

G R A Ftm
GRAPHICS SYSTEM
REFERENCE MANUAL
R E L A T Etm/ 3 0 0 0
Relational Data Base Management System

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CAPABILITIES AND FEATURES

GRAF allows the user to create line drawings in 2 or 3 dimensions and to quickly create:

- * pie charts
- * bar charts
- * line graphs
- * histograms
- * scattergrams

The major features include:

- * The ability to use data directly from most IMAGE, KSAM, MPE and all RELATE/3000 databases.
- * The ability to transform and subset the data before plotting with the Command Interpreter.
- * Automatic or manual scaling of graphs.
- * Significant control over axis format and placement.
- * Device independent or device dependent graph design.
- * Execution of procedure files to generate charts periodically.
- * Capability of creating the instructions for chart drawing in a job so that major data transformations can be completed overnight, leaving only the task of drawing the chart for the morning.
- * English language error messages.
- * Text and lines can be placed or drawn at user specified positions.

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SECTION 1
C O N C E P T S

NOTATION

The following notation is used to define the syntax of the commands described in this manual:

CAPITALIZED BOLD WORDS	are the names of commands or subroutine names.
CAPITALIZED WORDS	identify words that have specific meanings to RELATE. These are sometimes referred to as keywords.
lower-case words	identify words that are names or labels to be specified by the user.
[] (Square Brackets)	are used to indicate that the enclosed item is optional and may be omitted. The brackets may be nested such that if the inner items are used the outer items must be used.
/ / (Slashes)	between items indicate that one of the items must be chosen.
... (Ellipsis)	indicates that the immediately preceding item may occur once, or any number of times in succession.

Commands may be entered in any combination of upper and lower case characters. They are processed as if only upper case characters had been used (except for information in double quotes). Commands may be up to 1500 characters in length and span up to 100 lines. Each line of the command may be up to 250 characters long. If an error occurs in a command, the command may be edited (see REDO in the RELATE/3000 reference manual) and then resubmitted.

All command names and keywords may be abbreviated to as few characters as are required to uniquely identify the word.

When the system is used in a batch mode or from the Host Language Interface routines it is recommended that keywords be spelled out fairly completely. This will ensure that ambiguities will not arise because of new features in subsequent releases of the software. Obviously, an error such as this is easy to correct at the terminal (since the new choices are displayed) but may take some time to correct in a job stream, procedure file, or program.

Punctuation and spacing are crucial when entering commands. Punctuation is performed by delimiters. Delimiters include a space (" "), comma (","), equal sign ("="), or semicolon (";"). Only the first space between items is important; extra spaces may be added to improve readability. Each command describes the punctuation required for proper operation. Generally, however, keywords are delimited by spaces (or equal signs), lists (field names, user names, etc.) are delimited by commas; and keyword sequences delimited by equal signs are separated with semicolons.

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SPECIAL CHARACTERS

& (ampersand)	An ampersand entered as the last character on a line indicates that the input for the current line continues on the next line. The prompt for the continuation line will then be an "&".
\ (backslash)	A backslash can be used to separate multiple commands, or responses, on a single line. A maximum of 1500 characters may be entered in this way. When multiple responses are entered, and an error occurs, all unused information is discarded and prompting is returned to the terminal.
//	This terminates the current input stream. It is also used to exit the system. If a "//" is actually desired as data it must be enclosed in quotes.
Control-H	(or Backspace) Characters can be deleted by using either a Control-H or a Backspace. One character is deleted each time the Control-H or backspace is used. If a hard-copy terminal is being used, the carriage will advance one line and then backspace a single position for each character deleted. If a CRT is being used, the cursor will normally backspace one position per character deleted.
Control-Q	The Control-Q resumes output suspended by the Control-S.
Control-S	The Control-S suspends output to the terminal. Output may be resumed by entering a Control-Q.
Control-X	Use Control-X to delete an entire line. The system responds with three exclamation points, a carriage return, and a line feed. No prompt is printed by the system and data or commands may immediately be entered.
Control-Y	A Control-Y can be used to terminate lengthy printout or cancel the execution of a command. The text "<Control-Y>" is printed when this key is used. If a procedure file is executing when the key is struck, the user will have the opportunity to continue with or terminate the procedure file.

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GLOSSARY

- bar chart** - A graph in which parallel bars represent data. The size of each bar is determined by the magnitude of the data.
- clipping** - The process of adjusting lines and text such that information is not placed outside of specific limits. This limit is the frame.
- device dependent** - A graph drawn in a device dependent mode will be the same size regardless of the output device used.
- device independent** - A graph drawn in a device independent mode will automatically be scaled based on the size of the output device.
- device size** - This is the physical dimension of the plotter. It is specified in inches, millimeters, or centimeters. For more information see the SET SIZE command.
- frame** - The frame is the area on the graphics device into which the plot will be placed. The position of the frame is specified in the current unit system. A frame cannot contain any space not within the device space. For more information see the SET FRAME command.
- graphics device** - A plotter or CRT (cathode ray tube) with graphic capability. See the SET DEVICE command for the devices presently supported.
- histogram** - A histogram is a graph that indicates the distribution of data. The graph is usually drawn with vertical bars. Each bar represents a range of data values. The height of each bar represents the number of points that fall within the range.
- pie chart** - A pie chart is a circular graph composed of slices. The size of each slice is based on the value of the data for the slice as compared to the total amount.
- plot file** - A plot file is an MPE file into which generic graphic instructions are placed. This file is eventually used to drive the graphics device. See the PLOT FILE section for more information.
- primary command** - A GRAF command that performs elementary graphing, such as drawing LINES, ARCs, LABELs, and so forth.
- secondary command** - A GRAF command that performs complex graphing, such as BARCHARTs, HISTOGRAMs, and so forth.
- surface** - A rectangle defined by the location of the lower left hand corner and the upper right hand corner. A surface is specified as a pair of points within parentheses as in (0,0), (100,100). A surface represents an area from which information is obtained or onto which information is plotted.
- unit system** - A unit system is a numbering system. When position or size information is given to the graphics system it must be represented in the current units system. The graphics system works in several standard unit systems. There is a fixed system (that uses inches, millimeters, or centimeters) and a variable system (which will compensate for the graphics device being used).

viewpoint - The location from which a 3-dimensional object is viewed. The viewpoint is given as an X, Y, Z coordinate representing distance, offset (left or right) and height from the object.

window - The window is the area of interest in a user's graph that should be plotted. The position of the window is specified in world coordinates. For more information see the SET WINDOW command. The information in the window is drawn in the frame.

world coordinates - World coordinates are coordinates in a user defined unit system.

PLOT FILE

GRAF generates plots in a two step process. First, user-entered commands are converted into an internal format and placed into a plot file. The contents of the plot file are generic low level commands that draw lines and arcs, adjust windows and frames and generate text. Subsequently, this plot file is read and the information contained in the file is converted into device specific commands to produce the desired chart. The plot file is simply a holding area between the user-entered commands and the actual plot.

The system will automatically create a plot file if the user does not do so. This plot file is an open temporary file and cannot be saved by the user. For simple applications this is normally sufficient. In some situations it may be appropriate for the user to actually create a named plot file. The most common situation would be to generate a number of plots requiring large amounts of computation during a job for later plotting or for plotting on multiple output devices. Only a single plot file can be open at one time. Once information is placed into a plot file it cannot be edited or changed.

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COMMAND TYPES

The plotting commands fall into two groups, primary and secondary. Primary commands have fewer parameters and generate a small number of plot file entries. These commands draw lines, arcs, and generate labels. Secondary commands have many options and may place hundreds of entries in the plot file. The secondary commands create pie charts, line graphs, bar charts, histograms, and scattergrams. A data file is used for each of the secondary commands. A data file may be used with a primary command but is not required. If a field is used in a primary command one line, arc, or label is drawn for each record in the file. More information is given in the SELECTING DATA section.

The commands DRAW GRAPH, DRAW BARCHART, and DRAW HISTOGRAM can perform automatic scaling. To do this, the data file is read at least twice, once to determine the minimum and maximum values to be plotted, and then one or more times to actually produce the graph. The size of a pie chart is determined by the current size of the frame and is not dependent on the values of the data.

The system will attempt to produce meaningful axis values by forcing the divisions of the graph to be multiples of reasonable values (such as 2, 5, or 10). The automatic scaling can be overridden by specifying the LIMITS keyword in the AXIS description. More information is contained in the AXIS SPECIFICATION section.

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COORDINATE SYSTEMS

The graphics system uses two coordinate systems in order to provide a flexible mechanism for mapping user information onto a plotting device. Knowledge of these coordinate systems is not generally required if only secondary commands are used. If primary commands are used, it is possible to perform clipping, windowing, and scaling by adjusting the sizes and positioning of the coordinate systems.

The location at which the plot is placed on the output device is represented in device coordinates. Device coordinates can be given in inches, millimeters, centimeters or a device independent ratio. The units for the device coordinates are defined by the SET UNITS command. The location of the plot on the output device is changed with the SET FRAME command.

The information that is placed into the frame is defined by the window. The window represents the area within a large space that is of interest to the user. The window's location is specified in world coordinates. World coordinates need not be in any particular unit system since they will be transformed and placed in the frame depending on the ratio of the window size to the frame size.

The system operates in two modes based on the type of SET UNITS command and the window coordinates. If a length type (such as inches) is given in the SET UNITS command, a device dependent mode is entered. In this mode, plotted information is not scaled based on the surface area of the device. The information will be plotted with the same dimensions on whatever output device is used. This mode may cause information on a graph to be clipped if a graph is drawn on a device smaller than the frame.

If a length type is not given in the SET UNITS command, a device independent mode is entered. In this mode, the objects drawn by the user will be scaled so that the entire graph fits on the output device. The device independent mode scales the frame based on the size of the device much like the window is scaled into the frame.

When the graphics system is started the following values are assumed:

COMMAND	INITIAL VALUE
SET UNITS	Device Independent
SET SIZE	Square
SET FRAME	(0,0), (100,100)
SET WINDOW	(0,0), (100,100)

The following relationships exist between the SET commands:

COMMAND	ALSO ISSUES
SET UNITS	SET FRAME SET WINDOW
SET SIZE	SET FRAME SET WINDOW
SET FRAME	SET WINDOW

SELECTING DATA

Before a decision is made about how a particular graph should look, the user must decide what data should be used. In the simplest case, the data exists in one file in the exact format desired. To create a graph of this information the file need only be opened (using a RELATE OPEN FILE command) and then a DRAW command (such as DRAW SALES BY YEAR) can be issued.

More likely, however, the data exists in several separate files, separate databases (in the case of IMAGE/3000) or in a very detailed format. In this case, a RELATE SELECT command can be issued prior to the DRAW command. The graphics system uses the results of the selection for the graph. By using a SELECT command the data can be:

- 1) Consolidated through the use of aggregates.
- 2) Obtained from many related sources at one time.
- 3) Transformed through the use of expressions which can include trigonometric, logarithmic, date and character functions.
- 4) Subset to display only what is relevant.

This very powerful flexibility to combine and calculate data can also be used to specify various other items that affect the appearance of a graph. This is possible because most values in the DRAW commands can be specified as expressions or constants.

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SECTION 2
C O M M A N D S

CLOSE PLOTFILE

Closes the currently open plotfile.

Since only one plotfile can be open at a time, no filename is necessary. An OPEN PLOTFILE command need not have been entered, as a plotfile is automatically opened when any GRAF commands are issued. The plotfile is saved into the domain specified when the file was created.

CLOSE PLOTFILE

EXAMPLES:

The currently open plot file can be closed with the CLOSE PLOTFILE command. The command will not generate an error if a plot file is not open.

```
)CLOSE PLOTFILE  
)
```

CREATE PLOTFILE **plotfilename**
[;RETENTION=PERMANENT/TEMPORARY/NONE]

Create a named plotfile which can be used to generate graphs at a later time.

plotfilename	Required. The name of the plot file to be created. The name must be a valid MPE file name and must not presently exist as a permanent file (or in the domain given if the RETENTION keyword is used).
RETENTION	Optional. Specifies the domain in which the file should be saved. By default the file is saved in the permanent domain. If the RETENTION is TEMPORARY, the file is purged when the user logs off. If the RETENTION is NONE, the file is purged when it is closed.

The execution of a CREATE PLOTFILE command will cause any previously opened plot file to be closed.

CREATE PLOTFILE

EXAMPLES:

A plot file may be explicitly created and saved by the user. This is useful if graph generation is done in a job. Normally, the user is not concerned with saving the results of a graph and the plot file management can be left to GRAF.

```
)CREATE PLOTFILE JOB1; RETENTION=TEMP  
THE "JOB1" FILE HAS BEEN CREATED AS A TEMPORARY PLOT FILE.  
)
```

```

DRAW ARC
START=angle
;FINISH=angle
;RADIUS=radius
[;AT=x,y]
[;COLOR=color]
[;LINETYPE=linetype]

```

Draws an arc (or a set of arcs) in the current frame.

START	Required. Must be followed by an expression that gives the starting angle of the arc. Zero degrees is at the 3 o'clock position. The angle is measured in the counterclockwise direction.
FINISH	Required. Must be followed by an expression that indicates the finish angle of the arc. Zero degrees is at the 3 o'clock position. The angle is measured in degrees in a counterclockwise direction. An arc with the same start and finish angle represents a complete circle.
RADIUS	Required. Must be followed by an expression that indicates the radius of the arc. The radius of the arc must be expressed in the current units system. A radius of zero will not cause an arc to be drawn. A negative radius is an error.
AT	Optional. If specified, an X and Y position must follow. This coordinate represents the center of the arc and must be expressed in the current unit system. If not specified, the arc is assumed to be centered at the current pen position.
COLOR	Optional. If specified, this must be followed by an expression which represents the color to be used. If not specified, 1 is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
LINETYPE	Optional. If specified, this must be followed by an expression which represents the linetype to be used. If not specified, 1 is assumed. If a line type of zero is used, no line is drawn. A negative line type is an error.

If any of the expressions contain fields, an arc will be drawn for each record read from the current file. If fields are not used in the command only a single arc will be drawn.

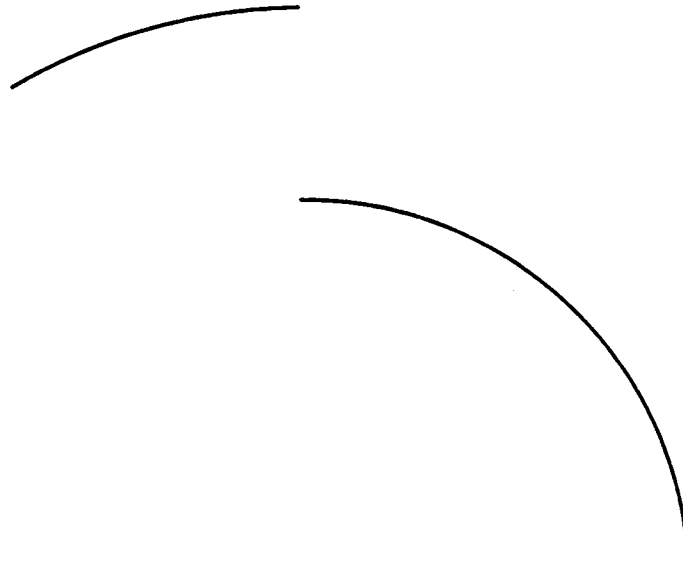
DRAW ARC

EXAMPLES:

The system can be used to draw circles and arcs. This capability is useful when creating overhead transparencies as well as complex shapes required by applications programs.

When an arc is drawn, the starting and ending angles, the radius, and usually the center are specified. The angles are measured counter clockwise from the 3 o'clock position. The radius and center must be in the current units system.

```
)DRAW ARC START=0; FINISH=90; RADIUS=2; AT=4,4  
)DRAW ARC START=90; FINISH=120; RADIUS=3; AT=4,4  
)PLOT
```



Normally, a single arc is drawn for each command. If a field (or an expression containing a field) is used in the command an arc is drawn for each record in the file.

)OPEN FILE ARCS

)PRINT

\$LINE	RAD
--------	-----

1	1.0
---	-----

2	1.5
---	-----

3	2.0
---	-----

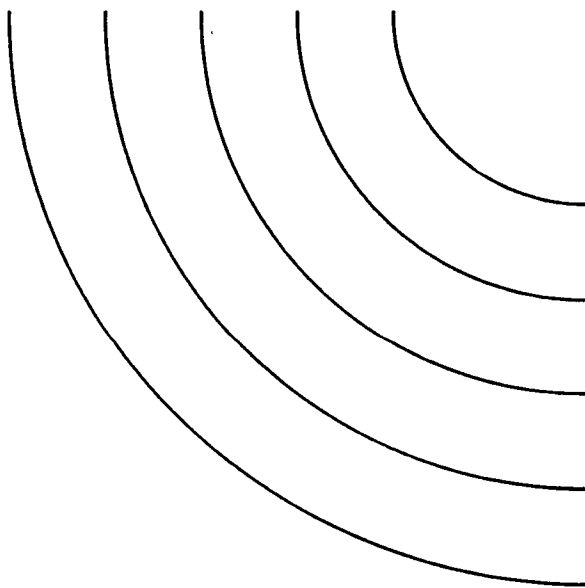
4	2.5
---	-----

5	3.0
---	-----

5 LINES PRINTED.

)DRAW ARC START=180; FINISH=270; RADIUS=RAD; AT=4,4

)PLOT



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```

DRAW BARCHART yspec [,...] BY xspec
      [,FORMAT=CLUSTERED/STACKED]
      [,KEY=keyspec]
      [,TITLE=titlespec]
      [,SUBTITLE=titlespec]
      [,LEGEND=legendspec]
      [,FRAME=[color],linetype]]

```

Draws a barchart of the data represented by the xspec against the data represented by the yspec(s).

xspec	Required. The specification of the x field. The specification may contain only a field name (or an expression) or it may be a more complex entity describing scale sizes, axis positions, character fonts, etc. Only a single xspec may be specified. For a complete description of the options available see the FIELD SPECIFICATIONS section.
yspec	Required. The specification of the y field. The specification may contain only a field name (or an expression) or it may be a more complex entity describing the scale of the axis, line types, colors, etc. Multiple y field specifications may be given. Only the first specification may contain information about the axis. For a complete description of the options available see the FIELD SPECIFICATIONS section.
FORMAT	Optional. If specified, the keyword must be followed by either CLUSTERED or STACKED. If CLUSTERED is specified, multiple bar charts will be drawn as adjacent bars. If STACKED is specified, multiple bar charts will be drawn stacked on top of each other. If FORMAT is not specified, CLUSTERED is assumed.
KEY	Optional. If specified, the keyword must be followed by a fieldname or an expression from the current path. The KEY option is used when multiple yspecs are desired, and the data for the different yspecs are contained in the same field in the file, but in different records. The key option specifies another field in the file that can be used to distinguish the yspecs. The SET option in the field specification specifies the value of the key field for each yspec.
TITLE	Optional. If specified, the keyword must be followed by information that describes the title for the graph. For a complete description of the options available for the title see the TITLE SPECIFICATIONS section.
SUBTITLE	Optional. If specified, the keyword must be followed by information that describes the subtitle for the graph. The subtitle will appear below the title (if the title appears) and the lettering will be slightly smaller. For a complete description of the options available for the subtitle see the TITLE SPECIFICATIONS section.

DRAW BARCHART

LEGEND

Optional. If specified, the keyword must be followed by information that describes the legends that should be placed on the graph to annotate the drawing. If not specified, no legends will be drawn. For a complete description of the options available see the LEGEND SPECIFICATIONS section.

FRAME

Optional. If specified, this must be followed by values for color or linetype or both. This determines the appearance of the outer frame around the entire graph. If color is not specified, one is assumed. If linetype is not specified, one is assumed. If either value is zero, no line will be drawn. See the COLORS and TEXTURES section for more information.

EXAMPLES:

Bar charts can be drawn to represent discrete data. In the simplest case, only two fields need be specified.

)OPEN FILE GRSALES

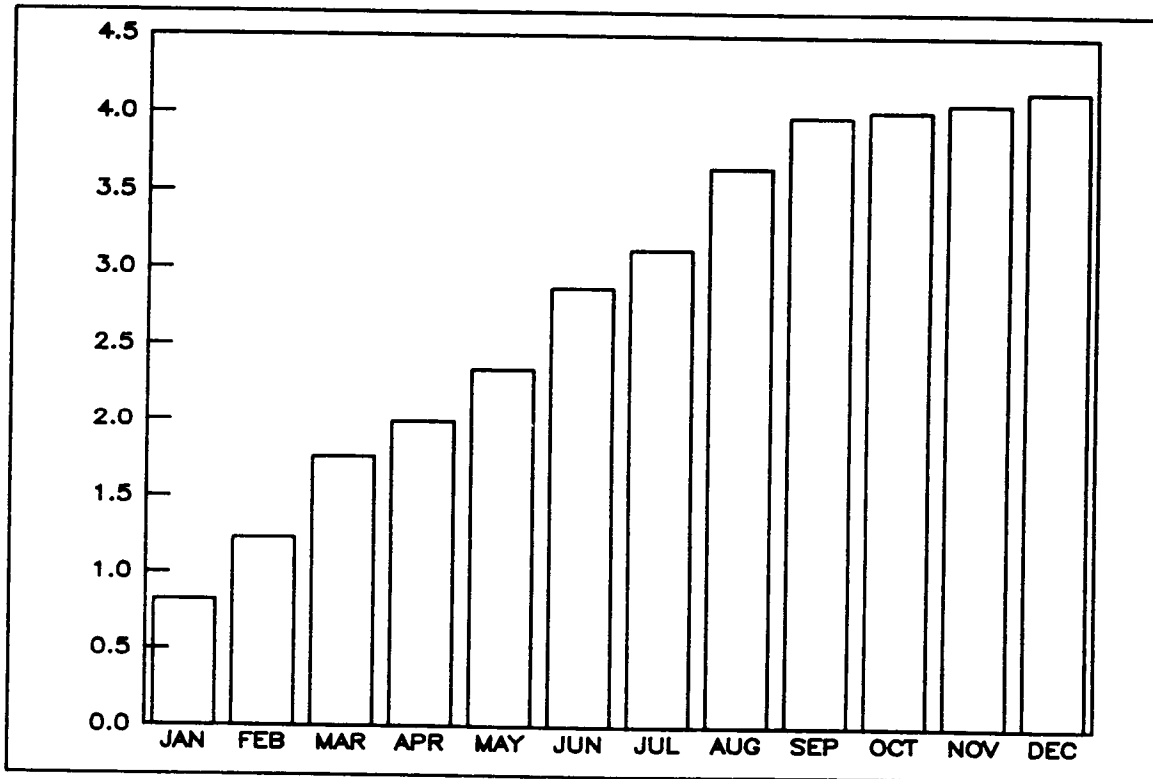
)PRINT

\$LINE	DATE	ACTUAL	PROJECTED
1	1/31/81	0.82	1.43
2	2/28/81	1.23	1.77
3	3/31/81	1.76	2.83
4	4/30/81	1.99	2.54
5	5/31/81	2.34	2.89
6	6/30/81	2.87	3.03
7	7/31/81	3.12	3.05
8	8/31/81	3.65	3.40
9	9/30/81	3.98	3.70
10	10/31/81	4.02	3.90
11	11/30/81	4.07	4.10
12	12/31/81	4.15	4.23

12 LINES PRINTED.

)DRAW BARCHART ACTUAL BY \$MONTH (DATE,1)

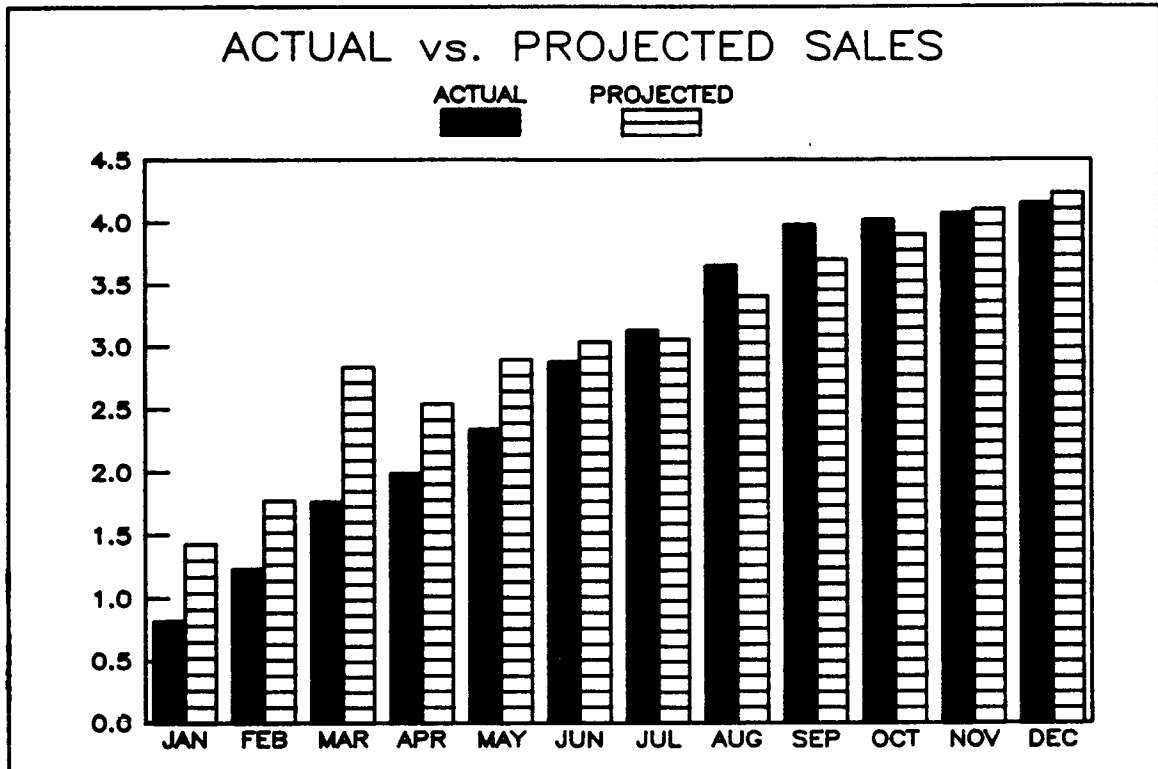
)PLOT



DRAW BARCHART

Bar charts may be annotated with titles, subtitles, legends, and axis information.

```
)DRAW BARCHART ACTUAL,(PROJECTED; SHADE=9) &  
&)    BY $MONTH(DATE,1) &  
&)    ; TITLE="ACTUAL vs. PROJECTED SALES" &  
&)    ; LEGEND= ("ACTUAL"), ("PROJECTED"; SHADE=9))  
)PLOT
```



Bars in a barchart may be stacked in order to represent subtotals and totals simultaneously. The positions of titles and legends may be user-specified. If an outer frame is not called for, it can be eliminated by specifying zero for linetype or color on the FRAME keyword.

)OPEN FILE REVENUE
)PRINT

\$LINE YEAR COMPUTER TEST MEDICAL INST

1	1976	450	493	120	58
2	1977	576	581	135	76
3	1978	744	732	163	98
4	1979	1060	986	193	122
5	1980	1510	1200	230	159
6	1981	1771	1349	273	185
7	1982	2140	1550	305	205
8	1983	2675	1920	355	235
9	1984	3325	2300	405	270
10	1985	4200	2765	475	310

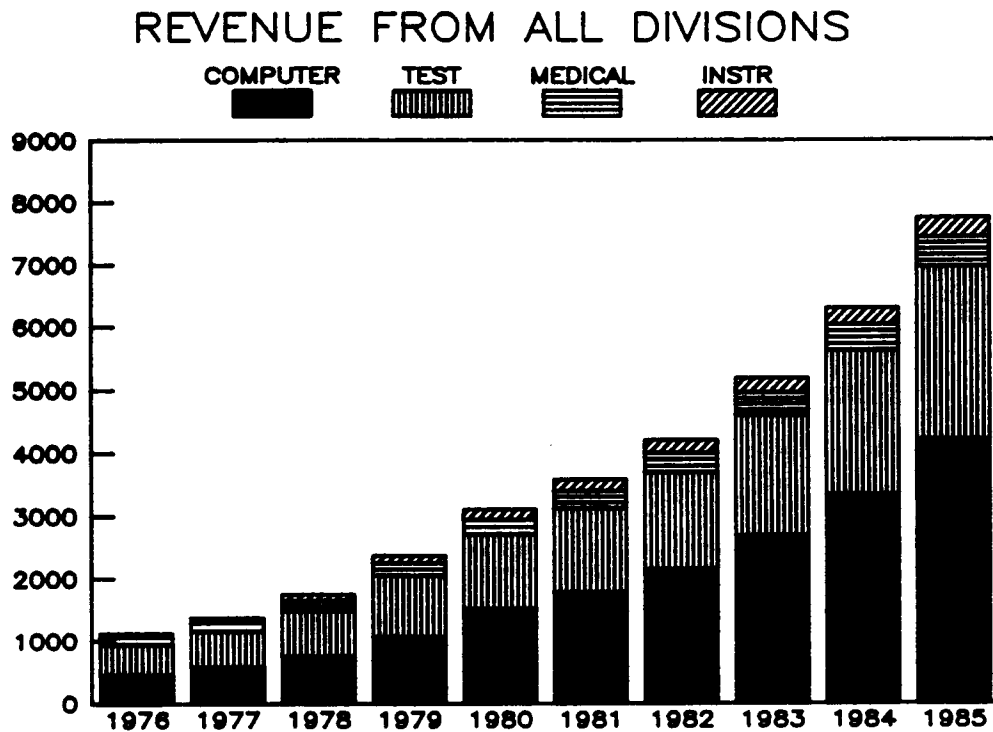
10 LINES PRINTED.

DRAW BARCHART

```

)DRAW BARCHART COMPUTER,(TEST;SHADE=2),(MEDICAL;SHADE=7),&
&      (INST;SHADE=13) BY YEAR; &
&      FORMAT=STACKED; &
&      TITLE= ("REVENUE FROM ALL DIVISIONS"),&
&      LEGEND=(POSITION=TOP,CENTER,("COMPUTER"),&
&      ("TEST";SHADE=2),("MEDICAL";SHADE=7),&
&      ("INSTR";SHADE=13)); &
&      FRAME=0
)PLOT

```



```

DRAW BOX SIZE=width, height
        [;AT=x,y]
        [;SHADE=shade]
        [;LINETYPE=linetype]
        [;COLOR=color]
        [;JUSTIFY=justify]

```

Draws a box of the specified size.

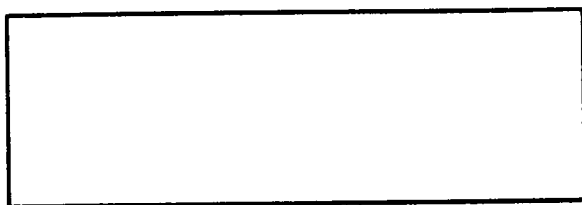
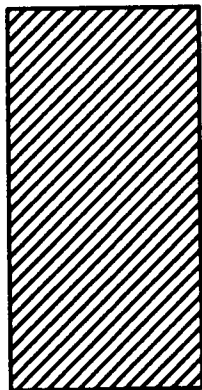
SIZE	Required. Specifies the width and height of the box in the current unit system.
AT	Optional. If specified, this keyword must be followed by expressions for the x and y coordinates in relation to which the box will be placed (see the JUSTIFY parameter). The default is zero, zero.
SHADE	Optional. If specified, this keyword must be followed by an expression that indicates what shade type to use inside the box. Two overlapping shade types may be specified by entering a 4-digit number. If not specified, zero is assumed. See the Colors and Textures appendix for more information.
LINETYPE	Optional. If specified, this keyword must be followed by an expression indicating the linetype to be used in drawing the box. If not specified, one is assumed. If a line type of zero is used, no line is drawn. A negative line type is an error. See the Colors and Textures appendix for more information.
COLOR	Optional. If specified, the keyword must be followed by an expression representing the color to be used in drawing and shading the box. If not specified, one is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
JUSTIFY	Optional. If specified, this keyword must be followed by an expression indicating how the box will be aligned in relation to the point specified with the AT parameter. The default is one; meaning the bottom left corner of the box will be aligned. Two is the center left side, three is the top left side, four is the bottom center, and so on through nine which is the top right corner.

DRAW BOX

EXAMPLES:

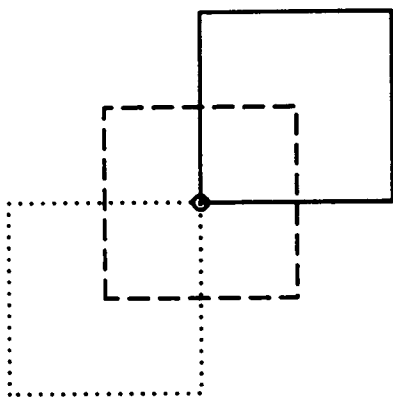
Boxes can be drawn to nearly any specification.

```
)DRAW BOX SIZE=1,2; AT=0,0; SHADE=14  
)DRAW BOX SIZE=3,1; AT=2,0  
)PLOT
```



The justification of the box indicates its relation to the "AT" point.

```
)DRAW MARKER 6; AT=2,2  
)NOTE DEFAULT JUSTIFICATION IS 1; SOLID LINE BOX  
)DRAW BOX SIZE=1,1; AT=2,2  
)NOTE BROKEN LINE  
)DRAW BOX SIZE=1,1; AT=2,2; JUSTIFY=5; LINETYPE=6  
)NOTE DOTTED LINE  
)DRAW BOX SIZE=1,1; AT=2,2; JUSTIFY=9; LINETYPE=8  
)PLOT
```



```

DRAW GRAPH yspec [,...] BY xspec
      [;KEY=keyspec]
      [;TITLE=titlespec]
      [;SUBTITLE=titlespec]
      [;LEGEND=legendspec]
      [;FRAME=[color[,linetype]]

```

Draws a graph (or scattergram) of the data represented by the xspec against the data represented by the yspec(s).

yspec	Required. The specification of the y field. The specification may contain only a field name (or an expression) or it may be a more complex entity describing the scale of the axis, line types, colors, etc. Multiple y field specifications may be given. Only the first specification may contain information about the axis. For a complete description of the options available see the FIELD SPECIFICATIONS section.
xspec	Required. The specification of the x field. The specification may contain only a field name (or an expression) or it may be a more complex entity describing scale sizes, axis positions, character fonts, etc. Only a single xspec may be specified. For a complete description of the options available see the FIELD SPECIFICATIONS section.
KEY	Optional. If specified, the keyword must be followed by a fieldname or an expression from the current path. The KEY option is used when multiple yspecs are desired, and the data for the different yspecs are contained in the same field in the file, but in different records. The key option specifies another field in the file that can be used to distinguish the yspecs. The SET option on the field specification specifies the value of the key field for each yspec.
TITLE	Optional. If specified, the keyword must be followed by information that describes the title for the graph. For a complete description of the options available for the title see the TITLE SPECIFICATIONS section.
SUBTITLE	Optional. If specified, the keyword must be followed by information that describes the subtitle for the graph. The subtitle will appear below the title (if the title appears) and the lettering will be slightly smaller. For a complete description of the options available for the subtitle see the TITLE SPECIFICATIONS section.
LEGEND	Optional. If specified, the keyword must be followed by information that describes the legends that should be placed on the graph to annotate the drawing. If not specified, no legends will be drawn. For a complete description of the options specified see the LEGEND SPECIFICATIONS section.

DRAW GRAPH

FRAME

Optional. If specified, this must be followed by values for color or linetype or both. This determines the appearance of the outer frame around the entire graph. If color is not specified, one is assumed. If linetype is not specified, one is assumed. If either value is zero, no frame will be drawn. See the Colors and Textures appendix for more information.

To draw a scattergram, a LINETYPE of zero should be specified in each of the appropriate yspecs. A LINETYPE of zero prevents lines from being drawn.

EXAMPLES:

The DRAW GRAPH command can be used to draw line graphs, scattergrams, and graphs containing both types of data representation. Normally, each variable on a graph is contained within a field in a file.

) OPEN FILE REVENUE

) PRINT

\$LINE YEAR COMPUTER TEST MEDICAL INST

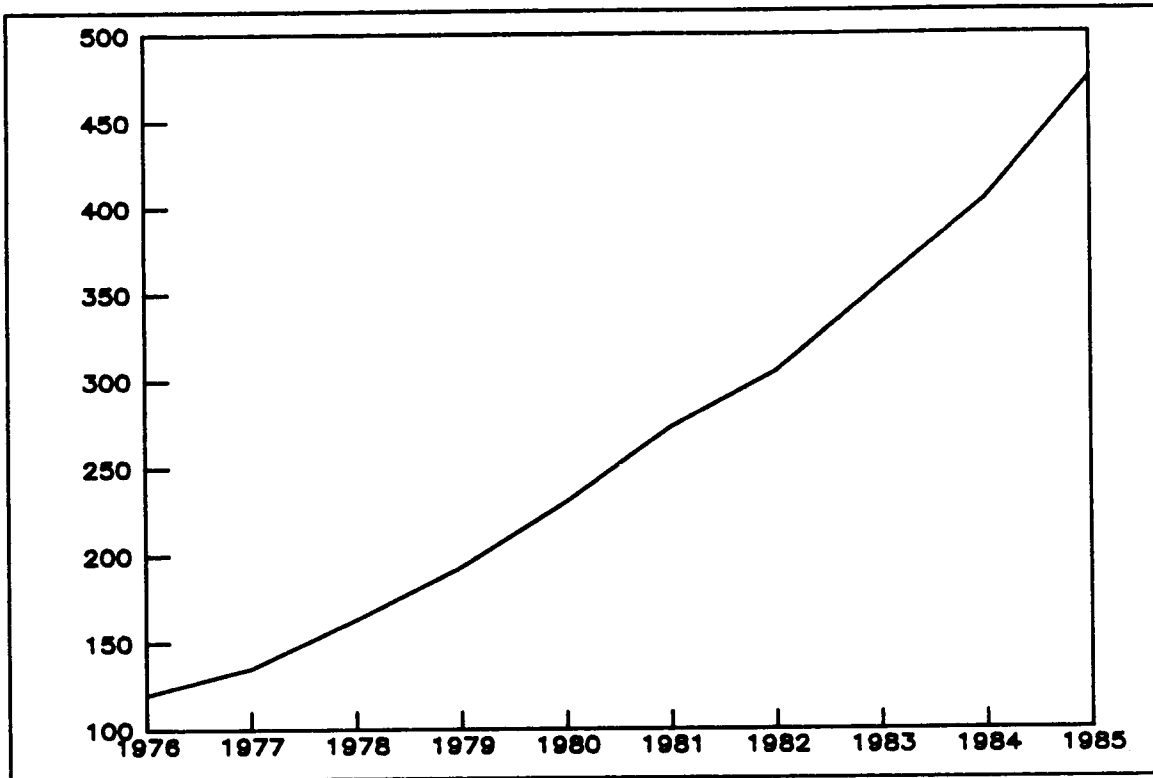
1	1976	450	493	120	58
2	1977	576	581	135	76
3	1978	744	732	163	98
4	1979	1060	986	193	122
5	1980	1510	1200	230	159
6	1981	1771	1349	273	185
7	1982	2140	1550	305	205
8	1983	2675	1920	355	235
9	1984	3325	2300	405	270
10	1985	4200	2765	475	310

10 LINES PRINTED.

DRAW GRAPH

In this example the file represents sales history and projections for divisions of a company. To generate a graph from this information the user needs to inform RELATE of the fields to compare. RELATE will automatically determine axis values and scale the graph accordingly.

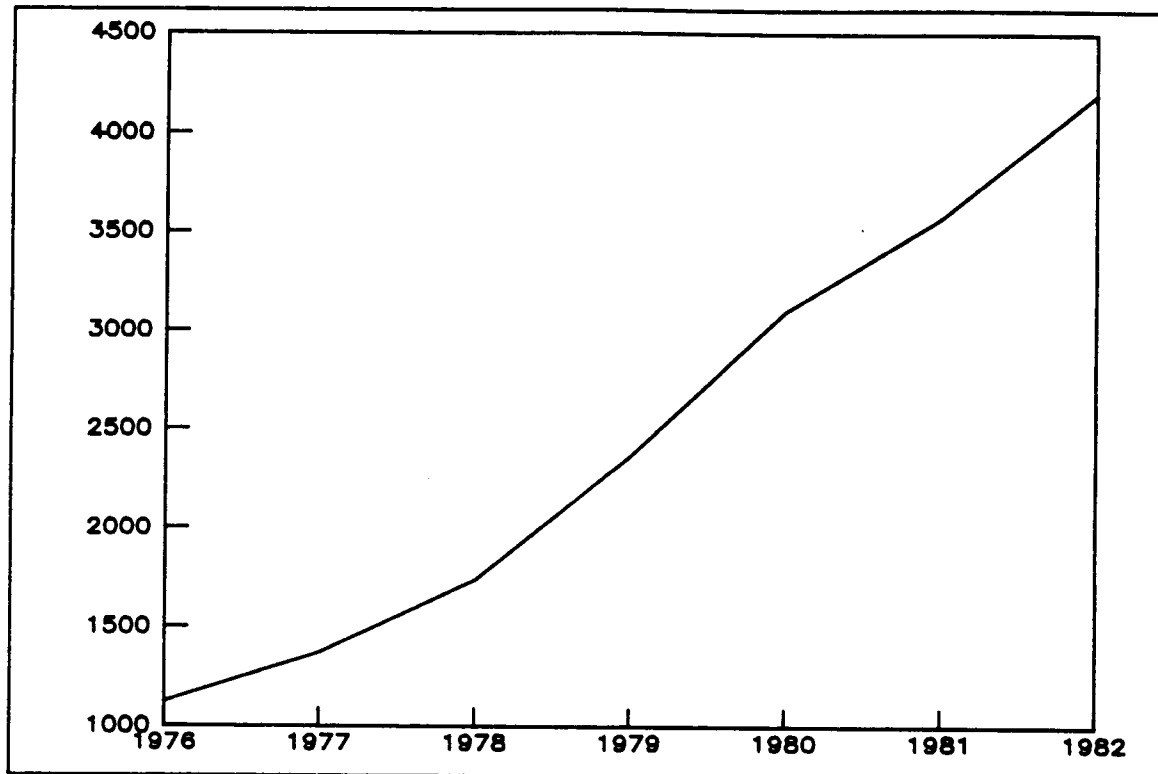
```
)DRAW GRAPH MEDICAL BY YEAR  
)PLOT
```



DRAW GRAPH

The data placed on the graph can be the result of a SELECT command. The SELECT command can be used to arithmetically manipulate, aggregate, or subset the data to display only the relevant portions. In the example below, only historic information is displayed.

```
)SELECT TOTAL=COMPUTER+TEST+MEDICAL+INST, YEAR WHERE YEAR<=1982  
)DRAW GRAPH TOTAL BY YEAR  
)PLOT
```

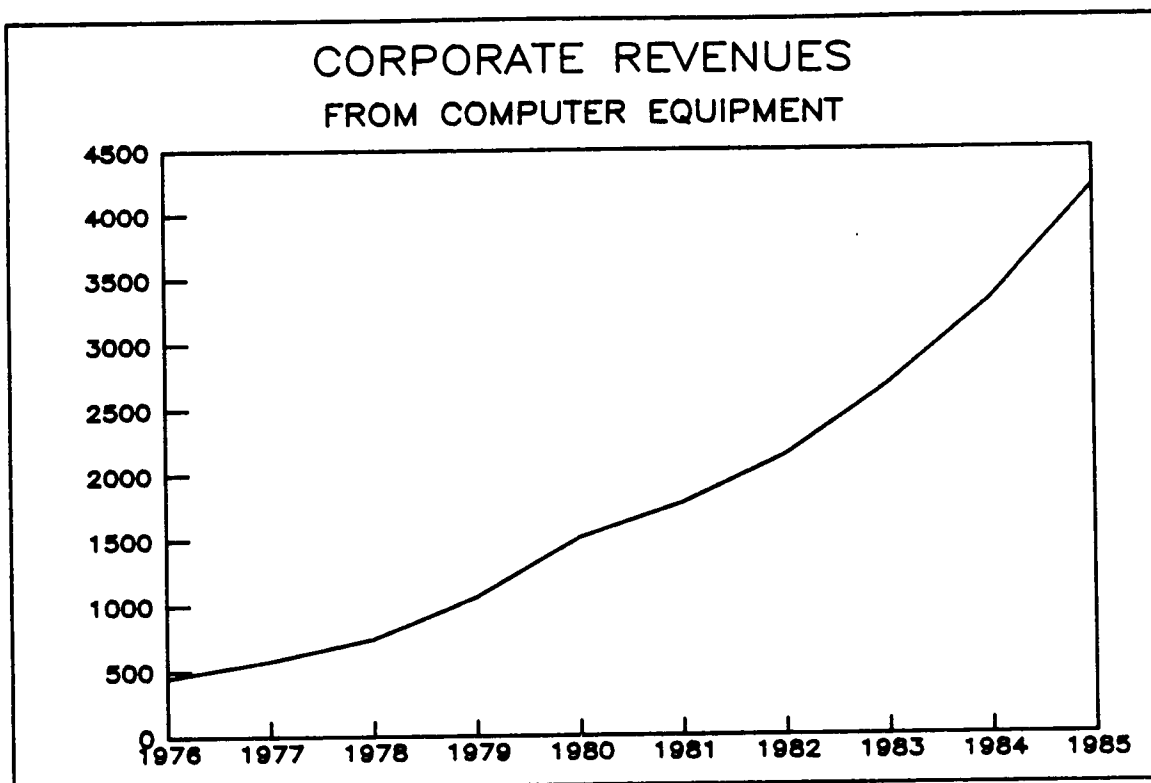


```
)SELECT  
DE-SELECTED. THE CURRENT PATH IS "REVENUE".
```

DRAW GRAPH

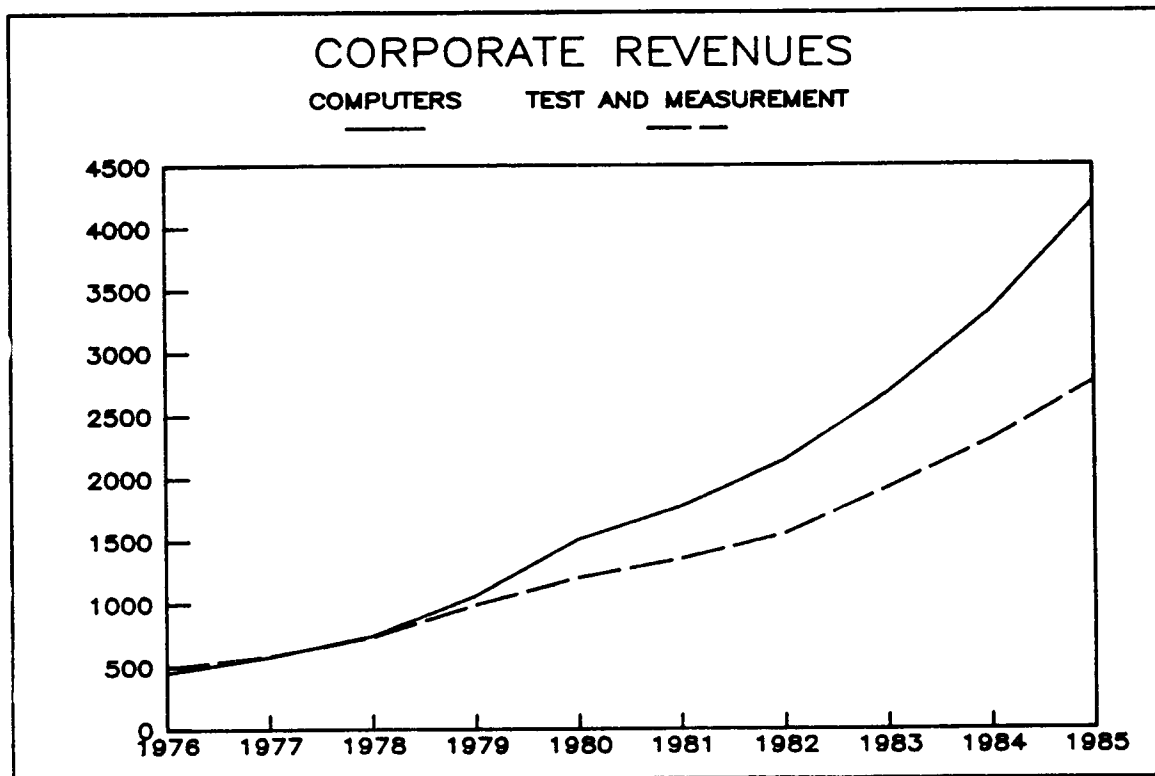
Titles and subtitles can easily be added. The user need only be concerned with the text, font, and color, and not the placement.

```
)DRAW GRAPH COMPUTER BY YEAR &  
&)      ; TITLE="CORPORATE REVENUES" &  
&)      ; SUBTITLE="FROM COMPUTER EQUIPMENT"  
)PLOT
```



Several variables may be placed on the same graph. Colors, linetypes, or markers can be used to differentiate between the data. Legends can then be used to define the data.

```
)DRAW GRAPH COMPUTER,(TEST; LINETYPE=2) BY YEAR &
&)      ; LEGEND= ("COMPUTERS"), &
&)      ("TEST AND MEASUREMENT"; LINETYPE=2)) &
&)      ; TITLE="CORPORATE REVENUES"
)PLOT
```



DRAW GRAPH

The DRAW GRAPH command can also be used to create scattergrams by including a MARKER type on the yspec and setting the LINETYPE to zero.

```
)OPEN FILE INCOME  
)PRINT
```

\$LINE COLLEGE SALARY

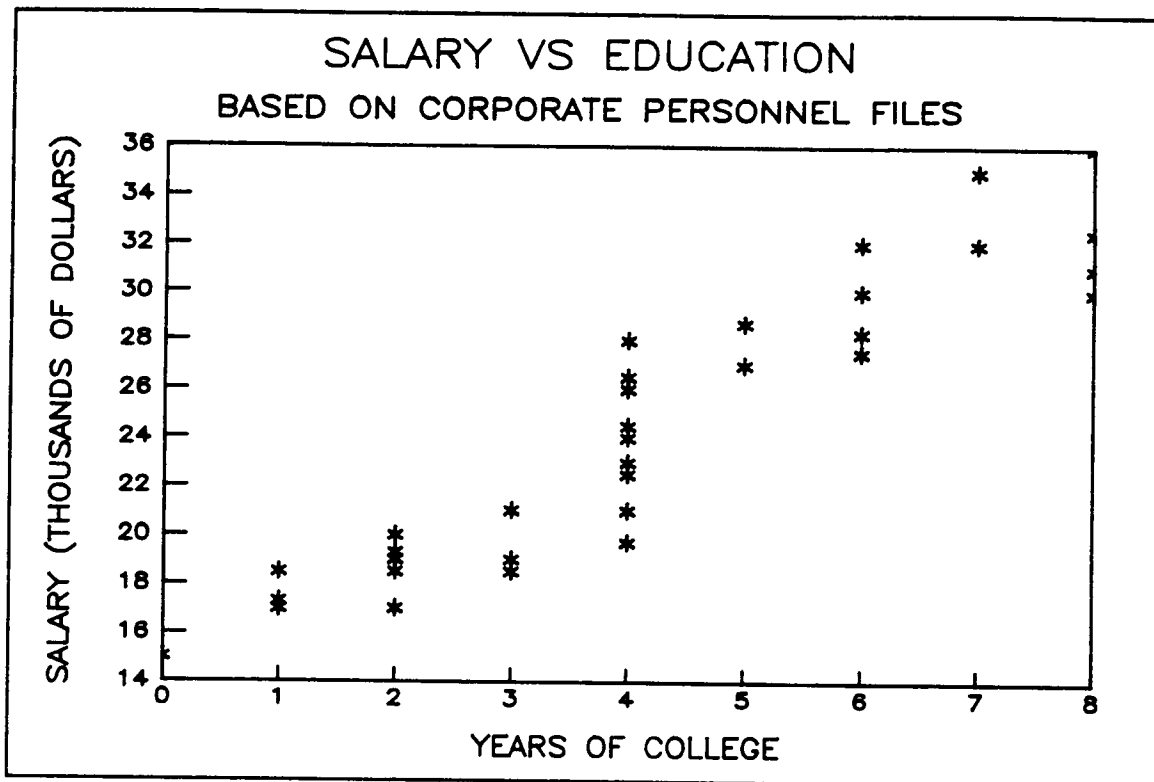
1	0	15.0
2	1	18.5
3	1	17.0
4	1	17.3
5	2	18.5
6	2	19.0
7	2	20.0
8	2	17.0
9	2	19.0
10	2	19.3
11	3	19.0
12	3	18.5
13	3	21.0
14	4	19.7
15	4	21.0
16	4	23.0
17	4	22.5
18	4	26.0
19	4	24.5
20	4	28.0
21	4	26.5
22	4	24.0
23	5	28.7
24	5	27.0
25	6	27.5
26	6	32.0
27	6	30.0
28	6	28.3
29	7	32.0
30	7	35.0
31	8	30.0
32	8	36.0
33	8	31.0
34	8	32.5

34 LINES PRINTED.

```

)DRAW GRAPH (SALARY;AXIS=(TITLE="SALARY (THOUSANDS OF DOLLARS)");&
&)
          MARKER=1;LINETYPE=0) &
&)
          BY (COLLEGE;AXIS=(TITLE="YEARS OF COLLEGE"));&
&)
          TITLE="SALARY VS EDUCATION";&
&)
          SUBTITLE="BASED ON CORPORATE PERSONNEL FILES"
)PLOT

```



Complete descriptions of the content of the xspec, yspex, keyspec, titlespec, and legendspec are given in individual sections later in the manual.

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```

DRAW HISTOGRAM spec[,...]
[;FORMAT=CLUSTERED/STACKED]
    [;KEY=keyspec]
    [;TITLE=titlespec]
    [;SUBTITLE=titlespec]
    [;LEGEND=legendspec]
    [;FRAME=[color[,linetype]]

```

Draws a histogram indicating the distribution of the data given in the specification.

spec	Required. The specification for the field(s) for which the distribution will be plotted. The specification(s) may be a field name or it may be a more complex entity describing the ranges and shades for each. For a complete description of the options available see the FIELD SPECIFICATIONS section.
FORMAT	Optional. If specified, the keyword must be followed by either CLUSTERED or STACKED. If CLUSTERED is specified, multiple histogram charts will be drawn as adjacent bars. If STACKED is specified, multiple bars will be drawn stacked on top of each other. If FORMAT is not specified CLUSTERED is assumed.
KEY	Optional. If specified, the keyword must be followed by a fieldname or an expression from the current path. The KEY option is used when multiple yspecs are desired, and the data for the different yspecs are contained in the same field in the file, but in different records. The key option specifies another field in the file that can be used to distinguish the yspecs. The SET option in the field specification specifies the value of the key field for each yspec.
TITLE	Optional. If specified, the keyword must be followed by information that describes the title for the graph. For a complete description of the options available for the title see the TITLE SPECIFICATIONS section.
SUBTITLE	Optional. If specified, the keyword must be followed by information that describes the subtitle for the graph. The subtitle will appear below the title (if the title appears) and the lettering will be slightly smaller. For a complete description of the options available for the subtitle see the TITLE SPECIFICATIONS section.
LEGEND	Optional. If specified, the keyword must be followed by information that describes the legends that should be placed on the graph to annotate the drawing. If not specified, no legends will be drawn. For a complete description of the options available see the LEGEND SPECIFICATIONS section.

DRAW HISTOGRAM

FRAME

Optional. If used, this keyword must be followed by values for color or linetype or both. This determines the appearance of the outer frame around the entire histogram. If color is not specified, one is assumed. If linetype is not specified, one is assumed. If either value is zero, no frame will be drawn. See the Colors and Textures appendix for more information.

EXAMPLES:

Histograms can be drawn to represent the distribution of discrete data. Unlike barcharts and line graphs only a single field need be specified to draw the chart. The system automatically calculates the ranges assigned to the bars.

```
)OPEN FILE SAMPLES
)1/15 PRINT
```

```
$LINE PRESSURE
```

1	0.01
2	0.01
3	0.02
4	0.00
5	0.01
6	0.03
7	0.01
8	0.03
9	0.02
10	0.05
11	0.04
12	0.04
13	0.04
14	0.02
15	0.03

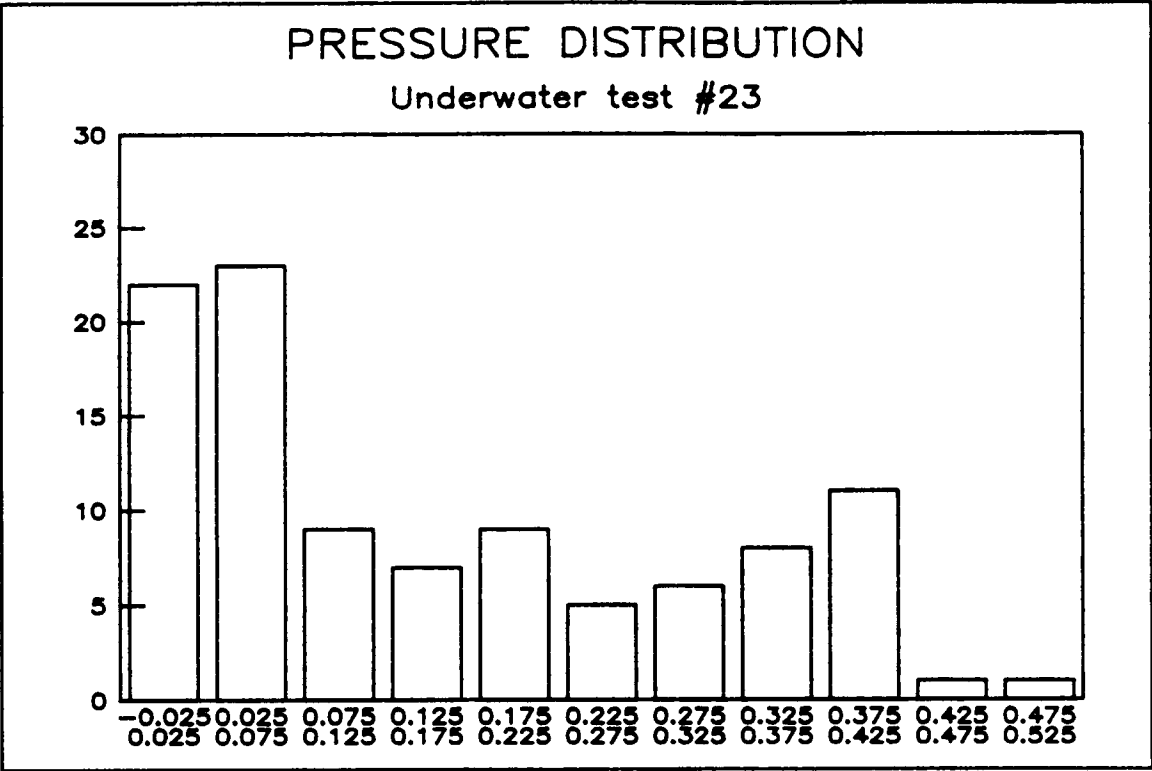
```
15 LINES PRINTED.
```

```
)NOTE THESE ARE ONLY THE FIRST 15 LINES OF THE FILE.
```

```
)NOTE THERE IS MUCH MORE DATA IN THE FILE THAN IS SHOWN HERE.
```

DRAW HISTOGRAM

```
)DRAW HISTOGRAM PRESSURE &  
&)      ; TITLE="PRESSURE DISTRIBUTION" &  
&)      ; SUBTITLE="Underwater test #23"  
)PLOT
```



)

```

DRAW LABEL text
      [;AT=x,y]
      [;SIZE=width,height]
      [;SLANT=slant]
      [;ANGLE=angle]
      [;COLOR=color]
      [;FONT=font]
[;JUSTIFY=[TOP/CENTER/BOTTOM],LEFT/CENTER/RIGHT]]

```

Draws a label in the current frame.

text	An expression (or quoted constant) which will be converted to characters and drawn.
AT	Optional. If specified, this keyword must be followed by expressions indicating an x and y position of the start of the label. The label's lower left hand corner is normally at the given position. This can be changed with the JUSTIFY option. If not specified, the label will be drawn starting at the current pen position. If the graph is drawn with color sequencing (see the PLOT command) the AT keyword should always be specified.
SIZE	Optional. If specified, this keyword must be followed by expressions that represent the height and width of each character in the label. If not specified, the height is assumed to be 2% of the height of the frame and the width is assumed to be 1% of the width of the current frame.
SLANT	Optional. If specified, this keyword must be followed by an expression that represents the slant of the text. Positive slants rotate in a clockwise direction and negative slants rotate counterclockwise. If not specified, the slant is assumed to be zero.
ANGLE	Optional. If specified, this keyword must be followed by an expression indicating the angle at which the text will be plotted. The angle is measured counterclockwise from zero at the 3 o'clock position. If not specified, zero is assumed.
COLOR	Optional. If specified, this keyword must be followed by an expression which represents the color to be used. If not specified, 1 is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
FONT	Optional. If specified, this keyword must be followed by an expression which represents the print font to be used. If not specified, a zero is assumed. See the Colors and Textures appendix for more information.
JUSTIFY	Optional. If specified, this keyword must be followed by one or two position keywords. These keywords indicate what part of the label should be placed at the given (or assumed) X and Y position. If not specified, BOTTOM and LEFT are assumed.

DRAW LABEL

If any of the expressions contain fields, a label will be drawn for each record read from the current file. If fields are not used in the command only a single label will be drawn.

EXAMPLES:

The AT option specifies the location around which a label will be justified. If a JUSTIFY keyword is not specified the position indicates the lower left hand corner of the first character of the label.

```
)DRAW LABEL "STARTING AT 1.0, 0.5"; AT=1.0,0.5
)DRAW LABEL "STARTING AT 3.0, 0.8"; AT=3.0,0.8
)PLOT
```

STARTING AT 3.0, 0.8
STARTING AT 1.0, 0.5

If the JUSTIFY keyword is used, the text can be justified at the corners or midpoints of the label.

```
)DRAW LABEL "CENTERED ON THE LABEL"; AT=1.0,1.0
)DRAW LABEL "LEFT JUSTIFIED"; AT=4.0,2.0; JUSTIFY=BOTTOM,RIGHT
)DRAW LABEL "RIGHT JUSTIFIED"; AT=4.0,2.0; JUSTIFY=TOP,LEFT
)PLOT
```

LEFT JUSTIFIED
RIGHT JUSTIFIED

CENTERED ON THE LABEL

The slant of text can be controlled. The slant is measured from the vertical. A positive slant rotates the text clockwise, a negative slant rotates counter clockwise.

```
)DRAW LABEL "CLOCKWISE (POSITIVE SLANT)"; AT=2.5,1.0; SLANT=15
)DRAW LABEL "COUNTER CLOCKWISE (NEGATIVE SLANT)"; AT=2.0,1.5; &
&) SLANT=-25
)PLOT
```

COUNTER CLOCKWISE (NEGATIVE SLANT)
CLOCKWISE (POSITIVE SLANT)

DRAW LABEL

The angle can also be controlled. The angle is measured counter clockwise from the 3 o'clock position.

```
)SET FRAME 0,0,7,7
)DRAW LABEL "NORMAL TEXT (not rotated)"; AT=4.1,4.0; ANGLE=0
)DRAW LABEL "ROTATED 90 DEGREES"; AT=4.0,4.1; ANGLE=90
)DRAW LABEL "ROTATED 180 DEGREES"; AT=3.8,4.0; ANGLE=180
)DRAW LABEL "ROTATED 225 DEGREES"; AT=3.9,3.9; ANGLE=225
)DRAW LABEL "ROTATED 270 DEGREES"; AT=4.0,3.9; ANGLE=-90
)PLOT
```

ROTATED 90 DEGREES

ROTATED 270 DEGREES

ROTATED 180 DEGREES

ROTATED 225 DEGREES

NORMAL TEXT (not rotated)

By default, the system only draws one label for each execution of the LABEL command. If a fieldname is included anywhere in the command, one label is drawn for each record in the data file.

)OPEN FILE LABELS
)PRINT

\$LINE	TEXT	X	Y	FONT
1	At=4.0, 4.0; Font=1	4	4	1
2	At=3.0, 3.0; Font=2	3	3	2
3	At=2.0, 2.0; Font=3	2	2	3
4	At=1.0, 1.0; Font=4	1	1	4

4 LINES PRINTED.

)DRAW LABEL TEXT; AT=X,Y ; FONT=FONT
)PLOT

At=4.0, 4.0; Font=1

At=3.0, 3.0; Font=2

At=2.0, 2.0; Font=3

At=1.0, 1.0; Font=4

)

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```

DRAW LINE
  TO=x,y[,z]
  [;FROM=x,y[,z]]
  [;COLOR=color]
  [;LINETYPE=linetype]
  [;VIEWPOINT=x,y,z]

```

Draws a line (or set of lines) between the given points.

TO	Required. An x, y and possibly a z position must follow the keyword. The line will end at this point. If the data for the lines comes from a file the first record will move the pen to the indicated position. Subsequent records will actually draw lines.
FROM	Optional. If specified, an x, y and possibly a z position must follow the keyword. The line will be started at this point. If not specified, the line will be started at the current pen position. If the z coordinate is specified here it must also be specified in the TO clause.
COLOR	Optional. If specified, this must be followed by an expression which represents the color to be used. If not specified, 1 is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
LINETYPE	Optional. If specified, an expression which indicates the line type to be used must follow. For a description of the line types see the Colors and Textures appendix. If a line type of zero is used, no line is drawn. A negative line type is an error.
VIEWPOINT	Required if a z coordinate was specified in the starting or ending points. If specified, an x, y, and z coordinate must follow. The coordinates of the line drawn will be transformed and plotted as if they had been viewed from this position looking towards the origin. If not specified, (0,0,0) is assumed.

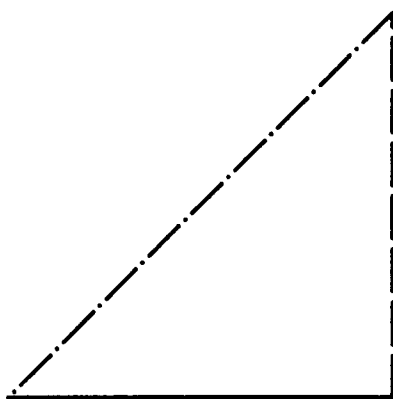
If any of the expressions contain fields, a line will be drawn for each record read from the current file. If fields are not used in the command only a single line will be drawn.

DRAW LINE

EXAMPLES:

Line drawings may be made directly by the user. The drawings can be in 2 or 3 dimensions. When lines are drawn the user must specify an ending position, and normally a starting position. The user has control over the line type and the color of the line.

```
)DRAW LINE FROM=1.0,1.0; TO=3.0,1.0; LINETYPE=1
)DRAW LINE FROM=3.0,1.0; TO=3.0,3.0; LINETYPE=2
)DRAW LINE FROM=3.0,3.0; TO=1.0,1.0; LINETYPE=3
)PLOT
```



If lines are drawn in three dimensions a viewpoint may be specified to change the point from which the object is observed.

```
)OPEN FILE LINES
)PRINT
```

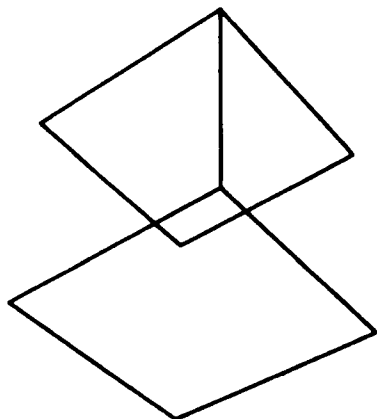
\$LINE	X	Y	Z
1	0	0	0
2	4	0	0
3	4	4	0
4	0	4	0
5	0	0	4
6	4	0	4
7	4	4	4
8	0	4	4
9	0	0	4
10	0	0	0

10 LINES PRINTED.

```
)SET UNITS .25 INCHES
```

DRAW LINE

**)DRAW LINE TO=X,Y,Z; VIEWPOINT=-8.0,-6.0,-10.0
)PLOT**



)

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**DRAW MARKER [markertype;] AT=x,y
[;COLOR=color]**

Draws a marker at the specified location.

markertype	Optional. Must be an expression determining the type of marker to be printed. Defaults to one. See the Colors and Textures appendix for more information.
AT	Required. Must be followed by expressions for the x and y coordinates where the marker will be placed.
COLOR	Optional. If specified, must be followed by an expression determining the color of the marker. If not specified, one is assumed. See the Colors and Textures appendix for more information.

DRAW MARKER

EXAMPLES:

The DRAW MARKER command will draw markers at locations based on the current units.

)OPEN FILE MARKS

)PRINT

\$LINE	MTYPE	X	Y
--------	-------	---	---

1	1	1	2
---	---	---	---

2	2	2	2
---	---	---	---

3	3	3	2
---	---	---	---

4	4	4	2
---	---	---	---

5	5	1	1
---	---	---	---

6	6	2	1
---	---	---	---

7	7	3	1
---	---	---	---

8	8	4	1
---	---	---	---

8 LINES PRINTED.

)DRAW MARKER MTYPE; AT=X,Y

)PLOT

*	+	△	□
---	---	---	---

◇	○	●	x
---	---	---	---

)

DRAW NEWPAGE

Causes any following graphics commands to be plotted on the next page.

On graphic CRTs, this will cause the screen to be cleared. On form-fed graphics devices, this will cause a formfeed to occur.

On single-sheet plotters, this will have no effect unless WAIT is specified on the PLOT command.

To cause GRAF to pause before doing each NEWPAGE, use the WAIT parameter on the PLOT command.

DRAW NEWPAGE

```

DRAW PIECHART amount
[;LABEL=labelspec[,labelspec]]
    [;SLANT=slant]
    [;COLOR=color]
    [;FONT=font]
    [;EXPLODE=explode]
    [;SHADE=shade]
    [;START=angle]
    [;TITLE=titlespec]
    [;SUBTITLE=titlespec]
    [;LEGEND=legendspec]
    [;FRAME=[color[,linetype]]

```

Draws a pie chart centered within the current frame.

amount	Required. An expression that represents the size of each of the segments. Each segment is proportioned based on the sum of the amounts in the file. The amounts may be in any unit system but must all be positive or negative.
LABEL	Optional. If specified, the keyword must be followed by a valid label specification as defined below. If not specified, labels are not drawn. If two labelspecs are specified, the first label will be drawn on the inside of the pie slices and the second will be drawn on the outside. If only the first labelspec is specified, an attempt will be made to put the label on the inside of the pie slices; but if it will not fit, the label will be placed on the outside.
SLANT	Optional. If specified, this must be followed by a value that represents the slant of the text. Positive slants rotate in a clockwise direction and negative slants rotate counterclockwise. If not specified, the slant is assumed to be zero.
COLOR	Optional. If specified, this must be followed by a value which represents the color to be used for each section of the chart. If not specified, 1 is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
FONT	Optional. If specified, the keyword must be followed by an expression which represents the print font to be used to label each section of the chart. If not specified, a zero is assumed. See the Colors and Textures appendix for more information.
START	Optional. If specified, the keyword must be followed by a constant or expression that gives the starting angle of the first section of the pie chart. Zero degrees is in the 3 o'clock position. The angle is measured in degrees in a counterclockwise direction. If not specified, the starting angle is assumed to be zero.

DRAW PIECHART

EXPLODE	Optional. If specified, the keyword must be followed by an expression that indicates which sections of the pie to pull out of the chart. If not specified no sections are exploded. If the expression evaluates to a non-zero value, the section of the pie will be exploded.
SHADE	Optional. If specified, the keyword must be followed by an expression that indicates what shade type to use on each section of the chart. Two overlapping shade types may be specified by entering a 4-digit number. If not specified, zero is assumed. See the Colors and Textures appendix for more information.
TITLE	Optional. If specified, the keyword must be followed by information that describes the title for the graph. For a complete description of the options available for the title see the TITLE SPECIFICATIONS section.
SUBTITLE	Optional. If specified, the keyword must be followed by information that describes the subtitle for the graph. The subtitle will appear below the title (if it appears) and the lettering will be slightly smaller. For a complete description of the options available for the subtitle see the TITLE SPECIFICATIONS section.
LEGEND	Optional. If specified, the keyword must be followed by information that describes the legends that should be placed on the graph to annotate the drawing. If not specified, legends will not be drawn. See the LEGEND SPECIFICATIONS section for more information.
FRAME	Optional. If used, this keyword must be followed by expressions for color or linetype or both. This determines the appearance of the outer frame around the piechart. If color is not specified, one is assumed. If linetype is not specified, one is assumed. If either value is zero, no frame will be drawn. See the Colors and Textures appendix for more information.

A label specification may be composed of the following:

```

textexpression
or
(textexpression
[;COLOR=color]
[;SLANT=slant]
[;FONT=font])

```

textexpression	Required. An expression that is used to label each section of the piechart. Multiple line labels may be generated by separating each logical line with a vertical bar character (" ").
COLOR	Optional. If specified, this must be followed by a value which represents the color to be used for the label. If not specified, 1 is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
SLANT	Optional. If specified, the keyword must be followed by a value that represents the slant of the text. Positive slants rotate in a clockwise direction and negative slants rotate counterclockwise. If not specified, the slant is assumed to be zero.
FONT	Optional. If specified, the keyword must be followed by an expression which represents the print font to be used to label each section of the chart. If not specified, a zero is assumed. See the Colors and Textures appendix for more information.

DRAW PIECHART

EXAMPLES:

To draw a pie chart the user need only specify an expression which represents the value of the pie slices. Normally, an expression is also specified for the labels of each segment. When only a single label is specified the system will place the label in the segment if possible, otherwise, the label is placed outside of the segment.

```
)OPEN FILE PIEDATA
```

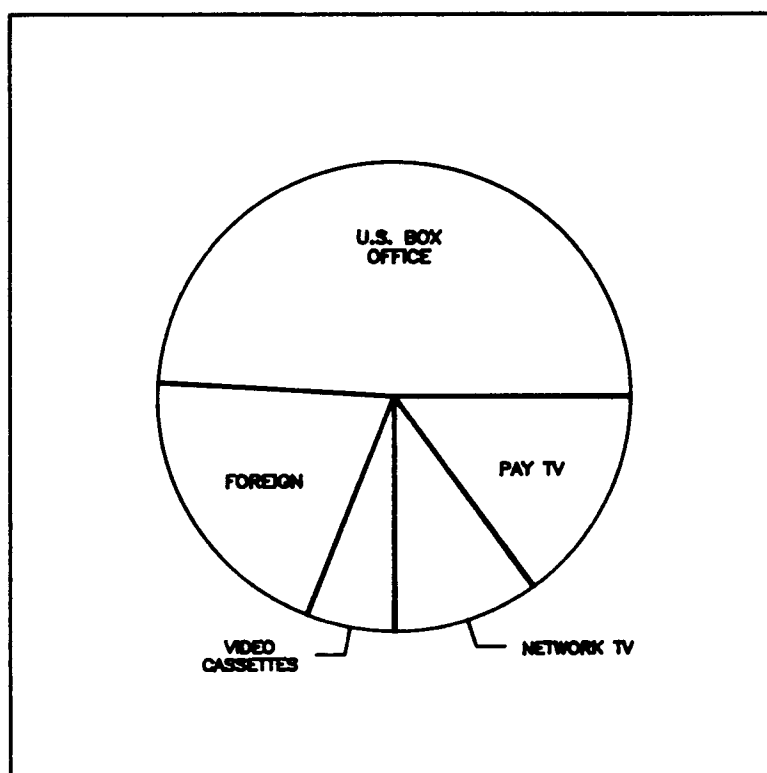
```
)PRINT
```

\$LINE	PERCENT	SEGMENT	CO	SH	EX
1	49	U.S. BOX OFFICE	3	0	0
2	20	FOREIGN	2	4	0
3	6	VIDEO CASSETTES	3	2	1
4	10	NETWORK TV	4	0	0
5	15	PAY TV	2	1	1

5 LINES PRINTED.

```
)DRAW PIECHART PERCENT; LABEL=SEGMENT
```

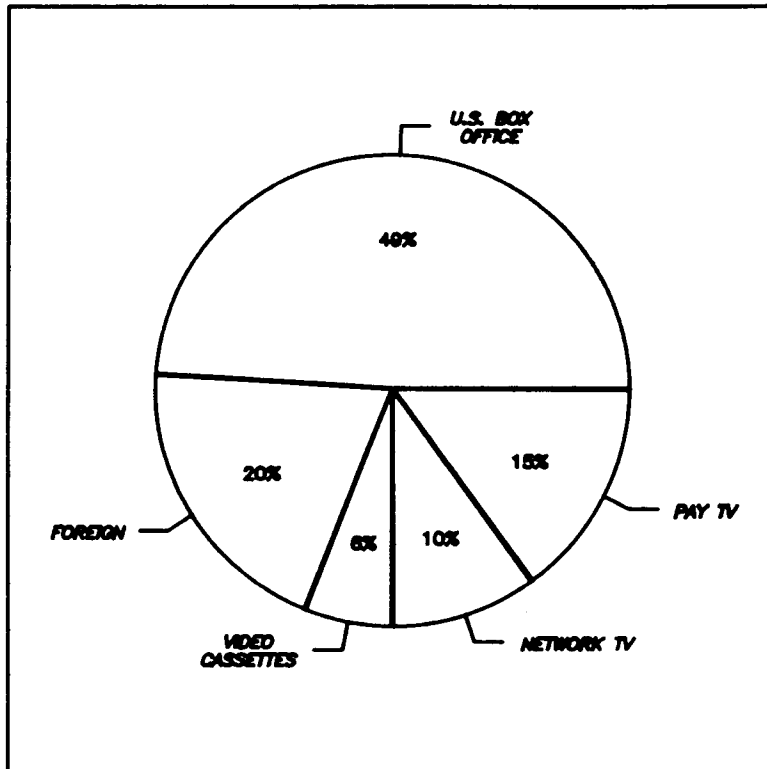
```
)PLOT
```



DRAW PIECHART

If two label specifications are provided, the system will place the first value in the pie slice and the second outside of the slice. In addition to controlling the placement of the labels the font, slant, and color of both labels may be controlled.

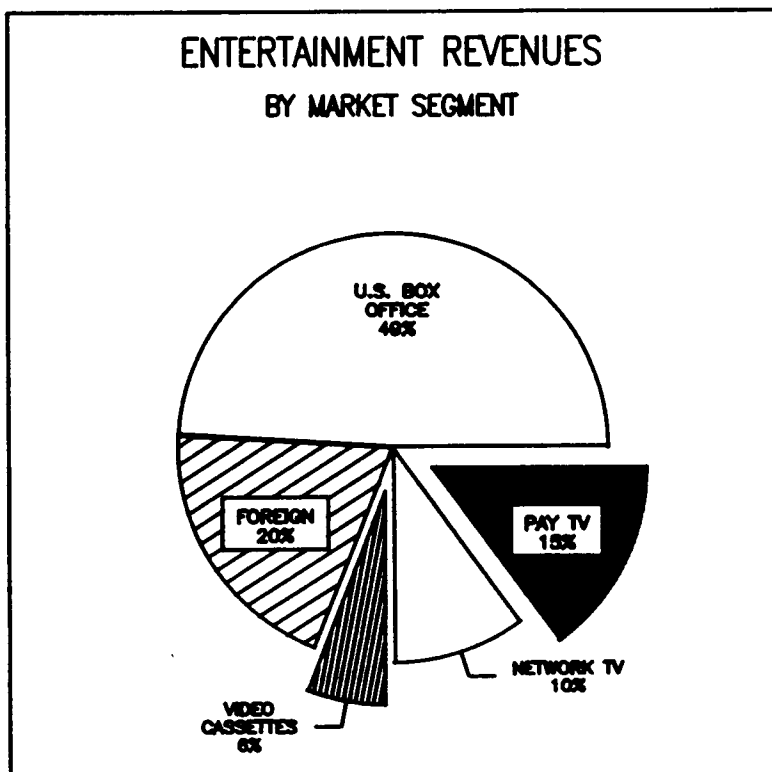
```
)DRAW PIECHART PERCENT &  
&) ; LABEL=$CONCAT(PERCENT,"%"),(SEGMENT; SLANT=15)  
)PLOT
```



DRAW PIECHART

Titles, subtitles, and legends can be added to the chart. Additionally, each segment can be exploded and can be colored and shaded differently.

```
)DRAW PIECHART PERCENT; LABEL=$CONCAT(SEGMENT,"|",PERCENT,"%") &  
&) ; TITLE="ENTERTAINMENT REVENUES" &  
&) ; SUBTITLE="BY MARKET SEGMENT" &  
&) ; SHADE=SH &  
&) ; EXPLODE=EX  
)PLOT
```



ERASE PLOTFILE

Erases the currently open plotfile.

ERASE PLOTFILE

EXAMPLES:

The currently open plot file can be erased and reused if an error is encountered during the execution of a GRAF command.

```
)ERASE PLOTFILE  
)
```

OPEN PLOTFILE plotfilename
[;DOMAIN=PERMANENT/TEMPORARY]

Opens an existing plot file.

plotfilename Required. The name of an existing Plot file. The plot file must exist in the permanent domain (or the domain given if the DOMAIN keyword is used).

DOMAIN Optional. Indicates the domain in which the plot file presently exists. By default the plot file is assumed to exist in the permanent domain. When the plot file is closed it is kept into the same domain.

The execution of an OPEN PLOTFILE command will cause any previously opened plot file to be closed.

OPEN PLOTFILE

EXAMPLES:

Plot files may be created and saved either in the permanent or temporary domains. These plot files can subsequently be displayed.

```
)OPEN PLOTFILE JOB1  
)
```

PLOT
[ONTO devicename[;HPIB=hpibnumber]]
[TO filename] [;SEQUENCE] [;WAIT]

Plots the information from the currently open plot file onto the indicated device.

devicename	Optional. A valid graphics device name. See the SET DEVICE command for a list of currently supported devices. If not specified, a SET DEVICE command must have been issued to inform the system of the device type.
HPIB	Optional. If the graphics device is connected by an HPIB interface, this keyword is required. The keyword must be followed by the correct device number.
TO	Optional. If the output file is not \$STDLIST, the actual name of the file should be given here.
SEQUENCE	Optional. If specified, the colors will be plotted in order, starting with all of color 1, then all of color 2, and so forth.
WAIT	Optional. If specified, the plotter will pause between colors, or at each occurrence of a DRAW NEWPAGE command, until the RETURN key is pressed. This allows each color to be plotted on a different piece of paper.

If more colors are used than are supplied on the plotter, the PLOT command will plot the number of colors supplied on the plotter, then wait to allow the operator to change pens. Pressing RETURN will resume plotting. This is an automatic feature and does not require any special input.

The output device should be turned on prior to the execution of the PLOT command. RELATE cannot verify the status of the device and may hang or abort if the device is not on.

PLOT

EXAMPLES:

```
) PLOT ONTO HP7221  
)
```

PURGE PLOTFILE

Purges the currently open plotfile.

PURGE PLOTFILE

EXAMPLES:

The PURGE PLOTFILE command can be used to purge the currently open plot file. The command can be used to remove a permanent plot file after the graphs have been generated.

```
)PURGE PLOTFILE  
)
```

```

SET DEFAULT LINETYPE=linetype1 [,linetype2 [...]]
SET DEFAULT SHADE=shade1 [,shade2 [...]]
SET DEFAULT COLOR=color1 [,color2 [...]]
SET DEFAULT MARKER=marker1 [,marker2 [...]]

```

Sets the default values for the DRAW GRAPH, DRAW BARCHART, and DRAW HISTOGRAM commands.

LINETYPE	If used, this keyword may be followed by one or more values indicating the linetypes to use in a GRAPH when plotting y-values. If no linetypes are specified, the defaults are reset to the original GRAF defaults. GRAF defaults are 1,2,3,4,5,6,7,8. See the Colors and Textures appendix for more information.
SHADE	If used, this keyword may be followed by one or more values indicating the shading to use in a BARCHART or HISTOGRAM when plotting y-values. If no shades are specified, the defaults are reset to the original GRAF defaults. GRAF defaults are 0,15,4,1,10,19. See the Colors and Textures appendix for more information.
COLOR	If used, this keyword may be followed by one or more values indicating the colors to use in a GRAPH, BARCHART, or HISTOGRAM when plotting y-values. If no colors are specified, the defaults are reset to the original GRAF defaults. GRAF defaults are 1,2,3,4. See the Colors and Textures appendix for more information.
MARKER	If used, this keyword must be followed by one or more values indicating the markertypes to use in a GRAPH, BARCHART, or HISTOGRAM when plotting y-values. If no markers are specified, the defaults are reset to the original GRAF defaults. GRAF defaults are all zeroes. See the Colors and Textures appendix for more information.

SET DEFAULT

EXAMPLES:

The SET DEFAULT sets the defaults for one or more of the y-specs listed in a DRAW command. The first integer of the SET DEFAULT sets the default for the first y-spec, the second integer sets the default for the second y-spec in the command, and so on.

```
)OPEN FILE REVENUE  
)PRINT
```

```
$LINE YEAR COMPUTER TEST MEDICAL INST
```

1	1976	450	493	120	58
2	1977	576	581	135	76
3	1978	744	732	163	98
4	1979	1060	986	193	122
5	1980	1510	1200	230	159
6	1981	1771	1349	273	185
7	1982	2140	1550	305	205
8	1983	2675	1920	355	235
9	1984	3325	2300	405	270
10	1985	4200	2765	475	310

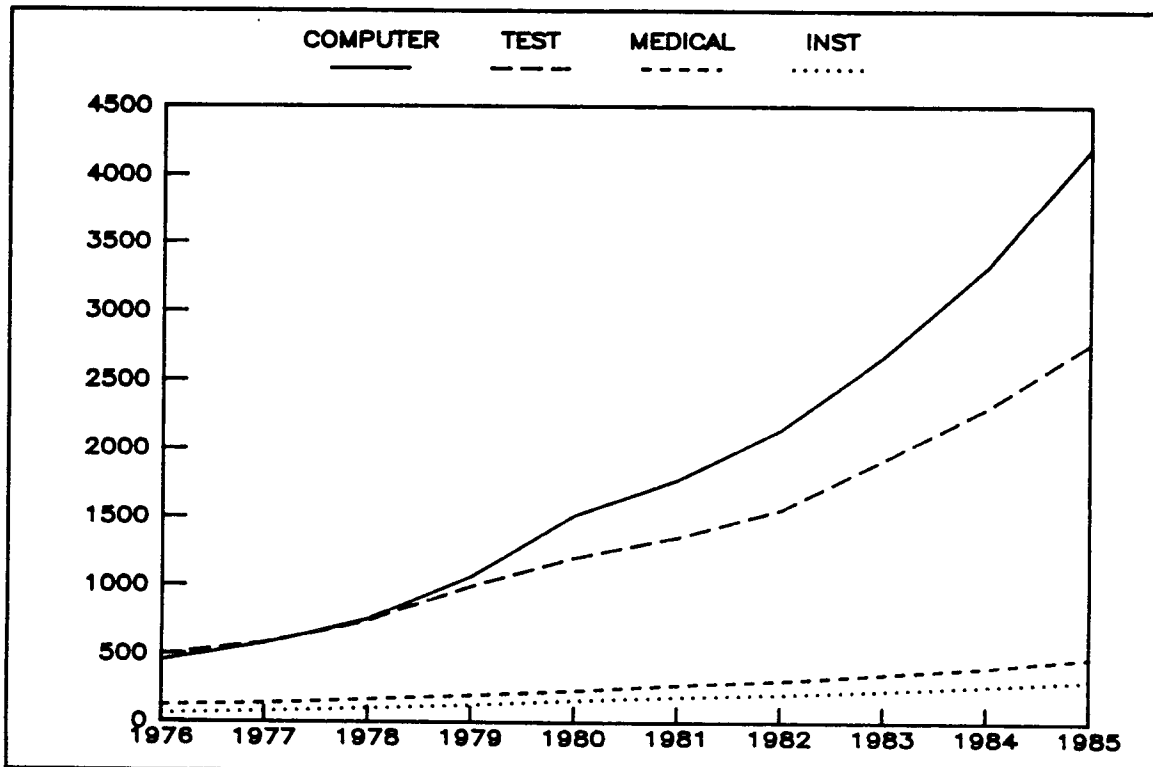
10 LINES PRINTED.

```
)NOTE The original linetype defaults were 1,2,3,4,...
```

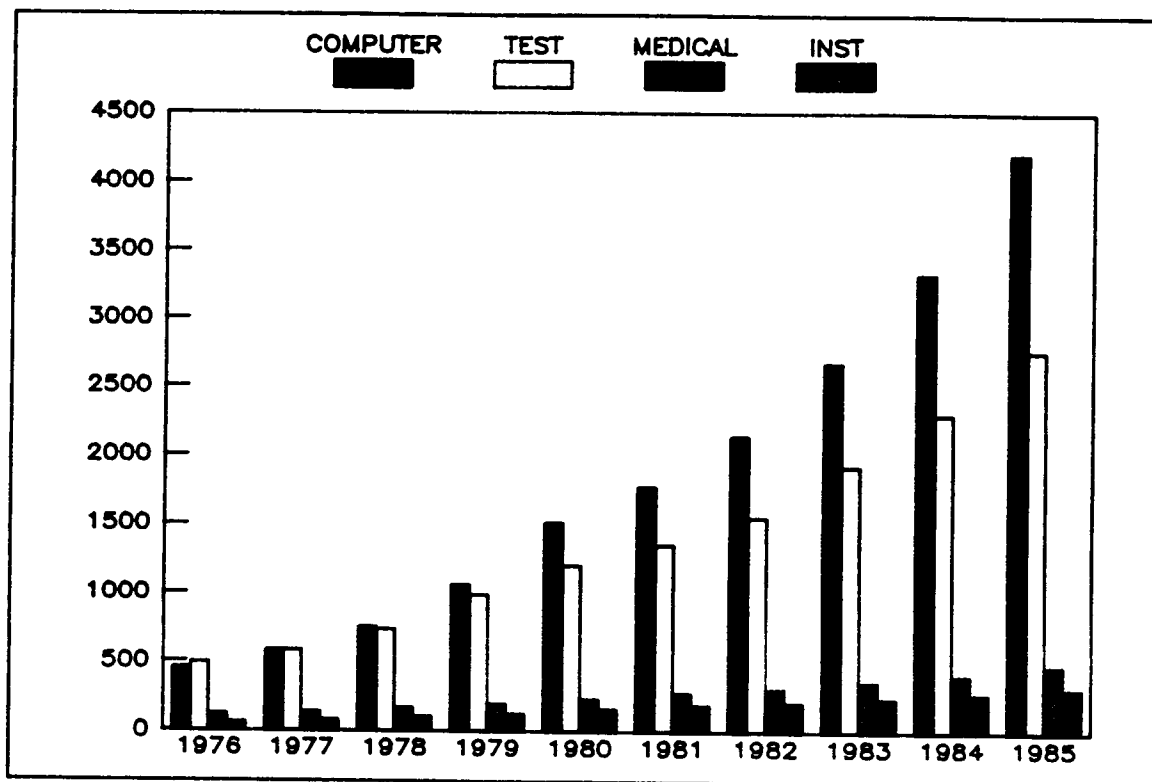
```
)SET DEFAULT LINETYPE=1,6,7,8
```

```
)DRAW GRAPH (COMPUTER),(TEST),(MEDICAL),(INST) BY YEAR; &  
&) LEGEND=(("COMPUTER"),("TEST"),("MEDICAL"),("INST"))
```

```
)PLOT
```



)NOTE The original shade defaults were 0,15,4,1,...
)SET DEFAULT SHADE=1,0,12,17
)DRAW BARCHART (COMPUTER),(TEST),(MEDICAL),(INST) BY YEAR; &
&) LEGEND= ("COMPUTER"), ("TEST"), ("MEDICAL"), ("INST")
)PLOT



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SET DEVICE devicename [;HPIB=hpibnumber]

Informs the system as to the expected output device type.

devicename The name of a supported graphics device. The supported devices are:

HP150/A/B
 HP2623/A
 HP2627/A
 HP2647/A/F
 HP2648/A
 HP2680/A
 HP2700
 HP7220A/C/S/T
 HP7221A/B/C/S/T
 HP7225A/B as HPIB
 HP7225A/B as RS232
 HP7240/A
 HP7245/A/B
 HP7470/A
 HP7475/A
 HP7550/A
 HP7580/A/B
 HP7585/A/B
 HP7586/A/B
 HP9872/A/B/C/S/T
 QMS1200

HPIB Optional. If the graphics device is connected by an HPIB interface, this keyword is required. The keyword must be followed by the correct device number.

If the device type has been established, the system will issue a warning if an attempt is made to position the frame outside of the physical device limits.

SET DEVICE

EXAMPLES:

The output device type may be established prior to the plotting of graphs. After GRAF is informed of the device type the name need not be included in any PLOT commands. If the user's device is connected with an HP-IB interface the device number can also be set up.

```
)SET DEVICE HP2623  
)
```

SET FRAME surface

Sets an area based on the current device coordinate system into which graphic information will be placed.

surface Required. A set of two coordinate pairs within the size of the device. These specify the lower left and upper right corners of the area into which plotted information can be placed. The frame coordinates must be specified in the current units system.

The SET FRAME command also sets the window so that the origin is in the lower left corner of the frame.

The frame is also set if a SET SIZE or SET UNITS command is executed.

All primary graph commands will be clipped at the frame. All secondary graph commands place the plot in the area represented by the frame.

SET FRAME

EXAMPLES:

The frame is the area on the plotting surface into which information is placed. The position and size of the frame is specified in the current units system. To move a graph (or change its size) only the frame need be adjusted.

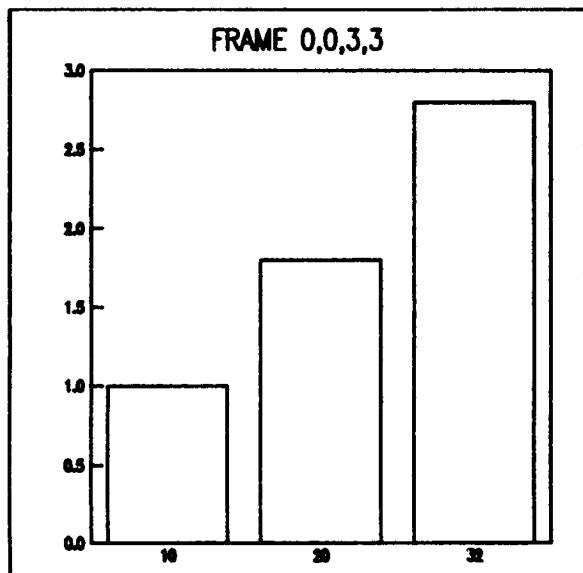
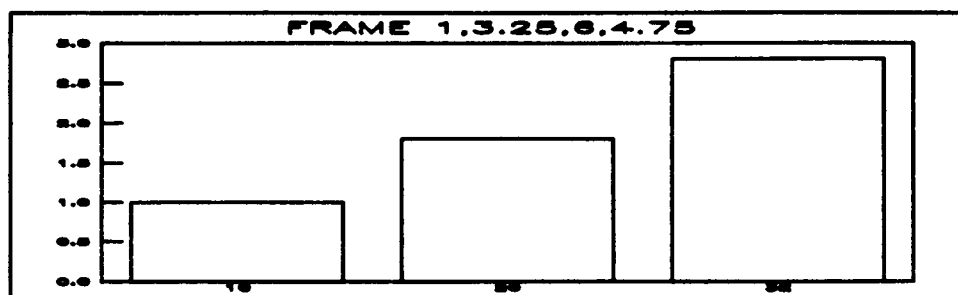
```
)OPEN FILE COSTS  
)PRINT
```

```
$LINE SIZE COST
```

```
1 10 1.00  
2 20 1.80  
3 32 2.80
```

3 LINES PRINTED.

```
)SET UNITS 1 INCH  
)SET FRAME 0,0,3,3  
)DRAW BARCHART COST BY SIZE ; TITLE="FRAME 0,0,3,3"  
)SET FRAME 1,3.25,6,4.75  
)DRAW BARCHART COST BY SIZE ; TITLE="FRAME 1,3.25,6,4.75"  
)PLOT
```



SET SIZE coordinate

Specifies the expected physical size of the output device or the paper being used on the device.

coordinate Required. A coordinate pair that specifies the upper right corner of the device limits. The coordinate must be specified in the current units system.

If the current units system is device independent then the size will be the largest rectangle with the same ratio that will fit on the device.

SET SIZE

EXAMPLES:

The SET SIZE command can be used to inform the system of the physical limits of the output device or the media on the device. If the user is in a device dependent mode the size must be represented in the current units system.

```
)SET UNITS 1 INCH  
)SET SIZE 5,5
```

If the system is in a device independent mode, the size represents a ratio (of height to width) which will be maintained when the graphs are plotted. For example, to create a rectangle twice as long as it is wide on any output device which has an upper right coordinate (and hence frame limit) of 100,50 the following commands can be entered.

```
)SET UNITS 2  
)SET SIZE 100,50
```

SET SPEED speed

Sets the speed at which the pen moves.

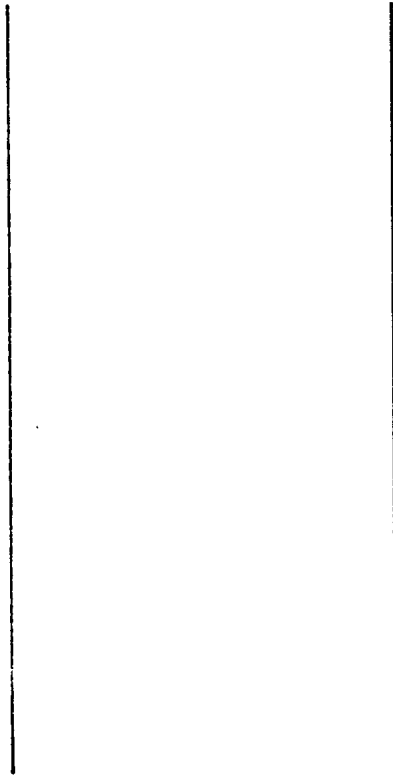
speed Required. Must be a value from 1 to 36, where 1 is slowest and 36 is fastest. Decreasing the speed increases the amount of ink left on the paper, for higher resolution lines. If not specified, 36 is assumed. This command has no effect for CRT plotters.

SET SPEED

EXAMPLES:

The speed of the pen on a plotter changes the clarity of the lines drawn. Use the fast speed for quick plotting; the slow speed for clearer lines.

```
)NOTE SET TO FAST SPEED
)SET SPEED 36
)DRAW LINE FROM=0,0; TO=0,4
)PLOT
)NOTE SET TO SLOW SPEED
)SET SPEED 1
)DRAW LINE FROM=2,0; TO=2,4
)PLOT
```



)

SET UNITS [ratio] [INCHES/CM/MM]

Sets the current units and the type of coordinate system.

ratio Optional. If specified and a keyword follows, each value specified by the user is assumed to represent ratio times as much space. For example, if a SET UNITS 2 INCHES is given, a DRAW LINE command from (1,1) to (3,1) will start 2 inches up and to the right of the lower left corner of the frame. The line will be 4 inches long.

If the ratio is specified and a keyword does not follow, the system will enter the device independent mode and divide the space into a square or rectangle (see the SET SIZE command) containing ratio units along the shorter axis. If a ratio is not specified, the ratio is assumed to be 1.

INCHES/CM/MM Optional. Sets the system to a device dependent mode where each value is represented in the indicated units. Default is millimeters.

Either a ratio or a unit type, or both, must be specified.

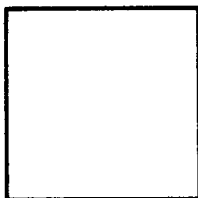
The SET UNITS command will change the frame to the new units and change the window to match the frame.

SET UNITS

EXAMPLES:

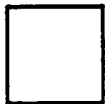
When arcs, lines, and labels are drawn, the position and size of the figures must be specified in the current units system. Normally, a direct correspondence is set up between the unit values and the actual size of drawn object. Below, a box one inch square is drawn.

```
)SET UNITS 1 INCH
)DRAW LINE FROM=1,1; TO=1,2
)DRAW LINE FROM=1,2; TO=2,2
)DRAW LINE FROM=2,2; TO=2,1
)DRAW LINE FROM=2,1; TO=1,1
)PLOT
```



An adjustment to the ratio used in the units command can be used to increase or decrease the size of the object.

```
)SET UNITS .5 INCHES
)DRAW LINE FROM=1,1; TO=1,2
)DRAW LINE FROM=1,2; TO=2,2
)DRAW LINE FROM=2,2; TO=2,1
)DRAW LINE FROM=2,1; TO=1,1
)PLOT
```



)

If a unit type (such as INCHES) is not given, a device independent mode is entered. In this mode, the ratio represents the relative sizes of the height and width. When plotting is done in a device independent mode the size of objects is adjusted depending on the size of the output device.

SET WINDOW surface

Sets the window of interest in the world coordinate system.

surface Required. The world coordinates which will be mapped onto the frame. If a window is not specified, the world coordinates are assumed to be the same as the device coordinates and the window is assumed to be the same as the frame.

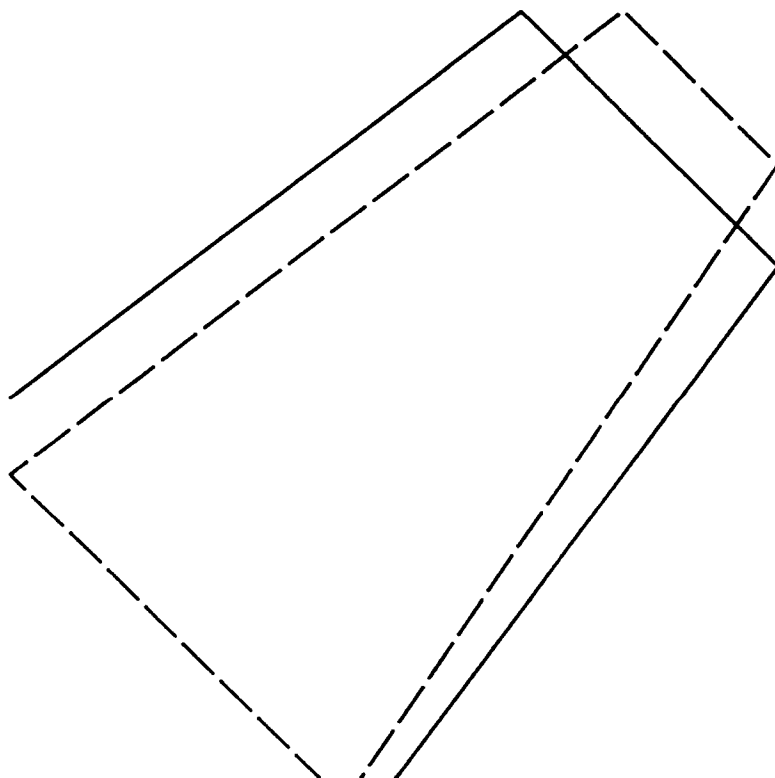
The window is mapped into the current frame. The window determines what will be plotted; and the frame determines where on the physical device the plot will be.

SET WINDOW

EXAMPLES:

When lines, arcs, or labels are drawn, the window represents the area in the user's space which is placed into the frame. By adjusting the position of the window, different portions of a large space can be observed.

```
)SET UNITS 1 INCH
)SET FRAME 0,0,4,4
)SET WINDOW 2,2,5,5
)DRAW LINE FROM=2,0; TO=5,4
)DRAW LINE FROM=5,4; TO=4,5
)DRAW LINE FROM=4,5; TO=0,2
)DRAW LINE FROM=0,2; TO=2,0
)SET WINDOW 0,0,5,5
)DRAW LINE FROM=2,0; TO=5,4; LINETYPE=2
)DRAW LINE FROM=5,4; TO=4,5; LINETYPE=2
)DRAW LINE FROM=4,5; TO=0,2; LINETYPE=2
)DRAW LINE FROM=0,2; TO=2,0; LINETYPE=2
)PLOT
```



)

SECTION 3
DETAILED
SPECIFICATIONS

FIELD SPECIFICATIONS

All secondary graphics commands except DRAW PIECHART are composed of one or more field specifications. A field specification contains at a minimum the field (or expression) to be used. A complete specification may contain information about colors, shading, patterns, line types and axis descriptions. Each graph type allows slightly different options. The options available are listed in a table at the end of this section.

A complete field specification can be composed of the following:

```
(expression
  [;COLOR=color]
  [;LINETYPE=linetype]
  [;SHADE=shade]
  [;MARKER=marker]
  [;AXIS=(axispec)]
  [;SET=constant]
  [;NULL=nullexp])
```

COLOR	Optional. If specified, the keyword must be followed by an expression which represents the color to be used. If not specified, 1 is assumed. A zero represents no color. See the Colors and Textures appendix for more information.
LINETYPE	Optional. If specified, the keyword must be followed by an expression which indicates the line type to be used. If a line type of zero is used, no line is drawn. A negative line type is an error. For a complete description of the line types see the Colors and Textures appendix.
SHADE	Optional. If specified, the keyword must be followed by an expression that indicates what shade type to use on each section of the chart. Two overlapping shade types may be specified by entering a 4-digit number. If not specified, zero is assumed. See the Colors and Textures appendix for more information.
MARKER	Optional. If specified, the keyword must be followed by an expression which represents the marker type to be used. If not specified, a zero (which represents no marker) is assumed. See the Colors and Textures appendix for a list of marker types.
AXIS	Optional. If specified, the keyword must be followed by a valid axis specification. If not specified, all portions of the axis are either calculated or defaulted to various values. See the AXIS SPECIFICATION section for more information.

FIELD SPECIFICATIONS

SET Required if the KEY option was specified on the command. If specified, the keyword must be followed by a constant that is compared to the value of the expression of the KEY option. Only those records in which the KEY field equals the SET expression will be used in the current specification.

NULL Optional. If specified, the keyword must be followed by an expression which determines if the data point should be ignored. When the expression condition evaluates to non-zero (i.e.: true) the record is treated as null. This means the point will not be plotted on the graph or used to compute the graph limits. By specifying different expressions you can treat different classes of values as nulls (e.g.: NULL=(X=0) treats 0 values as null; NULL=(X<0) treats negative numbers as nulls).

The following chart indicates the field specification options that may be used on each command.

	B		H
	A		I
	R		S
	C	G	T
	H	R	O
	A	A	G
	R	P	R
	T	H	A
			M
AXIS			
X-AXIS.	X	X	X
Y-AXIS.	X	X	
COLOR.	X	X	X
LINETYPE		X	
MARKER.		X	
SHADE	X		X
SET.	X	X	X
NULL.		X	

EXAMPLES:

Field specifications define the format of the curves, bars, or markers which are displayed on a graph. The format for each of these items can be either a constant or an expression based any of the fields from the currently open file.

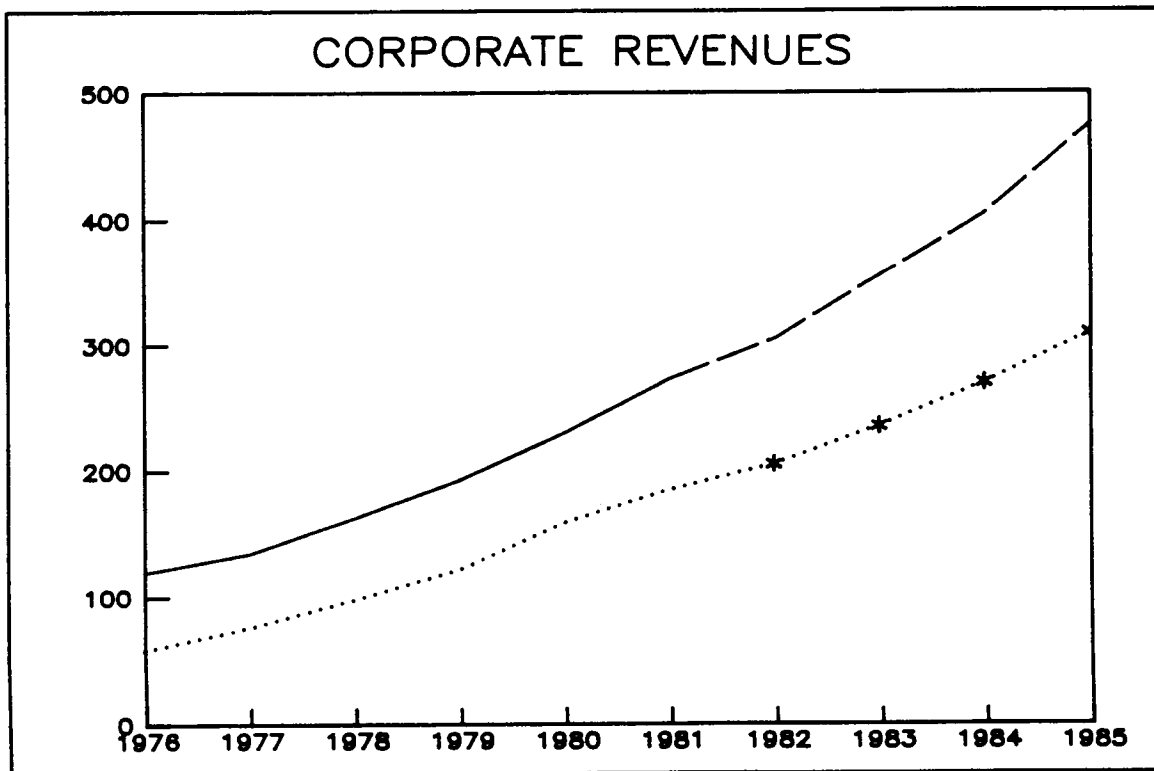
```
)OPEN FILE REVENUE
)PRINT YEAR,MEDICAL,INST
```

```
$LINE YEAR MEDICAL INST
```

1	1976	120	58
2	1977	135	76
3	1978	163	98
4	1979	193	122
5	1980	230	159
6	1981	273	185
7	1982	305	205
8	1983	355	235
9	1984	405	270
10	1985	475	310

```
10 LINES PRINTED.
```

```
)DRAW GRAPH (MEDICAL; LINETYPE=$IF(YEAR>1981,2,1) &
&)          ; AXIS=(LIMIT=0,500,100)), &
&)          (INST; MARKER=$IF(INST>200,1,0); LINETYPE=8) &
&)          BY YEAR &
&)          ;TITLE="CORPORATE REVENUES"
)PLOT
```



FIELD SPECIFICATIONS

In some cases the data to be plotted does not exist in a single field but exists in a set of records within the file. If the group of records can be identified with a constant, the SET option in conjunction with KEY can be used to obtain the desired information. In the example below, performance data is stored in the field "SALES" which is indexed by YEAR and DIVISION.

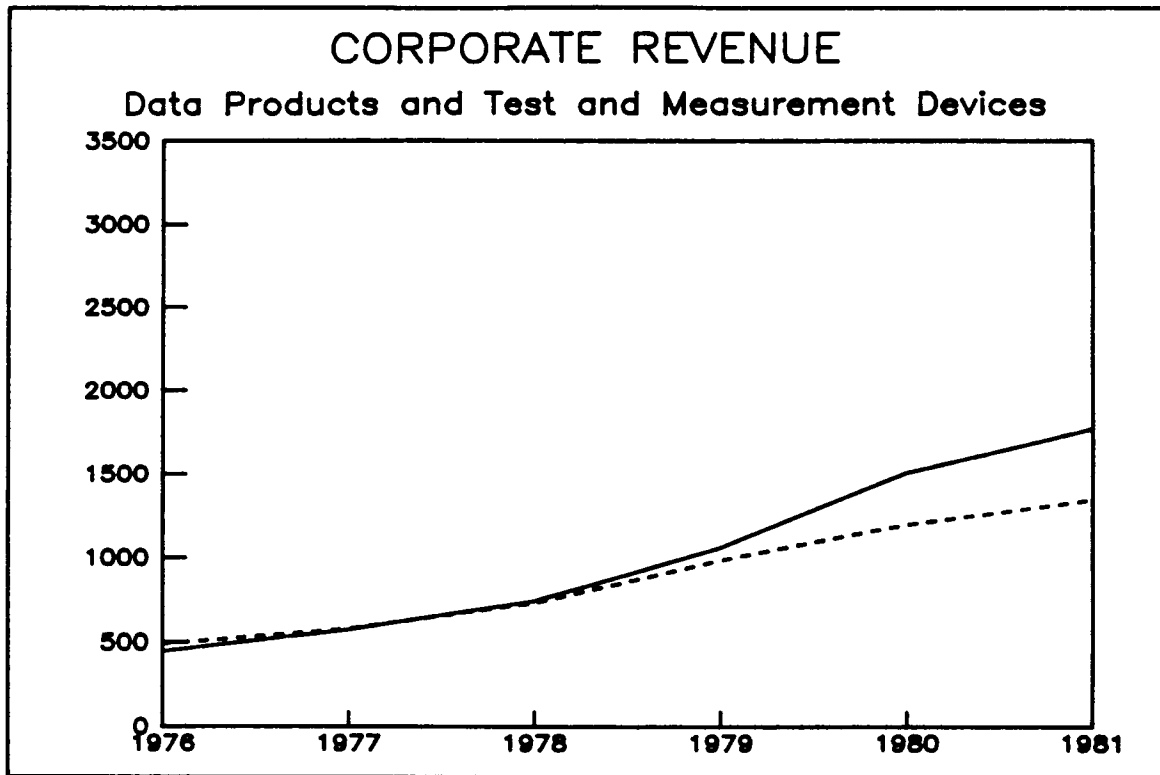
```
) OPEN FILE REV2
) 1/10 PRINT
```

```
$LINE YEAR DIVISION SALES
```

1	1976	1	450
2	1976	2	493
3	1976	3	120
4	1976	4	58
5	1977	1	576
6	1977	2	581
7	1977	3	135
8	1977	4	76
9	1978	1	744
10	1978	2	732

```
10 LINES PRINTED.
```

```
)SELECT DIVISION=$ASCII(DIVISION,1),@  
)DRAW GRAPH (SALES; SET="1"), &  
&)  
&)(SALES; SET="2"; LINETYPE=7) &  
&) BY (YEAR; AXIS=(LIMIT=1976,1981,1)) &  
&) ; KEY=DIVISION &  
&) ; TITLE="CORPORATE REVENUE" &  
&) ; SUBTITLE="Data Products and Test and Measurement Devices"  
)PLOT
```



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AXIS SPECIFICATIONS

Most field specifications may contain an axis specification. The axis specification describes how a graph should be scaled and how this scaling should be displayed.

A complete axis specification may be composed of the following:

```
[;TYPE=LINEAR/LOG]
[;LIMITS=[minimum],[maximum],[increment]]
[;POSITION=LEFT/RIGHT/TOP/BOTTOM/BOTH/NONE]
[;FONT=font]
[;SLANT=slant]
[;ANGLE=angle]
[;COLOR=color]
[;TICKS=count]
[;LABEL=(expression[;LOCATION=BETWEEN/UNDER]
[;DUPLICATES=SUPPRESSED/RETAINED])]
[;GRID=[(gridspec)I,(gridspec)]]
[;TITLE=titlespec]
[;SIZE=n]
```

TYPE	Optional. If specified, the keyword must be followed by LINEAR to indicate linear scaling, or LOG to indicate logarithmic scaling. If not specified, LINEAR is assumed.
LIMITS	Optional. If specified, the keyword must be followed by a minimum, maximum, or increment (or any combination) that represents the limits on the axis. If any data falls outside this range the information will be clipped (on graphs or scattergrams) or ignored (on barcharts or histograms). If a value is not specified, it will be calculated by the system, which will scale the graph to include ALL data.
POSITION	Optional. If specified, the keyword must be followed by LEFT, RIGHT, TOP, BOTTOM, BOTH, OR NONE. The keyword indicates where the axes labels and title should be placed. For vertical axes only BOTTOM, TOP, BOTH or NONE may be specified. For horizontal axes only LEFT, RIGHT, BOTH or NONE may be specified. If not specified, BOTTOM is selected for horizontal axes and LEFT for vertical axes.
FONT	Optional. If specified, this must be followed by a value which represents the print font to be used. If not specified, a zero is assumed. See the Colors and Textures appendix for more information.
SLANT	Optional. If specified, this must be followed by a value that represents the slant of the text. Positive slants rotate in a clockwise direction and negative slants rotate counterclockwise. If not specified, the slant is assumed to be zero.

AXIS SPECIFICATIONS

ANGLE	Optional. If specified, this must be followed by the angle at which the text will be plotted. The angle is measured counterclockwise from zero at the 3 o'clock position. If not specified, zero is assumed.
COLOR	Optional. If specified, this must be followed by a value which represents the color to be used. If not specified, 1 is assumed. See the Colors and Textures appendix for more information.
TICKS	Optional. If specified, the keyword must be followed by a value that indicates the number of minor ticks that should be drawn between major ticks. If not specified, only major ticks are drawn.
GRID	Optional. If specified, the keyword must be followed by a specification for the major grid and then the minor grid. The grid specification indicates the color of the grid, its linetype (if a full grid is drawn) and possibly the tick length (for a partial grid). If not specified, the color will be the AXIS COLOR and a partial grid will be drawn. The major tick will be 2.5% of the graph size and minor ticks 1.25% of the graph size. See the GRID SPECIFICATION section for more information.
LABEL	<p>Optional. This may only be specified for an axis in a DRAW GRAPH command. If specified, the keyword must be followed by an expression that is used to label the major ticks of the axis. The expression represents a major tick and is displayed each time the value changes. The expression in the field specification should be numeric data that is proportional to the position of the ticks on the axis. If the LABEL parameter is specified, the LIMITS parameter is ignored, and the minimum, maximum, and increment are calculated by the system. The major dimensions will be labeled with alphabetic text from the label expression.</p> <p>If LOCATION is specified, UNDER will cause major ticks to appear directly under points in the file and the label from the expression to be centered under the tick. BETWEEN will cause major ticks to be centered between points in the file and the label from the expression to be centered between major ticks. If LOCATION is not specified, UNDER is the default.</p> <p>If DUPLICATES is specified, SUPPRESSED will cause two or more successive points with the same value for the expression to have only one label printed, centered under the points. RETAINED will cause one label to be printed for each point in the file. If DUPLICATES is not specified, RETAINED is the default.</p>
TITLE	Optional. If specified, the keyword must be followed by information that describes the title of the axis. For a complete description of the options available for the title see the TITLE SPECIFICATIONS section.

SIZE Optional. If specified, the keyword must be followed by a constant greater than zero which may contain a decimal fraction. This indicates how large the axis labels should be in relation to their calculated size (e.g.: n=1.0 doesn't change their size; n=2.0 makes them twice as large; n=.5 makes them half as large).

The following chart indicates the axis specification options that may be used on each command.

	B A R C H A R T	G R A P H	H I S T O R Y A M
ANGLE	X	X	X
COLOR	X	X	X
FONT	X	X	X
GRID	X	X	X
LABEL		X	
LIMITS	X	X	X
POSITION	X	X	X
SLANT	X	X	X
TICKS	X	X	X
TYPE		X	
TITLE	X	X	X
SIZE	X	X	X

AXIS SPECIFICATIONS

EXAMPLES:

GRAF automatically calculates all axis information. In some instances, more control over these defaults is required and in most cases a label on the axis is desired. This information is in axis specifications which are placed in a field specification.

```
)OPEN FILE REVENUE  
)PRINT YEAR,TEST
```

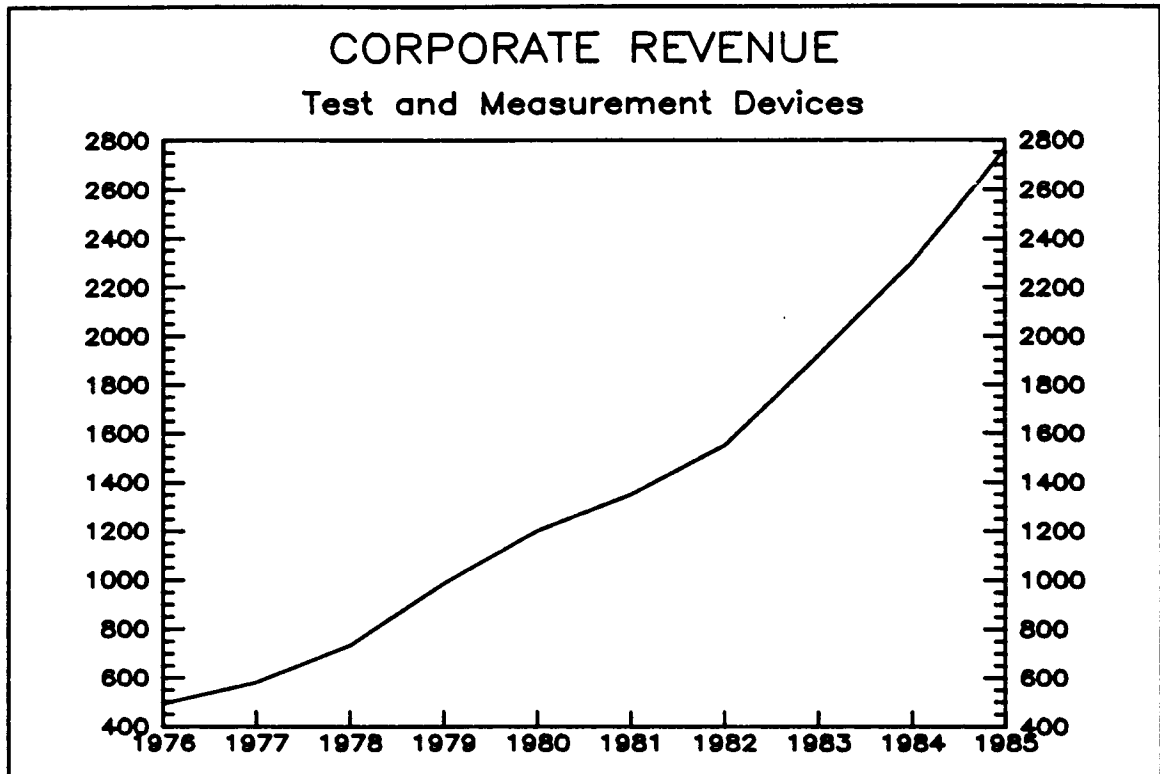
```
$LINE YEAR TEST
```

1	1976	493
2	1977	581
3	1978	732
4	1979	986
5	1980	1200
6	1981	1349
7	1982	1550
8	1983	1920
9	1984	2300
10	1985	2765

```
10 LINES PRINTED.
```

```

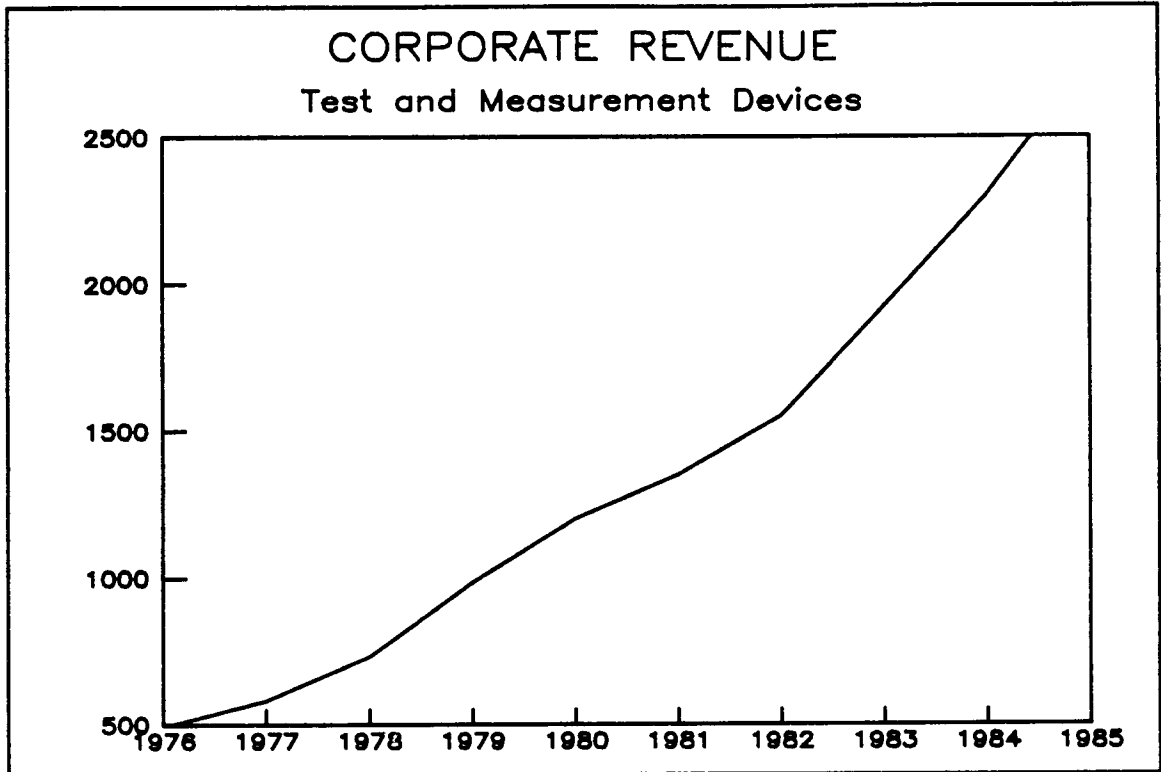
)DRAW GRAPH (TEST; AXIS=(POSITION=BOTH; TICKS=3)) &
&)      BY YEAR &
&)      ;TITLE="CORPORATE REVENUE" &
&)      ;SUBTITLE="Test and Measurement Devices"
)PLOT
    
```



AXIS SPECIFICATIONS

If the default limits or increment selected by the system are incorrect they can be changed with the LIMIT keyword. If the limits (or increment) is specified any data in the file not within the limits is ignored.

```
)DRAW GRAPH (TEST; AXIS=(LIMITS=500,2500,500)) &  
& BY YEAR &  
& ;TITLE="CORPORATE REVENUE" &  
& ;SUBTITLE="Test and Measurement Devices"  
)PLOT
```



When a graph is being drawn, the LABEL parameter may be specified. This keyword informs GRAF as to the desired major tick label text. It also allows graphs to be drawn that contain a variable number of units per major tick (such as the number of Fridays per month). When this parameter is used, the data specified in the BY field specification must be monotonically increasing and the range and value represents the relationship between the positions of the major ticks.

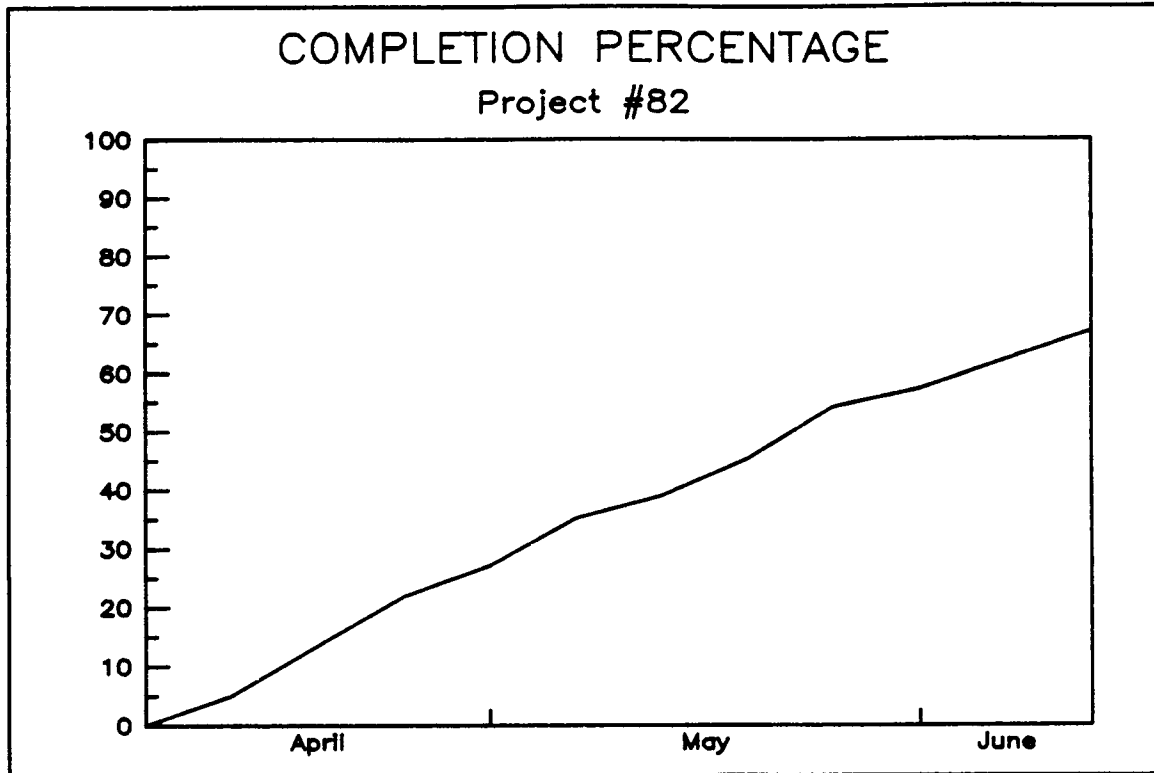
```
) OPEN FILE STATUS
) SELECT @, LINE=$RTOTAL(1)
) PRINT
```

DATE	PERCENT	LI
4/03/81	0.0	1
4/10/81	5.0	2
4/17/81	13.5	3
4/24/81	21.9	4
5/01/81	27.2	5
5/08/81	35.2	6
5/15/81	39.0	7
5/22/81	45.3	8
5/29/81	54.2	9
6/05/81	57.3	10
6/12/81	62.3	11
6/19/81	67.2	12

12 LINES PRINTED.

AXIS SPECIFICATIONS

```
)DRAW GRAPH (PERCENT; AXIS=(LIMIT=0,100,10; TICKS=1)) &  
&) BY (LINE; AXIS=(LABEL=$MONTH(DATE,2))) &  
&) ;TITLE="COMPLETION PERCENTAGE" &  
&) ;SUBTITLE="Project #82"  
)PLOT
```



GRID SPECIFICATIONS

Each axis specification may also contain a grid specification. The axis specification is primarily concerned with the range of values being plotted and how the scaling should be done. The grid specification describes the sizes, colors, and linetypes of the grid placed inside the limits of the graph.

A complete grid specification may be composed of the following:

[;COLOR=color]
[;LINETYPE=linetype]
[;SIZE=size]

COLOR	Optional. If specified, this must be followed by a value which represents the color to be used for the grid. If not specified, 1 is assumed. See the Colors and Textures appendix for more information.
LINETYPE	Optional. If specified, the keyword must be followed by an expression which indicates the line type to be used. If a linetype of zero is used, no line is drawn. A negative line type is an error. See the Colors and Textures appendix for more information.
SIZE	Optional. If specified, the keyword must be followed by a value which represents the length of the grid line as a percentage of the graph size. By default, the major ticks are labeled with a tick size of 2.5% and minor ticks with a size of 1.25%. If a full line grid is desired, 100 may be specified. If a negative number is specified, the tick mark will be drawn on the outside of the graph.

GRID SPECIFICATIONS

EXAMPLES:

An axis specification may additionally contain a grid specification. The grid specification allows the user to control the color, linetype, and size of both the minor and major ticks.

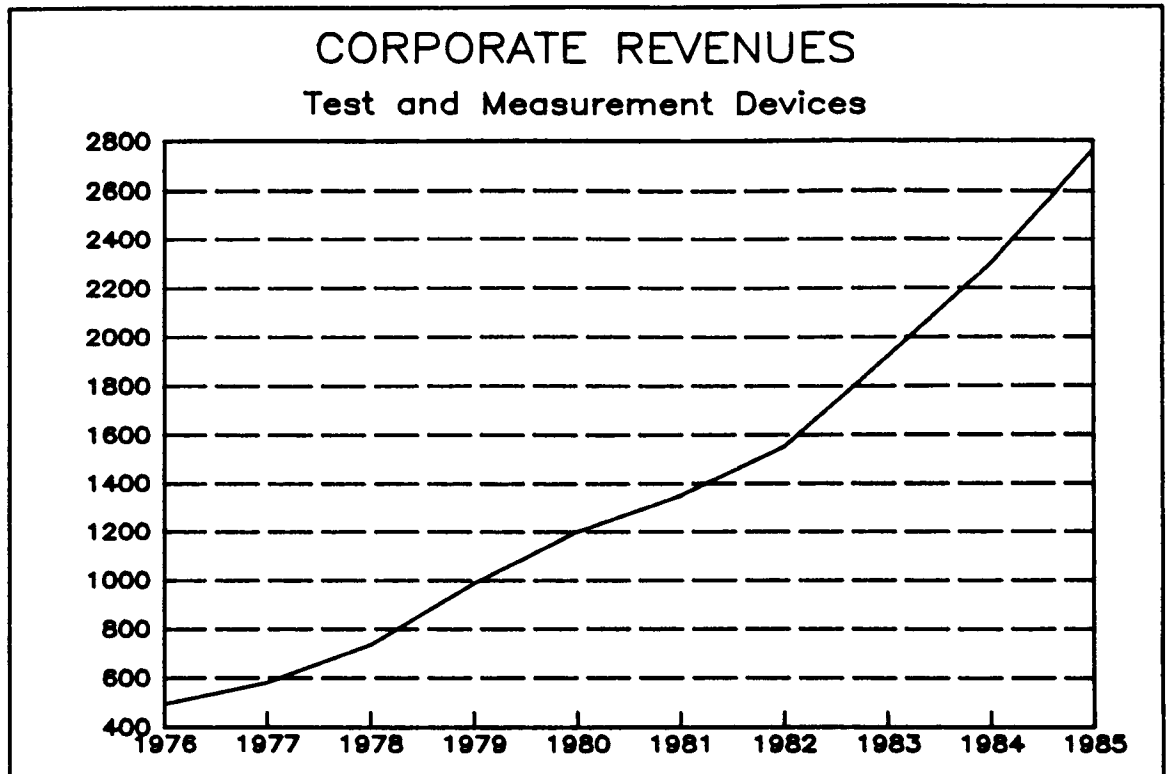
```
)OPEN FILE REVENUE  
)PRINT
```

```
$LINE YEAR COMPUTER TEST MEDICAL INST
```

1	1976	450	493	120	58
2	1977	576	581	135	76
3	1978	744	732	163	98
4	1979	1060	986	193	122
5	1980	1510	1200	230	159
6	1981	1771	1349	273	185
7	1982	2140	1550	305	205
8	1983	2675	1920	355	235
9	1984	3325	2300	405	270
10	1985	4200	2765	475	310

```
10 LINES PRINTED.
```

```
)DRAW GRAPH (TEST; AXIS=(GRID=(LINETYPE=2,SIZE=100))) &  
&)      BY YEAR &  
&)      ; TITLE="CORPORATE REVENUES" &  
&)      ; SUBTITLE="Test and Measurement Devices"  
)PLOT
```



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TITLE SPECIFICATIONS

The secondary graphics commands and the axis specifications may contain title specifications. The title specification may consist of simply the title enclosed in quotes as in TITLE="This is a Title" or may include other options. If other options are included, the title specification must be enclosed in parentheses as in TITLE=("This is a Title"; COLOR=1). A complete title specification may be composed of the following:

```
(title
  [;COLOR=color]
  [;FONT=font]
  [;ANGLE=angle]
  [;SLANT=slant]
  [;POSITION=TOP/BOTTOM]
  [;SIZE=n])
```

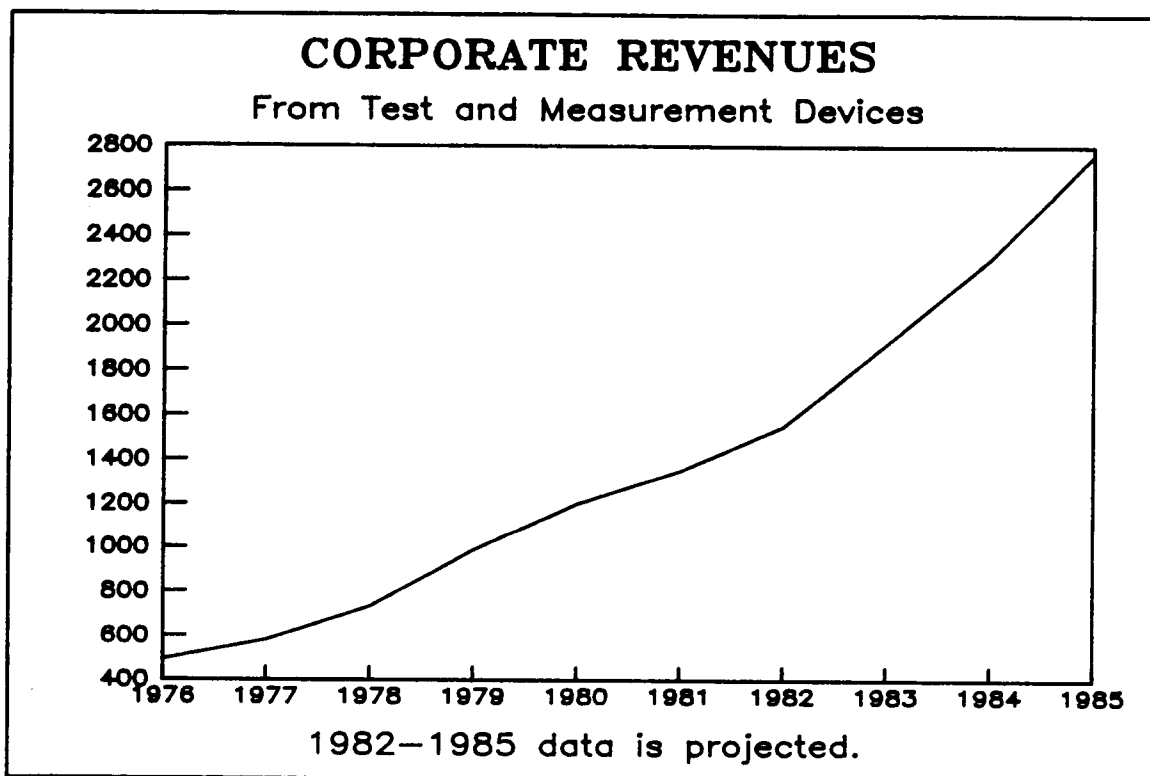
title	The graph is labeled with the title specified. It should be enclosed in quotes (").
COLOR	Optional. If specified, this must be followed by a value which represents the color to be used. If not specified, 1 is assumed. See the Colors and Textures appendix for more information.
FONT	Optional. If specified, this must be followed by a value which represents the print font to be used. If not specified, a zero is assumed. See the Colors and Textures appendix for more information.
ANGLE	Optional. If specified, this must be followed by the angle at which the text will be plotted. The angle is measured counterclockwise from zero at the 3 o'clock position. If not specified, zero is assumed.
SLANT	Optional. If specified, this must be followed by a value that represents the slant of the text. Positive slants rotate in a clockwise direction and negative slants rotate counterclockwise. If not specified, the slant is assumed to be zero.
POSITION	Optional. If specified, the keyword must be followed by TOP or BOTTOM. The keyword indicates where the title information should be placed. If not specified, TOP is assumed for title and subtitle specifications. Axis titles will always appear where the axis labeling appears.
SIZE	Optional. If specified, the keyword must be followed by a constant greater than zero. The constant may have a decimal fraction, and indicates how large the text size should be in comparison to its calculated size (e.g.: n=1.0 doesn't change the text size; n=2.0 doubles it, and n=.5 halves it).

TITLE SPECIFICATIONS

EXAMPLES:

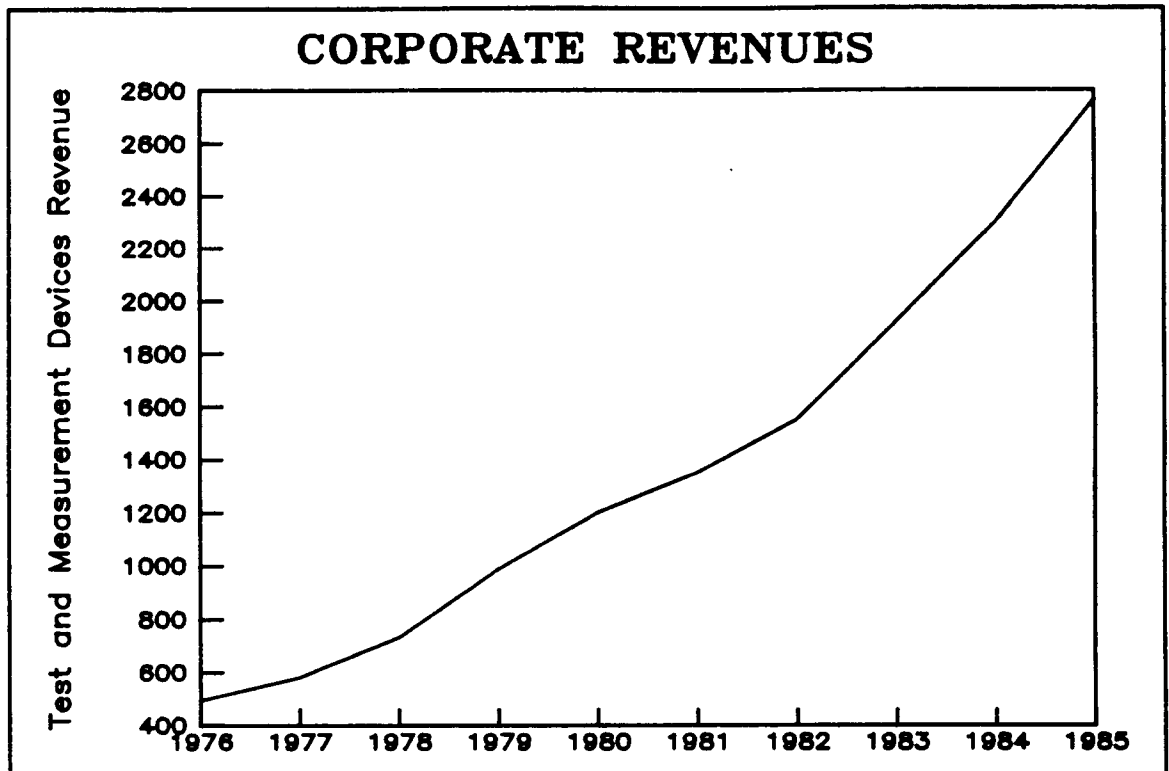
Any secondary graph may be annotated with titles. Titles may be placed on the top, bottom, left, or right hand portion of the page or any combination. Each title may be of a different font, color, angle, and slant. The title is centered on the side of the graph indicated. If a subtitle is specified, it appears below the title.

```
)OPEN FILE REVENUE
)DRAW GRAPH TEST BY YEAR &
&)      ; TITLE=("CORPORATE REVENUES"; FONT=3) &
&)      ; SUBTITLE="From Test and Measurement Devices" &
&)      ; SUBTITLE=("1982-1985 data is projected." &
&)              ; POSITION=BOTTOM)
)PLOT
```



A title specification may also be included within an axis specification. In this case, the title is centered between the borders of the graph and the POSITION keyword is not valid.

```
)DRAW GRAPH (TEST &
&)      ; AXIS=(TITLE="Test and Measurement Devices Revenue")) &
&)      BY YEAR &
&)      ; TITLE= ("CORPORATE REVENUES"; FONT=3)
)PLOT
```



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LEGEND SPECIFICATIONS

All of the secondary graphics commands allow the user to specify legend information. The user has control over the content and placement of the legend.

A complete legend specification may be composed of the following:

```
[;TYPE=LINE/BOX]
[;POSITION=[TOP/CENTER/BOTTOM],LEFT/CENTER/RIGHT]]
[;FORMAT=[HORIZONTAL/VERTICAL],OVER/SIDE]]
[;COLOR=color]
[;SLANT=slant]
[;FONT=font]
[;(legenditem),...]]
[;SIZE=n]
```

TYPE	Optional. If specified, the keyword must be followed by an indication of the type of legend that should be drawn. If not specified, LINE is assumed for graphs and BOX for piecharts, barcharts, and histograms.
POSITION	Optional. If specified, the keyword must be followed by an indication of where the legends should be placed. If not specified, the system will assume TOP, CENTER. The combination CENTER, CENTER is not valid.
FORMAT	Optional. If specified, the keyword must be followed by an indication of how the legend should be generated. VERTICAL legends are displayed one above the other. HORIZONTAL legends are displayed next to one another. The second parameter indicates where the text should be placed relative to the marker (or box or line). If OVER is specified, the text will be placed over the marker. If SIDE is specified, the text will be placed next to the marker. If not specified, the default is based on the POSITION requested. If the position is TOP or BOTTOM, CENTER the format will default to HORIZONTAL, OVER. Any other position will default to VERTICAL, SIDE.
COLOR	Optional. If specified, the keyword must be followed by a value which represents the color for the text in the legend. If not specified, the color of each text item will correspond to the color of the marker for the item.
SLANT	Optional. If specified, the keyword must be followed by a value that represents the slant of the text. Positive slants rotate in a clockwise direction and negative slants rotate counterclockwise. If not specified, the slant is assumed to be zero.

LEGEND SPECIFICATIONS

FONT	Optional. If specified, the keyword must be followed by a value which represents the print font to be used for the text. If not specified, a zero is assumed.
SIZE	Optional. If specified, this keyword must be followed by a constant greater than zero which may contain a decimal fraction. This number indicates how large the text should be in relation to its calculated size (e.g.: n=1.0 doesn't change the size; n=2.0 makes it twice as large; n=.5 makes it half as large).

A legenditem is composed of the following:

```
        "text"  
        [;COLOR=color]  
        [;SHADE=shade]  
        [;LINETYPE=linetype]  
        [;MARKER=marker]
```

A legenditem must contain at least the text which should be used to annotate the legend. In the absence of other parameters the values are obtained from the field specifications.

text	Required. The text which should be associated with the legenditem.
COLOR	Optional. If specified, the keyword must be followed by a constant which represents the color for the marker (line or box) in the legend. If a global text color was not specified the color of the text item which is paired to this marker will correspond to this color.
SHADE	Optional. If specified, the keyword must be followed by a constant that indicates the shade type to use on the legend. Two overlapping shade types may be specified by entering a 4-digit number. If not specified, a zero is assumed for line graphs and pie charts, and the shade type of the field specification which is paired to this legenditem is assumed for bar charts and histograms. See the Colors and Textures appendix for a list of shading patterns.
LINETYPE	Optional. If specified, a constant which indicates the line type to be used must follow. See the Colors and Textures appendix for a list of line types.
MARKER	Optional. If specified, the keyword must be followed by a constant which represents the marker type to be used. If not specified, a zero (which represents no marker) is assumed for pie charts, bar charts, and histograms. The marker type for a graph will be obtained from the field specification which is paired to this legenditem. See the Colors and Textures appendix for a list of marker types.

EXAMPLES:

All graphs drawn with the secondary graph commands may be annotated with legends. The legend placement and content can be controlled by the user.

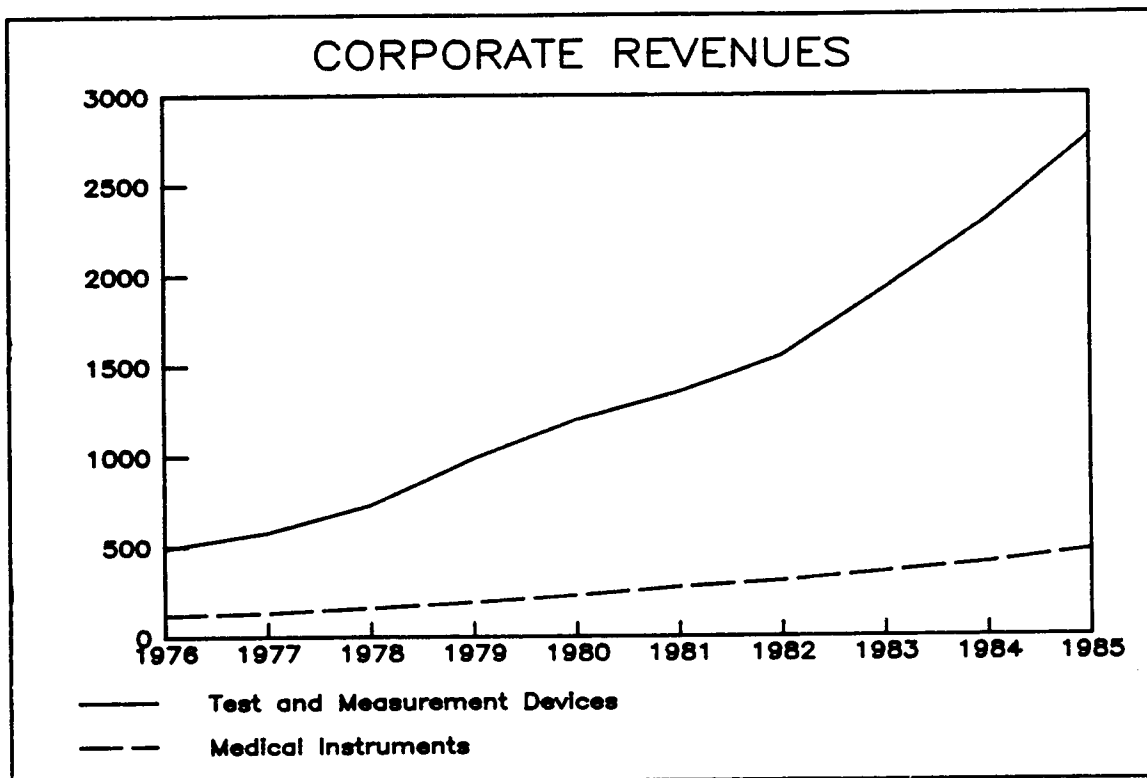
)OPEN FILE REVENUE
)PRINT

\$LINE	YEAR	COMPUTER	TEST	MEDICAL	INST
1	1976	450	493	120	58
2	1977	576	581	135	76
3	1978	744	732	163	98
4	1979	1060	986	193	122
5	1980	1510	1200	230	159
6	1981	1771	1349	273	185
7	1982	2140	1550	305	205
8	1983	2675	1920	355	235
9	1984	3325	2300	405	270
10	1985	4200	2765	475	310

10 LINES PRINTED.

LEGEND SPECIFICATIONS

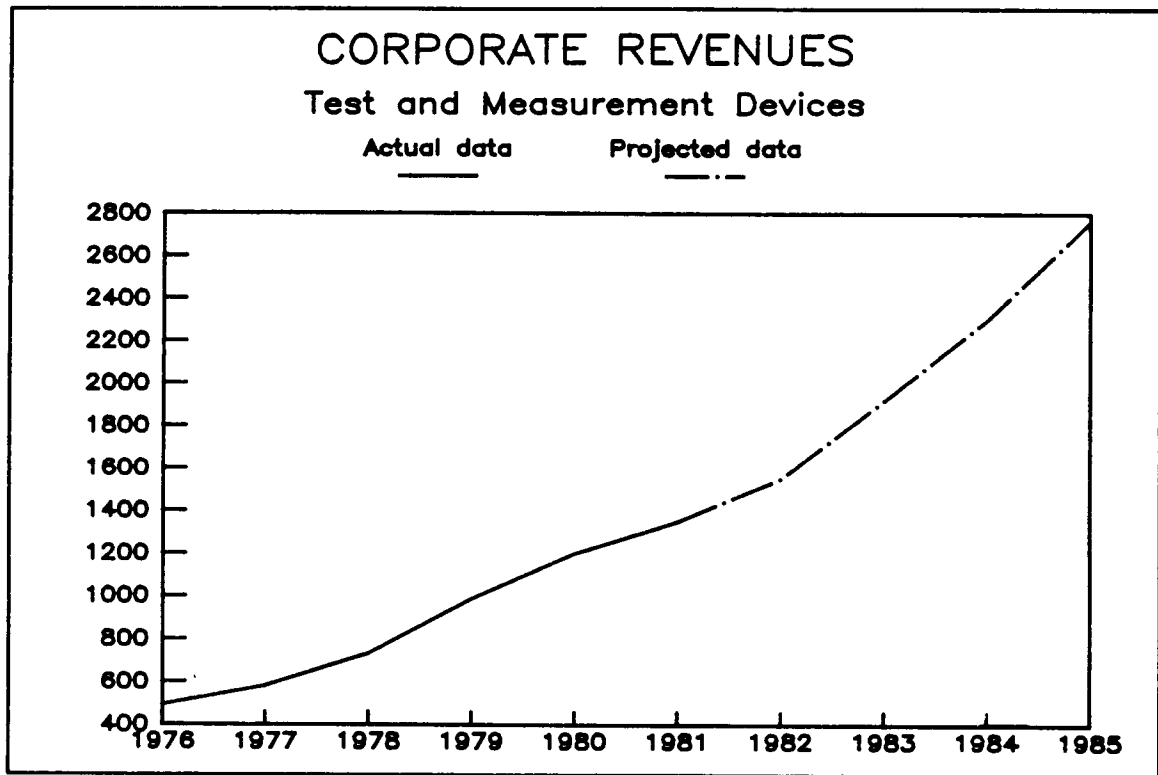
```
)DRAW GRAPH (TEST; AXIS=(LIMIT=0,3000,500)), &  
&      (MEDICAL; LINETYPE=2) &  
&      BY YEAR &  
&      ; LEGEND=(POSITION=BOTTOM,LEFT; FORMAT=VERTICAL,SIDE; &  
&      ("Test and Measurement Devices"), &  
&      ("Medical Instruments"; LINETYPE=2)) &  
&      ; TITLE="CORPORATE REVENUES"  
)PLOT
```



LEGEND SPECIFICATIONS

Legend items need not form a one-to-one correspondence with the fields being graphed. Thus, several legend items may be used to describe a single curve.

```
)DRAW GRAPH (TEST; LINETYPE=$IF(YEAR>1981,3,1)) BY YEAR &  
&) ; LEGEND=(("Actual data"),("Projected data"; LINETYPE=3)) &  
&) ; TITLE="CORPORATE REVENUES" &  
&) ; SUBTITLE="Test and Measurement Devices"  
)PLOT
```



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APPENDICES

APPENDIX A

COMMAND FORMATS

CLOSE PLOTFILE

PURPOSE: Closes the currently open plotfile.

CREATE PLOTFILE plotfilename [;RETENTION=PERMANENT/TEMPORARY/NONE]

PURPOSE: Create a named plotfile which can be used to generate graphs at a later time.

DRAW ARC START=angle; FINISH=angle; RADIUS=radius [;AT=x,y]
[;COLOR=color]
[;LINETYPE=linetype]

PURPOSE: Draws an arc (or a set of arcs) in the current frame.

DRAW BARCHART yspec [,...] BY xspec
[;FORMAT=CLUSTERED/STACKED]
[;KEY=keyspec]
[;TITLE=titlespec] [;SUBTITLE=titlespec]
[;LEGEND=legendspec]
[;FRAME=[color[,linetype]]]

PURPOSE: Draws a barchart of the data represented by the xspec against the data represented by the yspecs(s).

DRAW BOX SIZE=width, height
[;AT=x,y]
[;SHADE=shade]
[;LINETYPE=linetype]
[;COLOR=color]
[;JUSTIFY=justify]

PURPOSE: Draws a box of the specified height and width.

APPENDIX A

DRAW GRAPH yspec [,...] BY xspec
 [;KEY=keyspec]
 [;TITLE=titlespec] [;SUBTITLE=titlespec]
 [;LEGEND=legendspec]
 [;FRAME=[color~~I~~,linetype]]

PURPOSE: Draws a graph or scattergram of the data represented by the xspec against the data represented by the yspec(s).

DRAW HISTOGRAM spec [,...]
 [;FORMAT=CLUSTERED/STACKED]
 [;KEY=keyspec]
 [;TITLE=titlespec] [;SUBTITLE=titlespec]
 [;LEGEND=legendspec]
 [;FRAME=[color~~I~~,linetype]]

PURPOSE: Draws a histogram indicating the distribution of the data given in the specification(s).

DRAW LABEL text
 [;AT=x,y] [;SIZE=width,height] [;SLANT=slant] [;ANGLE=angle]
 [;COLOR=color] [;FONT=font]
 [;JUSTIFY=[TOP/CENTER/BOTTOM~~I~~,LEFT/CENTER/RIGHT]]

PURPOSE: Draws a label (or a set of labels) in the current frame.

DRAW LINE TO=x,y[,z] [;FROM=x,y[,z]] [;COLOR=color]
 [;LINETYPE=linetype] [;VIEWPOINT=x,y,z]

PURPOSE: Draws a line (or a set of lines) in the current frame.

DRAW MARKER [markertype;] AT=x,y [;COLOR=color]

PURPOSE: Draws a marker of the indicated type at the specified position.

DRAW NEWPAGE

PURPOSE: Causes any following graphics commands to be plotted on the next page.

DRAW PIECHART amount

[;LABEL=[labelspec] [,labelspec]]
[;SLANT=slant] [;COLOR=color] [;FONT=font]
[;EXPLODE=explode] [;SHADE=shade] [;START=angle]
[;TITLE=titlespec] [;SUBTITLE=titlespec]
[;LEGEND=legendspec]
[FRAME=[color],linetype]]

PURPOSE: Draws a pie chart centered within the current frame.

ERASE PLOTFILE

PURPOSE: Erases the currently open plotfile.

OPEN PLOTFILE plotfilename [;DOMAIN=PERMANENT/TEMPORARY]

PURPOSE: Opens an existing plot file.

PLOT [ONTO devicename [;HPIB=hpibnumber]] [TO filename] [;SEQUENCE] [;WAIT]

PURPOSE: Generates a plot.

PURGE PLOTFILE

PURPOSE: Purges the currently open plotfile.

```
SET DEFAULT LINETYPE=linetype1 [,linetype2 [...]]  
SET DEFAULT SHADE=shade1 [,shade2 [...]]  
SET DEFAULT COLOR=color1 [,color2 [...]]  
SET DEFAULT MARKER=marker1 [,marker2 [...]]
```

PURPOSE: Sets the default values for the DRAW GRAPH, BARCHART, and HISTOGRAM commands.

```
SET DEVICE devicename [;HPIB=hpibnumber]
```

PURPOSE: Informs the system as to the expected output device type.

```
SET FRAME surface
```

PURPOSE: Sets an area based on the current device coordinate system into which graphic information will be placed.

```
SET SIZE coordinate
```

PURPOSE: Specifies the expected physical size of output device or the size of the paper being used on the device.

```
SET SPEED speed
```

PURPOSE: Sets the speed at which the pen moves.

```
SET UNITS [ratio] [INCHES/CM/MM]
```

PURPOSE: Sets the current units and the type of coordinate system.

SET WINDOW surface

PURPOSE: Sets the window of interest in the world coordinate system.

FIELD SPECIFICATIONS

(expression
[;COLOR=color]
[;LINETYPE=linetype]
[;SHADE=shade]
[;MARKER=marker]
[;AXIS=(axispec)]
[;SET=constant]
[;NULL=(nullexp)])

AXIS SPECIFICATION

[;TYPE=LINEAR/LOG]
[;LIMITS=[minimum],[maximum],[increment]]
[;POSITION=LEFT/RIGHT/TOP/BOTTOM/BOTH/NONE]
[;FONT=font]
[;SLANT=slant]
[;ANGLE=angle]
[;COLOR=color]
[;TICKS=count]
[;LABEL=(expression[;LOCATION=BETWEEN/UNDER]
[;DUPLICATES=SUPPRESSED/RETAINED])]
[;GRID=[(gridspec)I,(gridspec)]]
[;TITLE=titlespec]
[;SIZE=n]

GRID SPECIFICATIONS

[;COLOR=color]
[;LINETYPE=linetype]
[;SIZE=size]

APPENDIX A

TITLE SPECIFICATIONS

(title
[;COLOR=color]
[;FONT=font]
[;ANGLE=angle]
[;SLANT=slant]
[;POSITION=TOP/BOTTOM])
[;SIZE=n]

LEGEND SPECIFICATIONS

[;TYPE=LINE/BOX]
[;POSITION=[TOP/CENTER/BOTTOM],LEFT/CENTER/RIGHT]
[;FORMAT=[HORIZONTAL/VERTICAL],OVER/SIDE]
[;COLOR=color]
[;SLANT=slant]
[;FONT=font]
[;(legenditem)[,...]]
[;SIZE=n]

LEGEND ITEM

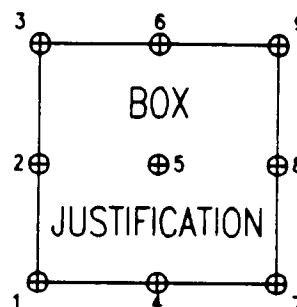
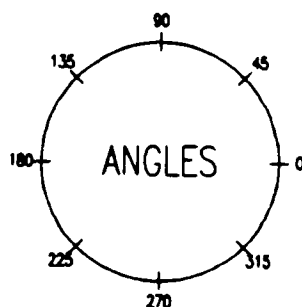
"text"
[;COLOR=color]
[;SHADE=shade]
[;LINETYPE=linetype]
[;MARKER=marker]

COLORS and TEXTURES

Colors - The following color sequence is standard on 4 color HP plotters. On other manufacturers' devices, adjustments may be required.

HP COLOR SEQUENCE

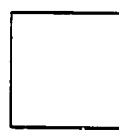
- 1 BLACK
- 2 RED
- 3 GREEN
- 4 BLUE



TYPES LINE MARKER

- | | | |
|---|-------------|---|
| 1 | _____ | * |
| 2 | ----- | + |
| 3 | - . - . - . | Δ |
| 4 | - - - - - | □ |
| 5 | - . - . - . | ◇ |
| 6 | ----- | ○ |
| 7 | - . - . - . | ⊕ |
| 8 | | x |

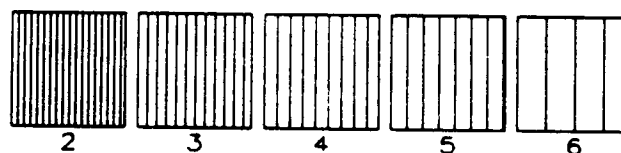
SHADE TYPES



0



1



2

3

4

5

6



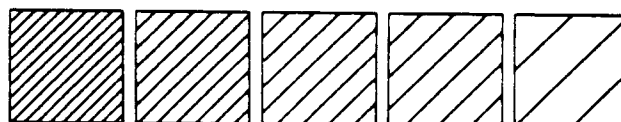
7

8

9

10

11



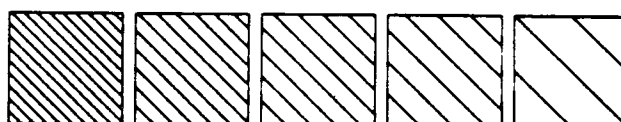
12

13

14

15

16



17

18

19

20

21

TYPE 1 FONT

TYPE 2 FONT

TYPE 3 FONT

TYPE 4 FONT

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