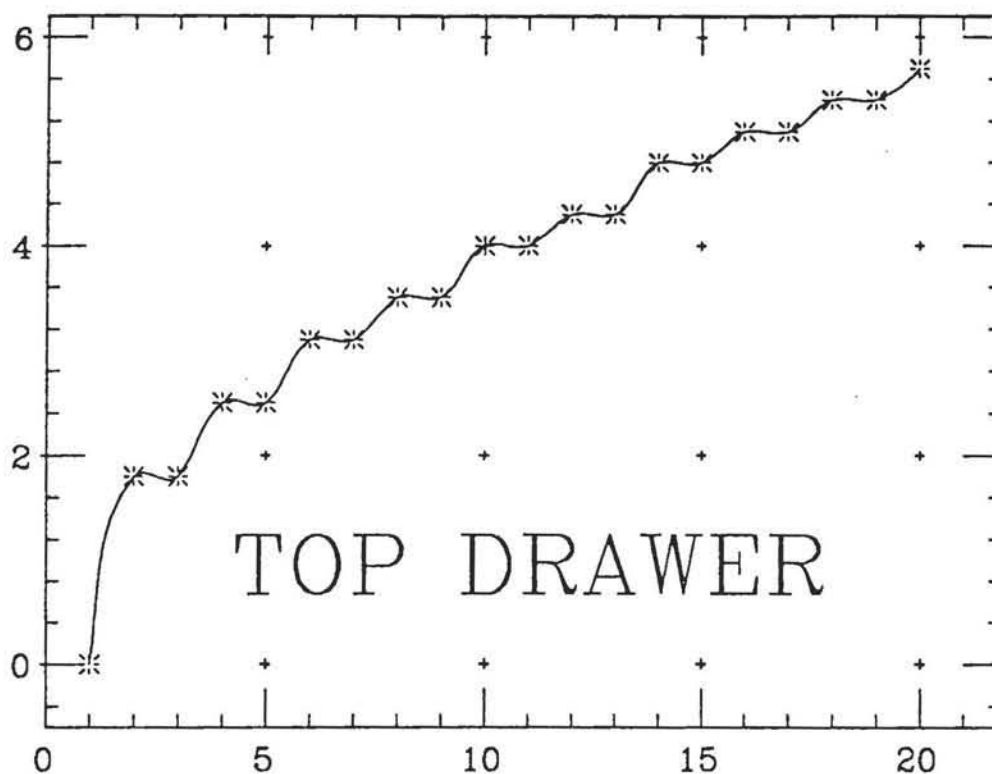


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## MEMORIAL

Roger B. Chaffee, who conceived and executed, TopDrawer, died on June 4, 1989. In a sense, at least, his statement in the introduction, "...and the program is still evolving," is no longer in force. Roger had a great love of simple things and of informality. Though the manual has been reworked by other hands, it still bears a flavor of these ideals. The program itself, though heavily layered with "added functionality" over the years by Roger and others, is stamped with some of the same character. Though these "layers" added great complexity, they were important to Roger who was extremely responsive to user needs and meticulous in choosing intuitive responses and defaults. Because of these convolutions, there are still a few parts of the program that don't quite work right, and I'm sure Roger, had there been time, would have been much more diligent about fixing things and adding new innovations than those of us who have been "minding the store" since Roger left SLAC in 1983. But across the face of the world, from Europe to Japan, there are many hundreds of admirers who have grown to love TopDrawer, warts and all. It is some consolation for those of us who were Roger's friends to know that his spirit yet endures.

Bill Johnson  
October 27, 1989

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## Section 1

### INTRODUCTION

Top Drawer is a program developed at SLAC to display the kinds of data that physicists produce. It makes histograms, scatter plots, data points with error bars and plot symbols, curves passing through data points, and elaborate titles. Because of its restricted applicability, Top Drawer can be controlled by a relatively simple set of commands, and this control is further simplified by the choice of reasonable default values for the plot parameters. Despite this emphasis on simplicity, Top Drawer plots are suitable for presentation at conferences and in journals. This represents a remarkable step forward in the preparation of data for publication, which is otherwise a tedious and lengthy process. Even for preliminary work, turning a list of numbers into a graph is so simple that the user is not distracted from the analysis itself.

There is very little facility in Top Drawer for arithmetic manipulations. Top Drawer generally assumes that the user has his data already, and wants it displayed to best advantage. For a function evaluation or data fitting, one should use something like APL, Speakeasy, or a statistical analysis package, which have more capabilities for calculation, and fewer for elaborate and detailed plotting.

Top Drawer was written by one person who works for a research group, and the program is still evolving. All of these factors indicate the informal nature of support for Top Drawer-- features (and bugs) may be added at any time.

## 1.1 OUTPUT

Output from Top Drawer is of two kinds. The first is printed immediately on the screen of a graphics terminal, such as the Tektronix 4013, or similiar device. (See the SET DEVICE command.) The second type is the graphic output--the plots--which ultimately are drawn on paper, a CRT screen, or photographic film by some sort of graphic device. The process involved in printing the plots and getting them to the user depends on the device that is used.

Connection to the graphic device(s) used for output is through the SLAC Unified Graphics System (U.G.), so output can be made on any non-interactive device known to U.G. This includes such devices as the Tektronix 4013, the Versatec Electrostatic plotter, the Imagen laser printers, or other graphics printers. Many of the features of a plot can be described by the user, with control cards containing keywords and values. In the absence of specific instructions, Top Drawer chooses values based on the given data. A good plot can often be made just from the data points, with no additional instructions.

Top Drawer is to be run as a self-contained program, reading a data file of TopDrawer commands. At SLAC, the device may be specified in a list of parameters, and passed on to the main program by a REXX EXEC. Otherwise, the SET DEVICE command should be used as one of the first cards.

) Robert Beach, The SLAC Unified Graphics System for FORTRAN 77, CGTM No. 203 (August 1981).

## 1.2 INPUT

Input for Top Drawer is a data file which is normally prepared using a text-editing system such as XEDIT. This file is a sequence of commands, one or more per record, which describe the plots to be made. The commands consist of keywords, which are English or technical words, and values. The command language is limited, and the syntax is not English, so it is not generally possible to generate a correct Top Drawer command from an English description of the desired result. However, it is often possible to infer the effect of a given Top Drawer command on the plot to be made, which makes input listings easy to read.

### 1.2.1 Input Formats

Data and commands are read from the input file, Fortran unit 5. Input is free-field. Field separators are \$ \* / , - and blank. Input values may be given in integer, decimal, or exponential notation. (As a general rule, any Fortran output, with I, F, E, or D format, is a legal input value for Top Drawer.)

Keywords are recognized by comparing the input string to a list of acceptable words. Keywords may be abbreviated to as few characters as will match one and only one word in the list, to a minimum of two characters. (Of course, one-character keywords, such as 'X', are matched by one character.) Top Drawer reads commands from left to right, so parameters follow the keyword they modify. Independent keywords may come in any order in the command, but in the case of conflicting keywords, the rightmost is used since it is the last one scanned.

Comments on input cards may be enclosed in parentheses (). All enclosed characters are ignored. Comment fields are not continued to the next line, whether or not they are explicitly terminated.

A semicolon (;) ends the current command. In this way, multiple commands and/or data points may be entered in a single record.

### 1.3 ABOUT THIS NOTE

This note is intended as a reference manual rather than an introduction. If you are just starting to use Top Drawer stop reading this and get "Introduction to Top Drawer", which will show you some of the things you can do, and get you started.... The information in this note is intended for "random access" reading, rather than sequential. Right now, put a paper clip or a piece of Scotch tape on the "Anatomy of a Plot" section, and look at that picture for a while. You will want to refer to it while you read about the various commands.

Read the rest of this chapter lightly. The information in it is technical, and it refers to commands and parameters which haven't been explained. Later, when a command description refers to the DATA coordinate system or a device-generated character string, you will want to know where to find an explanation.

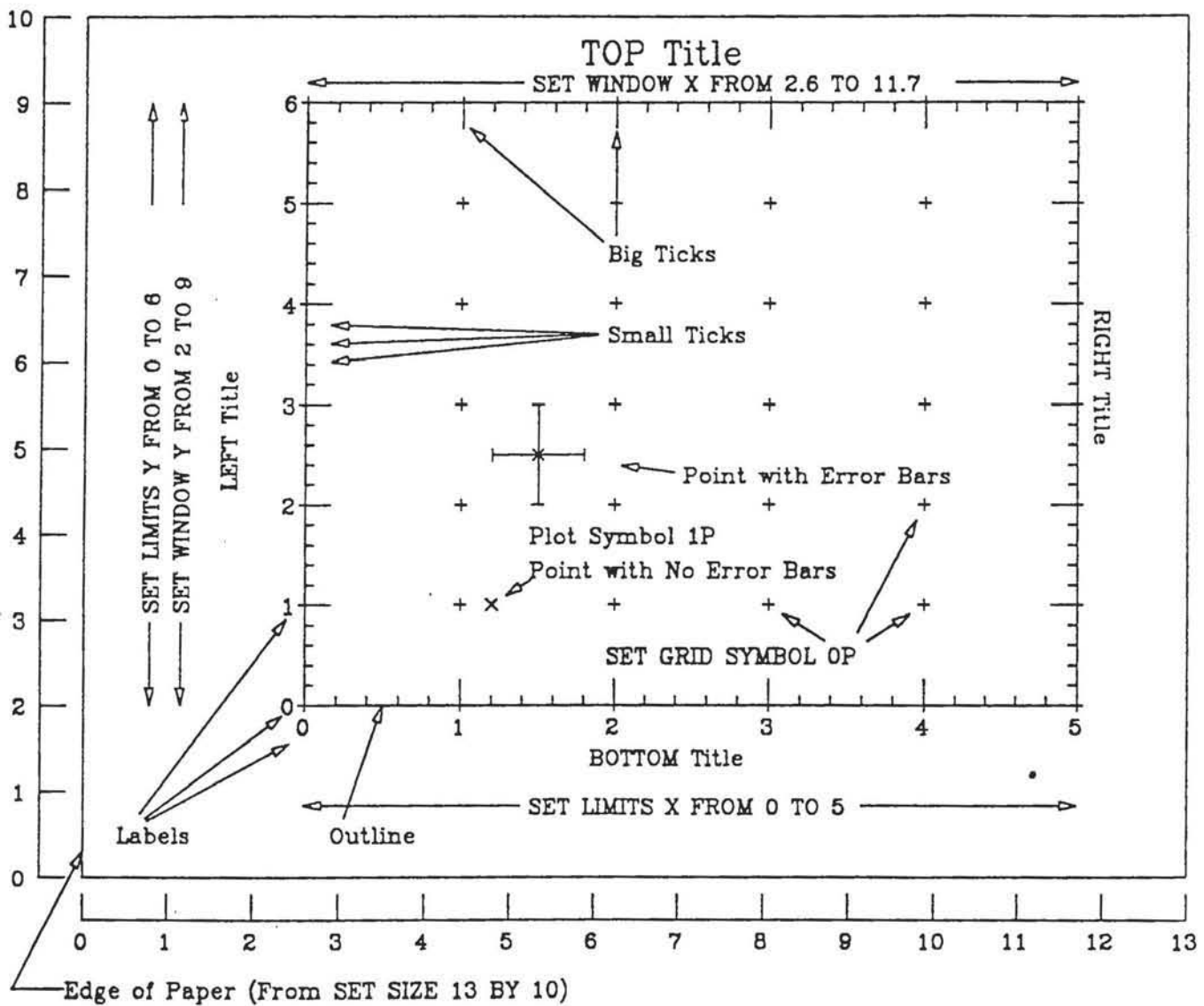
The other chapters should be read in "browse" mode. Look at the lists of commands, pick keywords which sound as if they might produce an effect that you could use, and read the description of that command.

Some of the material in this note is specific to SLAC VM under CMS. Top Drawer now lives in several different environments, with different operating systems and graphic devices, and the details of getting a picture will be different in each situation. If Top Drawer has been installed for general use, there should be another note describing the local conventions. If you are using it on an informal ("at your own risk") basis, remember that Top Drawer is a Fortran program, and uses standard Fortran conventions and the graphics drivers that are indigenous to your system.

) Roger B. Chaffee, Introduction to Top Drawer, CGTM No. 189 (August 1977).

#### 1.4 THE ANATOMY OF A PLOT

The figure shows some of the features of a Top Drawer plot, and indicates the commands which control them.



## 1.5 COORDINATE SYSTEMS

There are two coordinate systems used by Top Drawer. The first is called the 'TEXT' system, because it is normally used for giving the positions of titles. The second is the 'DATA' system, which is the coordinate system in which the data points are normally plotted.

### 1.5.1 The TEXT Coordinate System

The TEXT system measures the positions of points on the screen or paper, in some units such as inches or centimeters. It is specified by the graphic device in use and by the SET SIZE command. The point  $(x,y) = (0,0)$  is at the bottom left of the screen or paper. (See the description of the SET SIZE command for details about units.) Any command which generates graphic output forces the TEXT coordinate system to be defined, with the default device (Imagen 8-300 at SLAC) and/or size (10 by 7.5 inches) if they haven't been set explicitly. The TEXT coordinate system is redefined by a SET DEVICE or SET SIZE command, but this requires the start of a new picture. It is not possible to 'undefine' it.

### 1.5.2 The Window

Data plotting is done in a rectangular area (the 'window') which is normally within the limits of the screen or paper. The position of the window in the TEXT coordinate system is set by the SET WINDOW command. The window position must be defined when the DATA coordinate system is defined, or when a title is made with a position relative to the window (TOP, BOTTOM, LEFT, or RIGHT). The default window position leaves a 10% border on the top and right, and a 20% border on the bottom and left. Axis labels and titles are put outside the window.

### 1.5.3 The DATA Coordinate System

The DATA system maps points to be plotted into the window area. The mapping does not have to be linear--logarithmic scales are part of the system, as well as linear and calendar scales, and others could be defined by the user. Parameters for the DATA system are set by the SET LIMITS and SET SCALE commands or implicitly by the data points known to Top Drawer at the time the DATA system becomes defined.

Plotting points or titles in the DATA mode, or putting on labelled axes, forces the DATA system to be defined. It becomes undefined when new data points are read in, and a NEW FRAME, SET DEVICE, or SET WINDOW command is given. New data points alone, or the change in picture, are not sufficient, and the old system is retained. The DATA system and the window become undefined when the TEXT system is redefined.

## 1.6 PLOTTING TEXT

### 1.6.1 Character Size

Text is specified by the TITLE command, and other symbol plotting is done for axis labels and plot symbols. For each of these, one of the parameters used is the SIZE. The convention used in Top Drawer is that character size is specified in tenths of an inch. For instance, for SIZE=2 the spacing between characters is nominally 0.2 inches. (Note that character size can be a decimal fraction as well as an integer. SIZE=2.5 is halfway between SIZE=2 and SIZE=3.)

This nominal value is affected by several factors. First, an overall reduction of the plot changes the character sizes. This is controlled by the SET SIZE command.

Second, for the more elaborate DUPLEX character set, the character spacing is adjusted according to the width of the particular characters used. For instance, the letter 'm' takes about twice as much space as the letter 'i'. This makes it difficult to achieve an exact length or fill a particular space with a string, but the pleasing appearance is generally a more important factor.



## 1.7 DEFAULT VALUES

There are four different levels of permanence for each Top Drawer parameter which can be set or changed by a SET command. Some values can be changed only by an explicit command, others revert instantly to the default, and most are treated in an intermediate fashion. The four levels are:

Level 1 parameters are never reset by Top Drawer, but are changed only by an explicit command. This group contains the DEVICE and the SIZE values associated with it. It also includes the parameters associated with the input and output, which are the FILE units, the CARD LENGTH, and the FORMAT. It contains the FONT, which is expensive to change. And finally, it contains the MODE values.

Level 2 parameters are set to the default value by the commands NEW FRAME (or NEW PLOT) and SET DEVICE, which clear the screen or advance to a clean plotting surface. Most parameters belong to this group.

Level 3 parameters define the DATA coordinate system, and are given by the SET LIMITS and SET SCALE commands. With one exception, all these parameters are reset by a NEW FRAME or SET DEVICE command, and the parameters for a single coordinate are reset by a SET WINDOW command for that coordinate. The exception is that if new points are not read in to the Top Drawer data storage, the old limit and scale parameters are retained even across a SET DEVICE, SET WINDOW, and NEW FRAME command. (Of course, they may be reset explicitly.)

Level 4 parameters are set only during the current command. The values are not retained. This group includes all parameters which are set in an action command, such as the texture of a JOIN or the size of a TITLE. There is generally a corresponding SET command (e.g. SET TEXTURE or SET TITLE SIZE) which produces a level 2 change in the same parameter. SET GRID also gives level 4 parameters, since the grid is made only on the current plot.



The following table gives some of the Top Drawer parameters.

Level	Command	Default Value
2	SET ARROW	
	SIZE	2
	FLARE	0.5
2	SET AXIS	ON
2	SET BAR SIZE	0.1
2	SET BOX SIZE	1 1
1	SET CARD LENGTH	72
2	SET COLOR	Black
1	SET DEVICE	4013 Interactive
2	SET DIAMOND SIZE	1 1
2	SET ELLIPSE SIZE	1 1
1	SET FILE	
	INPUT	5
	OUTPUT	6
1	SET FONT	Extended
1	SET FORMAT	(80A1)
4	SET GRID	OFF
2	SET INTENSITY	2
2	SET LABEL	
	LEFT, BOTTOM	ON
	TOP, RIGHT	OFF
3	SET LIMITS	Depend on data
2	SET ORDER	X Y DX DY SYMBOL
2	SET OUTLINE	ON
3	SET SCALE	Linear 6 -5 Base 10
1	SET SIZE	10 BY 7.5 UNITS 1
	REDUCE	Depends on Device
2	SET SYMBOL	Blank (plotted as dots)
2	SET TEXTURE	Solid
2	SET TICKS	ON
2	SET TITLE SIZE	2
2	SET WINDOW	In 20% from screen edge on bottom and left, 10% on top and right.

## 1.8 COMMANDS

There are four types of commands: DATA, ACTION, SET, and CONTROL.

DATA commands give points to be entered into Top Drawer storage, or they specify operations to be performed on the stored data. The basic DATA command is the data point, which can give coordinate values, error-bar values, and a symbol. Other DATA commands are SMOOTH, which replaces the stored data values by new values which make a smoother curve, and BIN, which replaces the stored data values by a summary of their distribution.

ACTION commands produce some kind of graphic output. The ACTION commands are PLOT, HISTOGRAM, JOIN, BARGRAPH, TITLE, and NEW FRAME.

SET commands describe the output which is to be made, by setting or changing parameters. They do not themselves cause output.

The notation used in command description is taken from the Xedit manual. Briefly, "|" means "OR" and separates alternatives. Brackets [] enclose optional material. Braces {} enclose one or more options, one of which must be specified. An underscore indicates a default option, which need not be given explicitly. Upper case text must be used as specified. Lower case indicates text, characters, or values to be given by the user.

## Section 2

### ACTION COMMANDS

#### List of Action Commands

ARROW FROM xxx yyy [DATA] [LESS ddd]  
TO xxx yyy [DATA] [LESS ddd]  
[SIZE xxx] [{FLAIR|FLARE} fff]

BARGRAPH [POINTS n1 [TO] n2]  
[SOLID|DOTS|DASHES|DOTDASH|PATTERNED]

BOX xxx yyy [DATA] [SIZE dx [dy]]

CIRCLE xxx yyy [DATA] [SIZE dx [dy]] (Same as ELLIPSE.)

DIAMOND xxx yyy [DATA] [SIZE dx [dy]]

ELLIPSE xxx yyy [DATA] [SIZE dx [dy]]

HISTOGRAM [POINTS n1 [TO] n2]  
[SOLID|DOTS|DASHES|DOTDASH|PATTERNED]

JOIN [level] {SPLINE|GENERAL} [TEXT]  
[SOLID|DOTS|DASHES|DOTDASH|PATTERNED|FUNNY]  
[POINTS n1 [TO] n2]  
makes a curve passing through given points.

NEW FRAME [{ALIAS=} 'alias'] starts a new page.

PLOT [POINTS n1 [TO] n2]  
plots given points, with error bars and symbol.

PLOT [AXIS|AXES] plots the axes, but no points.

TITLE [TOP|BOTTOM|RIGHT|LEFT|  
xxx yyy [DATA|XDATA|YDATA] [CENTER] [LINES=n]]  
[SIZE n] [ANGLE x] [SPACES n] [INDEX n] 'text'

CASE 'text'  
MORE 'text'  
writes text on plot. The CASE card or parameter  
is optional. It calls for fancy characters.

## 2.1 ARROW

```
ARROW FROM xxx yyy [DATA] [LESS ddd]
      TO xxx yyy [DATA] [LESS ddd]
      [SIZE xxx] [(FLAIR|FLARE) fff]
```

Draw an arrow from one point to another. The coordinate point (xxx,yyy) is in the TEXT coordinate system unless the DATA keyword is specified, in which case the DATA coordinate system is used.

If the LESS parameter is used, the result is an arrow which goes toward or away from the indicated point, but does not extend all the way to the point. The distance ddd between the arrow and the point is measured in units in the TEXT coordinate system, whether or not the DATA system is used to specify the point (xxx,yyy). (This parameter is useful for drawing an arrow from the first character of a title, or for pointing at some plot feature, without obliterating the character or feature.)

The SIZE parameter gives the length of the arrowhead--that is, the altitude of the isosceles triangle--measured in tenths of an inch. FLARE gives the ratio of the base to the altitude, which is the "fatness". The default values are set by the SET ARROW command.

### Examples:

```
ARROW FROM 3 5 TO 3.5 5 (A horiz. arrow 1/2 unit long)
ARROW TO 3.5 5 FROM 195 8.3E5 DATA
ARROW FROM 1 1 LESS .3 TO 17.8 190 DATA LESS .2
```

## 2.2 BARGRAPH

```
BARGRAPH [POINTS n1 [TO] n2]
      [SOLID|DOTS|DASHES|DOTDASH|PATTERNED]
```

Make a simple bargraph. Bars are centered on the given x-values, with heights given by the y-values. Half-widths can be given by the dx-values, or Top Drawer will choose an appropriate value. The dy values are not used.

The SOLID, etc., keyword specifies the texture of the lines to be drawn. (See the description of the SET TEXTURE command.)

The POINT range refers to the data points by the order in which they were entered into the Top Drawer data arrays. If one is given, only the given points will be used in the graph. However, all the points that Top Drawer knows about will be used to determine the plot limits, if that is required.

Example:

BARGRAPH POINTS 11 TO 50

2.3 BOX

BOX xxx yyy [DATA] [SIZE dx [dy]]

Draw a rectangle, with sides parallel to the plot axes and center at the given point. 'DATA' signifies that (xxx,yyy) is in the DATA coordinate system. Otherwise, it is taken in the TEXT system.

The size values are for the width (dx) and height (dy) of the rectangle. If the height is not given, the width is used and the rectangle becomes a square. If size values are not specified at all, the values from the SET BOX SIZE command are used.

2.4 CIRCLE

CIRCLE xxx yyy [DATA] [SIZE dx [dy]]

CIRCLE is another word for ELLIPSE (q.v.).

2.5 DIAMOND

DIAMOND xxx yyy [DATA] [SIZE dx [dy]]

Draw a diamond, with axes parallel to the plot axes and center at the given point. 'DATA' signifies that (xxx,yyy) is in the DATA coordinate system. Otherwise, it is taken in the TEXT system.

The size values are for the width (dx) and height (dy) of the diamond. If the height is not given, the

width is used and the diamond becomes a square, rotated at 45 to the plot axes. If size values are not specified at all, the values from the SET DIAMOND SIZE command are used.

## 2.6 ELLIPSE

ELLIPSE xxx yyy [DATA] [SIZE dx [dy]]

Draw an ellipse, with axes parallel to the plot axes and center at the given point. 'DATA' signifies that (xxx,yyy) is in the DATA coordinate system. Otherwise, it is taken in the TEXT system.

The size values are for the width (dx) and height (dy) of the ellipse. If the height is not given, the width is used and the ellipse becomes a circle. If size values are not specified at all, the values from the SET ELLIPSE SIZE command are used.

## 2.7 HISTOGRAM

HISTOGRAM [POINTS n1 [TO] n2]  
[SOLID|DOTS|DASHES|DOTDASH|PATTERNED]

Top Drawer makes simple histograms from data points. Bin edges are put halfway between the ends of the adjacent error bars, or halfway between the points if there are no error bars.

The SOLID, etc., keyword specifies the texture of the lines to be drawn. (See the description of the SET TEXTURE command.)

The POINT range refers to the data points by the order in which they were entered into the Top Drawer data arrays. If one is given, only the given points will be used in the graph. However, all the points that Top Drawer knows about will be used to determine the plot limits, if that is required.

### Example:

HISTOGRAM POINTS 11 TO 50

## 2.8 JOIN

```
JOIN [level] [{SPLINE|GENERAL}  
  {POINTS n1 [TO] n2} {TEXT}  
  {SOLID|DOTS|DASHES|DOTDASH|PATTERNED|FUNNY}]
```

Draw a line from point to point. Error bars and symbols are not used. If 'level' is specified, it is the number of straight line segments which will be used in connecting adjacent points. If 'level' is not specified, Top Drawer chooses an appropriate value, depending on the number of points.

The GENERAL curve is calculated using an algorithm which allows multiple-valued functions and repeated points.

SPLINE invokes a natural cubic spline fit to the given points. (For the SPLINE fit, there is a maximum number of points, and either the x- or y-values must be strictly increasing. Top Drawer checks these conditions, and uses the GENERAL fit if they are violated.)

TEXT instructs Top Drawer to use the TEXT coordinate system. No plot axes are made. (Otherwise, the DATA system is used, and axes are drawn if needed.)

The POINT range refers to the data points by the order in which they were entered into the Top Drawer data arrays. If one is given, only the given points will be used in the graph. However, all the points that Top Drawer knows about will be used to determine the plot limits, if that is required.

The SOLID|DOTS|DASHES|DOTDASH|FUNNY keyword specifies the texture of the lines to be drawn. FUNNY gives dots at odd intervals, determined by the level parameter and the joining algorithm.

(JOIN draws only the curve or line segments, not the symbol or error bars. For symbol and error bars, you must PLOT as well.)

### Examples:

```
JOIN  
JOIN 1 DASHES (Joins with dashed straight lines)  
JOIN POINTS 1 TO 200 DOTS
```

### 2.8.1 The Join Algorithm

The algorithm used for the GENERAL curve is an adaptation of ACM algorithm #433, by Hiroshi Akima (C.A.C.M. 15, 10 pp 914-918 (Oct 72).), with control near cusps and discontinuities suggested by J.R. Manning (Computer Journal 17, 2 p 181), and extended by some unpublished work of Roger Chaffee and Anthony Lawton. It is unique to Top Drawer.

### 2.9 NEW FRAME

```
NEW FRAME [[ALIAS=]'alias']
```

Start a completely new picture. Untreated points are PLOTTed before going on.

#### Examples:

```
NEW FRAME  
NEW FRAME ALIAS 'TRANSFER'
```

### 2.10 PLOT

```
PLOT [POINTS n1 [TO] n2]
```

Plot the current points, with the given error bars and symbols. This command sets limits if not already set. If the current points have not been processed (i.e. by a PLOT, JOIN, or HIST command), PLOT is performed automatically at the end of input, or before a NEW FRAME or SET WINDOW command.

The POINT range refers to the data points by the order in which they were entered into the Top Drawer data arrays. If one is given, only the given points will be used in the graph. However, all the points that Top Drawer knows about will be used to determine the plot limits, if that is required.

#### Examples:

```
PLOT  
PLOT POINTS 20 TO 50
```



## 2.11 PLOT AXES

PLOT {AXIS|AXES}

PLOT AXES plots the axes, using all the current parameters, but does not plot points. The points in point storage will be used if it is necessary to set limits. Axes will be plotted even if they have been plotted before.

The axes are plotted automatically at the first PLOT, HIST, or JOIN command, so PLOT AXES is not normally needed. It is useful for special effects such as making two different x-axes for the same plot, as in the following commands:

```
SET AXES ON RIGHT OFF
SET LIMITS Y 0 TO 100
PLOT AXES
SET AXES OFF RIGHT ON
SET LIMITS Y 0 TO 500
PLOT AXES
```

The two forms, with AXIS and AXES, exist only for convenience. They are equivalent.

Example:

```
PLOT AXES
```

## 2.12 TITLE, CASE, AND MORE

```
TITLE [TOP|BOTTOM|RIGHT|LEFT|
      xxx yyy [DATA|XDATA|YDATA] [CENTER] [LINES=n]]
      [SIZE n] [ANGLE x] [SPACES n] [INDEX n] 'text'

[CASE 'case text']

[MORE 'more text']
```

"text" will be written on the plot. It must be enclosed in apostrophes or quotes. The title size and orientation, and the position of the first character are set by the other parameters on the card. If the text delimiter (" or ') appears in the text as well, it must be doubled. Thus, 'This Exp't' is equivalent to "This Exp't".

If DATA is not specified, (xxx,yyy) are measured in the TEXT coordinate system. (See "Coordinate Systems".) 'TOP', 'BOTTOM', 'RIGHT', or 'LEFT', may be used instead, to indicate a position relative to the current "window". The picture in the section called "Anatomy of a Plot" may help to explain these terms. If no position is given, the text will be placed below the most recent title line. INDEX=n gives the line spacing in this case, in multiples of the character spacing. The default is INDEX=2.

If DATA is specified, (xxx,yyy) are in the coordinate system of the data points, as set by the most recent SET LIMITS command or operation with the data points. If XDATA or YDATA is specified, xxx or yyy respectively will be in the coordinate system of the data points. (To avoid surprises, place TITLE commands which refer to the data coordinate system after SET LIMITS commands and data point entry operations. If no data point limits have been established, program errors may occur.)

If CENTER is not specified, the given (x,y) position is for the center of the first character of the string to be plotted. If CENTER is specified, Top Drawer will attempt to place the first character of the string so that the middle of the entire string is at the given position. This may not work right, because of the variable character spacing which is used for esthetic reasons, or because the string contains control or positioning characters which affect the physical length. In this case, SPACES=n can be used to tell Top Drawer the width of the title, in character widths as given by the SIZE parameter. TOP, BOTTOM, RIGHT, and LEFT titles are always centered.

LINES n moves the starting position of the line "up" n spaces. Thus, TITLE TOP LINES 3 'text' would put the given text in the right place for a three-line title above the plot. (Unless the window were set lower than normal, it would also put it off the top of the paper in this case.)

SIZE n gives the approximate spacing between the letters, in tenths of an inch. (See "Text Plotting" for a further explanation of character string sizes.)

ANGLE x is in degrees, measured counter-clockwise from the x-axis.

SPACES n See the discussion under CENTER.

INDEX n See the discussion under DATA.

CASE 'case text' is optional and may appear on the same card or the following card. It modifies the TITLE text that it follows. It must correspond, character for character, to 'text' in the preceeding card. Each pair of characters, the first from the TITLE card and the second from the CASE card, makes a character pair which will be interpreted according to the U.G. extended-character-set specifications, described in the U.G. writeup (CGTM No. 203) and briefly listed in Appendix A.

For example,

```
TITLE BOTTOM 'E2IP3=-1'
CASE      'LXLGX  '
```

would produce the x-axis title "e to the i pi equals minus 1", since L as second character of a pair produces lower case Roman letters, G produces lower case Greek, and 2X and 3X are the control characters specifying, respectively, "enter superscript mode" and "leave superscript mode".

The MORE command may follow a TITLE command or a TITLE-CASE pair. The 'more text' is used as a continuation of the text from the TITLE command. MORE text may be modified by CASE text in the same or the next input line. More MORE commands may follow, to give up to 160 characters or character pairs for the entire TITLE string.

For more examples, see "Introduction to Top Drawer", CGTM No. 189.

## Section 3

### DATA COMMANDS

#### 3.1 LIST OF DATA COMMANDS

Data points: a data point command has only values, and no keyword. See the SET ORDER command for an explanation of parameter position.

BIN [BINS=n] [FROM xmin] [TO xmax] [BY dx]

SMOOTH [X|Y] [LEVEL n] [POINTS n1 [TO] n2]

[X|Y|DX|DY] [{BINS|POINTS}{n1 [TO] n2|n2}]  
[FROM xxx] [TO xxx] [BY xxx]

#### 3.2 DATA POINTS

The basic DATA command is the data point, which can give coordinate values, error-bar values, and a symbol. This "command" gives points to be entered into Top Drawer storage.

The SET ORDER command specifies the order and meaning of values that appear on a data card. Each value is a number or a symbol. Values are separated by blanks or some other separator, as explained in the section on Input Formats.

#### Examples:

```
10 3 50 10 0P
10 1.2 5.e-9 '$' 23
1
```

### 3.3 BIN

BIN [BINS=n] [FROM xmin] [TO xmax] [BY dx]

The data points are replaced by a new set which give the frequency distribution of the old points. (The original values are destroyed.) To do this, an array of "bins" is made with width and centers as given in the command. If no parameters are given in the command, a bin is centered on each of the small ticks on the x-axis, as given by the SET SCALE command or the default scaling. Only linear scaling is allowed.

As the points are "binned", each old point has a weight given by the y-value for that point. (If the y-value is zero, or none was given, then 1.0 is used.) A bin is determined for each point, according to its x-value, and the weight for the point is added to the contents of the bin. (If the x-error for the point is non-zero, then the point is taken as a normal distribution centered at the x-value, with a standard deviation given by the x-error.) (The y-errors of the old points are not used.)

The BIN command is usually followed by a HISTOGRAM command.

### 3.4 FREQUENCY

FREQUENCY is a synonym for BIN; see the above section.

### 3.5 SMOOTH

SMOOTH {X|Y} [LEVEL n] [POINTS n1 [TO] n2]

Replace the y-values specified by new values which give a smoother curve. The values are smoothed according to a non-linear algorithm which supposes that the given values are from a histogram of equally spaced bins. It is relatively insensitive to fluctuations in individual points. (The original values are destroyed.)

LEVEL n refers, approximately, to the number of points on each side of the bin in question which will be used in setting the value for that bin.

POINTS n1 TO n2 specifies the points, of those currently present in the Top Drawer point storage, which will be treated. (Remember that point storage is restarted with point 1 after each PLOT, JOIN, or HIST command.)

Examples:

```
SMOOTH
SMOOTH LEVEL 3
SMOOTH Y POINTS 1 TO 100 LEVEL 5
```

### 3.5.1 The Smoothing Algorithm

The algorithm used for the SMOOTH command was developed by John W. Tukey and Alberto Tubillo at SLAC. It repeatedly transforms the points and the residuals, using running medians, running means, quadratic interpolation, and hanning. Similar smoothing algorithms are described in Tukey's book Exploratory Data Analysis, although this particular combination of means, etc., is not in the book, and may be unique to Top Drawer.

### 3.6 X/Y BINS/POINTS

```
{X|Y|DX|DY} [{BINS|POINTS}[n1 [TO] n2|n2]]
      [FROM xxx] [TO xxx] [BY xxx]
```

Put a linear sequence of values into one of the data point or error arrays. It is particularly useful for doing the base axis of a histogram, or installing constant errors.

POINTS means that the values are to be generated as defined. BINS gives values at the centers of bins whose edges are specified by the command. For instance,

```
X POINTS FROM 0 TO 10 BY 1
```

gives 11 values: 0,1,2,...,10.

```
X BINS FROM 0 TO 10 BY 1
```

gives 10 values: 0.5,1.5,2.5,...,9.5. POINTS is assumed if neither is specified.

n1 and n2 define the indices in the Top Drawer data array. If not given, n1 is taken as 1. Thus,

```
X BINS=10 FROM 0 TO 20
```

gives 10 values: 1,3,5,...,19.

If there is insufficient information to make the array, e.g.  
if only FROM and TO are given, the current number of  
data points is used for n2.

Example:

```
SET ORDER Y; 10; 6; 3; 8; 12; 14;  
X BINS FROM 0 BY 2; HIST
```

is equivalent to

```
SET ORDER X Y  
1 10 ; 3 6 ; 5 3 ; 7 8 ; 9 12 ; 11 14 ; HIST
```

Section 4  
CONTROL COMMANDS

Examples of Control Commands

DUMP [FLAGS]        is a debugging aid  
END        (This command is not required.)  
LIST [POINTS [FROM] n1 [TO] n2]  
             lists values currently in T.D. data buffers.

4.1    DUMP

DUMP [FLAGS]

This is a debugging command, not for general use. The common blocks, or only the flag settings, will be dumped.

4.2

END

Stop reading input cards. This command is not required. Top Drawer normally stops processing at the end of the input.



#### 4.3 LIST

LIST [POINTS [FROM] n1 [TO] n2]

LIST causes Top Drawer to make a list in the line-printer output of the data currently in the data buffer. This would be useful after a BIN, SMOOTH, or other command which changed the values.

The POINTS parameters allow a partial listing. n1 and n2 refer to the order of the points.

## Section 5

### SET COMMANDS

#### List of SET Commands

SET ARROW [SIZE xxx] [{FLAIR|FLARE} fff]

SET {AXIS|AXES}  
    [{ALL|TOP|BOTTOM|RIGHT|LEFT}{ON|OFF}]  
    controls presence/absence of axes.

SET BAR [SIZE] xxx     sets size of ends of error bars

SET BOX [SIZE xxx [yy]]

SET CARD [LENGTH] length     sets length of input cards.

SET CIRCLE [SIZE xxx [yy]] (Same as SET ELLIPSE.)

SET  
[WHITE|RED|GREEN|BLUE|YELLOW|MAGENTA|CYAN|BLACK]     COLOR

SET DEVICE [device keyword] ['string'] [SIDEWAYS]  
    [DDNAME=ddname]  
    [INTERNAL | EXTERNAL]  
    [SEQUENTIAL | INTERACTIVE]  
    [FANFOLD | CONTINUOUS].  
    chooses output device. (4013, Imagen,...)

SET DIAMOND [SIZE xxx [yy]]

SET ELLIPSE [SIZE xxx [yy]] (Same as SET CIRCLE.)

SET FONT {BASIC|EXTENDED|DUPLEX}  
    chooses U.G. character set.

SET FORMAT 'format'  
    format for TDMAIN card reader (usually '80A1').

SET GRID[{OFF|HORIZONTAL|VERTICAL|ON|  
SYMBOL [x][SIZE n]}]  
    specifies grid marks to overlay the plot.

SET INTENSITY level  
    sets line width or intensity for some devices.

SET LABELS [SIZE=n]  
     [[ALL|TOP|BOTTOM|RIGHT|LEFT]{ON|OFF}]  
     controls numeric labels along axes.

SET LIMITS [X [FROM] xxx [TO] xxx]  
     [Y [FROM] yyy [TO] yyy]  
     [XMIN xxx] [XMAX xxx] [YMIN yyy] [YMAX yyy]  
     sets limits for each plot axis.

SET ORDER [X [fctr]] [Y [fctr]] [DX|RX [fctr]]  
     [DY|RY [fctr]] [SYMBOL] [DUMMY]  
     determines interpretation of input data cards.

SET OUTLINE  
     [[ALL|TOP|BOTTOM|RIGHT|LEFT]{ON|OFF}]  
     controls presence/absence of plot outline.

SET PATTERN p1 s1 p2 s2 p3 ...  
     controls the pattern used in 'patterned' lines.

SET SCALE [X|Y] [n1 [n2]] [BASE n]  
     [LINEAR|LOGARITHMIC|MONTHS|YEARS|USER n|  
     NORMAL [MEAN x] [DEVIATION s] ]  
     sets scaling, number of labels, and ticks

SET SIZE xxx [BY] yyy [UNITS=units] [REDUCE=reduce]  
     defines active area of paper or screen.

SET SYMBOL [x] [SIZE n]  
     sets symbol used for plot character.

SET TEXTURE  
     [SOLID|DOTS|DASHES|DOTDASH|PATTERNED]  
     sets line texture for all lines to be drawn

SET TICKS [SIZE n]  
     [[ALL|TOP|BOTTOM|RIGHT|LEFT]{ON|OFF}]  
     controls tick marks on axes.

SET TITLE [SIZE n]      sets size for titles

SET WINDOW [X xxx [TO] xxx] [Y yyy [TO] yyy]  
 SET WINDOW [X n1 OF n2] [Y n1 OF n2]  
     defines position of outline of current graph.  
     (Labels are outside this window. Titles and other  
     graphs may be made inside or outside.)

### 5.1 SET ARROW

SET ARROW [SIZE xxx] [{FLAIR|FLARE} fff]

Set the size and shape of the arrowhead drawn by the ARROW command. The default SIZE is 2. The default FLARE is 0.5.

#### Examples:

SET ARROW FLARE 1 (wide arrowhead)  
SET ARROW SIZE 1 FLARE 0.8

### 5.2 SET AXES

SET {AXIS|AXES}  
[ {ALL|TOP|BOTTOM|RIGHT|LEFT} {ON|OFF} ]

Controls the presence or absence of each axis, which consists of the outline, ticks, and labels. The axes are drawn at the first HIST, JOIN, PLOT, or PLOT AXES command, using the axis parameters in effect at the time.

OFF prevents drawing the outline, labels, and ticks. ON allows all three: the outline, ticks and labels may or may not be drawn, depending on the SET OUTLINE, SET TICKS and SET LABELS commands. (The book-keeping for SET AXES and for these latter three commands is kept separately by Top Drawer. Both the axis and the individual element must be ON for the element to be drawn, but changing one does not affect the state of the other.)

The two forms, SET AXIS and SET AXES, exist only for convenience. They are equivalent.

#### Examples:

SET AXES ALL OFF (no axes)  
SET AXES ALL OFF BOTTOM ON (bottom only)  
SET AXES TOP OFF RIGHT OFF (left and bottom unaffected)

### 5.3 SET BAR

SET BAR [SIZE] xxx

Set the size of the lines on the ends of the error bars. As in the SET TICK SIZE command, the default value is 0.1, and the unit is inches.

#### Example:

SET BAR SIZE 0 (Just a line for the error bar, with no cross bars at the ends of it.)

### 5.4 SET BOX

SET BOX [SIZE dx [dy]]

Set the default values for the BOX half-widths. See the BOX command.

### 5.5 SET CARD

SET CARD [LENGTH] length

Sets the number of significant columns for the input cards. The default value is 72.

#### Example:

SET CARD LENGTH 80 (Read 80 columns)

### 5.6 SET CIRCLE

SET CIRCLE [SIZE dx [dy]]

Set the default values for the CIRCLE and ELLIPSE semi-axes. See the ELLIPSE command.

## 5.7 SET COLOR

SET COLOR [WHITE|RED|GREEN|BLUE|YELLOW|MAGENTA|CYAN|BLACK]

Select the color for a device which will draw in more than one color.

Three SLAC devices presently support color: IBM 5080, IBM 3179 terminals, and Tektronix 4105 terminals. Files prepared for the latter can be viewed on Mac II workstations using Versaterm.

### Example:

SET COLOR RED

## 5.8 SET DEVICE

SET DEVICE [device keyword] ['string'] [SIDEWAYS]  
[DDNAME=ddname]  
[INTERNAL | EXTERNAL]  
[SEQUENTIAL | INTERACTIVE]  
[FANFOLD | CONTINUOUS]

keyword	Device
IBM 3179	IBM 3179 Color Graphics Terminal
IBM 5080	IBM 5080 Graphics Display Station
IMAGEN	Any of the Imagen 300 printers.
IMGN300	Same as Imagen.
TEKTRONIX	Tektronix 401x graphics terminal
4013	Same as TEKTRONIX
4105	Tektronix 4105 graphics terminal
VERSATEC	SLAC On-Line Versatec Plotter

SET DEVICE VERSATEC may be followed by the keywords CONTINUOUS and/or EXTERNAL.

For TEKTRONIX or 4013 under VM/CMS, the INTERACTIVE keyword is used to send output to the terminal, rather than to a disk file.

If a 'string' is given, it is passed as the argument to subroutine UGOPEN, concatenated at the end of the argument options specified by the other keywords. See the U.G. writeup (CGTM No. 203) for details of UGOPEN options. Most UGOPEN options are available through Top Drawer keywords, and this parameter is useful mainly for new or experimental graphic devices.

SET DEVICE 4013 may be followed by the keyword SEQUENTIAL, to specify the sequential dataset output format.

DDNAME can be used to specify the ddname of the graphic output dataset, on some IBM/U.G. systems. This would be useful if you wanted to plot on several devices in one Top Drawer job.

SIDEWAYS causes Top Drawer to treat the graphic device as if it were rotated by 90 degrees. For devices like Imagen (with a drawing space 10 inches by 7.5 inches) this has the illusion of rendering plots in "portrait" mode as opposed to "landscape" mode. There is at present, however, a restriction in TopDrawer which rescales plots when they are more than 7.5 inches in height; hence, the SIDEWAYS doesn't let you use the full 10 inch drawing space vertically.

The default device, and the default parameters associated with each device, vary according to the operating system and the devices available. To be sure of a particular result, you should specify the device and keywords.

#### 5.9 SET DIAMOND

SET DIAMOND [SIZE dx [dy]]

Set the default values for the DIAMOND half-widths. See the DIAMOND command.

#### 5.10 SET ELLIPSE

SET ELLIPSE [SIZE dx [dy]]

Set the default values for the CIRCLE and ELLIPSE semi-axes. See the ELLIPSE command.

### 5.11 SET FILE

Top Drawer normally writes to Fortran unit 6. This may be changed, for example to unit 3, by the command SET FILE OUTPUT 3. The DEBUG and ERROR parts of this command allow different kinds of output to be routed to different units. They are not intended for general use.

Top Drawer normally reads cards from Fortran unit 5. This may be changed, for instance to unit 12, by the command SET FILE INPUT 12.

SET FILE can cause execution errors due to missing units, and it may cause printed output or garbage to appear in the graphic output.

#### Examples:

```
SET FILE INPUT 3 (Read from Fortran unit 3.)  
SET FILE OUTPUT 8 (Printed output to Fortran unit 8.)
```

### 5.12 SET FONT

```
SET FONT {BASIC|EXTENDED|DUPLEX}
```

This command causes the Unified Graphics system to load the appropriate character set.

The BASIC set is missing many characters, and is probably not useful.

The EXTENDED set is the usual one, and is loaded by Top Drawer before any graphic output is done.

The DUPLEX set is the most complex, and provides output suitable for publication. It is also the most expensive, in memory requirement, computing time, and volume of graphic output. On devices which use dots instead of vectors, and which have only moderate resolution, the DUPLEX set may not give good results. On other devices, the drawing time may be prohibitive.

#### Example:

```
SET FONT DUPLEX
```



### 5.13 SET FORMAT

SET FORMAT 'format'

Sets the format used by the Fortran READ statement in reading input cards. The default value is '(80A1)'.

This command would be useful only if an input dataset is defined which contains unit records longer than 80 characters. It should be used together with the SET CARD LENGTH command, as in the following example.

Some versions of Top Drawer, such as Top Drawer under VM/CMS, do not use the standard Fortran input routines. If this is the case, the SET FORMAT command may have no effect.

#### Example:

SET FORMAT '(133A1)'; SET CARD LENGTH 133

### 5.14 SET GRID

SET GRID {OFF|HORIZONTAL|VERTICAL|ON|SYMBOL [x]  
[SIZE n]}

This command causes a grid to be overlayed on the plot when the axes are drawn. The grid marks appear in line with the large tick marks on each axis.

OFF inhibits the grid marks. HORIZONTAL causes horizontal lines only (joining pairs of big ticks on the y-axes). VERTICAL causes vertical lines only. ON causes both horizontal and vertical, that is, a rectangular grid. SYMBOL x causes the given symbol to be plotted at the vertices of a rectangular grid, and the grid lines to be omitted. (The default symbol is 00, a plus, which makes the plot look like a NASA photograph.) The SIZE parameter sets the size of the grid symbols to be plotted.

SET GRID is not an action command, because the grid is not made until the next PLOT, HIST, JOIN, PLOT AXES, or BARGRAPH. For this reason, the grid can be called for before the axes are defined, but it will not be made until the necessary information is available. SET GRID acts only on the current plot. Only one grid is made by each SET GRID command. A new SET GRID command is required to make another grid, and it must follow a NEW FRAME or a SET WINDOW command.

Examples:

```
SET GRID ON
SET GRID HORIZONTAL
SET GRID SYMBOL
SET GRID SYMBOL 10 SIZE 3
```

5.15 SET INTENSITY

SET INTENSITY level

On some graphic output devices, the plots can be made using different levels of brightness or line width. This command sets this level. Line intensity can be changed in mid-plot, so plots can contain several different intensities.

Currently, the only device for which this option is supported is the Versatec model 1200 plotter.

'level' depends somewhat on the graphics device but typically is a number from 1 to 5. For the Versatec, it is an integer, and decimal fractions are truncated. The default intensity level is 2.

Example:

```
SET INTENSITY 4 (very bright or wide lines)
```

5.16 SET LABELS

```
SET LABELS [SIZE=n] [ON|OFF]
           [{ALL|TOP|BOTTOM|RIGHT|LEFT} {ON|OFF}]
```

Sets the size of the numeric labels along the axes, and specifies which axes are to be labelled. Character size conventions are described in the section on "Plotting Text". The default size is 2. The defaults are ON for left and bottom, and OFF for top and right. See also SET AXES.

Examples:

```
SET LABEL SIZE 3 (Make bigger labels.)
SET LABELS ALL OFF (Make no labels.)
SET LABELS ALL OFF TOP ON (Label the top only.)
```

5.17 SET LIMITS

```
SET LIMITS [X [FROM] xxx [TO] xxx]
           [Y [FROM] yyy [TO] yyy]
           [XMIN xxx] [XMAX xxx] [YMIN yyy] [YMAX yyy]
```

Override (or request) the automatic selection of plot limits. If no limits are given, all are set for automatic selection. With automatic selection, limits are set to 10% beyond the range of input values, at the first PLOT, PLOT AXES, JOIN or HIST command. If some are specified, the others are not changed.

The difference between limits may have any non-zero value. XMIN gives the value at the left edge of the x-axis, and XMAX gives the value at the right end, but there is no requirement that XMIN be less than XMAX. (And the use of YMIN and YMAX is of course similar.) For instance,

```
SET LIMITS X FROM 10 TO -10 Y FROM 0 TO -20
```

is legal, and sets values from 10 at the left edge to -10 at the right, and from zero at the bottom to -20 at the top.

Examples:

```
SET LIMITS X FROM 0 TO 100
SET LIMITS XMIN 0 XMAX 100
SET LIMITS X 0 100 Y 100 150
```

## 5.18 SET ORDER

```
SET ORDER [X [fctr]] [Y [fctr]] [Z [fctr]]  
          [DX|RX [fctr]] [DY|RY [fctr]] [DZ|RZ [fctr]]  
          [SYMBOL] [DUMMY]
```

Set the order in which the values on each data card will be interpreted. The default order is [X Y DX DY SYMBOL]. Each value is a number or a symbol. Values are separated by blanks or some other separator, as explained in the section on Input Formats.

X and Y are coordinate values. DX and DY are half-widths for the error bars used in the PLOT command. RX and RY signify that the errors to be given are relative to the central value.

"fctr" are four multiplicative factors which will be applied to the data on each input card. If a factor is not explicitly given, 1.0 is used. Values from a previous SET ORDER card are not retained.

DUMMY signifies that the value at that position on the card is to be ignored. You can specify multiple DUMMY positions.

SYMBOL is the symbol which will be used to PLOT the point. (The default symbol is given by the SYMBOL card.) It may be specified by a single character or a U.G. extended-character-set pair, as for the SYMBOL command.

For instance,

```
SET ORDER X DX Y DY SY  
10 3 50 10 00
```

is equivalent to

```
SET ORDER X RX Y RY SYM  
10 .3 50 .2 00
```

and to

```
SET ORDER X 10 RX Y DY 10 SYMBOL  
1 .3 50 1 00
```

and to

```
SET ORDER X DUMMY DUMMY DX Y DY SYMBOL  
10 ABC 123 3 50 10 00
```

Note that the 00 under SYMBOL is a "zero" and the letter "O"

### 5.19 SET OUTLINE

```
SET OUTLINE
      [[ALL|TOP|BOTTOM|RIGHT|LEFT] [ON|OFF]]
```

Controls the presence/absence of the outline surrounding the plot. See also SET AXES.

#### Examples:

```
SET OUTLINE ALL OFF
SET OUTLINE ALL OFF BOTTOM ON
```

### 5.20 SET PATTERN

```
SET PATTERN p1 s1 p2 s2 p3 ...
```

The 'pattern' set by this command is used in drawing 'patterned' lines, when enabled by a SET TEXTURE PATTERNED command or a PATTERNED keyword in a JOIN, HIST, PLOT, or BAR command.

The first number gives a distance (in inches as modified by any REDUCE value) to draw. The second number gives a distance to be skipped or left blank. The third gives a distance to draw, the fourth a distance to skip, and so forth. When the list is exhausted, it starts again with the first number. (A zero skip is assumed at the end if there is an odd number of numbers in the list.)

#### Examples:

```
SET PATTERN .1 .1 gives dashed lines
SET PATTERN .01 .09 gives dotted lines
SET PATTERN .01 .04 gives dots with half the spacing
SET PATTERN .1 .1 .01 .1 gives dot-dash
SET PATTERN 0 .1 .1 gives dashes, starting with a blank
```

## 5.21 SET SCALE

```
SET SCALE {X|Y} [n1 [n2]] [BASE n]
          [LINEAR|LOGARITHMIC|MONTHS|YEARS|USER n|
          NORMAL [MEAN x] [DEVIATION s] ]
```

Scaling for each axis is independent. n1 and n2 specify the type and spacing of labels and ticks. If n1 and/or n2 are zero or omitted, TOP DRAWER chooses its own value(s). Control is different for each scaling mode.

### Linear:

There will be at most  $(|n1|+1)$  intervals (and  $|n1|+2$  major ticks) on the axis. (Since labels are placed at round numbers, which may not coincide with the ends of the axis, there may be fewer.) Each interval is divided into  $|n2|$  subintervals by unlabelled ticks.

Positive n1 gives big ticks at major intervals. Positive n2 gives big ticks for subintervals. Negative gives small ticks. The default values are n1=6 and n2=-5, which produces approximately 6 intervals, separated by large labeled ticks. Each interval is divided by small ticks into 5 small intervals.

Setting n2=1 eliminates small ticks altogether.

(To choose the linear axis markings, Top Drawer lays out an axis with n1 intervals of size  $BASE \cdot ROUND \cdot POWER$ , where BASE is given by the BASE parameter, ROUND is 1., 2., 2.5, or 5., and POWER is an integral power of ten. ROUND and POWER are chosen for the minimum axis length which is not less than the difference of the limits. Normally this axis is longer than is required, and only the part within the limits is plotted. Under certain circumstances, it is not long enough, and  $|n1|+1$  intervals are used.)

### Logarithmic:

Each decade is labelled the same. n1 controls the labels. If n1 is positive, standard notation, e.g. '10000', is used for the labels. If n1 is negative, exponential notation, e.g. '10 ', is used at integral powers of ten, and only the first digit is used for any intermediate labels. n2 controls ticks. If n2 is negative, short ticks are used except at integral powers of ten. If n2 is positive, long ticks are used exclusively. In any case, the magnitudes of n1 and n2 make bit patterns which specify the positions of intermediate ticks and labels, according to the following scheme:

value	meaning
-------	---------

1	No intermediate labels (n1) or ticks (n2)
2	Label or tick at all positions, 2 thru 9
2**n	Label or tick at the n-th position

(A sum may be used to specify more than one position at a time, except for the values 1 and 2. Thus,  $n2 = -36$  specifies a small tick at 2 and 5, since  $36 = 2 + 2 + \dots + 2$ .)

#### Months:

Labels are Jan, Feb, etc. MONTHS specifies a special scale which is useful for plotting functions of calendar date. January 1 is given by the value 1.01. (Technically, this is noon of January 1. The entire day is from 1.005 to 1.015.) January 31 is 1.31. February 1 is 2.01, and the scaling function is arranged so that 1.315 is equivalent to 2.005, since midnight of January 31 is the same as "zero o'clock" of February first.

The axis is labelled by the names of the months, in a twelve-month cycle. That is, 1, 13, 25, etc. are all labeled 'Jan'. Every fourth February, starting with month 38, has 29 days, although for most purposes this will not be noticeable. Values less than zero are not allowed, and values greater than 1000 may be affected by round-off errors. No year titles are generated, although they could be put in with a TITLE command.

The n1 parameter, as usual, controls the labels, which are put at month 1 (January) and every |n1| months thereafter.  $n1 > 0$  signifies that the labels are to have three letters each (Jan Feb Mar etc.) and  $n1 < 0$  calls for one letter each (J F M etc.).

#### Years:

Values can be given by year and Julian day. YEARS specifies a special scale which is useful for plotting functions of a calendar date. For instance, January 1, 1976, is given by 76.001, or 1976.001. (The former method is preferred, to avoid round-off errors.) 76.3655 is equivalent to 77.005.

Base n:

For log scaling, labels and large ticks are put at powers of the base. BASE 2, for instance, would put labels at 0.5, 1, 2, 4, 8, etc.

For linear scaling, this is useful for non-decimal units, such as time (BASE 12) or angle (BASE 90 or BASE 3.14159).

Examples:

```
SET SCALE X LINEAR BASE 12 (Time scale)
SET SCALE X LOG Y LOG
SET SCALE X 13 1 (For limits from 0 to 13, this gives a
                tick and label at every integer)
SET SCALE X 13 -2 (The same, but with an unlabelled
                small tick between each pair of large ones.)
SET SCALE X LOG BASE 2 (Label at .5,1,2,4,8,...)
SET SCALE X MONTHS
```

## 5.22 SET SIZE

```
SET SIZE xxx [BY] yyy [UNITS units] [REDUCE reduce]
```

The SIZE of a plot measures the area of the paper (or screen, or film) in which plotting can be done. The UNITS and REDUCE parameters, together, determine the physical length of the units involved.

First, take the case where REDUCE = 1.0. UNITS then measures the number of plot units which will fit in one inch. If UNITS = 1.0, which is the default value, xxx and yyy are measured in inches, and all positions in the TEXT coordinate system are also in inches.

If REDUCE = 1.0 and UNITS = 2.54, then positions are measured in centimeters. Remember that all sizes, such as for titles, ticks, and arrows, are still measured in tenths of an inch. A title size of 2 gives title spacing of 0.508 cm, which is the same as 0.2 inches.

If the UNITS parameter and the xxx by yyy size are kept constant, the REDUCE parameter is a factor by which all elements of the plot are reduced. This is different from the units parameter because it affects sizes as well as positions. Thus the command SET SIZE 10 BY 7.5 REDUCE 2 will reduce a plot to half-size, whereas SET SIZE 10 BY 7.5 UNITS 2 will reduce the overall dimensions, but leave the titles disproportionately large.



There is one further complication. The minimum value of REDUCE is that which just allows the entire plot, xxx by yyy units, to fit on the graphic device in use. Top Drawer will adjust it if too small a value is given. The following table gives the minimum and default REDUCE values. The minimum reduce value in any case can be calculated by knowing that the true size of the plot, in inches, is the given size value (xxx or yyy) divided by (UNITS\*REDUCE). This true size must be small enough to fit on the device in question.

#### Examples:

```
SET SIZE 10 BY 7.5 REDUCE 2 (Everything half-size.)
SET SIZE 33 BY 25 UNITS 2.54 (Measure in centimeters.)
```

#### 5.22.1 Device Size Parameters

Device	Maximum Size (inches)	Minimum REDUCE	Default REDUCE
Imagen 8/300	10.0 by 7.5	1.00	1.00
Fan-fold Versatec	10.5 by 7.88	1.27	1.27
Continuous Vers.	--- by 10.0	1.00	1.00
4013 terminal	8.0 by 6.1	1.65	1.65
4105 terminal	9.5 by 7.0	1.05	1.05
IBM 3179 terminal	9.5 by 7.0	1.12	1.12
IBM 5080	11.2 by 11.2	0.89	1.00

#### 5.23 SET STORAGE

```
SET STORAGE [X] [Y] [DX] [DY] [SYMBOL]
```

The Top Drawer point buffer is about 5120 numbers long, which gives room for 1024 points of five numbers (x,y,dx,dy,symbol) each. If you want more points to fit, you may use the SET STORAGE command to redefine the numbers allocated to each point. For instance, if your points have no error bars, you could use SET STORAGE X Y SYMBOL, and there would be room for  $5120/3 = 1706$  points.

SET STORAGE destroys the current contents of the point buffer. SET ORDER (q.v.) will invoke a SET STORAGE if it contains a variable which is not allocated in the

currently defined storage. (So, for instance, SET ORDER X Y Z redefines each point as having values for X, Y, Z, DX, DY and SYMBOL, and there is room for only  $5120/6 = 853$  points.)

#### 5.24 SET SYMBOL

SYMBOL [x] [SIZE n]

SET SYMBOL [x] [SIZE n]

The symbol 'x' becomes the default symbol to be PLOTted for the following points. This card does not affect the plotting of points already read in--the SYMBOL card must precede the data cards for the points it is to affect. As explained for the SET ORDER command, the symbol may be set for each data point, overriding this default symbol. The symbol may be specified by one character followed by a blank or by a character pair from the U.G. extended-character-set. The latter two are useful for specifying plotting characters, as described in Appendix A.

The default symbol is a blank or no character, which is plotted as a dot if zero error bars are specified. If 'SIZE n' is specified, n is the approximate width of the plotted character, in tenths of an inch. The default size is 2.0.

The best symbols to use are the plot symbols (00 to 90), (note again that this is "zero" "0" as in the letter "O") for which the center of the symbol is plotted at the specified point. This is not true of many other symbols, such as the period, which are not plotted in the center of the area they control.

The two forms of the command, 'SYMBOL...' and 'SET SYMBOL...' exist only for convenience. They are equivalent.

#### Examples:

SET SYMBOL SIZE 4 (Big plot symbols)  
SET SYMBOL 30 (Plot symbol is a square)

## 5.25 SET TEXTURE

```
SET TEXTURE  
[SOLID|DOTS|DASHES|DOTDASH|PATTERNED]
```

Set the texture of all lines to be drawn subsequently, including ticks, outlines, histograms, and the error bars plotted by the PLOT command and by the automatic PLOT command. It does not affect titles or axis labels. A texture parameter in the PLOT, JOIN, etc. commands overrides the value set by this command, for that action only.

PATTERNED textures must be used in conjunction with the SET PATTERN command (q.v.).

### Example:

```
SET TEXTURE DOTDASH
```

## 5.26 SET TICKS

```
SET TICKS [SIZE n] [ON|OFF]  
[ALL|TOP|BOTTOM|RIGHT|LEFT] {ON|OFF}
```

This command controls the presence of the tick marks on the axes, and sets the length of the (smaller) ticks. The larger ticks are three times the length of the smaller. The value specified is in inches. The default size is 0.1.

### Examples:

```
SET TICKS TOP OFF RIGHT OFF (Ticks on bottom and left.)  
SET TICKS OFF BOTTOM ON (Allows ticks on bottom only.)
```

## 5.27 SET TITLE

SET TITLE [SIZE n]

Set the default size for titles. (The default size for the 'TOP' title is 1.5 times this value.) The default value is 2. See the section on "Plotting Text" for more information about title sizes and character generation.

### Example:

SET TITLE SIZE 4.5

## 5.28 SET WINDOW

SET WINDOW [X xxx [TO] xxx] [Y yyy [TO] yyy]

SET WINDOW [X n1 OF n2] [Y n1 OF n2]

SET WINDOW sets the coordinates, in inches, of the axes of the coming graph. (The available plotting surface is set by the SET SIZE command.) More than one area may be used before making a NEW FRAME. If neither X nor Y is specified, the values are reset to the original, nearly full-size, values. If only one is specified, the other is not changed. When one or both is specified, the corresponding limits are reset for automatic selection. They may of course be reset by a SET LIMITS command.

The alternate form, using the OF keyword, divides the x- or y-axis into n2 sections, and sets the window values to fit within the n1-th section (reading left to right or bottom to top). The default title and label sizes are adjusted accordingly, although they may of course be set explicitly. As usual, a border is left on each side, to leave some room for the titles. Non-integral n1 and/or n2 may be used for fine adjustment to the window position and border size.

### Examples:

SET WINDOW X FROM 1 TO 4 Y FROM 1 TO 4 (Bottom left)  
SET WINDOW X 6 12 (Right side of screen)  
SET WINDOW X 3 of 3 Y 1 OF 2 (Divides the screen/paper  
3 across and 2 high, and sets the current  
window at the bottom right.)

## Section 6

### TDPREvU--A PC SPECIFIC TOPDRAW INCARNATION

TDPREvU is yet another incarnation of TopDraw--this one written specifically to take advantage of the more modern hardware platform and interfaces of the desktop workstation --in this case the PC. The purpose of this section is to describe TDPREvU, its facilities, how it differs from TopDraw, where it will run and how to do so.

#### 6.1 WHAT IS A TDPREvU?

TDPREvU is an entirely new version of Top Drawer written in Pascal with very different design goals from the main-frame version. It exploits the interactive facilities available on the IBM PC--while maintaining compatibility with existing Top Draw files.

This implementation takes the form of an integrated environment, an environment where one is encouraged to iterate back and forth between editing the TD file with the TDPREvU integrated editor and viewing the resulting graph until the "right" picture has been generated. Once that "right" view is obtained, you can print a copy, landscape or portrait, on the locally attached dot matrix or laser printer. In this environment when TDPREvU finds an error, it will invoke the editor, with the cursor positioned at the token in question and with an error message at the bottom of the screen.

This iterative approach is not limited to a single graph. TDPREvU treats a TopDraw file with multiple plots as a stack of graphs which can be manipulated by using the cursor control keys: 'Home' takes you back to the first graph in the stack, 'End' takes you to the last plot in the file, and 'PgUp' and 'PgDn' move you up or down in the stack by one graph, respectively.

This stack of graphs, and their generating top drawer file, are "bound." This means that if one wants to review a previously drawn graph whose generating data have not been changed, then the plot is redrawn from the graph's metacode definition, saved when the graph was origi-

nally rendered, with significantly faster performance. If, on the other hand, the generating text has been changed, the plot and its metacode are rendered from scratch.

One of the distinguishing features between a mainframe and desktop computer is the ability to provide real time keystroke sensitivity and less than 10 millisecond trivial response times. For TDPreVu this means you can hit 'PgDn' twice in rapid succession and have the PC immediately start drawing the graph two plots "up" in the stack. One can also invoke the editor while a graph is being drawn (e.g., as soon as an error is noted) without waiting until the plot is complete. This is accomplished by striking 'E'. The source file is automatically positioned at the first line and first character of the text that generated the plot.

Top Draw over the years has supported myriads of devices, often with very differently sized drawing areas. In order to maintain compatibility with these devices, TDPreVu treats all "SET SIZE" sizes as virtual (i.e., you can define the drawing surface to be any desired size and TDPreVu will map that domain into the full physical size of the PC screen.

Minor caveat: for version 0 only--TDPreVu is a 98% subset of Top Draw--Join Smooth and Spline are not yet implemented nor are user defined line patterns. Version 1.00 will include this functionality.

## 6.2 TDPREVU HARDWARE REQUIREMENTS

TDPreVu will run on almost any PC or true clone with at least 512k of memory, any of four popular graphics cards, and a hard disk. The graphics cards supported are VGA, AT&T 6300, EGA and CGA. Hercules cards are supported for display, but not for local printing. Now that TDPreVu has more generalized color support, and more supported colors, a color monitor is clearly advantageous.

### 6.3 RUNNING TDPREVU

TDPReVu can be invoked for two different purposes: 1) to produce a one page help/intro or 2) to process a Top Draw file and produce plots. To generate the one page intro screen use the command

TDPREVU ?

To invoke TDPReVu to process a Top Draw file, use

TDPREVU fn [prefixing.command.list]

where "fn" is the file name of the Top Draw file to be processed and where the prefixing command list is a list of commands, separated by semicolons, that are to be inserted at the head of the working copy of the Top Draw file. If fn is specified without an explicit extension, ".TD" is assumed. One may use of fully qualified file names; in the absence of full qualification, TDPReVu will search the current directory and then the PATH. If fn is specified as a file mask as opposed to an explicit file name, all matching files will be processed in the order found. If no file is found, TDPReVu will invoke its editor directly so that the user can create a file with that name.

If the file exists, TDPReVu will compile the file into a metacode on a frame by frame basis, display the first frame of the file, and wait for a keystroke from the user. Keystrokes have the following meaning:

KeyStroke	Interpretation
<esc>	Quit the current file and present the exit menu.
E	Edit the current file at the current graph location.
H	Present a scrollable copy of the TopDrawer Manual (CGTM 178)
P	Print on the local printer a copy of the current graph display.
Q	Toggles the upper-right corner status display between showing a "?" when waiting and showing the amount of free storage.
<Home>	For multiplot Top Draw files: make the first plot of the file the current file.
<End>	For multiplot files: make the last plot the



file the current file.

<PgUp>        Make the previous plot in the file the c  
                 current plot.

<PgDn>        Make the next plot the current plot.  
?              Produces a one page quick reminder of  
                 keystroke interpretation.

While TDPreVu is processing a Top Draw file, but has not yet started to display any generated metacode, it displays an indicator flag in the right upper corner of the screen. The flags have the following meaning:

? -- Awaiting new user keystroke.  
^ -- Loading Top Draw file text from disk.  
\* -- Compiling metacode from Top Draw text.

If TDPreVu detects an error while translating the Top Draw text into its metacode counterpart, it will abort further translation, display an error message and await a user keystroke. If the user at this point strikes 'E', the editor is invoked with the cursor under the offending token.

If the user enters a meaningful keystroke during compilation of the text into metacode or during the drawing process, processing is interrupted and the keystroke is serviced.

The exit menu, reached by entering an <esc> from either the editor or the main graph display, is provided as a quick way to "reinvoke" TDPreVu against another Top Draw file without returning to DOS.

#### 6.4    USING THE TDPREUVU INTEGRATED EDITOR

To facilitate the iterative process of refining graphs, TDPreVu has an integrated editor. The editor allows a user to extend existing files, start new ones, correct TDPreVu detected errors in the current file, etc. The editor is in the style of WordStar, i.e., keystroke driven rather than command driven. It supports most of the WordStar keystrokes and has a number of specific limitations like 80 character line length and 20,000 line maximum file size. In the context of TDPreVu, however, it is adequate for most interactive "alterations" needed for grooming a plot. If you need to make major changes to a TopDrawer file you may want to use a "real" editor and reserve the TDPreVu editor for minor editorial changes.



TDPreVu error messages are visible in the editor at the bottom of the main graph screen and remain visible until the first keystroke of the editing session. When error conditions are encountered, the cursor is positioned under the first character of the token that TDPreVu found to be in error.

KeyStroke	Interpretation
Esc	Have TDPReVu quit processing the current file and present the user with the TDPReVu exit menu. If the current file had been modified since it was last saved, the user will be prompted as to whether the modified file should be saved back to disk.
F3	Have TDPReVu leave the editor and try to process/re-graph the current graph. If the Top Draw text defining the graph hasn't been changed, then the graph will be quickly redrawn from the prior drawing's saved metacode. If the text has been modified, then the new text will be processed, a new metacode produced and drawn.
?	Presents a terse one page Editor Help screen.
Home	Will move the cursor to column 1 of the current line.
End	Will position the cursor immediately after the last character of the current line.
PgUp -or- F7	Will reposition the screen one screen's worth of line (23 in this case) higher in the file. The top of the screen can not be positioned "above" the beginning of the file.
PgDn -or- F8	Will reposition the screen down one screen's worth of lines. The top of the screen can not be positioned "below" the last line of the file.
UpArrow	Will move the cursor up 1 line. If the cursor was already on the top text line of the screen and that line isn't the first line of the file then the screen will be scrolled down one line. Like PgUp, the screen can not be repositioned to "above" the top of the file.
DownArrow	Will move the cursor down 1 line. If the cursor was already on the last text line of the screen and that is not the last line of the file, the screen will be scrolled up one line.
LeftArrow	Moves the cursor left one column. Moving to the left of column one is not permitted.
RightArrow	Moves the cursor right one column. Moving to the right of column 80 (at least in this version) is not supported.
Del	If the cursor is within the text of the line,

then the character (or blank) above the cursor will be deleted and any following characters moved left one column.

Ins           Toggles the editor's Insert vs. Overwrite state. The current state is displayed at the bottom of the edit window. Insert vs. OverWrite alter the interpretation of a <cr>.

<cr>           If the editor is in Insert mode (the default), a new line will be inserted immediately after the current line. Any text above and to the right of the cursor in the original line will be moved to the new line. The cursor will be positioned at column one of the new line. If the editor is in OverWrite mode, then the cursor will simply be moved to column one of the next line. In either case, if the cursor was on the last line of the screen, then screen will be scrolled upward one line to make room for new cursor position.

Backspace      If the cursor is within the text of the line and to the right of column 1, then BackSpace is simply a Delete of the character to the left of the cursor. If the cursor is in column one, then that line is deleted and its contents appended to the end of the preceding line. If the resulting line would be longer the current editor maximum line length, then the request is ignored. A BackSpace from column one of line one is also ignored.

characters      Other (permitted) keystrokes are added to the current line above the cursor. If the editor is in Insert mode (the default) then any existing characters to the right of the cursor are moved right one column, making room for the new character. If the line is already full, the new character is ignored and the bell is sounded as a warning. If the editor is in OverWrite mode, then the character above the cursor is replace with the new character.

## 6.5 LANGUAGE DIFFERENCES BETWEEN TOP DRAWER AND TDPREVU

As noted above, TDPreVu version 0 is an interim version which implements only a subset of the functions available in TopDrawer on mainframes. Version 1, when it becomes available, will implement the full functionality of the mainframe programs.

The limitations of version 0 are:

- User specified line drawing patterns are not yet implemented (though some effort is made to fake the result).
- Log scales, either x or y, will generate different major tick intervals than expected.
- SMOOTH and SPLINE on JOIN not yet implemented.

TDPreVu differs from Top Drawer in the way it maps pictures onto the available drawing space. Through the SET SIZE command with its REDUCE parameter, Top Drawer allows some versatility for controlling the size of plots, at least over a range of possibilities. Since TDPreVu maps the plot onto the full drawing space of the PC screen, the SET SIZE command merely functions to adjust the units used in defining the plot.

TDPreVu expands the color capabilities in a number of different ways from color use in Top Drawer: more colors are allowed, color fill is available, and different areas within the plot (BORDER, BACKGROUND, OUTLINE) can be assigned colors. The SET COLOR command itself works a little differently also--in mainframe Top Drawer, data points were bound to their color when the PLOT or HISTOGRAM command was issued; in TDPreVu, points and color are bound at the time the point is entered. For example,

```
SET COLOR RED
1.0 1.2; 2.0 1.7
SET COLOR BLUE
3.0 2.3; 3.0 2.5
PLOT
```

will product four blue points with mainframe Top Drawer since BLUE was the color in effect at the time PLOT was issued. TDPreVu, on the other hand produces, two red points and two blue points.

The SET COLOR command has been expanded so that colors may be assigned to the different areas of the plot as indicated below:

```
SET COLOR <color1> [OUTLINE <color2>] [BACKGROUND <color3>]
[BORDER <color4>]
```

where OUTLINE signifies the axes of the plot including tick marks, BACKGROUND is the color field within the OUTLINE where data points are plotted, and BORDER is the picture frame surrounding the plot where titles and labels generally appear. In addition to the eight colors available in mainframe Top Drawer (WHITE, RED, GREEN, BLUE, YELLOW, MAGENTA, CYAN, BLACK), TDPreVu provides eight more in the lighter tones: GRAY, LTGRAY, LTGREEN, LTBLUE, LTCYAN, LTRED, LTMAGENTA, and BROWN.

TDPreVu takes advantage of the color potentials of an IBM PC through the notion of a COLOR SET. A COLOR SET is a particular collection of colors for points, BACKGROUND, OUTLINE, and BORDER which can be referred to by a single color in the COLOR SET command. COLOR SET RED is shorthand for the following SET COLOR command:

```
SET COLOR BLACK OUTLINE LTGREEN BORDER LTRED BACKGROUND RED
```

The table below lists the available COLOR SETs. Other combinations may be obtained through the SET COLOR command, and we are receptive to aesthetically pleasing candidates for inclusion as additional COLOR SETs. It should be noted that the name of a COLOR SET is derived from the BACKGROUND color. The format for the COLOR SET command is:

```
COLOR SET <name>
```

where <name> is one of the COLOR SET names listed below.

ColorSet	C o l o r s			
Name	Drawing	Background	Border	Outline
BLACK	RED	BLACK	LTGRAY	LTGREEN
BLUE	YELLOW	BLUE	BLUE	WHITE
GREEN	BLACK	GREEN	MAGENTA	BLACK
RED	BLACK	RED	BLUE	BLACK
CYAN	BLACK	CYAN	BLUE	LTRED
MAGENTA	BLACK	MAGENTA	LTMAGENTA	BLACK
BROWN	LTGREEN	BROWN	LTMAGENTA	BLACK
GRAY	BLACK	GRAY	WHITE	BLACK
LTGRAY	BLACK	LTGRAY	GRAY	WHITE
LTBLUE	YELLOW	LTBLUE	GREEN	WHITE
LTGREEN	BLACK	LTGREEN	GRAY	BLACK
LTRED	BLACK	LTRED	RED	BLACK
LTCYAN	BLACK	LTCYAN	BLUE	BLACK
LTMAGENTA	BLACK	LTMAGENTA	MAGENTA	BLACK
YELLOW	BLACK	YELLOW	BROWN	BLACK
WHITE	BLACK	WHITE	GRAY	BLACK

MONO	WHITE	BLACK	WHITE	WHITE
INV	BLACK	WHITE	BLACK	BLACK

Top Drawer has CIRCLES, ELLIPSES and a few other geometric primitives. TDPReVu adds an additional primitive called POLYGON. POLYGON allows one to draw regular n-sided polygons centered at a specific location in either text or data coordinate systems, optionally rotated by a specified number of degrees. POLYGONS may also be "filled" with the currently specified color. The format for the POLYGON command is

```
POLYGON <n> <x> <y> [DATA] <r> [FILL] [OFFSET <t>]
```

where <n> is number of sides on the polygon (3 through 360 are supported). <x> and <y> are the coordinates for the center of the polygon. If DATA is specified, then <x> and <y> will be DATA coordinate system based, otherwise they are taken to be in the TEXT coordinate system. <r> is the radius of the polygon to be drawn. If FILL is specified, the POLYGON will be filled with the currently active color from the most recent SET COLOR command. <t> is the number of degrees counter-clockwise that the polygon is to be rotated. By default, the polygon is drawn with a vertex at the "3 O'Clock position."

TDPReVu supports two varieties of EPSON printers and the HP LaserJet-1 printer. The PRINTER command is used to specify to TDPReVu which type of printer is attached to your PC for producing local screen dumps. The format of the PRINTER command is:

```
PRINTER [FX | LQ | LJ] [PORTRAIT | LANDSCAPE]
        [ONCE | TWICE]
```

FX and LQ are used to specify either EPSON FX or LQ series printers to TDPReVu. LJ is used to specify a HP LaserJet-1. If PORTRAIT is specified, any locally printed screen dumps will be printed as seen on the screen on the printer. If LANDSCAPE is specified, the screen display will be rotated 90 degrees clockwise before printing. TWICE specifies, for dot-matrix printers, double striking each point of the plot for added contrast. ONCE is used to reset this mode. The defaults are "FX, PORTRAIT and ONCE".

## Appendix A

### THE UNIFIED GRAPHICS CHARACTER SET

The U.G. System Expanded and Duplex character sets include upper and lower case Roman and Greek letters, many special characters, and any number of levels of sub- or superscripts. Many characters are specified by a character pair, as explained in the section on TITLE and CASE strings.

Second Character	Alphabetic First Character																									
blank	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
L	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
F	Α	Β	Χ	Δ	Ε	Φ	Γ	Φ	Ι		Κ	Λ	Μ	Ν	Ο	Π	Θ	Ρ	Σ	Τ	Υ	Ω	Ξ	Ψ	Ζ	
G	α	β	χ	δ	ε	φ	γ	φ	ι		κ	λ	μ	ν	ο	π	θ	ρ	σ	τ	υ	ω	ξ	ψ	ζ	
K								ħ				λ														
M	≈	[	≈	°	]		>	≥	∫	∅		<	≤	≠	•	×	~	⊥					×	∅	∇	
P	'			†	!	‡			‡						§	"					?					
S	⊕	<	⊕	\$	)						{	-		#	}		~	-			'					
T	∇			∃	⊃	⊃		∩		⊆	⊂	∈	€								∪					
W		↔		↓							←										→					
D																										

Non-Alphabetic First Character																										
blank	0	1	2	3	4	5	6	7	8	9	+	-	*	/	=	.	,	(								
M	∞	√									±	∓	•	÷	≡	.		[	)							
O	+	×	◊	□	+	×	×	×	×	×	×	×	×	×	×	×	×	]								
P																										
S	%										&		\					[	]							

Other Keyboard Characters € . | & ! \$ % ; ~ - , % \_ # @ ' = "

Non-Printing Characters do not appear in this table.

Some typewriters can make some special characters, without requiring a character pair. In this case, the special character can be used. If a CASE string is used also, then the second character of the pair should be a blank. For instance, the 'left bracket' character '[' can be given by a character pair '[' or by a character pair '(S'. Similarly, the lower case alphabet can be given by lower case characters, if they are available on the terminal or keypunch, or they can be given by the corresponding upper case characters, paired with the CASE character 'L'.

Below is an example using TITLE and CASE commands along with the plot produced by Top Drawer.

```

SET SIZE 10 BY 7.5 REDUCE 2
SET FONT DUPLEX
SET TITLE SIZE 2.4
TITLE 1 6'UC Roman A B C D E F G H I J K L M N O P '
MORE 'Q R S T U V W X Y Z'
TITLE 'LC Roman A B C D E F G H I J K L M N O P '
CASE '          L L L L L L L L L L L L L L L L '
MORE 'Q R S T U V W X Y Z'
CASE 'L L L L L L L L L L L L'
TITLE 'Keyboard C T . ( + | & ! $ * ) ; " - / , % _ '
CASE '          S S
TITLE 'Keyboard > U . # @ ' ' = " 0 1 2 3 4 5 6 7 8 9 '
CASE '          P P
TITLE 'UC Greek A B C D E F G H I K L M N O P '
MORE 'Q R S T U W X Y Z'
CASE '          F F F F F F F F F F F F F F F F '
CASE 'F F F F F F F F F F'
TITLE 'LC Greek A B C D E F G H I K L M N O P '
MORE 'Q R S T U W X Y Z'
CASE '          G G G G G G G G G G G G G G G G '
CASE 'G G G G G G G G G G'
TITLE 'Math Sym A B C D E G H I J L M N P R S T X Y Z'
CASE '          M M M M M M M M M M M M M M M M M M M M'
TITLE 'More Math 0 2 + - * / = . ( ) A E F G I K L M N U'
CASE '          M M M M M M M M M M M M T T T T T T T T T T'
TITLE 'Plot Sym 0 1 2 3 4 5 6 7 8 9'
CASE '          O O O O O O O O O O O'
TITLE 'Special I U D L R B D F B E ( ) L R P H L D U O /'
CASE '          P W W W W W P P S S S S S S S S P K K M D D S'

```



UC Roman A B C D E F G H I J K L M N O P Q R S T U V W X Y Z  
 LC Roman a b c d e f g h i j k l m n o p q r s t u v w x y z  
 Keyboard € ^ . ( + | & ! \$ \* ) ; " - / , % \_  
 Keyboard > ? : # @ ' = " 0 1 2 3 4 5 6 7 8 9  
 UC Greek Α Β Χ Δ Ε Φ Γ Η Ι Κ Λ Μ Ν Ο Π Θ Ρ Σ Τ Τ Ω Ξ Ψ Ζ  
 LC Greek α β χ δ ε φ γ η ι κ λ μ ν ο π θ ρ σ τ υ ω ξ ψ ζ  
 Math Sym ≈ [ ≈ ° ] > ≥ ∫ ∫ < ≤ ≠ ⊗ α ~ ⊥ × ∂ ∇  
 More Math ∞ √ ± ∓ ⊗ ÷ ≡ · { } ∇ ∃ ∃ ∃ ∃ ∃ ∃ ∃ ∃ ∃ ∃  
 Plot Sym + × ◊ □ + × ⊕ ⊗ × ∞ ∞  
 Special ↑ ↑ ↓ ← → ↔ † ‡ ‹ › [ ] { } § ¢ ¤ ° \_ ^ \

Char Pair	Character Description	Char Pair	Character Description
A	U.C. A	AL	L.C. A
B	U.C. B	BL	L.C. B
C	U.C. C	CL	L.C. C
D	U.C. D	DL	L.C. D
E	U.C. E	EL	L.C. E
F	U.C. F	FL	L.C. F
G	U.C. G	GL	L.C. G
H	U.C. H	HL	L.C. H
I	U.C. I	IL	L.C. I
J	U.C. J	JL	L.C. J
K	U.C. K	KL	L.C. K
L	U.C. L	LL	L.C. L
M	U.C. M	ML	L.C. M
N	U.C. N	NL	L.C. N
O	U.C. O	OL	L.C. O
P	U.C. P	PL	L.C. P
Q	U.C. Q	QL	L.C. Q
R	U.C. R	RL	L.C. R
S	U.C. S	SL	L.C. S
T	U.C. T	TL	L.C. T
U	U.C. U	UL	L.C. U
V	U.C. V	VL	L.C. V
W	U.C. W	WL	L.C. W
X	U.C. X	XL	L.C. X
Y	U.C. Y	YL	L.C. Y
Z	U.C. Z	ZL	L.C. Z

#### Other Keyboard Characters

~	Blank	>	Greater Than
^	Cent Sign	?	Question Mark
.	Period	:	Colon
<	Less Than	#	Pound Sign
(	Left Parenthesis	@	At Sign
+	Plus Sign	'	Apostrophe
	Vertical Line	=	Equals Sign
&	Ampersand	"	Quote Marks
!	Exclamation Mark		
\$	Dollar Sign	0	Numeral 0
*	Asterisk	1	Numeral 1
)	Right Parenthesis	2	Numeral 2
;	Semi-Colon	3	Numeral 3
+	Not	4	Numeral 4
-	Minus Sign	5	Numeral 5
/	Slash Mark	6	Numeral 6
,	Comma	7	Numeral 7
%	Percent	8	Numeral 8
_	Underline	9	Numeral 9

Char Pair	Character Description
--------------	--------------------------

#### Upper Case Greek

AF	U.C. Alpha
BF	U.C. Beta
CF	U.C. Chi
DF	U.C. Delta
EF	U.C. Epsilon
FF	U.C. Phi
GF	U.C. Gamma
HF	U.C. Eta
IF	U.C. Iota
KF	U.C. Kappa
LF	U.C. Lambda
MF	U.C. Mu
NF	U.C. Nu
OF	U.C. Omicron
PF	U.C. Pi
QF	U.C. Theta
RF	U.C. Rho
SF	U.C. Sigma
TF	U.C. Tau
UF	U.C. Upsilon
WF	U.C. Omega
XF	U.C. Xi
YF	U.C. Psi
ZF	U.C. Zeta

#### Subscripts and Superscripts

0X	Enter Subscr Mode
1X	Leave Subscr Mode
2X	Enter Superscr Mode
3X	Leave Superscr Mode

#### Size Changes

0Y	Increase Size
1Y	Decrease Size

#### Position Save/Restore

0Z	Save Position-1
1Z	Restore Pos-1
2Z	Save Position-2
3Z	Restore Pos-2
4Z	Save Position-3
5Z	Restore Pos-3

Char Pair	Character Description
--------------	--------------------------

#### Lower Case Greek

AG	L.C. Alpha
BG	L.C. Beta
CG	L.C. Chi
DG	L.C. Delta
EG	L.C. Epsilon
FG	L.C. Phi
GG	L.C. Gamma
HG	L.C. Eta
IG	L.C. Iota
KG	L.C. Kappa
LG	L.C. Lambda
MG	L.C. Mu
NG	L.C. Nu
OG	L.C. Omicron
PG	L.C. Pi
QG	L.C. Theta
RG	L.C. Rho
SG	L.C. Sigma
TG	L.C. Tau
UG	L.C. Upsilon
WG	L.C. Omega
XG	L.C. Xi
YG	L.C. Psi
ZG	L.C. Zeta

#### Blanks of Various Widths

U	Null
0U	Backwards Blank
1U	Extra Half Blank
2U	Half Back Blank
3U	Extra Third Blank
4U	Third Back Blank
5U	Extra Sixth Blank
6U	Sixth Back Blank

1V	Half Up
2V	Half Down
3V	Third Up
4V	Third Down
5V	Sixth Up
6V	Sixth Down

Char Pair	Character Description
--------------	--------------------------

### Mathematical Symbols

IM	Integral Sign
XM	Times Sign
/M	Division Sign
AM	Approximately Equal
YM	Partial Derivative
ZM	Del
JM	Line Integral
PM	Group Plus
*M	Group Multiply
RM	Proportional to
+M	Plus or Minus
2M	Square Root
MM	Less or Equal
HM	Greater or Equal
NM	Not Equal
OM	Infinity

### More Mathematical Symbols

MT	Membership Symbol
NT	Membership Negation
ET	Existential Quant.
IT	Intersection
AT	Universal Quant.
UT	Union
LT	Contained in
GT	Contains
KT	Contained in/Equal
FT	Contains/Equal

Char Pair	Character Description
--------------	--------------------------

### Plot Symbols

00	Plot Sym V Cross
10	Plot Sym D Cross
20	Plot Sym Diamond
30	Plot Sym Square
40	Plot Sym F Diamond
50	Plot Sym F Square
60	Plot Sym F V Cross
70	Plot Sym F D Cross
80	Plot Sym Star
90	Plot Sym Octagon

### Other Special Symbols

IP	Interbang
UW	Up Arrow
DW	Down Arrow
LW	Left Arrow
RW	Right Arrow
BW	Left/Right Arrow
DP	Dagger
FP	Double Dagger
BS	Left Angle Bracket
ES	Right Angle bracket
(S	Left Bracket
)S	Right Bracket
LS	Left Brace
RS	Right Brace
PP	New Paragraph
HK	H-Bar
LK	Lambda-Bar
DM	Degrees
UD	Underscore
OD	Overscore
/S	Backwards Slash

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