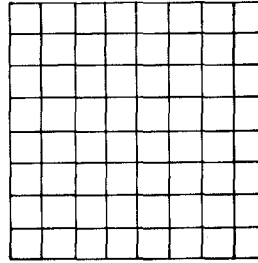


Figure 14. Example of an 8-by-8 Pixel Grid

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 x 8, 24 x 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 F.

Example

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

8 x 8 grid								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

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 Ø 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\$(&HØØ) specifies a black background and CHR\$(&HFF) is a totally white background. If background is not specified, BASICG uses CHR\$(&HØØ).

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.

```
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 black and white stripes. The character "D" (0100

Ø1ØØ) sets this vertical pattern: one vertical row of pixels ON, three rows OFF.

```
1Ø CIRCLE (32Ø,12Ø),2ØØ
2Ø PAINT (32Ø,12Ø),"332211",1
3Ø PAINT (1ØØ,7Ø),"EFEF",1
```

This example draws and paints a circle, then paints the area surrounding the circle with a different paint style (line 3Ø). This PAINT statement's (line 3Ø) startpoint must be outside the border of the circle.

```
1Ø PAINT (32Ø,12Ø),CHR$(&HFF),1
2Ø CIRCLE (32Ø,12Ø),1ØØ,Ø
3Ø PAINT (32Ø,12Ø),CHR$(Ø)+CHR$(&HFF),Ø,CHR$(&HFF)
```

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

```
1Ø PAINT (32Ø,12Ø),CHR$(&HFF),1
2Ø CIRCLE (32Ø,12Ø),1ØØ,Ø
3Ø PAINT (32Ø,12Ø),CHR$(Ø)+CHR$(&HAA),Ø,CHR$(&HFF)
```

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

```
1Ø CIRCLE(3ØØ,1ØØ),1ØØ
2Ø A$=CHR$(&HØØ)+CHR$(&H7E)+CHR$(&H18)+CHR$(&H18)+CHR$(&H18)
+CHR$(&H18)+CHR$(&H18)+CHR$(&HØØ)
3Ø PAINT(3ØØ,1ØØ),A$,1
```

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

```
1Ø A$=CHR$(&H41)+CHR$(&H22)+CHR$(&H14)+CHR$(&HØ8)+CHR$(&H14)
+CHR$(&H22)+CHR$(&H41)+CHR$(&HØØ)
2Ø PAINT (3ØØ,1ØØ),A$, 1
```

This paints Xs over the entire screen.

```
1 CLEAR 1000
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$(&HFF)+CHR$(&HFF)+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 an 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(300,100)
```

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

```
PRINT &POINT(-300,-100)
```

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 an 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).

```
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 Appendix C of the **Model III Operation and BASIC Language Reference 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 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 an 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(x1,y1),array name,action

(x1,y1) are coordinates of the upper-left corner of the rectangular pixel area which is to contain a graphic display. x1 is a numeric expression from 0 to 639 and y1 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 III Operation and BASIC Language Reference Manual**. BASIC recognizes only the PUT syntax described in the **Model III Operation and BASIC Language Reference 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.

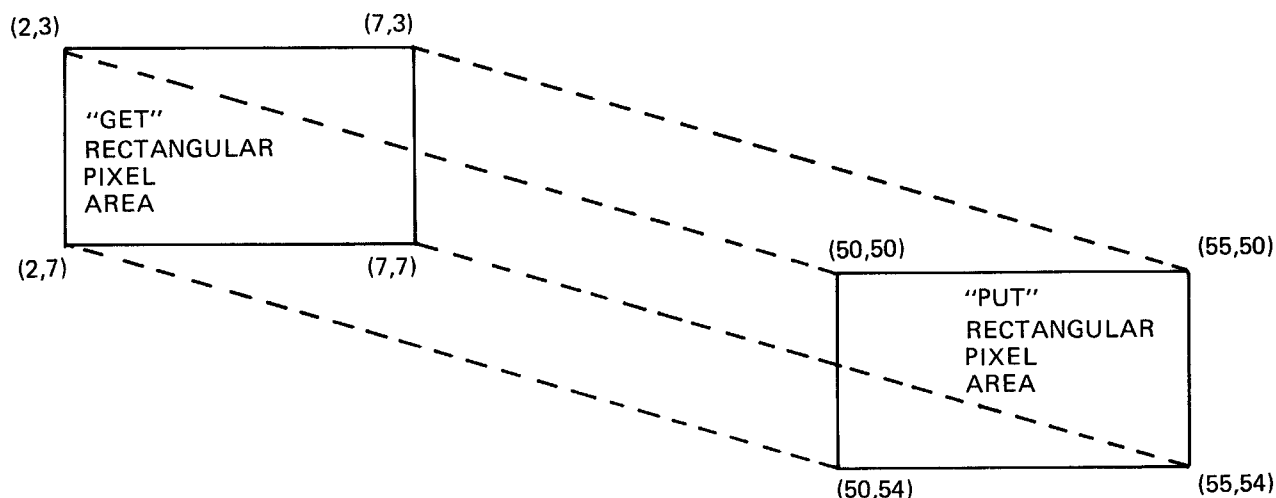


Figure 16

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 CMD "I", "GPRINT"
270 SCREEN1

```

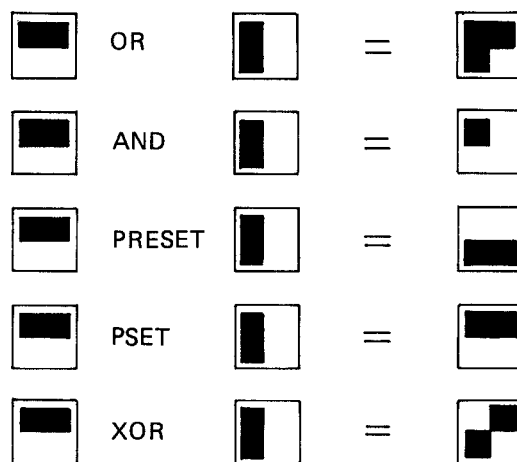


Figure 17

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
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.

```
10 DIM V%(7000)
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.

```
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 (x1,y1)-(x2,y2), c, b

(x1,y1) are coordinates of the upper-left corner of a rectangular viewport area. x1 is an integer expression between 0 and 639. y1 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 \geq to x1 and \leq 639. y2 is an integer expression \geq y1 and \leq 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 an 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
```

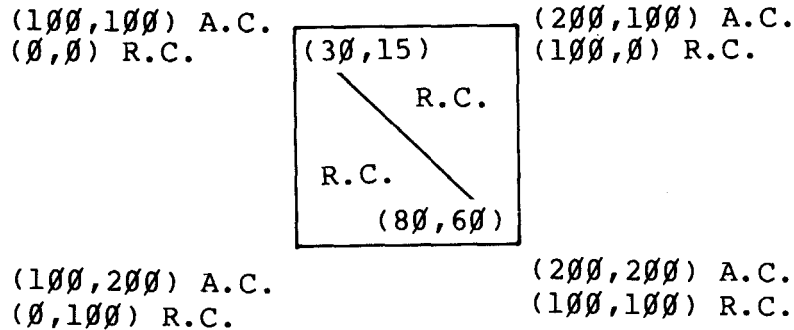


Figure 18

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 a 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: 22Ø

Type: PRINT &VIEW(3) <ENTER>

Displays: 15Ø

Set up the following viewports:

VIEW(1ØØ,8Ø)-(22Ø,15Ø),Ø,1 <ENTER>

VIEW(25Ø,17Ø)-(35Ø,22Ø),Ø,1 <ENTER>

Now enter: PRINT &VIEW(Ø) <ENTER>

Displays: 25Ø

Type: PRINT &VIEW(1) <ENTER>

Displays: 17Ø

Now type: PRINT &VIEW(2) <ENTER>

Displays: 35Ø

Type: PRINT &VIEW(3) <ENTER>

Displays: 22Ø

3/ Graphics Utilities

There are six 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 illustrate 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 CMD"I" command followed by a comma and the name of the utility in quotation marks (e.g., CMD"I","GCLS" <ENTER>) and control returns to TRSDOS 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 III FORTRAN Manual (26-2200).

Note: These utilities load into high memory starting at F000 (hex); therefore, they cannot be used with DEBUG, DO, or any communication drivers that use high memory.

=====

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:

CMD"I","GCLS" <ENTER>

or

100 CMD"I","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:

CMD"I","GLOAD PROGRAM" <ENTER>

or

1000 CMD"I", "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 9 1/2" 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.

Most uses will require that you set FORMS when TRSDOS Ready is displayed:

```
FORMS (LINES=60,WIDTH=0) <ENTER>
```

See your **Model III Operation and BASIC Language Reference** and printer owner's manual for more 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:

```
CMD"I","GPRINT" <ENTER>
```

or

```
100 CMD"I","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 print out 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:

CMD"I","GPRT2" <ENTER>

or

100 CMD"I","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 BASICG READY prompt (>) is displayed, type:

CMD"I","GPRT3" <ENTER>

or

100 CMD"I","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:

or CMD"I","GROFF" <ENTER>
 100 CMD"I","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:

CMD"I","GRON" <ENTER>

or 100 CMD"I","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:

CMD"I","GSAVE PROGRAM" <ENTER>

or

1000 CMD"I","GSAVE PROGRAM"

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 III FORTRAN (26-22000). 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.

=====

FORTTRAN 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

=====

FORTTRAN 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 a 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 = (x1,y1)
 lower left corner = endpoint = (x2,y2)

Size (in pixels): width = x2-x1+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)
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 Appendix C of the **Model III Operation and BASIC Language Reference 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 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 a 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)
```

Sample 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 (0)

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

```

001000 C    EXAMPLE FOR PAINT WITH TILE
001500      LOGICAL A,B,BORDER
002000      DIMENSION A(9)
003000      DIMENSION B(2)
003500 C    DEFINE TILE ARRAY HERE
004000      DATA A(1), A(2), A(3) / 8, X'81', X'42' /
005000      DATA A(4),A(5),A(6)/X'24',X'18',X'18' /
006000      DATA A(7),A(8),A(9)/X'24',X'42',X'81' /
006500 C    DEFINE BACKGROUND ARRAY HERE
007000      DATA B(1),B(2)/1,0 /
008000      CALL GRPINI(0)
009000      CALL CLS
010000      CALL SETXY(300,100)
011000      CALL CIRCLE(150,1,0.0,0.0,0.0)
012000      BORDER=1
013000      CALL PAINTT(A,BORDER,B)
014000      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

```
001000 C      PRESET EXAMPLE
002000          LOGICAL COLOR
003000          COLOR=1
004000          CALL GRPINI(0)
005000          CALL CLS
006000 C      SET PIXEL TO ON
006000          CALL SETXY(300,120)
008000          CALL PRESET(COLOR)
009000 C      TEST PIXEL WHETHER ON OR OFF
010000          K=POINT(M)
011000 30      WRITE (3,35)K
012000 35      FORMAT ('2','PIXEL VALUE IS',I4)
013000          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

```

001000 C    PSET EXAMPLE
002000      LOGICAL COLOR
003000      LOGICAL POINT
004000      COLOR=1
005000      CALL GRPINI(0)
006000      CALL CLS
007000 C    SET PIXEL TO ON
008000      CALL SETXY(300,120)
009000      CALL PSET(COLOR)
010000 C    TEST PIXEL WHETHER ON OR OFF
011000      K=POINT(M)
012000      WRITE (3,35)K
013000 35   FORMAT ('2','PIXEL VALUE IS',I4)
014000      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. leftX 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

```
001000 C    SAMPLE VIEW PROGRAM
002000      LOGICAL COLOR,BORDER,K
003000      INTEGER FVIEW
004000      CALL GRPINI(1)
005000      CALL CLS
005000 C    SET UP VIEW PORT
007000      COLOR=0
008000      BORDER=1
009000      CALL VIEW(210,80,420,160,COLOR,BORDER)
010000 C    DRAW MULTIPLE CIRCLES
011000      CALL SETXY(105,40)
012000      DO 20 I=10,150,10
013000      CALL CIRCLE(I,1,0.0,0.0,0)
014000 20    CONTINUE
015000 C    DISPLAY VIEWPORT COORDINATES
016000      DO 40 I=1,4
017000      K=I-1
018000      J=FVIEW(K)
019000      WRITE (3,35)I,J
020000 35    FORMAT ('2','VIEW PORT COORDINATE ',I4,' IS AT',I4)
021000 40    CONTINUE
022000 C    PRINT EMPTY LINES
023000      DO 60 I=1,6
024000      WRITE (3,50)
025000 50    FORMAT (1H1)
026000 60    CONTINUE
027000      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 X 240 byte addressable pixels on a TRS-80 Model III. 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 X 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:

- . x0 - X-Register Write. (80)
- . x1 - Y-Register Write. (81)
- . x2 - Video data read or write. (82)
- . x3 - 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 (79,239). 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
Ø	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 "Ø" 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 "Ø" clocks the Y address up or down AFTER a Read depending on the status of BIT 3.
6	X CLK WR*	A "Ø" clocks AFTER a Write.
7	Y CLK WR*	A "Ø" clocks AFTER a Write.

Table 9. Options Programming

SERVICE POLICY

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Graphic Utilities Source Code Listings

```

001 ; GCLS -- Clear graphics screen
002 ;
003 PSECT 0F000H
004 GCLS PUSH HL ;Save registers
005 PUSH DE
006 PUSH BC
007 CALL INITG
008 LD A, INCY ;Set graphics status:
009 OUT (STATUS), A ; Graphics off, waits off, inc Y
010 XOR A
011 OUT (X), A ;Set X & Y address to 0
012 OUT (Y), A
013 LD B, 80 ;80 X addresses
014 OUTER LD C, B
015 LD B, 239 ;239 Y addresses. 240th done after loop.
016 INNER OUT (WRITE), A ;Zero graphics memory
017 DJNZ INNER ;Go clear next Y
018 LD A, INCXY ;Set status to inc X & Y after write
019 OUT (STATUS), A
020 XOR A
021 OUT (WRITE), A ;and clear last (240th) Y address
022 OUT (Y), A ;Set Y back to zero
023 LD A, INCY ;Reset status to inc Y only
024 OUT (STATUS), A
025 XOR A
026 LD B, C
027 DJNZ OUTER ;Go clear next X
028 LD A, 0FFH ;Set status to graphics, waits, no incs.
029 OUT (STATUS), A
030 POP BC ;Restore registers
031 POP DE
032 POP HL
033 XOR A
034 RET ;All done. Go back to caller.
035 INCY EQU 70H
036 INCXY EQU 30H
037 X EQU 80H
038 Y EQU 81H
039 WRITE EQU 82H
040 STATUS EQU 83H
041 ;
042 ; INITG -- Initialize Model III Graphics Board
043 ;
044 INITG LD A, 10H
045 OUT (236), A ;Turn on port
046 LD BC, 15

```

```
047      LD      HL,DATA
048 LOOP  LD      A,B           ;Program CRTC chip for 80 by 24
049      OUT     (136),A
050      LD      A,(HL)
051      OUT     (137),A
052      INC     HL
053      INC     B
054      LD      A,B
055      CP      C
056      JR      NZ,LOOP
057      RET
058 DATA  DEFB    99
059      DEFB    80
060      DEFB    85
061      DEFB    8
062      DEFB    25
063      DEFB    4
064      DEFB    24
065      DEFB    24
066      DEFB    0
067      DEFB    9
068      DEFB    0
069      DEFB    0
070      DEFB    0
071      DEFB    0
072      DEFB    0
073      DEFB    0
074 ;
075      END      GCLS
```

```

001 ; GRON -- Turn on graphics display with waits on
002 ;
003         PSECT 0F000H
004 GRON    CALL  INITG
005         LD     A,0FFH
006         OUT    (STATUS),A
007         XOR    A
008         RET
009 STATUS EQU 83H
010 ;
011 ; INITG -- Initialize Model III Graphics Board
012 ;
013 INITG    PUSH  HL
014         PUSH  BC
015         PUSH  AF
016         LD     A,10H
017         OUT    (236),A      ;Turn on port
018         LD     BC,15
019         LD     HL,DATA
020 LOOP     LD     A,B          ;Program CRTC chip for 80 by 24
021         OUT    (136),A
022         LD     A,(HL)
023         OUT    (137),A
024         INC    HL
025         INC    B
026         LD     A,B
027         CP     C
028         JR     NZ,LOOP
029         POP    AF
030         POP    BC
031         POP    HL
032         RET
033 DATA    DEFB 99
034         DEFB 80
035         DEFB 85
036         DEFB 8
037         DEFB 25
038         DEFB 4
039         DEFB 24
040         DEFB 24
041         DEFB 0
042         DEFB 9
043         DEFB 0
044         DEFB 0
045         DEFB 0
046         DEFB 0
047         DEFB 0
048         DEFB 0
049 ;

```

050

END

GRON

```

001 ; GROFF -- Turn graphics display off with waits off
002 ;
003      PSECT 0F000H
004 GROFF CALL INITG
005      LD     A,0FCH
006      OUT    (STATUS),A
007      XOR    A
008      RET
009 STATUS EQU 83H
010 ;
011 ; INITG -- Initialize Model III Graphics Board
012 ;
013 INITG PUSH HL
014      PUSH BC
015      PUSH AF
016      LD     A,10H
017      OUT    (236),A      ;Turn on port
018      LD     BC,15
019      LD     HL,DATA
020 LOOP  LD     A,B          ;Program CRTC chip for 80 by 24
021      OUT    (136),A
022      LD     A,(HL)
023      OUT    (137),A
024      INC    HL
025      INC    B
026      LD     A,B
027      CP     C
028      JR     NZ,LOOP
029      POP    AF
030      POP    BC
031      POP    HL
032      RET
033 DATA DEFB 99
034      DEFB 80
035      DEFB 85
036      DEFB 8
037      DEFB 25
038      DEFB 4
039      DEFB 24
040      DEFB 24
041      DEFB 0
042      DEFB 9
043      DEFB 0
044      DEFB 0
045      DEFB 0
046      DEFB 0
047      DEFB 0
048      DEFB 0
049 ;

```

Ø5Ø

END

GROFF

```

001 ; GSAVE -- Save graphics display to disk
002 ;
003 PSECT 0F000H
004 GSAVE PUSH HL ;Save registers
005 PUSH DE
006 PUSH BC
007 PUSH IY
008 PUSH HL
009 CALL INITG
010 LD HL,DCBEE ;Zero DCB buffer
011 LD DE,DCBEE+1
012 LD BC,49
013 LD (HL),00H
014 LDIR
015 POP HL
016 LD A,0DH
017 CP (HL)
018 JP Z,ERROR ;Error if filespec not given
019 LD DE,DCBEE
020 CALL 441CH ;Move filespec to DCB
021 JP NZ,BOMB
022 LD HL,BUFFER
023 LD DE,DCBEE
024 LD B,0
025 CALL 4420H ;Open file
026 JP NZ,BOMB
027 XOR A
028 LD (OPNFLG),A ;Set flag: file is open
029 ;
030 LD A,0E3H ;status = inc X after read
031 OUT (STATUS),A
032 XOR A
033 OUT (X),A ;init X & Y to zero
034 OUT (Y),A
035 LD E,A ;counter for X values
036 LD D,80 ;80 X values
037 LD B,75 ;75 disk records for entire screen
038 NXTREC LD HL,BUFFER
039 LD C,B
040 LD B,0 ;256 bytes per record
041 NGRPH IN A,(GRAPH) ;Get next graphics byte
042 LD (HL),A ; and put in buffer
043 INC HL
044 INC E
045 LD A,E
046 CP D
047 JR NZ,EGRPH ;Same row?
048 XOR A
049 LD E,A

```

```

050      OUT      (X),A          ;Next row. Set X to zero
051      LD       A,(YPOS)
052      INC      A
053      LD       (YPOS),A
054      OUT      (Y),A
055 EGRPH  DJNZ    NGRPH        ;Go get next graphics byte
056      PUSH     DE
057      LD       DE,DCBEE
058      CALL     4439H         ;Write disk record
059      POP      DE
060      JR       NZ,BOMB
061      LD       B,C
062      DJNZ    NXTREC        ;Go fill buffer for next record
063 ;
064 EXIT   CALL    CLOSE
065      LD       A,0FFH        ;Status = graphics, waits, no incs
066      OUT      (STATUS),A
067      POP      IY
068      POP      BC
069      POP      DE
070      POP      HL
071      LD       A,(EFLAG)
072      CP       0
073      RET                      ;All done. Return to caller.
074 ;
075 ; Subroutines
076 ;
077 CLOSE  LD       A,(OPNFLAG)
078      OR       A
079      RET      NZ            ;Return if file not open
080      LD       DE,DCBEE
081      JP       4428H        ;Go close file
082 ;
083 ; Error exits
084 ;
085 ;
086 ERROR  LD       A,47        ;Required Command Parameter Not Found
087 ;
088 BOMB   LD       (EFLAG),A
089      LD       B,A
090      LD       A,39
091      RST      8            ;Print "ERROR nn" message
092      JP      EXIT
093 ;
094 X      EQU     80H
095 Y      EQU     81H
096 GRAPH  EQU     82H
097 STATUS EQU     83H
098 EFLAG  DEFB    0

```

```
099 YPOS  DEFB  0
100 OPNFLG DEFB  1
101 DCBEE  DEFS  50
102 BUFFER DEFS  256
103 ;  INITG  --  Initialize Model III Graphics Board
104 ;
105 INITG  LD    A,10H
106        OUT   (236),A      ;Turn on port
107        LD    BC,15
108        LD    HL,DATA
109 LOOP   LD    A,B          ;Program CRTC chip for 80 by 24
110        OUT   (136),A
111        LD    A,(HL)
112        OUT   (137),A
113        INC   HL
114        INC   B
115        LD    A,B
116        CP    C
117        JR    NZ,LOOP
118        RET
119 DATA  DEFB  99
120        DEFB  80
121        DEFB  85
122        DEFB  8
123        DEFB  25
124        DEFB  4
125        DEFB  24
126        DEFB  24
127        DEFB  0
128        DEFB  9
129        DEFB  0
130        DEFB  0
131        DEFB  0
132        DEFB  0
133        DEFB  0
134        DEFB  0
135 ;
136        END    GSAVE
```

```

001 ; GLOAD -- Save graphics display to disk
002 ;
003 PSECT 0F000H
004 GLOAD PUSH HL ;Save registers
005 PUSH DE
006 PUSH BC
007 PUSH IY
008 PUSH HL
009 CALL INITG
010 LD HL,DCBEE ;Zero DCB buffer
011 LD DE,DCBEE+1
012 LD BC,49
013 LD (HL),H
014 LDIR
015 POP HL
016 LD A,0DH
017 CP (HL)
018 JR Z,ERROR
019 LD DE,DCBEE
020 CALL 441CH ;Move filespec to DCB
021 JR NZ,BOMB
022 LD HL,BUFFER
023 LD DE,DCBEE
024 LD B,0
025 CALL 4424H ;Open file
026 JP NZ,BOMB
027 XOR A
028 LD (OPNFLG),A ;Set flag: file is open
029 ;
030 LD A,0B3H ;status = inc X after write
031 OUT (STATUS),A
032 XOR A
033 OUT (X),A ;init X & Y to zero
034 OUT (Y),A
035 LD E,A ;counter for X values
036 LD D,80 ;80 X values
037 LD B,75 ;75 disk records for entire screen
038 NXTREC PUSH DE
039 LD DE,DCBEE
040 CALL 4436H ;Read record from disk
041 POP DE
042 JR NZ,BOMB
043 LD HL,BUFFER
044 LD C,B
045 LD B,0 ;256 bytes per record
046 NGRPH LD A,(HL)
047 OUT (GRAPH),A
048 INC HL
049 INC E

```

```

050      LD      A,E
051      CP      D
052      JR      NZ,EGRPH      ;Same row?
053      XOR     A
054      LD      E,A
055      OUT     (X),A          ;Next row. Set X to zero
056      LD      A,(YPOS)
057      INC     A
058      LD      (YPOS),A
059      OUT     (Y),A
060 EGRPH DJNZ    NGRPH        ;Go get next graphics byte
061      LD      B,C
062      DJNZ    NXTREC        ;Go read next disk record
063 ;
064 EXIT  CALL    CLOSE
065      LD      A,0FFH          ;Status = graphics, waits, no incs.
066      OUT     (STATUS),A
067      POP     IY
068      POP     BC
069      POP     DE
070      POP     HL
071      LD      A,(EFLAG)
072      CP      0
073      RET
074 ;
075 ; Subroutines
076 ;
077 CLOSE LD      A,(OPNFLAG)
078      OR      A
079      RET     NZ              ;Return if file not open
080      LD      DE,DCBEE
081      JP      4428H          ;Go close file
082 ;
083 ; Error exits
084 ;
085 ERROR LD      A,47          ;Required Command Parameter Not Found
086 ;
087 BOMB  LD      (EFLAG),A
088      LD      B,A
089      LD      A,39
090      RST     8              ;Print "ERROR nn" message
091      JP      EXIT
092 ;
093 X      EQU    80H
094 Y      EQU    81H
095 GRAPH  EQU    82H
096 STATUS EQU    83H
097 EFLAG  DEFB    0
098 YPOS   DEFB    0

```

```
099 OPNFLG DEFB 1
100 DCBEE DEFS 50
101 BUFFER DEFS 256
102 ;
103 ; INITG -- Initialize Model III Graphics Board
104 ;
105 INITG LD A,10H
106 OUT (236),A ;Turn on port
107 LD BC,15
108 LD HL,DATA
109 LOOP LD A,B ;Program CRTC chip for 80 by 24
110 OUT (136),A
111 LD A,(HL)
112 OUT (137),A
113 INC HL
114 INC B
115 LD A,B
116 CP C
117 JR NZ,LOOP
118 RET
119 DATA DEFB 99
120 DEFB 80
121 DEFB 85
122 DEFB 8
123 DEFB 25
124 DEFB 4
125 DEFB 24
126 DEFB 24
127 DEFB 0
128 DEFB 9
129 DEFB 0
130 DEFB 0
131 DEFB 0
132 DEFB 0
133 DEFB 0
134 DEFB 0
135 ;
136 END GLOAD
```

```

001 ; GPRINT -- Print graphics screen to graphics printer
002 ;
003     PSECT 0F000H
004 GPRINT PUSH HL ;Save registers
005     PUSH DE
006     PUSH BC
007     PUSH IX
008     CALL INITG
009     OR 0DBH ;Output a Control byte to cause
010     OUT (STATUS),A ; Y to automatically dec. on a read
011     CALL INITBF
012 ;
013     XOR A ;Set A to 0
014     OUT (X),A ;Initialize the X position
015     LD (BPOS),A ; " " bit position
016     LD (XLOC),A ; " " " location counter
017     LD HL,BGMode
018     LD B,1
019     LD C,0DH
020     CALL PRLINE ;Begin graphics print mode
021 ;
022 LOOP1 LD IX,BUFFER ;point IX at the printer buffer
023     LD B,240 ;go through a whole column of bytes
024     LD A,B ;Put value in A and decrement
025     DEC A ; so it can be put out as
026     OUT (Y),A ; the Y position
027 COLUMN LD HL,MASK ;point HL at the mask byte
028     IN A,(GRAPH) ;input a graphics byte
029     AND (HL) ;chop off all but proper bit
030     CALL PO,SET0 ;if result is odd parity set bit 0
031     ; otherwise bit A is 0
032     LD HL,BPOS ;point HL at the bit position
033     PUSH BC ;save register B (for DJNZ loop)
034     LD B,(HL) ;get count
035     INC B ;increment (in case it is 0)
036 DECJ DEC B ;move bit left BPOS number of times
037     JR Z,PAST ;if done, move on...
038     RLC A ;move bit left one position
039     JR DECJ ;repeat loop
040 PAST POP BC ;get loop counter back
041     OR (IX) ;merge A with byte of printer buffer
042     LD (IX),A ;put merged result in buffer
043     INC IX ;increment buffer pointer
044     DJNZ COLUMN ;continue loop
045 ;-----
046     LD A,7 ;See if BPOS has gotten to 8.
047     INC (HL) ; If it has (printer uses 7 bits)
048     CP (HL) ; print the buffer and reset
049     CALL Z,PRNDRS ; BPOS to 0

```

```

050 ;
051     LD     HL,MASK      ;After getting a vertical row of bits
052     RRC     (HL)        ; rotate the mask right one position
053     LD     A,80H        ;Check to see if its back to
054     CP     (HL)        ; it's original value, if not
055     JR     NZ,LOOP1     ; go get another row of bits
056     LD     A,(XLOC)     ;If so, get X pos (to increment it)
057     CP     79           ;Check to see if we are at the end...
058     JP     Z,BYE
059     INC     A            ;otherwise increment the X counter
060     LD     (XLOC),A     ;and store it back
061     OUT     (X),A       ;also update the port value
062     JR     LOOP1        ;now go get another row of bits
063 ;-----
064 SET0  LD     A,1        ;set A to binary 0000 0001
065     RET                     ; and return
066 ;
067 PRNDRS LD     HL,BUFFER ;Set up the
068     LD     B,240         ; PRLINE call and
069     LD     C,0DH         ; send the buffer
070     CALL   PRLINE
071     XOR     A            ;clear A
072     LD     (BPOS),A     ;reset bit position counter
073 ;
074 INITBF LD     HL,BUFFER ;Initialize the printer buffer
075     LD     DE,BUFFER+1  ; with all 80H
076     LD     BC,239
077     LD     A,80H
078     LD     (HL),A
079     LDIR
080     RET
081 ;-----
082 PRLINE EQU     $        ;Print a line. HL==>line to print
083     LD     A,(HL)        ;B = # characters to print
084     INC     HL            ;C = EOL char (sent after line)
085     CALL   3BH           ;HL, BC, AF, and DE used
086     DJNZ   PRLINE
087     LD     A,C
088     CALL   3BH
089     RET
090 ;-----
091 BYE    CALL   PRNDRS
092     LD     HL,EGMODE
093     LD     B,1
094     LD     C,0DH
095     CALL   PRLINE        ;End graphics print mode
096     POP     IX           ;Restore registers
097     POP     BC
098     POP     DE

```

```

099      POP      HL
100      XOR      A
101      RET
102 X     EQU     80H
103 Y     EQU     81H
104 GRAPH EQU     82H
105 STATUS EQU     83H
106 MASK  DEFB    80H      ;Mask to use in extracting bits
107 BGMODE DEFB    12H      ;Control byte: start graphics mode
108 BUFFER DEFS    240      ;Printer data buffer
109 EGMODE DEFB    1EH      ;Control byte: end graphics mode
110 BPOS   DEFB    0        ;Bit position in printer buffer
111 XLOC   DEFB    0        ;Current X location value
112 ;
113 ;
114 ;  INITG  --  Initialize Model III Graphics Board
115 ;
116 INITG  LD      A,10H
117         OUT     (236),A      ;Turn on port
118         LD      BC,15
119         LD      HL,DATA
120 LOOP    LD      A,B          ;Program CRTC chip for 80 by 24
121         OUT     (136),A
122         LD      A,(HL)
123         OUT     (137),A
124         INC     HL
125         INC     B
126         LD      A,B
127         CP      C
128         JR      NZ,LOOP
129         RET
130 DATA  DEFB    99
131         DEFB    80
132         DEFB    85
132         DEFB    8
133         DEFB    25
134         DEFB    4
135         DEFB    24
136         DEFB    24
137         DEFB    0
138         DEFB    9
139         DEFB    0
140         DEFB    0
141         DEFB    0
142         DEFB    0
143         DEFB    0
144         DEFB    0
145 ;
146         END     GPRINT

```



```

000001 ; GPRT2 -- Print graphics X horizontal
000002 ;
000003 PSECT 0F000H
000004 GPRT2 PUSH HL
000005 PUSH DE
000006 PUSH BC
000007 PUSH IX
000008 CALL INITG
000009 LD HL,BGMode ;Turn on graphics print mode
000010 LD B,1
000011 LD C,0DH
000012 CALL PRLINE
000013 LD C,0 ;Graphics Y address
000014 LD A,0E3H
000015 OUT (STATUS),A
000016 ;
000017 NEWLN PUSH BC
000018 LD HL,BUF ;Clear buffer
000019 LD DE,BUF+1
000020 LD BC,639
000021 LD A,80H
000022 LD (HL),A
000023 LDIR
000024 ;
000025 POP BC
000026 LD D,1 ;Bit in buf to set
000027 ;
000028 NEWRW LD A,C
000029 OUT (Y),A ;Update Y address
000030 INC C
000031 LD HL,BUF
000032 XOR A
000033 OUT (X),A ;Restart X address
000034 LD B,80 ;Get 80 graphics bytes
000035 ;
000036 BYTE PUSH BC ;Save Y & loop counter
000037 IN A,(GRAPH)
000038 LD C,A ;Save graphics byte in C
000039 LD E,80H ;Get bits left to right
000040 BIT LD A,C
000041 AND E
000042 JR Z,OFF1
000043 LD A,D
000044 OR (HL)
000045 LD (HL),A ;Set bit in buffer
000046 OFF1 INC HL ;Next buffer byte
000047 SRL E ;Next bit

```

```

00048      JR      NZ,BIT
00049      POP      BC
00050      DJNZ     BYTE
00051 ;
00052      LD      A,240
00053      CP      C           ;Last Y address?
00054      JR      Z,DONE
00055      SLA      D           ;Next bit in buffer
00056      JP      P,NEWRW
00057 ;
00058      CALL     PRINT       ;Print buffer
00059      JR      NEWLN
00060 ;
00061 DONE   CALL     PRINT
00062      LD      A,0FCH
00063      OUT      (STATUS),A
00064      LD      HL,EGMODE    ;Turn off graphics print
00065      LD      B,1
00066      LD      C,0DH
00067      CALL     PRLINE
00068      POP      IX
00069      POP      BC
00070      POP      DE
00071      POP      HL
00072      XOR      A
00073      RET
00074 ;
00075 PRINT   PUSH     BC
00076      LD      DE,0         ;Offset for print buffer
00077 PART    LD      HL,BUF
00078      ADD      HL,DE
00079      XOR      A
00080      CP      (HL)         ;End of buffer?
00081      JR      Z,EPRT
00082      LD      BC,(CTL)
00083      CALL     PRLINE
00084      LD      HL,214
00085      ADD      HL,DE       ;Next part of buffer
00086      EX      DE,HL
00087      JR      PART
00088 EPRT    POP      BC
00089      RET
00090 ;
00091 PRLINE   EQU      $       ;Print a line. HL==>line to print
00092      PUSH     DE
00093 PRL2      LD      A,(HL)   ;B = # characters to print
00094      INC      HL          ;C = EOL char (sent after line)
00095      CALL     3BH         ;HL, BC, AF, and DE used
00096      DJNZ     PRL2

```

```

00097      LD      A,C
00098      OR       A
00099      CALL    NZ,3BH
00100      POP      DE
00101      RET
00102 ;
00103 ;  INITG --  Initialize Model III Graphics Board
00104 ;
00105 INITG  LD      A,10H
00106      OUT      (236),A      ;Turn on port
00107      LD      BC,15
00108      LD      HL,DATA
00109 LOOP   LD      A,B          ;Program CRTC chip for 80 by 24
00110      OUT      (136),A
00111      LD      A,(HL)
00112      OUT      (137),A
00113      INC      HL
00114      INC      B
00115      LD      A,B
00116      CP       C
00117      JR       NZ,LOOP
00118      RET
00119 DATA  DEFB    99
00120      DEFB    80
00121      DEFB    85
00122      DEFB    8
00123      DEFB    25
00124      DEFB    4
00125      DEFB    24
00126      DEFB    24
00127      DEFB    0
00128      DEFB    9
00129      DEFB    0
00130      DEFB    0
00131      DEFB    0
00132      DEFB    0
00133      DEFB    0
00134      DEFB    0
00135 ;
00136 BGMODE DEFB    12H
00137 EGMODE DEFB    1EH
00138 CTL    DEFB    0          ;Print 214 char, followed by null
00139      DEFB    214
00140 BUF    DEFS    640
00141      DEFB    0          ;Filler
00142      DEFB    0DH        ;Carriage return
00143      DEFB    0          ;End of buffer signal
00144 X      EQU     80H
00145 Y      EQU     81H

```

```
00146 GRAPH EQU 82H
00147 STATUS EQU 83H
00148 ;
00149      END GPRT2
```

```

000001 ; GPRT3 -- Print graphics X horizontal double Y axis
000002 ;
000003 PSECT 0F0000H
000004 GPRT3 PUSH HL
000005 PUSH DE
000006 PUSH BC
000007 PUSH IX
000008 CALL INITG
000009 LD HL,BGMode ;Turn on graphics print
000010 LD B,1
000011 LD C,0DH
000012 CALL PRLINE
000013 LD C,0 ;Graphics Y address
000014 LD A,0E3H
000015 OUT (STATUS),A
000016 LD D,3 ;Bit(s) in buf to set
000017 ;
000018 NEWLN PUSH BC
000019 PUSH DE
000020 LD HL,BUF ;Clear buffer
000021 LD DE,BUF+1
000022 LD BC,639
000023 LD A,80H
000024 LD (HL),A
000025 LDIR
000026 ;
000027 POP DE
000028 POP BC
000029 ;
000030 NEWRW LD A,C
000031 OUT (Y),A ;Update Y address
000032 LD A,40H
000033 CP D
000034 JR Z,NEWRL ;If printing row second time
000035 INC C ;Move to next row
000036 NEWRL LD HL,BUF
000037 XOR A
000038 OUT (X),A ;Restart X address
000039 LD B,80 ;Get 80 graphics bytes
000040 LD A,4
000041 CP D
000042 JR NZ,BYTE
000043 LD D,6
000044 ;
000045 BYTE PUSH BC ;Save Y & loop counter
000046 IN A,(GRAPH)
000047 LD C,A ;Save graphics byte in C
000048 LD E,80H ;Get bits left to right

```

```

00049 BIT      LD      A,C
00050          AND      E
00051          JR      Z,OFF1
00052          LD      A,D
00053          OR      (HL)
00054          LD      (HL),A      ;Set bit in buffer
00055 OFF1      INC      HL      ;Next buffer byte
00056          SRL      E      ;Next bit
00057          JR      NZ,BIT
00058          POP      BC
00059          DJNZ     BYTE
00060 ;
00061          LD      A,240
00062          CP      C      ;Last Y address?
00063          JR      Z,DONE
00064          SLA      D      ;Next bit in buffer
00065          SLA      D
00066          JR      Z,ENDRW
00067          JP      P,NEWRW
00068          LD      A,7FH
00069          AND      D
00070          LD      D,A
00071          JR      NZ,NEWRW
00072          LD      D,3
00073          JR      ENDR2
00074 ;
00075 ENDRW      LD      D,1
00076 ENDR2      PUSH     DE
00077          CALL     PRINT      ;Print buffer
00078          POP      DE
00079          JR      NEWLN
00080 ;
00081 DONE      CALL     PRINT
00082          LD      A,0FCH
00083          OUT      (STATUS),A
00084          LD      HL,EGMODE      ;Turn off graphics print
00085          LD      B,1
00086          LD      C,0DH
00087          CALL     PRLINE
00088          POP      IX
00089          POP      BC
00090          POP      DE
00091          POP      HL
00092          XOR      A
00093          RET
00094 ;
00095 PRINT      PUSH     BC
00096          LD      DE,0      ;Offset for print buffer
00097 PART      LD      HL,BUF

```

```

00098      ADD    HL,DE
00099      XOR    A
00100      CP     (HL)          ;End of buffer?
00101      JR     Z,EPRT
00102      LD     C,(CTL)
00103      CALL   PRLINE
00104      LD     HL,214
00105      ADD    HL,DE          ;Next part of buffer
00106      EX     DE,HL
00107      JR     PART
00108 EPRT   POP    BC
00109      RET
00110 ;
00111 PRLINE EQU    $          ;Print a line. HL==>line to print
00112      PUSH   DE
00113 PRL2    LD     A,(HL)      ;B = # characters to print
00114      INC    HL             ;C = EOL char (sent after line)
00115      CALL   3BH           ;HL, BC, AF, and DE used
00116      DJNZ   PRL2
00117      LD     A,C
00118      OR     A
00119      CALL   NZ,3BH
00120      POP    DE
00121      RET
00122 ;
00123 ;  INITG --  Initialize Model III Graphics Board
00124 ;
00125 INITG   LD     A,10H
00126      OUT    (236),A        ;Turn on port
00127      LD     BC,15
00128      LD     HL,DATA
00129 LOOP    LD     A,B          ;Program CRTC chip for 80 by 24
00130      OUT    (136),A
00131      LD     A,(HL)
00132      OUT    (137),A
00133      INC    HL
00134      INC    B
00135      LD     A,B
00136      CP     C
00137      JR     NZ,LOOP
00138      RET
00139 DATA  DEFB  99

```

```

00140      DEFB  80
00141      DEFB  85
00142      DEFB   8
00143      DEFB  25
00144      DEFB   4
00145      DEFB  24
00146      DEFB  24
00147      DEFB  0
00148      DEFB   9
00149      DEFB  0
00150      DEFB  0
00151      DEFB  0
00152      DEFB  0
00153      DEFB  0
00154      DEFB  0
00155      ;
00156 BGMODE DEFB 12H
00157 EGMODE DEFB 1EH
00158 CTL    DEFB 0
00159      DEFB 214
00160 BUF    DEFS 640
00161      DEFB 0
00162      DEFB 0DH
00163      DEFB 0
00164 X      EQU 80H
00165 Y      EQU 81H
00166 GRAPH  EQU 82H
00167 STATUS EQU 83H
00168      ;
00169      END    GPRT3

```

;Print 214 char, followed by null

;Filler

;Carriage return

;End of buffer signal

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 is 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 CMD "I","GCLS" 100 CMD "I","GCLS"

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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 CMD "I","GLOAD PROG"

GLOCATE (x,y),direction Sets the Graphics Cursor
 GLOCATE (320,120),0

GPRINT Dumps graphic display on the printer.
 GPRINT CMD "I","GPRINT" 100 CMD "I","GPRINT"

GPRT2 Dumps graphic display on the printer without rotating 90 degrees.
 GPRT2 CMD "I","GPRT2" 100 CMD "I","GPRT2"

GPRT3 Dumps graphic display on the printer without rotating 90 degrees.
 GPRT3 CMD "I","GPRT3" 100 CMD "I","GPRT3"

GROFF Turns Graphic Display OFF.
 GROFF CMD "I","GROFF"

GRON Turns Graphic Display ON.
 GRON CMD "I","GRON"

GSAVE filename/ext.password:d Saves graphics memory.
 GSAVE PROG CMD "I","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/ BASICG Error Messages

=====		
Code	Abbreviation	Explanation

1	NF	NEXT without FOR. NEXT is used without a matching FOR statement. This error may also occur if NEXT variables are reversed in a nested loop.
2	SN	Syntax. This is usually the result of incorrect punctuation, an illegal character or a misspelled command.
3	RG	RETURN without GOSUB. A RETURN statement was executed with insufficient data available. The DATA statement may have been left out or all data may have been read.
4	OD	Out of data. A READ statement was executed with insufficient data available. The DATA statement may have been left out or all data may have been read.
5	FC	Illegal function call. An attempt was made to execute an operation using an illegal parameter. Graphic examples: PUTting a display that is partially off the Screen, GETting an array that is not properly dimensioned, or using more than two OFF tiles or two ON tiles in a string when tiling (with PAINT).
6	OV	Overflow. The magnitude of the number derived or input is too large for the data storage type assigned to it. The integer range is (-32768 to 32767) for BASICG.
7	OM	Out of memory. All available memory has been used or reserved. This may occur with large array dimensions and nested branches such as GOSUB and

FOR/NEXT loops.

8	UL	Undefined line. An attempt was made to reference a non-existent line.
9	BS	Bad subscript. An attempt was made to assign an array element with a subscript beyond the dimensioned range.
10	DD	Double-dimensioned array. An attempt was made to dimension an array which had previously been created with DIM or by default statements. ERASE must be used first.
11	/0	Division by zero. An attempt was made to use a value of zero in the denominator. Note: If you can't find an obvious division by zero, check for division by numbers smaller than allowable ranges (see OV).
12	ID	Illegal direct. An attempt was made to use a program only statement like INPUT in an immediate (non-program) line.
13	TM	Type mismatch. An attempt was made to assign a number to a string variable or a string to a numeric variable.
14	OS	Out of string space. The amount of string space allocated was exceeded. Use CLEAR to allocate more string space. 100 bytes is the default string space allocation.
15	LS	Long string. A string variable was assigned a string which exceeded 255 characters in length.
16	ST	String too complex. A string operation was too complex to handle. The operation must be broken into shorter steps.
17	CN	Can't continue. A CONT command was given at a point where the command can't be carried out, e.g., directly after the program has been edited.

18	UF	Undefined user function. An attempt has been made to call a USR function without first defining its entry point via a DEFUSR statement.
19	NR	No RESUME. During an error-trapping routine, BASICG has reached the end of the program without encountering a RESUME.
20	RW	RESUME without error. A RESUME was encountered when no error was present. You need to insert END or GOTO in front of the error-handling routine.
21	UE	Undefined error. Reserved for future use.
22	MO	Missing operand. An operation was attempted without providing one of the required operands.
23	BO	Buffer overflow. An attempt was made to input a data line which has too many characters to be held in the line buffer.
24	NB	Files not compatible. An attempt was made to load a BASIC file (in compressed format) into BASICG.
25-49	UE	Undefined error. Reserved for future use.
50	FO	Field overflow. An attempt was made to have more characters than the direct-access file record length allows. The record length is assigned when the file is first opened. The default length is 256.
51	IE	Internal error. Also indicates an attempt to use EOF on a file which is not open.

52	BN	Bad file number. An attempt was made to use a file number which specifies a file that is not open or that is greater than the number of files specified when BASICG was started up.
53	FF	File not found. Reference was made in a LOAD, KILL or OPEN statement to a file which did not exist on the diskette specified.
54	BM	Bad file mode. Program attempted to perform direct access on a file opened for sequential access or vice-versa.
55	AO	File already open. An attempt was made to open a file that was already open. This error is also output if KILL, LOAD, SAVE, etc., is given for an open file.
56	IO	Disk I/O error. An error has been detected during a disk access.
57	UE	Undefined in Model III BASIC.
58	UE	Undefined error. Reserved for future use.
59	DF	Diskette full. All storage space on the diskette has been used. KILL unneeded files or use a formatted diskette which has available space.
60	EF	End of file. An attempt was made to read past the end of file.
61	RN	Bad record number. In a PUT or GET statement, the record number is either greater than the allowable maximum, equal to zero, or negative.
62	NM	Bad file name.
63	MM	Mode mismatch. A sequential OPEN was executed for a file that already existed on the diskette as a direct access file, or vice versa.

64 UE Undefined error. Reserved for future use.

65 DS Direct statement. A direct statement was encountered during a load of a program in ASCII format. The load is terminated.

66 FL Too many files.

=====

Appendix C/ Subroutine Language Reference Summary

CIRCLE (radius,color,start,end,ar) Draws a circle, ellipse, semicircle, arc, or point.
(x,y) coordinates set by SETXY.
CALL CIRCLE(100,1,0,0,0)

CLS Clears the Graphics Screen.
CALL CLS

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 (0)

PAINT (color,border) Paints the screen.
CALL PAINT(1,1)

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

CALL PAINTT (A,1,V)

POINT Returns the pixel value at current coordinates.
K=POINT(M)

PRESET (color) Sets the pixel ON or OFF.
CALL PRESET(Ø)

PSET (color) Sets the pixel ON or OFF.
CALL PSET(Ø)

SCREEN (type) Sets the screen.
CALL SCREEN(1)

SETXY(X,Y) Sets the coordinates (absolute).
CALL SETXY(1ØØ,1ØØ)

SETXYR(X,Y) Sets the coordinates (relative).
CALL SETXYR(5Ø,5Ø)

VIEW(leftX,leftY,rightX,rightY,color,border)
Sets the viewport.
CALL VIEW(1ØØ,1ØØ,2ØØ,2ØØ,Ø,1)

Appendix D/ Sample Programs**BASICG**

```
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
```

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```

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 10000
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$(&H00)
790 TILE$(1)=CHR$(&HFF)+CHR$(&H00)
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$(&H0F)+CHR$(&H0F)
840 TILE$(6)=CHR$(&H3C)+CHR$(&H3C)+CHR$(&HFF)
850 TILE$(7)=CHR$(&H03)+CHR$(&H0C)+CHR$(&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 SCREEN1
930 PRINT @64,"Enter month "
940 PRINT @192,"Enter amount spent by"
950 PRINT @256,"$"
960 PRINT @0,""
970 LINE INPUT "Enter month ";MN$
980 FOR I=1 TO 8
990 PRINT @214,ACCT$(I);"
1000 PRINT @256,"$"
1010 PRINT @192,""
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 SCREEN0
1130 '
1140 ' Draw the circle and calculate the location of the lines and
1150 ' the line numbers
1160 '
1170 CIRCLE(410,120),R
1180 FOR I=0 TO 8
1190 T0=TWOPI/100*PER(I)+T0
1200 X0=410+R*COS(T0)
1210 Y0=120-R*SIN(T0)*0.5
1220 T1=TWOPI/100*PER(I+1)+T0
1230 THALF(I)=(T0+T1)/2
1240 HXCOL=(410+R*1.15*COS(THALF(I)))
1250 HYRW=(120-R*1.15*SIN(THALF(I))*0.5)
1260 IF PER(I)>1 THEN LINE (410,120)-(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=410+R*0.5*COS(THALF(I))
1350 YP=120-R*0.5*SIN(THALF(I))*0.5
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 SCREEN1
1640 END
```

```
10 ' "THREEDDEE/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$="G r o s s   I n c o m e   F o r   1 9 8 0 "
350 BMSG$="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 SCREEN0
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$,1
750 NEXT I
760 GLOCATE(40,215),0
770 PRINT #-3,"Jan    Feb    Mar    Apr    May    June    July    Aug    Sept    Oct
Nov    Dec"
780 GLOCATE(290,230),0
790 PRINT #-3,BMSG$
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 SCREEN1
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 FORMS (WIDTH=255, LINES=60). (See your **Model III 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: CMD"I","GSAVE SINE" <ENTER>.

5. The graphics memory is saved as a TRSDOS file on your diskette and you will return to TRSDOS Ready.

6. Type: GCLS <ENTER>

The graphics memory is now cleared.

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

GLOAD SINE <ENTER>

The display is now on the Graphics Screen.

8. To print, type: GPRINT <ENTER>.

FORTTRAN Sample Programs

```
001000 C      HIGH RESOLUTION GRAPHICS TEST - MAIN PROGRAM
002000 C
003000      CALL GRPINI(0)
004000      CALL SCREEN(0)
005000 C
006000 C      CIRCLE TEST
007000 C
008000      CALL CTEST
009000 C
010000 C      LINE TEST
011000 C
012000      CALL LTEST
013000 C
014000 C      LINEB TEST
015000 C
016000      CALL LBTST
017000 C
018000 C      LINEBF TEST
019000 C
020000      CALL LBFTST
021000 C
022000 C      PAINTT TEST
023000 C
024000      CALL PTTTST
025000 C
026000 C      GET AND PUT TEST
027000 C
028000      CALL GPTST
029000 C
030000 C      PSET/POINT TEST
031000 C
032000      CALL PPTST
033000 C
034000 C      PRESET/POINT TEST
035000 C
036000      CALL PRETST
037000 C
038000 C      SCREEN TEST
039000 C
040000      CALL SCRTST
041000 C
042000 C      VIEW/FVIEW TEST
043000 C
044000      CALL VTEST
```

Ø45ØØ
Ø46ØØ

CALL CLS(2)
END

```

00100      SUBROUTINE CTEST
00200      C
00300      C      THIS SUBROUTINE TESTS CIRCLE, SETXY, AND PAINT
00400      C
00500      LOGICAL MSG(29)
00600      CALL CLS
00700      ENCODE(MSG,100)
00800      100    FORMAT('TEST CIRCLE, SETXY, AND PAINT')
00900      CALL SETXY(0,0)
01000      CALL LOCATE(0)
01100      CALL GPRINT(29,MSG)
01200      CALL WAIT
01300      CALL VIEW(0,30,639,239,0,0)
01400      DO 10 I=1,100
01500      IX=MOD(I*17,640)
01600      IY=MOD(I*13,210)
01700      IR=I*1.5
01800      START=MOD(I,13)-6.0
01900      END=MOD(I*3,13)-6.0
02000      IF (START.LT.END) GOTO 1
02100      T=START
02200      START=END
02300      END=T
02400      1      CONTINUE
02500      RATIO=MOD(I*3,100)
02600      IF (RATIO.GT.0) RATIO=RATIO/40.
02700      CALL SETXY(IX,IY)
02800      CALL CIRCLE(IR,1,START,END,RATIO)
02900      100    CONTINUE
03000      C
03100      C      RANDOMLY FILL IN THE AREAS
03200      C
03300      DO 11 I=1,50
03400      IX=MOD(I*23,640)
03500      IY=MOD(I*11,210)
03600      CALL SETXY(IX,IY)
03700      CALL PAINT(1,1)
03800      11     CONTINUE
03900      CALL WAIT
04000      CALL VIEW(0,0,639,239,-1,-1)
04100      RETURN
04200      END

```

```

00100      SUBROUTINE LTEST
00200      C
00300      C      THIS ROUTINE EXERCISES LINE
00400      C
00500      LOGICAL MSG(19)
00600      CALL CLS(0)
00700      ENCODE(MSG,100)
00800      100      FORMAT('LINE AND PAINT TEST')
00900      CALL SETXY(0,0)
01000      CALL LOCATE(0)
01100      CALL GPRINT(19,MSG)
01200      CALL WAIT
01300      J=100
01400      DO 10 I=1,639,2
01500      CALL SETXY(I,15)
01600      CALL SETXY(I,239)
01700      CALL LINE(1,J)
01800      J=J-1
01900      10      CONTINUE
02000      CALL WAIT
02100      CALL VIEW(0,15,639,239,0,0)
02200      CALL CLS
02300      C
02400      C      DRAW WHITE LINES AND FILL IN RANDOMLY
02500      C
02600      IX=MOD(I*19,639)
02700      IY=MOD(I*17,223)
02800      CALL SETXY(IX,IY)
02900      DO 11 I=1,100
03000      IX=MOD(I*23,639)
03100      IY=MOD(I*29,223)
03200      CALL SETXY(IX,IY)
03300      CALL LINE(1,-1)
03400      11      CONTINUE
03500      DO 12 I=1,50
03600      IX=MOD(I*31,639)
03700      IY=MOD(I*37,223)
03800      CALL SETXY(IX,IY)
03900      CALL PAINT(1,1)
04000      12      CONTINUE
04100      CALL WAIT
04200      C
04300      C      WHITE OUT SCREEN, DRAW BLACK LINES, PAINT BLACK RANDOMLY
04400      C
04500      CALL VIEW(0,15,639,239,1,1)
04600      DO 15 I=1,100
04700      IX=MOD(I*11,639)
04800      IY=MOD(I*13,223)
04900      CALL SETXY(IX,IY)

```

```
050000      CALL LINE(0,-1)
051000      15      CONTINUE
052000      DO 16 I=1,50
053000      IX=MOD(I*17,639)
054000      IY=MOD(I*19,223)
055000      CALL SETXY(IX,IY)
056000      CALL PAINT(0,0)
057000      16      CONTINUE
058000      CALL WAIT
059000      CALL VIEW(0,0,639,239,0,0)
060000      RETURN
061000      END
```

```
00100      SUBROUTINE LBFTST
00200      C
00300      C      LINEBF TEST
00400      C
00500      LOGICAL MSG(11)
00600      CALL CLS
00700      ENCODE(MSG,100)
00800      100    FORMAT('LINEBF TEST')
00900      CALL SETXY(0,0)
01000      CALL LOCATE(0)
01100      CALL GPRINT(11,MSG)
01200      CALL WAIT
01300      IXP=639
01400      ICLR=1
01500      DO 10 IX=0,120
01600      CALL SETXY(IX*2,IX+30)
01700      CALL SETXY(IXP,IXP-400)
01800      CALL LINEBF(ICLR)
01900      IXP=IXP-3
02000      ICLR=ICLR-1
02100      IF (ICLR.LT.0) ICLR=1
02200      10    CONTINUE
02300      CALL WAIT
02400      RETURN
02500      END
```

```

001000      SUBROUTINE PTTTST
002000      C
003000      C      PAINT WITH TILES TEST
004000      C
005000      LOGICAL A(65),B(4),IS(16),MSG(23)
006000      DATA A(1)/8/
007000      C      X
008000      DATA A(2),A(3),A(4),A(5)/X'41',X'22',X'14',X'08'/
009000      DATA A(6),A(7),A(8),A(9)/X'14',X'22',X'41',X'00'/
010000      C      FINE HORIZONTAL LINES
011000      DATA A(10),A(11),A(12)/2,X'FF',X'00'/
012000      C      MEDIUM HORIZONTAL LINES
013000      DATA A(13)/4/
014000      DATA A(14),A(15),A(16),A(17)/X'FF',X'FF',X'00',X'00'/
015000      C      DIAGONAL LINES
016000      DATA A(18)/4/
017000      DATA A(19),A(20),A(21),A(22)/X'03',X'0C',X'30',X'C0'/
018000      C      LEFT TO RIGHT DIAGONALS
019000      DATA A(23)/4/
020000      DATA A(24),A(25),A(26),A(27)/X'C0',X'30',X'0C',X'03'/
021000      C      FINE VERTICAL LINES
022000      DATA A(28),A(29)/1,X'AA'/
023000      C      MEDIUM VERTICAL LINES
024000      DATA A(30),A(31)/1,X'CC'/
025000      C      COARSE VERTICAL LINES
026000      DATA A(32),A(33)/1,X'F0'/
027000      C      ONE PIXEL DOTS
028000      DATA A(34),A(35),A(36)/2,X'22',X'00'/
029000      C      TWO PIXEL DOTS
030000      DATA A(37),A(38),A(39)/2,X'99',X'66'/
031000      C      PLUSES
032000      DATA A(40),A(41),A(42),A(43)/3,X'3C',X'3C',X'FF'/
033000      C      SOLID
034000      DATA A(44),A(45)/1,X'FF'/
035000      C      BROAD CROSS HATCH
036000      DATA A(46),A(47),A(48),A(49)/3,X'92',X'92',X'FF'/
037000      C      THICK CROSS HATCH
038000      DATA A(50)/4/
039000      DATA A(51),A(52),A(53),A(54)/X'FF',X'FF',X'DB',X'DB'/
040000      C      FINE CROSS HATCH
041000      DATA A(54),A(55),A(56)/2,X'92',X'FF'/
042000      C      ALTERNATING PIXELS
043000      DATA A(57),A(58),A(59)/2,X'55',X'AA'/
044000      DATA B(1),B(2),B(3),B(4)/1,0,1,X'FF'/
045000      DATA IS(1),IS(2),IS(3),IS(4),IS(5),IS(6)/1,10,13,18,23,28/
046000      DATA IS(7),IS(8),IS(9),IS(10),IS(11)/30,32,34,37,40/
047000      DATA IS(12),IS(13),IS(14),IS(15),IS(16)/44,46,50,54,57/
048000      CALL CLS
049000      ENCODE(MSG,100)

```

```

050000 100  FORMAT('PAINTT AND SETXYR TESTS')
051000      CALL SETXY(0,0)
052000      CALL LOCATE(0)
053000      CALL GPRINT(23,MSG)
054000      CALL WAIT
055000  C
056000  C      PAINT ON A BLACK BACKGROUND
057000  C
058000      DO 10 I=1,16
059000      CALL SETXY(0,40)
060000      CALL SETXYR(639,199)
061000      CALL LINEB(1,-1)
062000      CALL SETXYR(-300,-100)
063000      ITMP=IS(I)
064000      CALL PAINTT(A(ITMP),1,B)
065000      CALL WAIT
066000      CALL VIEW(0,40,639,239,0,0)
067000      CALL VIEW(0,0,639,239,-1,-1)
068000 10  CONTINUE
069000  C
070000  C      PAINT ON A WHITE BACKGROUND
071000  C
072000      DO 11 I=1,16
073000      IF(I.EQ.12) GOTO 11
074000      CALL VIEW(0,40,639,239,0,0)
075000      CALL VIEW(0,0,639,239,-1,-1)
076000      CALL SETXY(0,40)
077000      CALL SETXYR(639,199)
078000      CALL LINEBF(1)
079000      CALL SETXYR(-300,-100)
080000      ITMP=IS(I)
081000      CALL PAINTT(A(ITMP),0,B(3))
082000      CALL WAIT
083000 11  CONTINUE
084000      RETURN
085000      END

```

```
00100      SUBROUTINE GPTST
00200      C
00300      C      GET AND PUT TEST
00400      C
00500      LOGICAL A(1000),MSG(16)
00600      CALL CLS
00700      ENCODE(MSG,100)
00800      100    FORMAT('GET AND PUT TEST')
00900      CALL SETXY(0,0)
01000      CALL LOCATE(0)
01100      CALL GPRINT(16,MSG)
01200      CALL VIEW(0,30,639,239,0,0)
01300      CALL SETXY(100,100)
01400      CALL SETXYR(30,30)
01500      CALL LINEBF(1)
01600      CALL GET(A,1000)
01700      CALL CLS
01800      CALL WAIT
01900      CALL SETXY(100,100)
02000      CALL PUT(A,1)
02100      CALL WAIT
02200      CALL VIEW(0,0,639,239,0,-1)
02300      RETURN
02400      END
```

```

001000      SUBROUTINE PPTST
002000      C
003000      C      PSET AND POINT TEST
004000      C
005000      LOGICAL POINT,MSG(21)
006000      CALL CLS
007000      ENCODE(MSG,100)
008000      100    FORMAT('PSET AND POINT TEST')
009000      CALL SETXY(0,0)
010000      CALL LOCATE(0)
011000      CALL GPRINT(19,MSG)
012000      CALL WAIT
013000      CALL CLS
014000      C
015000      C      SET AND CHECK ALL PIXELS
016000      C
017000      DO 10 I=0,639
018000      DO 11 J=0,239
019000      CALL SETXY(I,J)
020000      CALL PSET(1)
021000      K=POINT(L)
022000      IF(K.EQ.0) GOTO 999
023000      11    CONTINUE
024000      10    CONTINUE
025000      C
026000      C      RESET AND CHECK ALL PIXELS
027000      C
028000      DO 12 I=0,639
029000      DO 13 J=0,239
030000      CALL SETXY(I,J)
031000      CALL PSET(0)
032000      K=POINT(L)
033000      IF (K.EQ.1) GOTO 999
034000      13    CONTINUE
035000      12    CONTINUE
036000      CALL CLS
037000      ENCODE(MSG,101)
038000      101    FORMAT('PSET AND POINT PASSED')
039000      CALL SETXY(0,0)
040000      CALL LOCATE(0)
041000      CALL GPRINT(21,MSG)
042000      GOTO 1000
043000      999    CALL CLS
044000      ENCODE(MSG,102)
045000      102    FORMAT('PSET AND POINT FAILED')
046000      CALL SETXY(0,0)
047000      CALL LOCATE(0)
048000      CALL GPRINT(21,MSG)
049000      1000   CALL WAIT

```

05000
05100

RETURN
END

```

001000      SUBROUTINE PRETST
002000      C
003000      C      PRESET AND POINT TEST
004000      C
005000      LOGICAL POINT,MSG(23)
006000      CALL CLS
007000      ENCODE(MSG,100)
008000      100    FORMAT('PRESET AND POINT TEST')
009000      CALL SETXY(0,0)
010000      CALL LOCATE(0)
011000      CALL GPRINT(23,MSG)
012000      CALL WAIT
013000      CALL CLS
014000      C
015000      C      SET AND CHECK ALL PIXELS
016000      C
017000      DO 10 I=0,639
018000      DO 11 J=0,239
019000      CALL SETXY(I,J)
020000      CALL PRESET(1)
021000      K=POINT(L)
022000      IF(K.EQ.0) GOTO 999
023000      11    CONTINUE
024000      10    CONTINUE
025000      C
026000      C      RESET AND CHECK ALL PIXELS
027000      C
028000      DO 12 I=0,639
029000      DO 13 J=0,239
030000      CALL SETXY(I,J)
031000      CALL PRESET(0)
032000      K=POINT(L)
033000      IF (K.EQ.1) GOTO 999
034000      13    CONTINUE
035000      12    CONTINUE
036000      CALL CLS
037000      ENCODE(MSG,101)
038000      101    FORMAT('PRESET AND POINT PASSED')
039000      CALL SETXY(0,0)
040000      CALL LOCATE(0)
041000      CALL GPRINT(23,MSG)
042000      GOTO 1000
043000      999    CALL CLS
044000      ENCODE(MSG,102)
045000      102    FORMAT('PRESET AND POINT FAILED')
046000      CALL SETXY(0,0)
047000      CALL LOCATE(0)
048000      CALL GPRINT(23,MSG)
049000      1000   CALL WAIT

```

05000
05100

RETURN
END

```
001000      SUBROUTINE SCRTST
002000      C
003000      C      SCREEN TEST
004000      C
005000      LOGICAL MSG(11)
006000      CALL CLS
007000      ENCODE(MSG,100)
008000      100    FORMAT('SCREEN TEST')
009000      CALL SETXY(0,0)
010000      CALL LOCATE(0)
011000      CALL GPRINT(11,MSG)
012000      CALL WAIT
013000      CALL SETXY(300,120)
014000      CALL CIRCLE(100,1,0.0,6.28,0.5)
015000      CALL CIRCLE(100,1,0.0,6.28,0.25)
016000      CALL CIRCLE(50,1,0.0,6.28,0.5)
017000      CALL PAINT(1,1)
018000      C
019000      C      GRAPHICS SCREEN
020000      C
021000      CALL SCREEN(0)
022000      CALL WAIT
023000      CALL WAIT
024000      CALL WAIT
025000      C
026000      C      TEXT SCREEN
027000      C
028000      CALL SCREEN(1)
029000      CALL WAIT
030000      CALL WAIT
031000      CALL WAIT
032000      C
033000      C      GRAPHICS SCREEN
034000      C
035000      CALL SCREEN(0)
036000      CALL WAIT
037000      CALL WAIT
038000      CALL WAIT
039000      RETURN
040000      END
```

```
00100      SUBROUTINE VTEST
00200      C
00300      C      VIEW AND FVIEW TEST
00400      C
00500      INTEGER FVIEW
00600      LOGICAL MSG(19)
00700      CALL CLS
00800      ENCODE(MSG,100)
00900      100    FORMAT('VIEW AND FVIEW TEST')
01000      CALL SETXY(0,0)
01100      CALL LOCATE(0)
01200      CALL GPRINT(19,MSG)
01300      CALL WAIT
01400      C
01500      C      DRAW VIEWPORT AND CIRCLES
01600      C
01700      CALL VIEW(0,40,639,239,0,1)
01800      CALL DCIRCL(1)
01900      C
02000      C      DRAW VIEWPORT AND LINES
02100      C
02200      CALL VIEW(20,50,619,229,1,0)
02300      CALL DLINE(0)
02400      C
02500      C      DRAW VIEWPORT AND CIRCLES
02600      C
02700      CALL VIEW(40,60,599,209,0,0)
02800      CALL DCIRCL(1)
02900      C
03000      C      DRAW VIEWPORT AND LINES
03100      C
03200      CALL VIEW(60,70,579,199,1,1)
03300      CALL DLINE(0)
03400      C
03500      C      CLEAR SCREEN
03600      C
03700      IX1=FVIEW(0)
03800      IY1=FVIEW(1)
03900      IX2=FVIEW(2)
04000      IY2=FVIEW(3)
04100      CALL VIEW(60-IX1,70-IY1,60+IX2,40+IY2,0,1)
04200      CALL CLS
04300      RETURN
04400      END
```

```
04500      SUBROUTINE DCIRCL(ICLR)
04600      CALL SETXY(100,100)
04700      DO 10 I=5,300,5
04800      CALL CIRCLE(I,ICLR,0.0,6.28,0.5)
04900  10     CONTINUE
05000      CALL WAIT
05100      RETURN
05200      END
```

```
05300      SUBROUTINE DLINE(ICLR)
05400      DO 11 I=2,200,4
05500      CALL SETXY(-10,-10)
05600      CALL SETXY(I+200,I)
05700      CALL LINE(ICLR,-1)
05800  11     CONTINUE
05900      CALL WAIT
06000      RETURN
06100      END
```

```
00100      SUBROUTINE WAIT
00200      C
00300      C      THIS SUBROUTINE INTRODUCES A TIME DELAY
00400      C
00500      DO 11 J=1,20
00600      DO 10 I=1,10000
00700      10 CONTINUE
00800      11 CONTINUE
00900      RETURN
01000      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

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)

0	0	0	0	0	0	1	1
0	0	0	0	1	1	0	0
0	0	1	1	0	0	0	0
1	1	0	0	0	0	0	0

Hex Decimal

03 3

0C 12

30 48

C0 192

(Left to right)

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

1	1	0	0	0	0	0	0
0	0	1	1	0	0	0	0
0	0	0	0	1	1	0	0
0	0	0	0	0	0	1	1

Hex Decimal

C0 192

30 48

0C 12

03 3

5. "Fine" vertical lines

CHR\$(&HAA)

1	0	1	0	1	0	1	0
---	---	---	---	---	---	---	---

Hex Decimal

AA 170

6. "Medium" vertical lines

CHR\$(&HCC)

1	1	0	0	1	1	0	0
---	---	---	---	---	---	---	---

Hex Decimal

CC 204

7. "Coarse" vertical lines

CHR\$(&HF0)

1	1	1	1	0	0	0	0
---	---	---	---	---	---	---	---

Hex	Decimal
F0	240

8. One-pixel dots

CHR\$(&H22)+CHR\$(&H00)

0	0	1	0	0	0	1	0
0	0	0	0	0	0	0	0

Hex	Decimal
22	34
00	0

9. Two-pixel dots

CHR\$(&H99)+CHR\$(&H66)

1	0	0	1	1	0	0	1
0	1	1	0	0	1	1	0

Hex	Decimal
99	153
66	102

10. Pluses ("+")

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

0	0	1	1	1	1	0	0
0	0	1	1	1	1	0	0
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 17Ø

Appendix G/ 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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