Top Drawer

Roger D. Chaffee
Computation Research Group
Stanford Linear Accelerator Center

Working Paper
Do not quote, cite, abstract, or reproduce without prior permission of the author(s).
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Output</td>
<td>2</td>
</tr>
<tr>
<td>Input</td>
<td>2</td>
</tr>
<tr>
<td>Input Formats</td>
<td>3</td>
</tr>
<tr>
<td>About This Note</td>
<td>4</td>
</tr>
<tr>
<td>The Anatomy of a Plot</td>
<td>5</td>
</tr>
<tr>
<td>Coordinate Systems</td>
<td>6</td>
</tr>
<tr>
<td>The TEXT Coordinate System</td>
<td>6</td>
</tr>
<tr>
<td>The Window</td>
<td>6</td>
</tr>
<tr>
<td>The DATA Coordinate System</td>
<td>7</td>
</tr>
<tr>
<td>Plotting Text</td>
<td>7</td>
</tr>
<tr>
<td>Character Size</td>
<td>7</td>
</tr>
<tr>
<td>Device-Generated and Vector Characters</td>
<td>8</td>
</tr>
<tr>
<td>Default Values</td>
<td>9</td>
</tr>
<tr>
<td>Commands</td>
<td>11</td>
</tr>
<tr>
<td>2. ACTION COMMANDS</td>
<td>12</td>
</tr>
<tr>
<td>ARROW</td>
<td>13</td>
</tr>
<tr>
<td>BARGRAPH</td>
<td>13</td>
</tr>
<tr>
<td>BOX</td>
<td>14</td>
</tr>
<tr>
<td>CIRCLE</td>
<td>14</td>
</tr>
<tr>
<td>DIAMOND</td>
<td>14</td>
</tr>
<tr>
<td>ELLIPSE</td>
<td>15</td>
</tr>
<tr>
<td>HISTOGRAM</td>
<td>15</td>
</tr>
<tr>
<td>JOIN</td>
<td>16</td>
</tr>
<tr>
<td>The</td>
<td>17</td>
</tr>
<tr>
<td>NEW FRAME</td>
<td>17</td>
</tr>
<tr>
<td>PLOT</td>
<td>17</td>
</tr>
<tr>
<td>PLOT AXES</td>
<td>18</td>
</tr>
<tr>
<td>TITLE, CASE, and MORE</td>
<td>19</td>
</tr>
<tr>
<td>3. DATA COMMANDS</td>
<td>21</td>
</tr>
<tr>
<td>List of Data Commands</td>
<td>21</td>
</tr>
<tr>
<td>Data Points</td>
<td>21</td>
</tr>
<tr>
<td>BIN</td>
<td>22</td>
</tr>
<tr>
<td>SMOOTH</td>
<td>22</td>
</tr>
<tr>
<td>The Smoothing Algorithm</td>
<td>23</td>
</tr>
<tr>
<td>X/Y BINS/POINTS</td>
<td>23</td>
</tr>
</tbody>
</table>
### 4. CONTROL COMMANDS

<table>
<thead>
<tr>
<th>Command</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUMP</td>
<td>25</td>
</tr>
<tr>
<td>END</td>
<td>25</td>
</tr>
<tr>
<td>LIST</td>
<td>26</td>
</tr>
<tr>
<td>PAUSE</td>
<td>26</td>
</tr>
<tr>
<td>RETURN</td>
<td>26</td>
</tr>
<tr>
<td>TIME</td>
<td>26</td>
</tr>
</tbody>
</table>

### 5. SET COMMANDS

<table>
<thead>
<tr>
<th>Command</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET ARROW</td>
<td>29</td>
</tr>
<tr>
<td>SET AXES</td>
<td>29</td>
</tr>
<tr>
<td>SET BAR</td>
<td>30</td>
</tr>
<tr>
<td>SET BOX</td>
<td>30</td>
</tr>
<tr>
<td>SET CARD</td>
<td>30</td>
</tr>
<tr>
<td>SET CIRCLE</td>
<td>30</td>
</tr>
<tr>
<td>SET COLOR</td>
<td>31</td>
</tr>
<tr>
<td>SET DEVICE</td>
<td>31</td>
</tr>
<tr>
<td>SET DIAMOND</td>
<td>32</td>
</tr>
<tr>
<td>SET ELLIPSE</td>
<td>33</td>
</tr>
<tr>
<td>SET FILE</td>
<td>33</td>
</tr>
<tr>
<td>SET FONT</td>
<td>33</td>
</tr>
<tr>
<td>SET FORMAT</td>
<td>34</td>
</tr>
<tr>
<td>SET GRID</td>
<td>34</td>
</tr>
<tr>
<td>SET INTENSITY</td>
<td>35</td>
</tr>
<tr>
<td>SET LABELS</td>
<td>36</td>
</tr>
<tr>
<td>SET LIMITS</td>
<td>36</td>
</tr>
<tr>
<td>SET MODE</td>
<td>37</td>
</tr>
<tr>
<td>SET ORDER</td>
<td>37</td>
</tr>
<tr>
<td>SET OUTLINE</td>
<td>38</td>
</tr>
<tr>
<td>SET PATTERN</td>
<td>39</td>
</tr>
<tr>
<td>SET PEN</td>
<td>39</td>
</tr>
<tr>
<td>SET SCALE</td>
<td>39</td>
</tr>
<tr>
<td>SET SIZE</td>
<td>42</td>
</tr>
<tr>
<td>SET STORAGE</td>
<td>43</td>
</tr>
<tr>
<td>SET SYMBOL</td>
<td>43</td>
</tr>
<tr>
<td>SET TEXTURE</td>
<td>44</td>
</tr>
<tr>
<td>SET TICKS</td>
<td>45</td>
</tr>
<tr>
<td>SET TITLE</td>
<td>45</td>
</tr>
<tr>
<td>SET WINDOW</td>
<td>46</td>
</tr>
</tbody>
</table>

#### Device Size Parameters

<table>
<thead>
<tr>
<th>Command</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET STORAGE</td>
<td>43</td>
</tr>
<tr>
<td>SET SYMBOL</td>
<td>44</td>
</tr>
<tr>
<td>SET TEXTURE</td>
<td>44</td>
</tr>
<tr>
<td>SET TICKS</td>
<td>45</td>
</tr>
<tr>
<td>SET TITLE</td>
<td>45</td>
</tr>
<tr>
<td>SET WINDOW</td>
<td>46</td>
</tr>
</tbody>
</table>

### 6. USING TOP DRAWER AS A STAND-ALONE PROGRAM

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limitations</td>
<td>47</td>
</tr>
<tr>
<td>JCL</td>
<td>47</td>
</tr>
<tr>
<td>Sample Job</td>
<td>48</td>
</tr>
</tbody>
</table>

### 7. CALLING FROM FORTRAN

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limitations</td>
<td>51</td>
</tr>
<tr>
<td>Arguments of Calls</td>
<td>51</td>
</tr>
<tr>
<td>Arrays</td>
<td>52</td>
</tr>
</tbody>
</table>
Abbreviated Calls ........................................ 52
Character Strings in Fortran ............................ 53
Explanation of Calling Sequences ....................... 54
List ................................................................ 55
TDEND .................................................. 55
TDHIST .................................................. 56
TDJOIN .................................................. 56
TDLIMS .................................................. 57
TDMAIN .................................................. 57
TDNEWP ............................................... 58
TDPLOT .................................................. 58
TDSET .................................................. 58
TDTITL, TDCASE and TDTSET ......................... 59
JCL ....................................................... 60
Sample Job ............................................... 61

Appendix

A. SPECIFIC OUTPUT DEVICES ......................... 62

<table>
<thead>
<tr>
<th>Device Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4013 PDS</td>
<td>62</td>
</tr>
<tr>
<td>4013 Sequential</td>
<td>63</td>
</tr>
<tr>
<td>CalComp</td>
<td>64</td>
</tr>
<tr>
<td>Microfiche</td>
<td>65</td>
</tr>
<tr>
<td>16-mm Unsprocketed Film</td>
<td>65</td>
</tr>
<tr>
<td>Gencom</td>
<td>65</td>
</tr>
<tr>
<td>Versatec Electrostatic Plotter Model 1100</td>
<td>66</td>
</tr>
<tr>
<td>Versatec Electrostatic Plotter Model 1200</td>
<td>66</td>
</tr>
<tr>
<td>Fan-fold</td>
<td>67</td>
</tr>
<tr>
<td>Continuous</td>
<td>67</td>
</tr>
<tr>
<td>Internal sort</td>
<td>67</td>
</tr>
<tr>
<td>External Sort</td>
<td>68</td>
</tr>
<tr>
<td>External Sort with Fortran Calls</td>
<td>69</td>
</tr>
</tbody>
</table>

B. INTERACTIVE MODE: UNDER MILTEN ................... 70

C. INTERACTIVE MODE: UNDER ORVYL .................... 71

D. INTERACTIVE MODE: UNDER VM/CMS ................... 72

E. USER SCALING ......................................... 73

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaling Function</td>
<td>73</td>
</tr>
<tr>
<td>Ticks and Labels</td>
<td>73</td>
</tr>
<tr>
<td>Example</td>
<td>74</td>
</tr>
<tr>
<td>JCL</td>
<td>76</td>
</tr>
</tbody>
</table>

F. THE UNIFIED GRAPHICS CHARACTER SET ............ 77

Index ................................................... 82
Chapter 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. I have made almost all the changes in an "upwards compatible" way, so that old Top Drawer jobs and methods will run unchanged, but I do not guarantee that this will always be absolutely true.

The other side of this coin is that I invite suggestions for improvements, and I often act on them. If you find a bug, or if you want a particular effect and can’t get it easily, phone me at SLAC extension 2741, suggest through Wylbur, to the consultants or to RBC@CG at SLAC.

RBC
1.1 OUTPUT

Output from Top Drawer is of two kinds. The first is a listing to be printed on a terminal or line printer, of the input commands plus any warning and error messages generated by Top Drawer. The second 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. See Appendix A for the details of each output device.

Connection to the graphic device(s) used for output is through the SLAC Unified Graphics System\(^1\) (U.G.), so output can be made on any non-interactive device known to U.G. Currently, this includes the Tektronix 4013 Wylbur terminals, the Gencom terminals, the Versatec Electrostatic plotter, the 10" and 33" CalComp plotters, and the CalComp Microfilm Plotter.

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 can be run as a self-contained program, reading a dataset of cards or card-images. There are also Fortran-callable subroutines which allow the user's main program to control the plotting.

\(^1\) Robert Beach, The SLAC Unified Graphics System, CGTM No. 170 (February 1976).

1.2 INPUT

Input for Top Drawer is a set of cards or card images, which are normally prepared using a text-editing system such as Wylbur. On these input cards is a sequence of commands, one per card, 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. Independent keywords may come in any order in the command. Parameters follow the keyword they modify. 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 card. Instead of reading a new card, Top Drawer continues after the semicolon. In this way, multiple commands and/or data points may be entered with one physical card.
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"\(^2\), 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/OS/370/Wylbur. 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.

Finally, especially if you have access to a fast graphic terminal (a Tektronix 4013) and Top Drawer under Orvyl, try it out.

\(^2\) 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 (Tektronix 4013) and/or size (13 by 10) 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, by calls to TDLIMS, 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.

Third, when "device-generated" characters (see below) are used, the character spacing may be somewhat different from the given value, but not different enough to require "vector" characters.
1.6.2 Device-Generated and Vector Characters

Some graphic devices, such as the interactive terminals, can make a single character as a unit, rather than drawing each character as a sequence of lines. Characters produced by the graphic device as a single unit are known in this writeup as "device-generated" characters, and are made by the device's "character generator". Characters which are drawn as a sequence of lines (or "vectors"), each individually calculated in the main computer program rather than in the graphic device, are called "vector" characters.

Device-generated characters are better for some applications than vector characters, because they take much less time to draw. In order to allow device-generated characters on a device which supports them, but to produce the text in any case, the following convention is used: if the size specified for a title or label is negative, and if the device in use has a character generator which can match the given angle and magnitude of the size reasonably closely, then the character generator is used. Otherwise, vector characters will be drawn. Thus, under default conditions, SET TITLE SIZE -2 will allow the character generator on the Tektronix 4013 terminals, but SET TITLE SIZE 2 will require vector characters. The Gencom terminals use pica spacing, with ten characters to the inch, and the corresponding SIZE is -1.0.

Some character strings can be produced only by vector characters. Examples are mathematical formulae and Greek characters, which do not exist in the character generators of the graphic devices used by Top Drawer. An inelegant solution to this problem has been implemented: character strings which contain a CASE parameter are in all cases produced as vector characters.

Further information about character string plotting, especially the CASE parameter and the control characters available for formatting, is given in the description of the TITLE command, and in Appendix F.
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.) If Top Drawer is called from a Fortran program, each call is assumed to provide new points.

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.

<table>
<thead>
<tr>
<th>Level</th>
<th>Command</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>SET ARROW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SIZE</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>FLARE</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>SET AXIS</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>SET BAR SIZE</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>SET BOX SIZE</td>
<td>1 1</td>
</tr>
<tr>
<td>1</td>
<td>SET CARD LENGTH</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>SET COLOR</td>
<td>Black</td>
</tr>
<tr>
<td>1</td>
<td>SET DEVICE</td>
<td>4013</td>
</tr>
<tr>
<td>2</td>
<td>SET DIAMOND SIZE</td>
<td>1 1</td>
</tr>
<tr>
<td>2</td>
<td>SET ELLIPSE SIZE</td>
<td>1 1</td>
</tr>
<tr>
<td>1</td>
<td>SET FILE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INPUT</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>OUTPUT</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>SET FONT</td>
<td>Extended</td>
</tr>
<tr>
<td>1</td>
<td>SET FORMAT</td>
<td>(80A1)</td>
</tr>
<tr>
<td>4</td>
<td>SET GRID</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>SET INTENSITY</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>SET LABEL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LEFT, BOTTOM</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td>TOP, RIGHT</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>SET LIMITS</td>
<td>Depend on data</td>
</tr>
<tr>
<td>1</td>
<td>SET MODE</td>
<td>Novector, Echo 20, Modebug</td>
</tr>
<tr>
<td>2</td>
<td>SET ORDER</td>
<td>X Y DX DY SYMBOL</td>
</tr>
<tr>
<td>2</td>
<td>SET OUTLINE</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>SET PEN</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>SET SCALE</td>
<td>Linear 6 -5 Base 10</td>
</tr>
<tr>
<td>1</td>
<td>SET SIZE</td>
<td>13 BY 10 UNITS 1</td>
</tr>
<tr>
<td></td>
<td>REDUCE</td>
<td>Depends on Device</td>
</tr>
<tr>
<td>2</td>
<td>SET SYMBOL</td>
<td>Blank (plotted as dots)</td>
</tr>
<tr>
<td>2</td>
<td>SET TEXTURE</td>
<td>Solid</td>
</tr>
<tr>
<td>2</td>
<td>SET TICKS</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>SET TITLE SIZE</td>
<td>-2</td>
</tr>
<tr>
<td>2</td>
<td>SET WINDOW</td>
<td>In 20% from screen edge on bottom and left, 10% on top and right.</td>
</tr>
</tbody>
</table>
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.

CONTROL commands are "none of the above", and have to do with the running of the program. CONTROL commands are END, LIST, RETURN, and TIME, plus some debugging commands.

The notation used in command description is taken from the Wylbur 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.
Chapter 2
ACTION COMMANDS

List of Action Commands

ARROW FROM xxx yyy [DATA] [LESS ddd]
TO xxx yyy [DATA] [LESS ddd]
[SIZE xxx] ['FRAIL'FLARE] [iff]

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

JOIN [level] [SPLINE|GENERAL] [TEXT]
[SOLID|DOTTED|DASHES|DASHED|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|DAASHES|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|DAASHES|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|DAASHES|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.)

- 16 -
Examples:

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

2.8.1 The

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 PLOTed before going on.

With the U.G. graphics package, OS/370, and some graphic devices, e.g. 4013 and GENCOM, output is a PDS, and each member is one plot. In this case, member names are PICT001, PICT002, etc., but they may be given an alias. The given alias names the following plot, not the previous one.

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 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.

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 preceding 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. 170) and briefly listed in Appendix E.

For example,

```
TITLE BOTTOM 'EOIP1=-1'
CASE 'LCLGC
```

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 OC and 1C 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.
Chapter 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]]

[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 OP
  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 **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

3.4.1 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.

3.5 X/Y BINS/POINTS

{X|Y|DX|DY} [{BIN|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
```
Examples of Control Commands

DUMP [FLAGS] is a debugging aid

END (This command is not required.)


PAUSE is a debugging aid for interactive Top Drawer

RETURN [n] returns to calling program
(see 'Calling from Fortran')

TIME prints information about computing time.

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

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.

4.4 PAUSE

PAUSE

This is a debugging command for Top Drawer under Orvyl. It is not intended for general use.

4.5 RETURN

RETURN [n]

This is a command to return to the calling program. It is useful when Top Drawer has been called from a user program (see 'Calling from Fortran'). If Top Drawer was called by the Fortran statement CALL TDMAIN(N), N becomes the fullword integer value n.

4.6 TIME

TIME

Prints information about computing time used. Has no effect on the plotting.
Chapter 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 COLOR [BLACK|RED|BLUE]

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

SET DIAMOND [SIZE xxx [yy]]

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

SET FILE {INPUT|OUTPUT|DEBUG|ERROR} n
   sets Fortran input/output units

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

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

SET GRID ] [SIZE n]]
   {OFF|HORIZONTAL|VERTICAL|ON|SYMBOL [x]}
   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 MODE [VECTOR|NOVECTOR] [ECHO [n]|NOECHO]
[DEBUG|NODEBUG] [TRACE|NOTRACE] [QUICK|SLOW]**
sets misc. flags.

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

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

**SET SCALE [X|Y] [n1 [n2]] [BASE n]
[LIN|LOGARITHMIC|M ETHS| YEARS| USER n]
[NORMAL [MEAN n] [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|DASHES|DASH|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 \[\text{SIZE } xxx\] \{\{\text{FLAIR|FLARE} \} \}\] 

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

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

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 bookkeeping 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 [BLACK|RED|BLUE]

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

(For the CalComp plotter, BLACK simply means pen #1, RED means pen #2, and BLUE means pen #3. The pens must be set up by the operator according to the instruction card or the dataset name on the tape.)

The only device known to Top Drawer which can do colors is the CalComp plotter.

**Example:**

```plaintext
SET COLOR RED
```

5.8 **SET DEVICE**

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

<table>
<thead>
<tr>
<th>keyword</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL CALCOMP</td>
<td>10-inch CalComp plotter</td>
</tr>
<tr>
<td>LARGE CALCOMP</td>
<td>33-inch CalComp plotter</td>
</tr>
<tr>
<td>TEKTRONIX</td>
<td>Tektronix 401x graphics terminal</td>
</tr>
<tr>
<td>4013</td>
<td>Same as TEKTRONIX</td>
</tr>
<tr>
<td>FILM</td>
<td>16-mm unsprocketed film</td>
</tr>
<tr>
<td>FICHE</td>
<td>Microfiche</td>
</tr>
<tr>
<td>GENCOM</td>
<td>Gencom 300Q</td>
</tr>
<tr>
<td>V1100</td>
<td>Versatec Plotter Model 1100</td>
</tr>
<tr>
<td>VERSATEC</td>
<td>SLAC On-Line Versatec Plotter</td>
</tr>
</tbody>
</table>

SET DEVICE VERSATEC may be followed by the keywords CONTINUOUS and/or EXTERNAL. (See the Versatec section in Appendix A.)

For some interactive systems, such as T.D. 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. 170) 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. The argument FULSCR is always placed at the beginning of the UGOPEN options list, regardless of the device or string.

SET DEVICE 4013 or GENCOM may be followed by the keyword SEQUENTIAL, to specify the sequential dataset output format. See the section on JCL.

The JCL must define an output dataset appropriate for the (or each) device. See the section on JCL for a description. SET DEVICE, if used, must come before any 'action' commands. The best place to put it is at the start of the Top Drawer commands.

DDNAME can be used to specify the dname 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. This is mostly for fitting the shape of a rectangular device to a rectangular picture. For instance, fan-fold Versatec output is normally 10.5 inches wide and 7.88 inches high. SET DEVICE VERSATEC FANFOLD SIDEWAYS gives you output that is 7.88 inches wide and 10.5 inches high, which is much better put in an 8.5-by-11 publication. (Of course, you couldn't use all the page unless you SET SIZE 7.88 by 10.5.)

For examples, see Appendix A. 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**

```
SET FILE {INPUT|OUTPUT|DEBUG|ERROR} n
```

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. (The VGT is an example.)

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 hori-
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 OP, 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 1P 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' is a number from 1 to 4. 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**

```plaintext
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:**

```plaintext
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**

```plaintext
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,

```plaintext
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:**

```plaintext
SET LIMITS X FROM 0 TO 100
SET LIMITS XMIN 0 XMAX 100
SET LIMITS X 0 100 Y 100 150
```
5.18 **SET MODE**

**SET MODE** [VECTOR|NOVECTOR] [ECHO [n]|NOECHO] [DEBUG|NODEBUG] [TRACE|NOTRACE] [QUICK|SLOW]

This is a catch-all command, for controlling miscellaneous unrelated flags.

VECTOR requires vector characters in all text, even if the current device has a character generator. NOVECTOR nullifies a previous VECTOR command.

With some plotting packages (but not U.G.), QUICK allows faster plotting with lower quality than is normal. SLOW requires maximum quality, at the expense of plotting time.

ECHO n sets the number of data point cards in each block which will be listed in the printed output. (There is no way to suppress the printing of control cards.) ECHO is equivalent to ECHO 10000. NOECHO is equivalent to ECHO 0. The starting value is 20.

DEBUG and TRACE set printing flags. NODEBUG and NOTRACE cancel them. They are not intended for general use.

**Examples:**

```
SET MODE NOECHO (Don't list input data points.)
SET MODE ECHO 100 (List only the first 100 points.)
```

5.19 **SET ORDER**

**SET ORDER** [X [fct]] [Y [fct]] [Z [fct]]

[DX|RX [fct]] [DY|RY [fct]] [DZ|RZ [fct]]

[SIMBOLE] [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 OP
```

is equivalent to

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

and to

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

and to

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

5.20 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
```
5.21 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 .01 .1 gives dot-dash
SET PATTERN 0 .1 .1 gives dashes, starting with a blank

5.22 SET PEN

SET PEN [1|2|3]

This command selects one of the three pens mounted in the CalComp drum plotter. Subsequent action commands will use the designated pen. This command is ignored for all devices except the CalComp drum plotter. The default pen is number 1.

Example:

SET PEN 2

5.23 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 \(|n_1|+1\) intervals (and \(|n_1|+2\) 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 \(|n_2|\) subintervals by unlabelled ticks.

Positive n1 gives big ticks at major intervals. Positive n2 gives big ticks for subintervals. Negative ticks. The default values are \(n_1=6\) and \(n_2=-5\), which produces approximately 6 intervals, separated by large labeled ticks. Each interval is divided by small ticks into 5 small intervals.

(To choose the linear axis markings, Top Drawer lays out an axis with \(n_1\) intervals of size \(\text{BASE} \times \text{ROUND} \times \text{POWER}\), 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 \(|n_1|+1\) 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. '10^4', 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:

<table>
<thead>
<tr>
<th>value</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No intermediate labels (n1) or ticks (n2)</td>
</tr>
<tr>
<td>2</td>
<td>Label or tick at all positions, 2 thru 9</td>
</tr>
<tr>
<td>2**n</td>
<td>Label or tick at the n-th position</td>
</tr>
</tbody>
</table>

(A sum may be used to specify more than one position at a time, except for the values 1 and 2. Thus, \(n_2 = -36\) specifies a small tick at 2 and 5, since 36 = \(2^2 + 2^5\).)
**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 ln1 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).

**User:**

A function can be supplied by the user. USER n invokes scaling given by user routines

FUNCTION TDFNCT(COORD,N) and
SUBROUTINE TDITCK(N,VMIN,VMAX,N1,N2,BASE,NUM,VALS,ITYPES).

N is the scale identifier.

(See Appendix E for more details.)
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

5.24 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 13 BY 10 REDUCE 2 will reduce a plot to half-size, whereas SET SIZE 13 BY 10 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. For size 13 by 10 and UNITS=1.0, 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 30 BY 30 (Large CalComp Plotter)
- SET SIZE 13 BY 10 REDUCE 2 (Everything half-size.)
- SET SIZE 33 BY 25 UNITS 2.54 (Measure in centimeters.)

### 5.24.1 Device Size Parameters

<table>
<thead>
<tr>
<th>Device</th>
<th>Maximum Size (inches)</th>
<th>Minimum REDUCE</th>
<th>Default REDUCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small CalComp</td>
<td>--- by 10</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Large CalComp</td>
<td>--- by 33</td>
<td>0.30</td>
<td>1.00</td>
</tr>
<tr>
<td>Fan-fold Versatec</td>
<td>10.5 by 7.88</td>
<td>1.27</td>
<td>1.27</td>
</tr>
<tr>
<td>Continuous Vers.</td>
<td>--- by 10.0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Gencom terminal</td>
<td>13.1 by 10.0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>4013 terminal</td>
<td>8.0 by 6.1</td>
<td>1.65</td>
<td>1.65</td>
</tr>
<tr>
<td>Fiche, film</td>
<td>12.6 by 10.4</td>
<td>1.03</td>
<td>1.03</td>
</tr>
<tr>
<td>V1100</td>
<td>10.2 by ---</td>
<td>1.27</td>
<td>1.27</td>
</tr>
</tbody>
</table>

### 5.25 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.)
5.26 **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 E.

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 (0P to 9P), 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 SYM-BOL...' exist only for convenience. They are equivalent.

**Examples:**

SET SYMBOL SIZE 4 (Big plot symbols)  
SET SYMBOL 3P (Plot symbol is a square)

5.27 **SET TEXTURE**

**SET TEXTURE**

[SOLID|DOTS|DASHES|DAASHES|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.
With some plotting packages (but not U.G.) support both 'short dash' and 'long dash' textures. These are invoked by the DASH or DAASH keywords.

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

Example:

```
SET TEXTURE DOTDASH
```

5.28 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.)
```

5.29 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
```
5.30 **SET WINDOW**

\[ \text{SET WINDOW} \ [X \ xxx \ [TO] \ xxx] \ [Y \ yyy \ [TO] \ yyy] \]

\[ \text{SET WINDOW} \ [X \ n1 \ OF \ n2] \ [Y \ n1 \ OF \ n2] \]

**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.)
Chapter 6

USING TOP DRAWER AS A STAND-ALONE PROGRAM

This is the easiest way to use Top Drawer. Input can be prepared with any text editor, or with a program written in your own favorite language. A set of cards or a sequential file of card images is used as the interface between your program and Top Drawer.

6.1 LIMITATIONS

The Top Drawer input language has evolved according to the idea that Top Drawer should do what you expect it to. This ideal is not always possible to realize, and some of the exceptions are described in this section.

- No more than 1024 points may be entered at one time. Blocks of this size or less must be separated by a PLOT, PLOT AXES, HIST, or JOIN command. (This limit is imposed by a dimension statement in the Top Drawer data array definitions. The data arrays in a Fortran program which calls Top Drawer may be of any length.)

- The limits for a plot must be set at the first PLOT, HIST, or JOIN command. This means that if two or more separate sets of points are being JOINed, the automatic limit setter will look at the first set, and Top Drawer will make the axes before the second set is read in. In this case, to make sure the limits are big enough for both sets, an explicit SET LIMITS command must be used.

6.2 JCL

At SLAC, the following job will work:

```
//ABCDRAW JOB ABC$DE,TIME=(,15)
// EXEC LOADGO,
// LKEDPRM='EP=MAIN',
// LKEDLB2='WYL.CG.RBC.LOADMODES',
// LKEDLB3='WYL.CG.RCB.UGFTNLIB'
```
GOSL1='WYL.CG.RCB.UGRUNLIB',
GORG=200K
GO.SYSLIN DD DSN=WYL.CG.RBC.LOADMODS(TOPDRAW),
DISP=SHR
JCL to define the output dataset(s) goes here.
(See Appendix A.)
GO.SYSIN DD *
Top Drawer input cards go here.

If you are logged onto Wylbur at SLAC or on Stanford Campus, to generate a standard set of JCL, get the Top Drawer input cards in the active file, and

EXECUTE FROM #TOPDRAW PUBLIC CLEAR

6.3 SAMPLE JOB

//ABCDRAW JOB ABC$DE,TIME=(,15)
//DRAW EXEC LOADGO.LKEDPRM='EP=MAIN',
// LKEDLB2='WYL.CG.RBC.LOADMODS',
// LKEDLB3='WYL.CG.RCB.UGFTNLIB',
// GOSL1='WYL.CG.RCB.UGRUNLIB'
//GO.SYSLIN DD DSN=WYL.CG.RBC.LOADMODS(TOPDRAW),
// DISP=SHR
//GO.UGDEVICE DD DCB=(RECFM=FB,LRECL=80,BLKSIZE=1600),
// DSN=WYL.gg.uuu.libname,DISP=(NEW,KEEP),
// VOL=SER=SCR001,UNIT=DISK,SPACE=(TRK,(5,1,3))
//SYSSIN DD *
SET DEVICE VERSATEC
TITLE 3 9.5 SIZE 4 'SAMPLE OUTPUT'
CASE 'LLLLL LLLL'
SET WINDOW Y 1 TO 4.5
800 3 ; 840 3 ; 880 0 ; 920 13
960 17 ; 1000 18 ; 1040 22 ; 1080 20
1120 25 ; 1160 24 ; 1200 40 ; 1240 58
1280 51 ; 1320 36 ; 1360 37 ; 1400 29
1440 26 ; 1480 16 ; 1520 0 ; 1560 0
HIST
SET WINDOW Y 4.5 TO 8
SET LABELS BOTTOM OFF
HIST (SINCE NO NEW POINTS HAVE BEEN FED IN,)
SMOOTH (THESE COMMANDS OPERATE ON THE OLD ONES)
JOIN
NEW PLOT
SET SCALE X LINEAR 5 4 Y LOG
SET BAR SIZE .02
TITLE TOP 'P0-1 + P R N H' CASE 'GC C L A L G'
SYMBOL 3P (RICHARDS ET AL)
TITLE 8 8 '3 RICHARDS ET AL.'
CASE 'P LLLLL LL LL'

- 48 -
SET ORDER X Y DY
718.  1.520  .165
782.  2.413  .264
832.  2.446  .231
1005. 1.091  .165
1106. 1.190  .165
1249. 1.190  .132
1433. 0.661  .066

SYMBOL 2P (NELSON)

TITLE '2 NELSON' CASE 'P LLLLL'

SET ORDER X Y 2.42 DY 2.42

(NELSON'S RESULTS DIFFER BY A FACTOR OF 2.42)
1590 .272 .02 ; 1790 .202 .015
1990 .215 .016 ; 2190 .170 .013
2390 .127 .010

PLOT

The two plots made by this job follow.

Sample Output
$\pi^- + p \rightarrow n \eta$

- Richards et al.
- Nelson
Chapter 7
CALLING FROM FORTRAN

Top Drawer also exists as a set of subroutines which can be called directly by a Fortran program. The action commands HIST, JOIN, NEW FRAME, PLOT, and TITLE have analogs in action subroutines such as TDHIST, TDJOIN, etc. The SET commands can all be given as the argument in a call to subroutine TDSET. The Top Drawer data buffer is not available through Fortran calls, and the data commands are not used. Instead, point arrays are passed as arguments of the calls to the action subroutines. The control commands are not available to Fortran calls.

7.1 LIMITATIONS

Calling TDJOIN, TDHIST, or TDPLOT fixes the plot limits if they have not been fixed already. If subsequent calls will contain points which lie beyond the points in the first call, the limits should be set beforehand by a SET LIMITS command (through a call to TDSET) or calls to TDLIMS.

Top Drawer Fortran entry points will generally accept either REAL or INTEGER arguments. This is not true for the value and error arrays, which must be REAL. Other types, such as INTEGER, DOUBLE PRECISION, and COMPLEX, and IBM dialect types such as REAL*8, INTEGER*2, etc. are illegal, and will produce strange results with no meaningful diagnostics. This is an inherent limitation of IBM Fortran.

Character string arguments which have no implicit length (for TDSET, TDTITL, and TDCASE) must end with a semicolon ';'. For safety, this semicolon should be followed by a blank. A single semicolon to appear in the string should be doubled, e.g.

```
CALL TDTITL( 'CALL TDTITL( 'TITLE;; ''TOP'' ); ', 'TOP')
```

(Under moderately unlikely circumstances, it is possible to make a double semicolon accidently, either in compiling or in execution-time string manipulation.)
This would be misinterpreted by Top Drawer, and could lead to incorrect text, wrong positioning, absent titles, or abnormal program termination due to fetch-protection errors. For your own protection, you should follow each terminating semicolon by an explicit blank. The added blank will never hurt, and might save a great deal of trouble.)

7.2 ARGUMENTS OF CALLS

7.2.1 Arrays

The value and error arrays X, DX, Y, and DY are REAL arrays with dimension NP (or greater) where NP is the number of points, as given in the call. DX and/or DY may be replaced by the letters NONE [e.g. CALL TDHIST(50, X, Y, 4HNone, DY)], and the corresponding errors will be assumed zero. If DX or DY is the last argument in the call, it may be omitted with the same result.

For instance, CALL TDHIST(50, X, Y) is the same as CALL TDHIST(50, X, Y, 4HNone, 4HNone)

7.2.2 Abbreviated Calls

In some dialects of Fortran, including IBM Fortran, it is possible to call a subroutine with fewer arguments than the subroutine expects, and the called routine can detect that this has been done. Top Drawer subroutines take advantage of this to supply default values for certain parameters, in case of short calls. As a general rule, leaving out the last argument in a call produces a default value for the omitted argument, if such a thing has meaning.

For instance, CALL TDJOIN(50, X, Y, 4HNone, 4HNone, 0, 0) is the same as CALL TDJOIN(50, X, Y),

but CALL TDJOIN(50, X) is wrong because at least the x- and y-values for each point are needed.

The default values are 4HNone for the error arrays DX and DY, and zero for other values.
Many of the calling sequences contain strings. If you want to manipulate string variables, rather than having the characters right in the call, you must arrange to mimic the way in which the Fortran compiler sets up string arguments. They are assigned one byte per character, and the called subroutine is pointed to the first character—the others follow in memory, but there is no information as to the number of characters.

For instance, suppose you want to call TDHIST, sometimes with an x-error array, and sometimes not. XERRS is a logical variable which is .TRUE. if the DX array is to be used, and .FALSE. if not. Then you could do this:

```
IF (.NOT.XERRS) GO TO 20
CALL TDHIST(N,X,Y,DX,DY)
GO TO 30
20 CALL TDHIST(N,X,Y,4HNONE,DY)
30 CONTINUE
```

But you could also do this:

```
DATA XNONE /4HNONE/
IF (.NOT.XERRS) DX(1)=XNONE
CALL TDHIST(N,X,Y,DX,DY)
```

Note that both DX(1) and XNONE are REAL variables with four bytes. If DX is to be used, it contains the error values. If not the first four bytes contain the characters NONE, which is the signal to TDHIST that all the errors are zero.

A more complicated example illustrates the sort of thing you can do. Suppose you have five plots, which you want to label 'PLOT NUMBER 1', 'PLOT NUMBER 2', and so forth. Then you could do this:

```
INTEGER TITLE(4), NUMBER(5)
DATA NUMBER /'1; ','2; ','3; ','4; ','5; '/
DATA TITLE /'PLOT'; 'NUM'; 'BER '; '/
DO 100 IPlot=1,5
CALL TDNEWP
TITLE(4) = NUMBER(IPlot)
CALL TDTITL('TOP',TITLE)
100 CONTINUE
```

The characters appropriate to the particular plot are put into the TITLE string. Note that the terminating semicolon and blank are included as well as the characters. This scheme depends on the fact that there are four characters in
each integer variable. Of course, you could do the same sort of thing using LOGICAL*1 variables, each with one character, or REAL*8, with eight characters.

7.3 EXPLANATION OF CALLING SEQUENCES

See above, "Arrays", for a description of the data arrays X, DX, Y, DY, and their dimension NP.

The function of a subroutine is generally the same as of the corresponding Top Drawer input command. Refer to the command description for a more complete discussion.
7.3.1 List

CALL TDEND
    empties T.D. buffers and closes graphic dataset.

CALL TDHIST(NP,X,Y,DX,DY,LEVEL,MODE)
    like HIST command

CALL TDJOIN(NP,X,Y,DX,DY,LEVEL,MODE)
    like JOIN command

CALL TDLIMS('keyword',NP,VALUES,ERRORS)
    sets plot limits

CALL TDMAIN(N)
    starts Top Drawer in card-reading mode.

CALL TDNEWP('alias')
    like NEW FRAME command.

CALL TDPLT(NP,X,Y,DX,DY,'symbol')
    like PLOT command

CALL TDSET('text;')
    like SET command

CALL TDTITL('text string;','XPOS,YPOS')
    like TITLE command

CALL TDCASE('text string;','case string;','XPOS,YPOS')
    like TITLE command with fancy characters

CALL TDTSET(SIZE,ANGLE,SPACES,DATA)
    additional parameters for TDTITL or TDCASE

7.3.2 TDEND

CALL TDEND

TDEND empties Top Drawer and U.G. buffers and closes the graphic output dataset. No more graphic work should be done. TDEND should be called exactly once in any job.
7.3.3 **TDHIST**

```plaintext
CALL TDHIST(NP, X, Y, DX, DY, LEVEL, MODE)
CALL TDHIST(NP, X, Y, DX, DY)
CALL TDHIST(NP, X, Y, DX)
CALL TDHIST(NP, X, Y)
```

TDHIST makes a simple histogram. Bin widths are as described for the HIST command.

**LEVEL**
- 0: HISTOGRAM
- 1: BARCHART

**MODE**
- 64: DOTS
- 128: DASHES
- 192: DOTDASH
- 256: SOLID
- 512: FUNNY
- 1024: PATTERNED
- 2048: DAASHES

7.3.4 **TDJOIN**

```plaintext
CALL TDJOIN(NP, X, Y, DX, DY, LEVEL, MODE)
CALL TDJOIN(NP, X, Y, DX, DY)
CALL TDJOIN(NP, X, Y, DX)
CALL TDJOIN(NP, X, Y)
```

TDJOIN provides the Top Drawer JOIN function.

**MODE** gives the type of fit to be used:

- **MODE = 0**: Default type ("general")
  - 1: Spline.
  - 2: "General" (Non-linear robust algorithm).
- **MODE + 64**: DOTS
  - +128: DASHES
  - +192: DOTDASH
  - +256: SOLID
  - +512: FUNNY
  - +1024: PATTERNED
  - +2048: DAASHES

**LEVEL** is the number of straight-line segments which will be used in connecting pairs of the given points. LEVEL=0
is default (Top Drawer will choose, depending on the value of NP).

To give level or mode without giving error bars, use 4HNONE for DX and/or DY.

7.3.5 TDLIMS

CALL TDLIMS('keyword', NP, VALUES, ERRORS)
CALL TDLIMS('keyword', NP, VALUES)

TDLIMS sets or resets a limit or limits for the plot. No plotting is done, and the argument values are not changed. 'keyword' may be 'X', 'XMIN', 'XMAX', 'Y', 'YMIN', or 'YMAX'.

VALUES should be the array of x-values, if X, XMIN, or XMAX is specified, or the array of y-values if Y, YMIN, or YMAX is specified. ERRORS is the corresponding error array, either DX or DY. Both are REAL arrays of dimension at least NP. The first NP values are used.

The plot limit(s) indicated by 'keyword' is(are) set to the minimum or maximum value found in VALUES, or VALUES±ERRORS. If they are already set, the plot limits will be expanded but not reduced by this call, so multiple calls with different arrays may be used. (Compare the SET LIMIT command, which resets without reference to the previous value.)

7.3.6 TDMAIN

CALL TDMAIN(N)
CALL TDMAIN

This statement sends Top Drawer into its card-reading mode. Input comes from Fortran unit 5, at its current position. The command RETURN or RETURN n causes a return, and if appropriate, N becomes zero or the value from the RETURN command.
7.3.7 **TDNEWP**

CALL TDNEWP('alias')
CALL TDNEWP(0)
CALL TDNEWP

TDNEWP starts a new plot. An alias may be given, and will be used if the graphic output device is appropriate (e.g. 4013, GENCOM). Zero or no argument results in no alias being used. Otherwise, eight characters are used.

7.3.8 **TDPLOT**

CALL TDPLOT(NP,X,Y,DX,DY,'symbol')
CALL TDPLOT(NP,X,Y,DX,DY)
CALL TDPLOT(NP,X,Y,DX)
CALL TDPLOT(NP,X,Y)
CALL TDPLOT(0)
CALL TDPLOT

TDPLOT provides the Top Drawer PLOT command. The default symbol is set by the SET SYMBOL 'symbol' command, e.g. by CALL TDSET('SET SYMBOL X;').

CALL TDPLOT with no argument, or with NP=0, gives the same function as the PLOT AXES command. Limits should be set already, by a SET LIMITS command or calls to TDLIMS.

7.3.9 **TDSET**

CALL TDSET('text; ')

TDSET allows the programmer to use any Top Drawer command beginning with the word 'SET'. The text of the command (with or without 'SET') is the argument in the call. The terminating semicolon is required, since there is no way in IBM Fortran for a called routine to determine the length of an argument string.
Examples:

CALL TDSET('SET SIZE 10 BY 8; ')
CALL TDSET('LIMITS X 0 TO 86.2; ')

7.3.10 TDTITL, TDCASE and TDTSET

CALL TDTITL('text string; ','XPOS,YPOS')
CALL TDTITL('text string; ','position')
CALL TDTITL('text string; ')

CALL TDCASE('text string; ','case string; ','XPOS,YPOS')
CALL TDCASE('text string; ','case string; ','position')
CALL TDCASE('text string; ','case string; ')

CALL TDTSET(SIZE,ANGLE,SPACES,DATA)
CALL TDTSET(SIZE,ANGLE,SPACES)
CALL TDTSET(SIZE,ANGLE)
CALL TDTSET(SIZE)

'position' may be 'TOP', 'BOTTOM', 'RIGHT', or 'LEFT'

These routines provide the Top Drawer TITLE functions. A call to TDTSET is optional, to be used if the default SIZE, ANGLE, SPACES, or coordinate system aren't wanted. A call to TDTSET works only once--you must call TDTSET every time you call TDTITL, unless the defaults are okay.

The position of the first character may be given by two variables (e.g., XPOS and YPOS) or equivalent constants. This coordinate pair may be replaced by a single argument consisting of the word 'TOP', 'BOTTOM', 'RIGHT', or 'LEFT', as in the TITLE command, or it may be omitted to write a line directly under the most recent line plotted by TDTITL.

A non-zero value for DATA indicates that the position is specified in the DATA coordinate system rather than the usual TEXT system.

TDCASE is identical to TDTITL except for the added argument, which contains the string of second characters for each of the U.G. extended-character-set pairs.

Examples:

CALL TDTSET(3.,0.,6)
CALL TDCASE('EOIP1=-1; ','X
 LCLGC ; ','BOTTOM')
will produce the x-axis label 'e to the i pi equals minus 1'.

CALL TDTITL('THIS IS THE X-AXIS; ','BOTTOM')
CALL TDTITL('THIS APPEARS ABOVE THE GRAPH; ','TOP')
CALL TDTITL('SO DOES THIS; ',1.,9.5)
CALL TDTITL('THIS COMES RIGHT BELOW THE PREVIOUS ONE; ')

7.4 JCL

At SLAC, you can use the standard Fortran or Mortran catalogued procedures, with the following additions: WYL.CG.RBC.LOADMODS and WYL.CG.RCB.UGFTNLIB must be concatenated to the Fortran library datasets, and WYL.CG.RCB.UGRUNLIB to the GO step library. In addition, the graphic dataset(s) must be set up for the GO step.

The subroutines in question all reside in a load module called WYL.CG.RBC.LOADMODS(TDEND). To load the subroutines, the user program must contain the statement CALL TDEND, even if it is never executed. Omission will result in an unresolved external reference at load time.
7.5 SAMPLE JOB

//ABCDRAW JOB ABC$DE
//PLOT EXEC FORTHCG, GORGN=200K,
// LKEDLB3='WYL.CG.RBC.LOADMODS',
// LKEDLB4='WYL.CG.RCB.UGFTNLIB',
// GOsl1='WYL.CG.RCB.UGRUNLIB'
//FORT.SYSIN DD *
DIMENSION X(101), Y(101), Z(101)
DO 10 I=1,101
  X(I)=5*(I-20)
  RADIUS=0.017453*X(I)
  Y(I)=SIN(RADIUS)
  Z(I)=0.8*COS(RADIUS)
10 CONTINUE
CALL TDSET('SCALE X BASE 90;')
CALL TDJOIN(101, X, Y)
CALL TDTITL('y = sin(x);','G')
CALL TDNEWP
CALL TDJOIN(101, X, Y)
CALL TDJOIN(101, X, Z)
CALL TDEND
STOP
END

//* THE FOLLOWING JCL SETS UP THE OUTPUT DATASET
//* FOR A TEKTRONIX 4013. OTHER DEVICES COULD
//* BE USED ALSO. (SEE APPENDIX A.)
//*
//GO.UGDEVICE DD DSN=WYL.gg.uuu.libname,
// DISP=(NEW,KEEP),
// VOL=SER=SCR001,UNIT=DISK,SPACE=(TRK,(5,1,3)),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=1600)
//GO.SYSIN DD *
Input data goes here.
In a Top Drawer batch job, getting the graphic output in picture form is different for each graphic device. There are three different things you must do, the details of which differ for each device.

First, you must include the JCL which describes the device to the operating system. This requires a two- or three-line DD statement with the DDNAME 'GO.UGDEVICE', which could come in your deck just before the //GO.SYSIN DD * card which starts the Top Drawer input.

Second, you must include the SET DEVICE card which describes the device to Top Drawer. This could be the first card in the Top Drawer input, that is, the first card following the //GO.SYSIN DD * card.

Third, the program output, which is a sequence of instructions for the device, must be translated into a picture. For some devices, like the Versatec plotter, this process is automatic, and the pictures will get to you in the same way that your printed output does. For other devices, you must take some action, such as signing onto Wybur and "listing" the output on a Tektronix 4013 terminal, or making sure the CalComp plot tape is sent to the Campus plotter. The rest of this Appendix describes the process for each device.

If you have access to Wybur, the command EXECUTE FROM #TOPDRAW PUBLIC will help you add the JCL and the SET DEVICE card to the Top Drawer input in your active file.

A.1 4013 PDS

The JCL for the output dataset could be:

```plaintext
//GO.UGDEVICE DD
// DSN=WYL.gg.uuu.libname,DISP=(NEW,KEEP),
// VOL=SER=SCR001,UNIT=DISK,SPACE=(TRK,(5,1,3)),
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=1600)
```
This is the default output device, and a

```
SET DEVICE 4013
```

command is not necessary unless a different device was previ-ously specified.

Plots for Tektronix 4013 terminals are normally made as members of a partitioned dataset (PDS). The first plot is member PICT001, and replaces any existing member with that name. Subsequent plots are members PICT002, PICT003, etc. To display a plot made by a Top Drawer batch job, you must sign onto Wylbur on a 4013 terminal. Place the plot in your active file with the standard Wyl-bur command

```
USE libname#PICT001 ON SCR001 CLEAN
```

and then "list" it:

```
LIST UNN CLEAN NONL
```

A.2 4013 SEQUENTIAL

If the keyword SEQUENTIAL is specified in the SET DEVICE command (i.e. SET DEVICE 4013 SEQUENTIAL), the plot output will be put into a sequential dataset. The text for different pictures (what you get with a NEW FRAME command) is separated by control cards starting with ./ in columns 1 and 2. Although it may seem more complicated to have all the plots in one file, and have to scan for a particu-lar delineator, it can simplify the JCL considerably. The following JCL will set up the UGDEVICE dataset as a system print file, which has a unique name, and which is purged along with the rest of the job. This may save you a separate jobstep in which you scratch any old library of plots before trying to make a new one.

The JCL for the output dataset device could be:

```
//GO.UGDEVICE DD SYSOUT=A,
// DCB=(RECFM=FB,LRECL=80,BLKSIZE=1600)
```

To view the plots: get them in your active file with the command

```
FETCH <jobname> CLEAR DD UGDEVICE.
```

Then scan for the separator cards with the command

```
LIST ./, 1,
```
and finally, 'list' a particular plot by the command

   LIST fff/lll UNN CLEAN NONL,

where fff and lll are the first and last line numbers of the range with the picture you want to see.

Plots are similar to standard 80-column card images, and may be used, saved, and manipulated with standard Wylbur commands.

The 4013's can also be used interactively, if Fortran calls are not used. See Appendix C.

A.3 CALCOMP

The JCL for the output dataset could be:

   //GO.UGDEVICE DD DSN=&&PLOT,DISP=(NEW,PASS),
   //    VOL=SER=PLOT,UNIT=T9-800,LABEL=(1,SL),
   //    DCB=(RECFM=F,LRECL=480,BLKSIZE=480,DEN=2)

Top Drawer input for CalComp plots should be preceded by the control statement:

   SET DEVICE SMALL CALCOMP
   or:
   SET DEVICE LARGE CALCOMP

When the job is completed, the plot tape will be put in your bin. Fill out a 'SCIP at SLAC 1130 Drum Plotter Request' from the pile on the front desk. Pen #1 is black. If you use colors, #2 is red and #3 is blue. Use blank paper. The PB pens are adequate and much easier for the operators, although liquid ink may be necessary for publication quality. L05 (0.5-mm liquid ink) is a good size. You must deliver the tape and request form to the information desk at Forsythe Hall (the Stanford campus computing center) for them to deliver to the outside shop that does the plotting. The tape and finished plot will be returned to Forsythe Hall within a couple of days.

The SET COLOR command is valid for CalComp plots.
A.4 MICROFICHE

The JCL for the output dataset could be:

```plaintext
//GO.UGDEVICE DD SYSOUT=Z,
  //       DCB=(RECFM=F,LRECL=1480,BLKSIZE=1480)
```

Top Drawer input to give fiche output should be preceded by the control statement:

```
SET DEVICE MICROFICHE
```

A.5 16-MM UNSPROCKETED FILM

The JCL for the output dataset could be:

```plaintext
//GO.UGDEVICE DD SYSOUT=X,
  //       DCB=(RECFM=F,LRECL=1480,BLKSIZE=1480)
```

Top Drawer input to give film output should be preceded by the control statement:

```
SET DEVICE 16-MM FILM
```

A.6 GENCOM

The JCL for the output dataset could be:

```plaintext
//GO.UGDEVICE DD DSN=WYL.gg.uuu.libname,
  //       DISP=(NEW,KEEP),
  //       VOL=SER=SCR001,UNIT=DISK,SPACE=(TRK,(5,1,3)),
  //       DCB=(RECFM=F8,LRECL=80,BLKSIZE=1600)
```

Top Drawer input should be preceded by the control statement:

```
SET DEVICE GENCOM
```

Plots for GENCOM terminals are made as members of a partitioned dataset (PDS). The first plot is member PICT001, and replaces any existing member with that name. Subsequent plots are members PICT002, PICT003, etc. To display a plot made by a Top Drawer batch job, you must sign onto Wylbur on a GENCOM terminal. Place the plot in your active file with the standard Wylbur command

```
USE libname#PICT001 ON SCR001 CLE
```
and then "list" it:

    LIST UNN CLEAN NOML

Sequential organization can also be specified for the output dataset, by including the keyword SEQUENTIAL (i.e. SET DEVICE GENCOM SEQUENTIAL). The advantages of this kind of dataset are discussed in the section about the 4013. JCL for GENCOM SEQUENTIAL output could be:

    //GO.UGDEVICE DD SYSOUT=A,
    // DCB=(RECFM=FB,LRECL=80,BLKSIZE=1600)

Plots are similar to standard 80-column card images, and may be used, saved, and manipulated with standard Wyibur commands.

The GENCOM terminals can also be used interactively, if Fortran calls are not used. See Appendix C.

A.7 VERSATEC ELECTROSTATIC PLOTTER MODEL 1100

This is the Data Analysis Group's Versatec plotter, not the plotter you usually see output from. Use of this plotter is on an informal basis. You must use your own output tape and plot the tape yourself. The JCL for the output dataset could be:

    //GO.UGDEVICE DD DSN=EFFPLOT,DISP=(NEW,PASS),
    // VOL=SER=xxxxxx,LABEL=(1,SL),UNIT=T9-800,
    // DCB=(RECFM=FB,LRECL=130,BLKSIZE=4160,DEN=2)

Top Drawer input for the Versatec plotter should be preceded by the control statement:

    SET DEVICE V1100

A.8 VERSATEC ELECTROSTATIC PLOTTER MODEL 1200

The on-line Versatec plotter will make plots in two different formats (continuous-roll or fan-fold) and the Unified Graphics System will use one of two different methods of preparing the plot (internal or external sort).
A.8.1 Fan-fold

This is the usual format, in which the maximum plot size is 7.88 inches high and 10.5 inches wide. (If you wish to give all your position measurements in real inches, you must include the command SET SIZE 10.5 BY 7.88.) A /*FORMAT card is not needed.

Input should be preceded by the command

```
SET DEVICE VERSATEC
```

or

```
SET DEVICE VERSATEC EXTERNAL.
```

A.8.2 Continuous

This output is like the small Cal-Comp: it is 10 inches high and as wide as you want. (But remember the SET SIZE command if you want something other than 13 by 10.)

Input should be preceded by one of the following:

```
SET DEVICE VERSATEC CONTINUOUS
SET DEVICE VERSATEC EXTERNAL CONTINUOUS
SET DEVICE VERSATEC CONTINUOUS EXTERNAL
```

For internal sort, use

```
/*FORMAT PR,DDNAME=GO.UGDEVICE,FORMS=ROLL
```

For external sort, use

```
/*FORMAT PR,DDNAME=UGFMAT.SYSOUT,FORMS=ROLL
```

In either case, put it as the second card in the deck, right after the JOB card.

At SLAC, continuous roll output is not processed until late at night, so you won't get it back until the next day.

A.8.3 Internal sort

Because of the special requirements of the Versatec plotter, the picture data must be sorted before it is sent to the plotter. This is normally done by the U.G. System in the course of generating the plot. In this case, the only JCL that is required is:
For complex pictures with many lines, internal sorting may require too large a region, causing the job to abend with a system code 80A. In this case you must specify a larger region, for instance by specifying GORGN=300K in the EXEC statement, or you must use external sorting.

A.8.4 External Sort

In this case, the U.G. System writes the picture data to a scratch file during the Top Drawer jobstep, and then sorts it and transmits it to the plotter in two subsequent steps. In this case, your job might look like this:

```plaintext
// JOB ,TIME=(),REGION=200K
//DRAW EXEC LOADGO,LKEDPRM='EP=MAIN',
// LKEDLB2='WYL.CG.RBC.LOADMODS',
// LKEDLB3='WYL.CG.RCB.UGFTRLIB',
// GOSL1='WYL.CG.RCB.UGRUNLIB'
//GO.SYSLIN DD DISP=SHR,
// DSN=WYL.CG.RBC.LOADMODS(TOPDRAW)
//GO.UGDEVICE DD DSN=&&PLOT1,DISP=(NEW,PASS),
// UNIT=SYSDA,SPACE=(CYL,5),
// DCB=(RECFM=FB,LRECL=12,BLKS=1440)
//SYSIN DD *
SET DEVICE VERSATEC EXTERNAL
TITLE 3 9.5 SIZE 4 'SAMPLE OUTPUT'
CASE 'LLLLL LLLLL'
SET WINDOW Y 1 TO 4.5
  800 3 ;  840 3 ;  880 0 ;  920 13
  960 17;  1000 18;  1040 22;  1080 20
  1120 25;  1160 24;  1200 40;  1240 58
  1280 51;  1320 36;  1360 37;  1400 29
  1440 26;  1480 16;  1520 0;  1560 0
HIST
//UGSORT EXEC SORT
//SORT.SORTIN DD DSN=&&PLOT1,DISP=(OLD,DELETE)
//SORT.SORTOUT DD DSN=&&PLOT2,DISP=(NEW,PASS),
// UNIT=SYSDA,SPACE=(CYL,5),
// DCB=(RECFM=FB,LRECL=12,BLKS=1440)
//SORT.SYSIN DD *
SORT FIELDS=(1,2,FI,A,3,2,FI,A)
//UGFMAT EXEC PGM=UGPPVEP
//STEPLIB DD DSN=WYL.CG.RCB.UGRUNLIB,DISP=SHR
//SYSIN DD DSN=&&PLOT2,DISP=(OLD,DELETE)
//SYSOUT DD SYSOUT=P,
// DCB=(RECFM=FBA,LRECL=134,BLKS=1340)
//SYSPRINT DD SYSOUT=A
```
A.8.5 External Sort with Fortran Calls

In this case, you must combine the JCL for External Sort with the JCL for Fortran Calls. Your job might look like this:

```
//ABCDRAW JOB ABC$DE
//DRAW EXEC FORTGC8,
// LKEDLB2='WYL.CG.RBC.LOADMODS',
// LKEDLB3='WYL.CG.RCB.UGFTNLIB',
// GOSL1='WYL.CG.RCB.UGRUNLIB',
// GORGN=300K
//FORT.SYSIN DD *
DIMENSION X(10001),Y(10001),Z(10001)
CALL TDSET('SET DEVICE VERSATEC EXTERNAL; ')
DO 10 I=1,10001
  X(I)=5*(I-20)
  RADIANT=0.017453*X(I)
  Y(I)=SIN(RADIANT)
  Z(I)=0.8*COS(RADIANT)
10 CONTINUE
CALL TDSET('SCALE X BASE 90; ')
CALL TDJOIN(10001,X,Y)
CALL TDJOIN(10001,X,Z)
CALL TDJOIN(10001,X,Y)
CALL TDJOIN(10001,X,Z)
CALL TDEND
STOP
END
GO.UGDEVICE DD DSN=&PLOT1,DISP=(NEW,PASS),
UNIT=SYSDA,SPACE=(CYL,5),
DCB=(RECFM=FB,LRECL=134,BLKSIZE=1340)
UGSORT EXEC SORT
SORT.SORTIN DD DSN=&PLOT1,DISP=(OLD,DELETE)
SORT.SORTOUT DD DSN=&PLOT2,DISP=(NEW,PASS),
UNIT=SYSDA,SPACE=(CYL,5),
DCB=(RECFM=FB,LRECL=134,BLKSIZE=1340)
SORT.SYSIN DD *
SORT FIELDS=(1,2,FI,A,3,2,FI,A)
UGFMT EXEC PGM=UGPPVEP
STEPLIB DD DSN=WYL.CG.RCB.UGRUNLIB,DISP=SHR
SYSIN DD DSN=&PLOT2,DISP=(OLD,DELETE)
SYSPUT DD SYSPUT=P,
DCB=(RECFM=FBA,LRECL=134,BLKSIZE=1340)
SYSPRINT DD SYSPRINT=A
```
The program called Back Door, which was Top Drawer running as a subsystem under Milten, has been removed from the system. Top Drawer under Orvyl provides equivalent functions with much less impact on the system. See Appendix C.
Appendix C

INTERACTIVE MODE: UNDER ORVYL

To use Top Drawer under Orvyl, sign onto OS Wylbur with a 4013 or a GENCOM terminal, then give the command CALL TOPDRAW.

Your active file should contain standard Top Drawer card input. At the appropriate prompt, you can edit the input using all the Wylbur capabilities. When you have finished editing, 'GO' will get you back into Top Drawer.

To bypass the initial prompting, a parameter string can be included in the initial call. The string may contain the keywords 'GENCOM' or '4013'. If the Top Drawer commands are already in the active file, it can also contain the keyword 'GO'. A call might be CALL TOPDRAW '4013,GO'.

When the plot looks right, and you want hard copy, SAVE your active file as a Wylbur dataset, for future use, and then EXECUTE FROM #TOPDRAW PUB. This will put in the appropriate JCL, and you can then RUN the job.

More details appear in the note 'Introduction to Top Drawer', CGTM No. 189.
Appendix D

INTERACTIVE MODE: UNDER VM/CMS

Top Drawer is alive and well on VM. The input file must be a CMS file, either the usual F- or V-format, or Wylbur EDIT format. Top Drawer cannot read files "packed" by COPYFILE or XEDIT, and gives the strange error message "NO INPUT FILE".

There is a TOPDRAW EXEC on the system U-disk, which will access the RBC 192 disk. This in turn holds the Top Drawer module, exec and txtlibs, as well as a limited number of helpfiles. HELP TOPDRAW or TOPDRAW ? will give a short introduction, but mostly it sends you back to this manual.

The only devices supported at present are the Tektronix 401x series and the Versatec plotter.
Appendix E

USER SCALING

It is possible to scale either or both axes, using an arbitrary function in the same way that logarithmic scaling uses the logarithm. Functions which might be useful are probability (normal probability distribution), square root (for comparing fits to experimental data), etc. USER scaling requires at least one user Fortran routine to be loaded with the program.

E.1 SCALING FUNCTION

If the command 'SET SCALE {X|Y} USER [n]' is given, Top Drawer will call the function TDFNCT(COORD,N) each time a point or tick is plotted, and the plotting will be done at a distance along the axis determined by the value given by TDFNCT. In this call, COORD is the appropriate x or y value, and N is an identifying non-negative integer, which is the value given by the SET SCALE USER n command.

E.2 TICKS AND LABELS

It is possible also to specify the position of ticks along a user-scaled axis. The user must load

SUBROUTINE TDTICK(N, VMIN, VMAX, N1, N2, BASE, NUM, VALS, ITYPES)

Input variables:

N INTEGER scale identifier from the SET SCALE command
VMIN REAL coordinate value at the left (bottom) edge
VMAX REAL coordinate value at the right (top) edge
N1, N2 INTEGER values from the SET SCALE command
BASE REAL value from the SET SCALE command
Output variables:

NUM      INTEGER number of ticks that the subroutine gives
VALS     REAL dimensioned array of coordinate values
ITYPES   INTEGER dimensioned array of tick/label types
to be put at the corresponding positions.

<table>
<thead>
<tr>
<th>Type</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>positive</td>
<td>big tick</td>
</tr>
<tr>
<td>negative</td>
<td>small tick</td>
</tr>
<tr>
<td>±1</td>
<td>no label</td>
</tr>
<tr>
<td>±2</td>
<td>normal label</td>
</tr>
<tr>
<td>±3</td>
<td>exponential label</td>
</tr>
<tr>
<td>±4</td>
<td>first decimal digit only</td>
</tr>
</tbody>
</table>

E.3 EXAMPLE

REAL FUNCTION TDFNCT(COORD,N)
REAL COORD
INTEGER N
REAL MEAN/100./,STDDEV/5./,ROOT2/1.414/
IF (N.EQ.2) GO TO 50
C LOGARITHMIC SCALING
IF (COORD.GT.0.) GO TO 10
TDFNCT = -300.
RETURN
10 TDFNCT=ALOG(COORD)
RETURN
C PROBABILITY SCALING
C (ERF IS AN IBM-SUPPLIED ROUTINE)
50 TDFNCT=ERF((COORD-MEAN)/(STDDEV*ROOT2))
RETURN
END
SUBROUTINE TDTICK(N, VN, VX, N1, N2, BASE, NUM, VALS, ITYPES)
DIMENSION VALS(100), ITYPES(100)
DIMENSION VALLOG(5), ITYLOG(5)
DIMENSION VALPRO(9), ITYPRO(9)
DATA VALLOG/1., 4., 1., 4., 10./, ITYLOG/2., -1, 2, -1, 2/
DATA VALPRO/0., 50., 90., 95., 100., 105., 110., 150., 200./
DATA ITYPRO/9*2/
IF (N.EQ.2) GO TO 20
C LOGARITHMIC SCALING
NUM=5
DO 10 I=1,5
    VALS(I)=VALLOG(I)
    ITYPES(I)=ITYLOG(I)
10 CONTINUE
RETURN

- 74 -
C PROBABILITY SCALING

20 NUM = 9
DO 30 I=1,9
   VALS(I)=VALPRO(I)
   ITYPES(I)=ITYPRO(I)
30 CONTINUE
RETURN
END

If these routines are loaded with the Top Drawer routines, then the command SET SCALE X USER 2 will cause the x-axis to be scaled according to a normal probability distribution. Any other value for N, for instance from the command SET SCALE X USER 25, will give logarithmic scaling.

Note:

- TDFNCT is not told which axis is involved, and the same function could be used for both axes.

- There is a check in the above function against illegal values of the argument for the logarithm. Top Drawer may exceed allowed values, in setting limits automatically or in trying to plot points or error bars that lie outside the limits.

- ERF is different from the normal probability distribution function by a linear relationship. Since the values supplied by TDFNCT are mapped onto the axis by another linear transformation, any linear function of the desired function may be used.

- TDFNCT should be a monotonic function of COORD.

- The TDTICK routine in this simple example puts into the VALS and ITYPES arrays the predetermined values which are set in the DATA statements. More elaborate schemes could be used to set these values, using the information supplied as arguments of the call.
If the Fortran-call control method is used, TDFNCT and TDTICK can be included with the other Fortran routines. If Top Drawer is run as a main program, the following deck will work:

```
// JOB
// EXEC FORTGCG,
//   LKEDPRM='EP=MAIN',
//   LKEDLB2='WYL.CG.RBC.LOADMODS',
//   LKEDLB3='WYL.CG.RCB.UGFTNLIB',
//   GOSL1='WYL.CG.RCB.UGRUMLIB',
//   GORGN=200k
//FORT.SYSIN DD *
FUNCTION TDFNCT(VALUE,N)
  ...
  END
  SUBROUTINE TDTICK(...)
  ...
  END
//GO.SYSLIN DD DSN=WYL.CG.RBC.LOADMODS(TOPDRAW),
//   DISP=SHR

JCL to define the output dataset(s) goes here.
(See Appendix A.)

//GO.SYSIN DD *

Top Drawer Input Cards Go Here.
```
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.

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 'l' 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'.

### Alphabetic First Character

<table>
<thead>
<tr>
<th>Second Character</th>
<th>Blank</th>
<th>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</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>A B X Δ E Φ Γ Η I K A M Ν Ο Π Θ Ψ Σ Ε Τ Ω Ξ Υ Ζ</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>α β χ δ ε Φ θ υ η ι ζ ξ ο π Π ρ Σ Τ Ω ω ( ψ ζ</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>{ ∀ ≡ † ‡ § • ⟨ § ° θ α ± − − x }</td>
<td></td>
</tr>
</tbody>
</table>
| X                | ∀ ∈ ∋ ∋ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ ∈ €


<table>
<thead>
<tr>
<th>Non-Alphabetic First Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank 0 1 2 3 4 5 6 7 8 9 : + * &lt; &gt; ( ) ? /</td>
</tr>
<tr>
<td>S     ≡ √ ± 0 0 ≤ ≥ [ ] ′ \</td>
</tr>
<tr>
<td>X     C x</td>
</tr>
<tr>
<td>P     + x ∘ + ∗ + x + x ∗ x ⊙</td>
</tr>
</tbody>
</table>

Other Keyboard Characters $ | & ! $ ; − , % # @ ’ = "
Non-Printing Characters do not appear in this table.
<table>
<thead>
<tr>
<th>Char</th>
<th>Character Description</th>
<th>Char</th>
<th>Character Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>U.C. A</td>
<td>AL</td>
<td>L.C. A</td>
</tr>
<tr>
<td>B</td>
<td>U.C. B</td>
<td>BL</td>
<td>L.C. B</td>
</tr>
<tr>
<td>C</td>
<td>U.C. C</td>
<td>CL</td>
<td>L.C. C</td>
</tr>
<tr>
<td>D</td>
<td>U.C. D</td>
<td>DL</td>
<td>L.C. D</td>
</tr>
<tr>
<td>E</td>
<td>U.C. E</td>
<td>EL</td>
<td>L.C. E</td>
</tr>
<tr>
<td>F</td>
<td>U.C. F</td>
<td>FL</td>
<td>L.C. F</td>
</tr>
<tr>
<td>G</td>
<td>U.C. G</td>
<td>GL</td>
<td>L.C. G</td>
</tr>
<tr>
<td>H</td>
<td>U.C. H</td>
<td>HL</td>
<td>L.C. H</td>
</tr>
<tr>
<td>I</td>
<td>U.C. I</td>
<td>IL</td>
<td>L.C. I</td>
</tr>
<tr>
<td>J</td>
<td>U.C. J</td>
<td>JL</td>
<td>L.C. J</td>
</tr>
<tr>
<td>K</td>
<td>U.C. K</td>
<td>KL</td>
<td>L.C. K</td>
</tr>
<tr>
<td>L</td>
<td>U.C. L</td>
<td>LL</td>
<td>L.C. L</td>
</tr>
<tr>
<td>M</td>
<td>U.C. M</td>
<td>ML</td>
<td>L.C. M</td>
</tr>
<tr>
<td>N</td>
<td>U.C. N</td>
<td>NL</td>
<td>L.C. N</td>
</tr>
<tr>
<td>O</td>
<td>U.C. O</td>
<td>OL</td>
<td>L.C. O</td>
</tr>
<tr>
<td>P</td>
<td>U.C. P</td>
<td>PL</td>
<td>L.C. P</td>
</tr>
<tr>
<td>Q</td>
<td>U.C. Q</td>
<td>QL</td>
<td>L.C. Q</td>
</tr>
<tr>
<td>R</td>
<td>U.C. R</td>
<td>RL</td>
<td>L.C. R</td>
</tr>
<tr>
<td>S</td>
<td>U.C. S</td>
<td>SL</td>
<td>L.C. S</td>
</tr>
<tr>
<td>T</td>
<td>U.C. T</td>
<td>TL</td>
<td>L.C. T</td>
</tr>
<tr>
<td>U</td>
<td>U.C. U</td>
<td>UL</td>
<td>L.C. U</td>
</tr>
<tr>
<td>V</td>
<td>U.C. V</td>
<td>VL</td>
<td>L.C. V</td>
</tr>
<tr>
<td>W</td>
<td>U.C. W</td>
<td>HL</td>
<td>L.C. W</td>
</tr>
<tr>
<td>X</td>
<td>U.C. X</td>
<td>XL</td>
<td>L.C. X</td>
</tr>
<tr>
<td>Y</td>
<td>U.C. Y</td>
<td>YL</td>
<td>L.C. Y</td>
</tr>
<tr>
<td>Z</td>
<td>U.C. Z</td>
<td>ZL</td>
<td>L.C. Z</td>
</tr>
</tbody>
</table>

Other Keyboard Characters

<table>
<thead>
<tr>
<th>Character Description</th>
<th>Char</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td></td>
</tr>
<tr>
<td>© Cent Sign</td>
<td>¶</td>
</tr>
<tr>
<td>· Period</td>
<td>.</td>
</tr>
<tr>
<td>&lt; Less Than</td>
<td>&lt;</td>
</tr>
<tr>
<td>( Left Parenthesis</td>
<td>(</td>
</tr>
<tr>
<td>+ Plus Sign</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Vertical Line</td>
</tr>
<tr>
<td>&amp; Ampersand</td>
<td>&amp;</td>
</tr>
<tr>
<td>! Exclamation Mark</td>
<td>!</td>
</tr>
<tr>
<td>$ Dollar Sign</td>
<td>$</td>
</tr>
<tr>
<td>* Asterisk</td>
<td>*</td>
</tr>
<tr>
<td>) Right Parenthesis</td>
<td>)</td>
</tr>
<tr>
<td>; Semi-Colon</td>
<td>;</td>
</tr>
<tr>
<td>L Not</td>
<td>L</td>
</tr>
<tr>
<td>- Minus Sign</td>
<td>-</td>
</tr>
<tr>
<td>/ Slash Mark</td>
<td>/</td>
</tr>
<tr>
<td>, Comma</td>
<td>,</td>
</tr>
<tr>
<td>% Percent</td>
<td>%</td>
</tr>
<tr>
<td>_ Underline</td>
<td>_</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Character Description</th>
<th>Numeral</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; Greater Than</td>
<td>0</td>
</tr>
<tr>
<td>? Question Mark</td>
<td>1</td>
</tr>
<tr>
<td>: Colon</td>
<td>2</td>
</tr>
<tr>
<td># Pound Sign</td>
<td>3</td>
</tr>
<tr>
<td>@ At Sign</td>
<td>4</td>
</tr>
<tr>
<td>' Apostrophe</td>
<td>5</td>
</tr>
<tr>
<td>= Equals Sign</td>
<td>6</td>
</tr>
<tr>
<td>&quot; Quote Marks</td>
<td>7</td>
</tr>
<tr>
<td>0 Numeral 0</td>
<td>8</td>
</tr>
<tr>
<td>1 Numeral 1</td>
<td>9</td>
</tr>
<tr>
<td>2 Numeral 2</td>
<td></td>
</tr>
<tr>
<td>3 Numeral 3</td>
<td></td>
</tr>
<tr>
<td>4 Numeral 4</td>
<td></td>
</tr>
<tr>
<td>5 Numeral 5</td>
<td></td>
</tr>
<tr>
<td>6 Numeral 6</td>
<td></td>
</tr>
<tr>
<td>7 Numeral 7</td>
<td></td>
</tr>
<tr>
<td>8 Numeral 8</td>
<td></td>
</tr>
<tr>
<td>9 Numeral 9</td>
<td></td>
</tr>
<tr>
<td>Char Pair</td>
<td>Character Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Upper Case Greek</td>
<td></td>
</tr>
<tr>
<td>AH</td>
<td>U.C. Alpha</td>
</tr>
<tr>
<td>BH</td>
<td>U.C. Beta</td>
</tr>
<tr>
<td>CH</td>
<td>U.C. Chi</td>
</tr>
<tr>
<td>DH</td>
<td>U.C. Delta</td>
</tr>
<tr>
<td>EH</td>
<td>U.C. Epsilon</td>
</tr>
<tr>
<td>FH</td>
<td>U.C. Phi</td>
</tr>
<tr>
<td>GH</td>
<td>U.C. Gamma</td>
</tr>
<tr>
<td>HH</td>
<td>U.C. Eta</td>
</tr>
<tr>
<td>IH</td>
<td>U.C. Iota</td>
</tr>
<tr>
<td>KH</td>
<td>U.C. Kappa</td>
</tr>
<tr>
<td>LH</td>
<td>U.C. Lambda</td>
</tr>
<tr>
<td>MH</td>
<td>U.C. Mu</td>
</tr>
<tr>
<td>NH</td>
<td>U.C. Nu</td>
</tr>
<tr>
<td>OH</td>
<td>U.C. Omicron</td>
</tr>
<tr>
<td>PH</td>
<td>U.C. Pi</td>
</tr>
<tr>
<td>QH</td>
<td>U.C. Theta</td>
</tr>
<tr>
<td>RH</td>
<td>U.C. Rho</td>
</tr>
<tr>
<td>SH</td>
<td>U.C. Sigma</td>
</tr>
<tr>
<td>TH</td>
<td>U.C. Tau</td>
</tr>
<tr>
<td>UH</td>
<td>U.C. Upsilon</td>
</tr>
<tr>
<td>WH</td>
<td>U.C. Omega</td>
</tr>
<tr>
<td>XH</td>
<td>U.C. Xi</td>
</tr>
<tr>
<td>YH</td>
<td>U.C. Psi</td>
</tr>
<tr>
<td>ZH</td>
<td>U.C. Zeta</td>
</tr>
<tr>
<td>Lower Case Greek</td>
<td></td>
</tr>
<tr>
<td>AG</td>
<td>L.C. Alpha</td>
</tr>
<tr>
<td>BG</td>
<td>L.C. Beta</td>
</tr>
<tr>
<td>CG</td>
<td>L.C. Chi</td>
</tr>
<tr>
<td>DG</td>
<td>L.C. Delta</td>
</tr>
<tr>
<td>EG</td>
<td>L.C. Epsilon</td>
</tr>
<tr>
<td>FG</td>
<td>L.C. Phi</td>
</tr>
<tr>
<td>GG</td>
<td>L.C. Gamma</td>
</tr>
<tr>
<td>HG</td>
<td>L.C. Eta</td>
</tr>
<tr>
<td>IG</td>
<td>L.C. Iota</td>
</tr>
<tr>
<td>KG</td>
<td>L.C. Kappa</td>
</tr>
<tr>
<td>LG</td>
<td>L.C. Lambda</td>
</tr>
<tr>
<td>MG</td>
<td>L.C. Mu</td>
</tr>
<tr>
<td>NG</td>
<td>L.C. Nu</td>
</tr>
<tr>
<td>OG</td>
<td>L.C. Omicron</td>
</tr>
<tr>
<td>PG</td>
<td>L.C. Pi</td>
</tr>
<tr>
<td>QQ</td>
<td>L.C. Theta</td>
</tr>
<tr>
<td>RG</td>
<td>L.C. Rho</td>
</tr>
<tr>
<td>SG</td>
<td>L.C. Sigma</td>
</tr>
<tr>
<td>TG</td>
<td>L.C. Tau</td>
</tr>
<tr>
<td>UG</td>
<td>L.C. Upsilon</td>
</tr>
<tr>
<td>WG</td>
<td>L.C. Omega</td>
</tr>
<tr>
<td>XG</td>
<td>L.C. Xi</td>
</tr>
<tr>
<td>YG</td>
<td>L.C. Psi</td>
</tr>
<tr>
<td>ZG</td>
<td>L.C. Zeta</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subscripts and Superscripts</th>
</tr>
</thead>
<tbody>
<tr>
<td>0C</td>
</tr>
<tr>
<td>1C</td>
</tr>
<tr>
<td>2C</td>
</tr>
<tr>
<td>3C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC</td>
</tr>
<tr>
<td>FC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position Save/Restore</th>
</tr>
</thead>
<tbody>
<tr>
<td>4C</td>
</tr>
<tr>
<td>5C</td>
</tr>
<tr>
<td>6C</td>
</tr>
<tr>
<td>7C</td>
</tr>
<tr>
<td>8C</td>
</tr>
<tr>
<td>9C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blanks of Various Widths</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
</tr>
<tr>
<td>0U</td>
</tr>
<tr>
<td>1U</td>
</tr>
<tr>
<td>2U</td>
</tr>
<tr>
<td>3U</td>
</tr>
<tr>
<td>4U</td>
</tr>
<tr>
<td>5U</td>
</tr>
<tr>
<td>6U</td>
</tr>
<tr>
<td>1V</td>
</tr>
<tr>
<td>2V</td>
</tr>
<tr>
<td>3V</td>
</tr>
<tr>
<td>4V</td>
</tr>
<tr>
<td>5V</td>
</tr>
<tr>
<td>6V</td>
</tr>
<tr>
<td>Char</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>IS</td>
</tr>
<tr>
<td>XS</td>
</tr>
<tr>
<td>:S</td>
</tr>
<tr>
<td>ES</td>
</tr>
<tr>
<td>PS</td>
</tr>
<tr>
<td>DS</td>
</tr>
<tr>
<td>JS</td>
</tr>
<tr>
<td>+S</td>
</tr>
<tr>
<td>*S</td>
</tr>
<tr>
<td>QS</td>
</tr>
<tr>
<td>SS</td>
</tr>
<tr>
<td>2S</td>
</tr>
<tr>
<td>&lt;S</td>
</tr>
<tr>
<td>&gt;S</td>
</tr>
<tr>
<td>=S</td>
</tr>
<tr>
<td>0S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Char</th>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX</td>
<td>Membership Symbol</td>
<td>More Mathematical Symbols</td>
</tr>
<tr>
<td>NX</td>
<td>Membership Negation</td>
<td></td>
</tr>
<tr>
<td>EX</td>
<td>Existential Quant.</td>
<td></td>
</tr>
<tr>
<td>IX</td>
<td>Intersection</td>
<td></td>
</tr>
<tr>
<td>AX</td>
<td>Universal Quant.</td>
<td></td>
</tr>
<tr>
<td>UX</td>
<td>Union</td>
<td></td>
</tr>
<tr>
<td>&lt;X</td>
<td>Contained in</td>
<td></td>
</tr>
<tr>
<td>&gt;X</td>
<td>Contains</td>
<td></td>
</tr>
<tr>
<td>LX</td>
<td>Contained in/Equal</td>
<td></td>
</tr>
<tr>
<td>RX</td>
<td>Contains/Equal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Char</th>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP</td>
<td>V Cross Plot Symbols</td>
<td></td>
</tr>
<tr>
<td>VP</td>
<td>D Cross</td>
<td></td>
</tr>
<tr>
<td>DP</td>
<td>Diamond</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>Square</td>
<td></td>
</tr>
<tr>
<td>7P</td>
<td>F V Cross</td>
<td></td>
</tr>
<tr>
<td>8P</td>
<td>F Octagon</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Char</th>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA</td>
<td>Up Arrow Other Special Symbols</td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>Down Arrow</td>
<td></td>
</tr>
<tr>
<td>LA</td>
<td>Left Arrow</td>
<td></td>
</tr>
<tr>
<td>RA</td>
<td>Right Arrow</td>
<td></td>
</tr>
<tr>
<td>BA</td>
<td>Left/Right Arrow</td>
<td></td>
</tr>
<tr>
<td>GS</td>
<td>Dagger</td>
<td></td>
</tr>
<tr>
<td>FS</td>
<td>Double Dagger</td>
<td></td>
</tr>
<tr>
<td>LS</td>
<td>Left Angle Bracket</td>
<td></td>
</tr>
<tr>
<td>RS</td>
<td>Right Angle Bracket</td>
<td></td>
</tr>
<tr>
<td>(S</td>
<td>Left Bracket</td>
<td></td>
</tr>
<tr>
<td>)S</td>
<td>Right Bracket</td>
<td></td>
</tr>
<tr>
<td>KS</td>
<td>New Paragraph</td>
<td></td>
</tr>
<tr>
<td>HS</td>
<td>H-Bar</td>
<td></td>
</tr>
<tr>
<td>WS</td>
<td>Lambda-Bar</td>
<td></td>
</tr>
<tr>
<td>DS</td>
<td>Degrees</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>Underscore</td>
<td></td>
</tr>
<tr>
<td>VS</td>
<td>Overscore</td>
<td></td>
</tr>
<tr>
<td>/S</td>
<td>Backwards Slash</td>
<td></td>
</tr>
</tbody>
</table>
Index

#TOPDRAW ... 48

Abbreviated Calls ... 52
abbreviation ... 3
ABEND 80A ... 68
ACTION
    commands ... 11
Akima, Hiroshi ... 17
algorithm ... 17
ALIAS ... 12, 17, 58
ALL ... 27, 28, 29, 36, 38
ANGLE ... 12, 19, 20, 41
APL ... 1
apostrophes ... 19
Arguments of Calls ... 52
arithmetic ... 1
Arrays ... 52
ARROW ... 10, 12, 13
AXIS ... 10
    labels ... 28

Back Door ... 70
BAR
    SIZE ... 10
BARCHART ... 56
BARGRAPH ... 11, 12, 13
BASE ... 28, 40, 41, 73
BASIC ... 27, 33
batch
    job ... 62
Beach, Robert ... 2
BIN ... 11, 21, 26
BINS ... 21, 23
BOTTOM ... 6, 12, 19, 27, 28, 29, 36, 38, 45
BOX ... 12
    SIZE ... 10
Braces ... 11
Brackets ... 11
brightness ... 35

CalComp ... 2, 31, 39, 62, 64, 67
calendar ... 7, 41
CALL
    TDPLT ... 55

TDSET ... 55
calling sequences ... 54, 55
CARD
    LENGTH ... 10
cards ... 47
CASE ... 8, 12, 19, 77, 78
catalogued
    procedures ... 60
CENTER ... 12, 19
centimeters ... 42
character
    generator ... 8
    set ... 7, 33, 76
    spacing ... 7, 19
Character string ... 51
Character Strings ... 52
CIRCLE ... 12, 14, 33
clear
    screen ... 9
CMS ... 72
COLOR ... 10, 64
columns ... 30
comments ... 3
COMPLEX ... 51
conflicting
    keywords ... 3
CONTINUOUS ... 27, 31
continuous-roll ... 66
CONTROL
    commands ... 11, 25
coordinate
    system ... 6
coordinate system ... *
CRT ... 2
cusps ... 17

DAASHES ... 56
DASHES ... 12, 13, 15, 16, 28, 44, 56
data ... 6, 7, 16, 19
Commands ... 20
coordinate
    system ... 13, 14, 15
fitting ... 1
points ... 21
DATA system ... see
"coordinate system"
DNAME ... 27, 31
DEBUG ... 27, 28, 33, 37
debugging
commands ... 11
decade ... 40
device-generated
characters ... 7, 8
diagnostics ... 51
DIAMOND ... 10, 12, 14
dimension ... 47, 52
discontinuity ... 17
DOTDASH ... 12, 13, 15, 16,
28, 44, 56
DOTS ... 12, 13, 15, 16, 28,
44, 56
DOUBLE PRECISION ... 51
DUMMY ... 28, 37
DUMP ... 25
DUPLEX ... 7, 27, 33
DX ... 21, 23
DY ... 21, 23
e to the i pi ... 20
ECHO ... 28, 37
Electrostatic
Plotter ... See Versatec
ELLIPSE ... 10, 12, 15, 33
END ... 11, 25, 60
English ... 2
error ... 27, 33
array ... 51
arrays ... 52
bars ... 16, 17, 21
messages ... 2
EXECUTE ... 48, 62, 71
exponential ... 40
notation ... 3
EXTENDED ... 27, 33
EXTERNAL ... 27, 31, 60, 66,
68
FANFOLD ... 27, 31, 66
fatness ... 13
FETCH ... 63
Field
separators ... 3
film ... 31, 65
FLAGS ... 25, 28, 37
FLAIR ... See Flare
FLARE ... 10, 12, 13, 29
FONT ... 9, 10

FORMAT ... 10
Fortran ... 2, 9, 25, 26,
27, 47, 50, 51, 52, 53,
57, 58, 60, 61, 64, 66,
69, 73
unit ... 33
FULSCR ... 32
function
evaluation ... 1
FUNNY ... 12, 16, 56
Gencom ... 2, 17, 31, 65, 71
GENERAL ... 12, 16, 56
Greek ... 8, 20, 77, 78
GRID ... 10
HELP ... 72
helpfile ... 72
HISTOGRAM ... 11, 12, 15,
22, 56
HORIZONTAL ... 27, 34
IBM ... 51, 52
improvements ... 1
inches ... 7, 42, 45, 46
INDEX ... 12, 19
input ... 27, 33
format ... 3
INTEGER ... 51
INTEGER#2 ... 51
INTENSITY ... 10
interactive ... 25, 27, 31,
69, 70, 71
terminals ... 8
interface ... 47
INTERNAL ... 27, 31, 66, 67
interpretation of
input ... 28
isosceles
triangle ... 13

{ ... 11
JCL ... 32, 47, 60, 62, 63,
64, 65, 66, 67, 69, 71
JOIN ... 11, 12, 16, 56
Julian ... 41
Keyboard ... 78
labels ... 28, 29, 40, 73
language ... 47
Lawton, Anthony ... 17
LEFT ... 6, 12, 19, 27, 28, 29, 36, 38, 45
legal
  input ... 3
LESS ... 12, 13
level ... 16, 22
limitations ... 47, 51
limits ... 17, 47
line
  segments ... 16
  texture ... 28
width ... 35
linear ... 7, 22, 28, 39, 40
LIST ... 11, 25, 63, 66
logarithmic ... 7, 28, 39, 40
LOGICAL*1 ... 53
Lower
  case ... 11, 20, 77
math symbol ... 78
microfiche ... 31, 64
Miften ... 70
MODE ... 9
module ... 72
months ... 28, 40
MORE ... 12, 19, 78
Mortran ... 60
multiple
  commands ... 3
NASA ... 35
NEW
  FRAME ... 7, 9, 11, 12, 17, 46, 55, 63
NODEBUG ... 28, 37
NOECHO ... 28, 37
non-decimal ... 41
NONE ... 52, 53
normal ... 28, 39
distribution ... 22
NOTRACE ... 28, 37
NOVECTOR ... 28, 37
numeric
  labels ... 36
OF ... 28, 46
OFF ... 27, 28, 29
ON ... 27, 28, 29, 34
ORDER ... 10
Orvyl ... 4, 26, 70, 71
OUTLINE ... 10, 28, 29
Output ... 2, 27, 33
devices ... 62
pair ... 38
paper clip ... 4
partitioned
dataset ... 63, 65
PATTERN ... 12, 13, 15, 16, 28, 39, 45, 56
PAUSE ... 25, 26
PDS ... 17, 27, 31, 62, 63, 65
PEN ... 10
permanence ... 9
pica ... 8
PLOT ... 11, 12, 17, 55, 58
  AXES ... 12, 18, 58
  character ... 28
  symbols ... 44
tape ... 64
plot symbol ... 78
plotter ... See Versatec,
           Tektronix, etc.
point buffer ... 43, 47
POINTS ... 12, 23
POWER ... 40
probability ... See "normal"
publishation ... 33
QUICK ... 28, 37
quotes ... 19
random
  access ... 4
RBC ... 1, 17
REAL ... 51, 53
REAL*8 ... 51, 54
rectangle ... 14
REDUCE ... 10, 28, 42, 43
reduction ... 7
RETURN ... 11, 25, 26, 57
RIGHT ... 6, 12, 19, 27, 28, 29, 36, 38, 45
robust ... 56
Roman ... 20, 77, 78
ROUND ... 40
round numbers ... 40

} ... 11

sample job ... 68, 69, 76
  with cards ... 48
  with Fortran ... 61
scaling ... 28, 40, 73
function ... 41
semi-axis ... 30, 33
semicolon ... 3, 51, 58
Stand-Alone Program ... 46
standard deviation ... 22
Stanford ... 48
string
manipulation ... 51
subroutines ... 51
subscript ... 77
superscript ... 20, 77
SYMBOL ... 27, 28, 34, 37
TDCASE ... 51, 55, 59
TDEND ... 55, 60
TDFNCT(COORD,N) ... 41, 73
TDHIST ... 51, 55, 56
TDJOIN ... 51, 55, 56
TDLIMS ... 7, 51, 55, 57, 58
TDMAIN ... 26, 27, 55, 57
TDNEWP ... 55, 57
TDPLT ... 58
TDSET ... 51, 58
TDTICK ... 41, 73
TDTITL ... 51, 55, 59
TDTSET ... 55, 59
Tektronix ... 2, 8, 17, 31, 62, 63, 72
TEXT ... see also "coordinate system", 6, 12, 16, 19
coordinate system ... 13, 14, 15, 42
editor ... 47
text-editing ... 2
TEXTURE ... 10, 16
tick
marks ... 28
TICKS ... 10, 28, 29, 40, 45, 73
TIME ... 11, 25, 26, 41
TITLE ... 7, 11, 12, 18, 20, 55, 59, 77, 78
SIZE ... 10
TOP ... 6, 12, 19, 27, 28, 29, 36, 38, 45
TRACE ... 28, 37
txtlib ... 72
U.G. ... 2, 20, 27, 32, 38, 44, 59, 67, 68, 77
UGDEVICE ... 62, 63, 64, 65, 66, 68
UGOPEN ... 31
UNITS ... 28, 42
unresolved external ... 60

separator ... 21
SEQUENTIAL ... 27, 31, 32, 63, 66
SET ... 55, 58
ARROW ... 13, 27, 28
AXES ... 29
AXIS ... 27, 29
BAR ... 27, 29
BOX ... 27, 30
CARD ... 27, 30
CIRCLE ... 27, 30
COLOR ... 27, 30, 64
Commands ... 26
DEVICE ... 6, 7, 9, 27, 31, 62, 64, 65, 67
DIAMOND ... 15, 27, 32
ELLIPSE ... 15, 27, 32
FILE ... 27, 33
FONT ... 27, 33
FORMAT ... 27, 34
GRID ... 9, 27, 34
INTENSITY ... 27, 35
LABELS ... 28, 29, 35
LIMITS ... 7, 19, 28, 36, 46, 47, 57, 58
MODE ... 28, 36, 37
ORDER ... 21, 28, 37, 43
OUTLINE ... 28, 29, 38
PEN ... 39
SCALE ... 7, 22, 28, 39, 73
SIZE ... 6, 28, 42, 46, 47, 57, 58
STORAGE ... 43
SYMBOL ... 28, 43, 58
TEXTURE ... 13, 15, 28, 44
TICKS ... 28, 29, 45
TITLE ... 28, 45
SIZE ... 8
WINDOW ... 6, 7, 9, 28, 45
sideways ... 27, 31, 32
SIZE ... 10
SLAC ... 47, 48, 60, 64
SLOW ... 28, 37
SMOOTH ... 11, 21, 22, 26
SOLID ... 12, 13, 15, 16, 28, 44, 56
SPACES ... 12, 19
spacing between characters ... 7
Speakeasy ... 1
SPLINE ... 12, 16, 56

85
Upper
  case ... 11, 77
user ... 28, 40, 41, 73
user scaling ... 72

value
  array ... 51, 52
vector ... 28, 37
  characters ... 7
Versatec ... 2, 31, 35, 62, 66, 72
VERTICAL ... 27, 34
VGT ... 34
VM/CMS ... 34, 72
V1100 ... 66

warning ... 2
weight ... 22
window ... 6, 7, 10
WORLD system ... see "coordinate system"
Wylbur ... 2, 48, 62, 63, 65, 66, 71, 72

X ... 21, 23
XDATA ... 12, 19
XMAX ... 28, 36, 57
XMIN ... 28, 36, 57

Y ... 21, 23, 57
YDATA ... 12, 19
years ... 28, 40, 41
YMAX ... 28, 36, 57
YMIN ... 28, 36, 57

[ ... 11

16-MM
FILM ... 65

4MMONE ... 52, 53
401x ... See Tektronix

80A ... 68

] ... 11
Roger B. Chaffee
Computation Research Group
Stanford Linear Accelerator Center

Revised April 1987 by
Bill Johnson and Joey Wells
SLAC Computing Services
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Output</td>
<td>2</td>
</tr>
<tr>
<td>Input</td>
<td>2</td>
</tr>
<tr>
<td>Input Formats</td>
<td>3</td>
</tr>
<tr>
<td>About This Note</td>
<td>4</td>
</tr>
<tr>
<td>The Anatomy of a Plot</td>
<td>5</td>
</tr>
<tr>
<td>Coordinate Systems</td>
<td>6</td>
</tr>
<tr>
<td>The TEXT Coordinate System</td>
<td>6</td>
</tr>
<tr>
<td>The Window</td>
<td>6</td>
</tr>
<tr>
<td>The DATA Coordinate System</td>
<td>7</td>
</tr>
<tr>
<td>Plotting Text</td>
<td>7</td>
</tr>
<tr>
<td>Character Size</td>
<td>7</td>
</tr>
<tr>
<td>Device-Generated and Vector Characters</td>
<td>8</td>
</tr>
<tr>
<td>Default Values</td>
<td>9</td>
</tr>
<tr>
<td>Commands</td>
<td>11</td>
</tr>
<tr>
<td>2. ACTION COMMANDS</td>
<td>12</td>
</tr>
<tr>
<td>ARROW</td>
<td>13</td>
</tr>
<tr>
<td>BARGRAPH</td>
<td>13</td>
</tr>
<tr>
<td>BOX</td>
<td>14</td>
</tr>
<tr>
<td>CIRCLE</td>
<td>14</td>
</tr>
<tr>
<td>DIAMOND</td>
<td>14</td>
</tr>
<tr>
<td>ELLIPSE</td>
<td>15</td>
</tr>
<tr>
<td>HISTOGRAM</td>
<td>15</td>
</tr>
<tr>
<td>JOIN</td>
<td>16</td>
</tr>
<tr>
<td>The</td>
<td>17</td>
</tr>
<tr>
<td>NEW FRAME</td>
<td>17</td>
</tr>
<tr>
<td>PLOT</td>
<td>17</td>
</tr>
<tr>
<td>PLOT AXES</td>
<td>18</td>
</tr>
<tr>
<td>TITLE, CASE, and MORE</td>
<td>18</td>
</tr>
<tr>
<td>3. DATA COMMANDS</td>
<td>21</td>
</tr>
<tr>
<td>List of Data Commands</td>
<td>21</td>
</tr>
<tr>
<td>Data Points</td>
<td>21</td>
</tr>
<tr>
<td>BIN</td>
<td>22</td>
</tr>
<tr>
<td>SMOOTH</td>
<td>22</td>
</tr>
<tr>
<td>The Smoothing Algorithm</td>
<td>23</td>
</tr>
<tr>
<td>X/Y BINS/POINTS</td>
<td>23</td>
</tr>
</tbody>
</table>
4. CONTROL COMMANDS
   DUMP ........................................... 25
   END .............................................. 25
   LIST ............................................. 25

5. SET COMMANDS .................................. 27
   SET ARROW ....................................... 29
   SET AXES ......................................... 29
   SET BAR .......................................... 29
   SET BOX .......................................... 29
   SET CARD ......................................... 29
   SET CIRCLE ....................................... 29
   SET COLOR ........................................ 29
   SET DEVICE ....................................... 29
   SET DIAMOND .................................... 30
   SET ELLIPSE ...................................... 30
   SET FILE ......................................... 30
   SET FONT ......................................... 30
   SET FORMAT ...................................... 30
   SET GRID .......................................... 30
   SET INTENSITY ................................... 30
   SET LABELS ....................................... 30
   SET LIMITS ....................................... 30
   SET MODE ......................................... 30
   SET ORDER ........................................ 30
   SET OUTLINE ..................................... 30
   SET PATTERN ..................................... 30
   SET SCALE ........................................ 30
   SET SIZE .......................................... 30
   Device Size Parameters ....................... 30
   SET STORAGE ..................................... 30
   SET SYMBOL ...................................... 30
   SET TEXTURE ..................................... 30
   SET TICKS ........................................ 30
   SET TITLE ........................................ 30
   SET WINDOW ...................................... 30

6. USING TOP DRAWER AS A STAND-ALONE PROGRAM ........ 47
   Limitations ...................................... 47

Appendix

A. THE UNIFIED GRAPHICS CHARACTER SET ............... 48

INDEX .................................................. 54

- iii -
Chapter 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 similar 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.


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. Independant 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"\(^2\), 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.

\(^2\) 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.

Third, when "device-generated" characters (see below) are used, the character spacing may be somewhat different from the given value, but not different enough to require "vector" characters.
1.6.2 Device-Generated and Vector Characters

Some graphic devices, such as the interactive terminals, can make a single character as a unit, rather than drawing each character as a sequence of lines. Characters produced by the graphic device as a single unit are known in this writeup as "device-generated" characters, and are made by the device's "character generator". Characters which are drawn as a sequence of lines (or "vectors"), each individually calculated in the main computer program rather than in the graphic device, are called "vector" characters.

Device-generated characters are better for some applications than vector characters, because they take much less time to draw. In order to allow device-generated characters on a device which supports them, but to produce the text in any case, the following convention is used: if the size specified for a title or label is negative, and if the device in use has a character generator which can match the given angle and magnitude of the size reasonably closely, then the character generator is used. Otherwise, vector characters will be drawn. Thus, under default conditions, SET TITLE SIZE -2 will allow the character generator on the Tektronix 4013 terminals, but SET TITLE SIZE 2 will require vector characters. The Gencom terminals use pica spacing, with ten characters to the inch, and the corresponding SIZE is -1.0.

Some character strings can be produced only by vector characters. Examples are mathematical formulae and Greek characters, which do not exist in the character generators of the graphic devices used by Top Drawer. An inelegant solution to this problem has been implemented: character strings which contain a CASE parameter are in all cases produced as vector characters.
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.

<table>
<thead>
<tr>
<th>Level</th>
<th>Command</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>SET ARROW</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>SIZE</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>FLARE</td>
<td>0 0.5</td>
</tr>
<tr>
<td>2</td>
<td>SET AXIS</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>SET BAR SIZE</td>
<td>0 0.1</td>
</tr>
<tr>
<td>2</td>
<td>SET BOX SIZE</td>
<td>1 1</td>
</tr>
<tr>
<td>1</td>
<td>SET CARD LENGTH</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>SET COLOR</td>
<td>Black</td>
</tr>
<tr>
<td>1</td>
<td>SET DEVICE</td>
<td>4013 Interactive</td>
</tr>
<tr>
<td>2</td>
<td>SET DIAMOND SIZE</td>
<td>1 1</td>
</tr>
<tr>
<td>2</td>
<td>SET ELLIPSE SIZE</td>
<td>1 1</td>
</tr>
<tr>
<td>1</td>
<td>SET FILE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INPUT</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>OUTPUT</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>SET FONT</td>
<td>Extended</td>
</tr>
<tr>
<td>1</td>
<td>SET FORMAT</td>
<td>(80A1)</td>
</tr>
<tr>
<td>4</td>
<td>SET GRID</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>SET INTENSITY</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>SET LABEL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LEFT, BOTTOM</td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td>TOP, RIGHT</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>SET LIMITS</td>
<td>Depend on data</td>
</tr>
<tr>
<td>1</td>
<td>SET MODE</td>
<td>Novector, Echo 20, Nodebug</td>
</tr>
<tr>
<td>2</td>
<td>SET ORDER</td>
<td>X Y DX DY SYMBOL</td>
</tr>
<tr>
<td>2</td>
<td>SET OUTLINE</td>
<td>ON</td>
</tr>
<tr>
<td>3</td>
<td>SET SCALE</td>
<td>Linear 6 -5 Base 10</td>
</tr>
<tr>
<td>1</td>
<td>SET SIZE</td>
<td>13 BY 10 UNITS 1</td>
</tr>
<tr>
<td></td>
<td>REDUCE</td>
<td>Depends on Device</td>
</tr>
<tr>
<td>2</td>
<td>SET SYMBOL</td>
<td>Blank (plotted as dots)</td>
</tr>
<tr>
<td>2</td>
<td>SET TEXTURE</td>
<td>Solid</td>
</tr>
<tr>
<td>2</td>
<td>SET TICKS</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>SET TITLE SIZE</td>
<td>-2</td>
</tr>
<tr>
<td>2</td>
<td>SET WINDOW</td>
<td>In 20% from screen edge on bottom and left, 10% on top and right.</td>
</tr>
</tbody>
</table>
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.
List of Action Commands

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

BARGRAF [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

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 PLOT-ed before going on.

With the U.G. graphics package, OS/370, and some graphic devices, e.g. 4013 and GENCOM, output is a PDS, and each member is one plot. In this case, member names are PICT001, PICT002, etc., but they may be given an alias. The given alias names the following plot, not the previous one.

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 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 aesthetic 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.

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 preceding 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. 170) and briefly listed in Appendix A.

For example,

TITLE BOTTOM 'EOIPl--l'
CASE 'LCLGC'

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 OC and lC 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.
Chapter 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 OP
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 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

3.4.1 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.

3.5 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
```
Chapter 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.

PAUSE is a debugging aid for interactive Top Drawer

RETURN [n]
returns to calling program
(see 'Calling from Fortran')

TIME prints information about computing time.

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.
Chapter 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]
[PDS | 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 '80Al').

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 MODE [VECTOR|NOVECTOR] [ECHO [n]|NOECHO]  
  [TRACE|NOTRACE]  
  sets misc. flags.

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 SCALE {X|Y} [n1 [n2]] [BASE n]  
  [LINEAR|LOGARITHMIC|MOMMENTS|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 bookkeeping 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**

```plaintext
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**

```plaintext
SET BOX [SIZE dx [dy]]
```

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

5.5 **SET CARD**

```plaintext
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**

```plaintext
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|GLUE|YELLOW|MAGENTA|CYAN|BLACK]

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

Presently the only device known to Top Drawer which can do colors is the IBM 3179 Color Graphics Terminal.

Example:

SET COLOR RED

---

5.8 SET DEVICE

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

<table>
<thead>
<tr>
<th>keyword</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM 3179</td>
<td>IBM 3179 Color Graphics Terminal</td>
</tr>
<tr>
<td>IMAGEN</td>
<td>Any of the Imagen 240 printers.</td>
</tr>
<tr>
<td>IMPRT10</td>
<td>Same as IMAGEN</td>
</tr>
<tr>
<td>IMGN240</td>
<td>Same as IMAGEN</td>
</tr>
<tr>
<td>IMGN300</td>
<td>Any of the Imagen 300 printers.</td>
</tr>
<tr>
<td>TEKTRONIX</td>
<td>Tektronix 401x graphics terminal</td>
</tr>
<tr>
<td>4013</td>
<td>Same as TEKTRONIX</td>
</tr>
<tr>
<td>V1100</td>
<td>Versatec Plotter Model 1100</td>
</tr>
<tr>
<td>VERSATEC</td>
<td>SLAC On-Line Versatec Plotter</td>
</tr>
</tbody>
</table>

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. 170) 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. The argument FULSCR is always placed at the beginning of the UGOPEN options list, regardless of the device or string.

SET DEVICE 4013 or GENCOM 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. This is mostly for fitting the shape of a rectangular device to a rectangular picture. For instance, fan-fold Versatec output is normally 10.5 inches wide and 7.88 inches high. SET DEVICE VERSATEC FANFOLD SIDEWAYS gives you output that is 7.88 inches wide and 10.5 inches high, which is much better put in an 8.5-by-11 publication. (Of course, you couldn't use all the page unless you SET SIZE 7.88 by 10.5.)

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. (The VGT is an example.)

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' is a number from 1 to 4. 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 MODE

SET MODE [VECTOR|NOVECTOR] [ECHO [n]|NOECHO]

VECTOR requires vector characters in all text, even if the current device has a character generator. NOVECTOR nullifies a previous VECTOR command.

ECHO n sets the number of data point cards in each block which will be listed in the printed output. (There is no way to suppress the printing of control cards.) ECHO is equivalent to ECHO 10000. NOECHO is equivalent to ECHO 0. The starting value is 20.

Examples:

SET MODE NOECHO (Don't list input data points.)
SET MODE ECHO 100 (List only the first 100 points.)

5.19 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"

5.20 **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
```
5.21 SET PATTERN

SET PATTERN pl sl 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

5.22 SET SCALE

SET SCALE {X|Y} [n1 [n2]] [BASE n] [LINEAR|LOGARITHMIC|MOMTHS|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.
(To choose the linear axis markings, Top Drawer lays out an axis with $nl$ intervals of size $BASE \times ROUND \times POWER$, 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 $|nl|+1$ intervals are used.)

Logarithmic:

Each decade is labelled the same. $nl$ controls the labels. If $nl$ is positive, standard notation, e.g. '10000', is used for the labels. If $nl$ 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 $nl$ and $n2$ make bit patterns which specify the positions of intermediate ticks and labels, according to the following scheme:

<table>
<thead>
<tr>
<th>value</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No intermediate labels ($nl$) or ticks ($n2$)</td>
</tr>
<tr>
<td>2</td>
<td>Label or tick at all positions, 2 thru 9</td>
</tr>
<tr>
<td>$2^n$</td>
<td>Label or tick at the $n$-th position</td>
</tr>
</tbody>
</table>

(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 $36 = 2 + 2$.)

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 nl parameter, as usual, controls the labels, which are put at month 1 (January) and every \(|nl|\) months thereafter. \(nl > 0\) signifies that the labels are to have three letters each (Jan Feb Mar etc.) and \(nl < 0\) 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
```
5.23 **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 13 BY 10 REDUCE 2** will reduce a plot to half-size, whereas **SET SIZE 13 BY 10 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. For size **13** by **10** and **UNITS=1.0**, 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 30 BY 30 (Large CalComp Plotter)
SET SIZE 13 BY 10 REDUCE 2 (Everything half-size.)
SET SIZE 33 BY 25 UNITS 2.54 (Measure in centimeters.)
5.23.1 Device Size Parameters

<table>
<thead>
<tr>
<th>Device</th>
<th>Maximum Size (inches)</th>
<th>Minimum REDUCE</th>
<th>Default REDUCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small CalComp</td>
<td>--- by 10</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Large CalComp</td>
<td>--- by 33</td>
<td>0.30</td>
<td>1.00</td>
</tr>
<tr>
<td>Fan-fold Versatec</td>
<td>10.5 by 7.88</td>
<td>1.27</td>
<td>1.27</td>
</tr>
<tr>
<td>Continuous Vers.</td>
<td>--- by 10.0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Gencom terminal</td>
<td>13.1 by 10.0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>4013 terminal</td>
<td>8.0 by 6.1</td>
<td>1.65</td>
<td>1.65</td>
</tr>
<tr>
<td>Fiche, film</td>
<td>12.6 by 10.4</td>
<td>1.03</td>
<td>1.03</td>
</tr>
<tr>
<td>V1100</td>
<td>10.2 by ---</td>
<td>1.27</td>
<td>1.27</td>
</tr>
</tbody>
</table>

5.24 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.)

5.25 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 "0") 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)

5.26 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
```

5.27 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.)
```

5.28 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
```
5.29 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 nl-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 nl 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.)
Chapter 6
USING TOP DRAWER AS A STAND-ALONE PROGRAM

This is the easiest way to use Top Drawer. Input can be prepared with any text editor, or with a program written in your own favorite language. A set of cards or a sequential file of card images is used as the interface between your program and Top Drawer.

6.1 LIMITATIONS

The Top Drawer input language has evolved according to the idea that Top Drawer should do what you expect it to. This ideal is not always possible to realize, and some of the exceptions are described in this section.

- No more than 1024 points may be entered at one time. Blocks of this size or less must be separated by a PLOT, PLOT AXES, HIST, or JOIN command. (This limit is imposed by a dimension statement in the Top Drawer data array definitions. The data arrays in a Fortran program which calls Top Drawer may be of any length.)

- The limits for a plot must be set at the first PLOT, HIST, or JOIN command. This means that if two or more separate sets of points are being JOINed, the automatic limit setter will look at the first set, and Top Drawer will make the axes before the second set is read in. In this case, to make sure the limits are big enough for both sets, an explicit SET LIMITS command must be used.
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.

### Alphabetic First Character

| Second Character | 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 |
| 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                | A | B | X | A | E | Æ | φ | Γ | Ψ | I | K | L | M | N | O | P | Θ | Π | Ρ | Σ | Τ | 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 | η | ζ |
| K                | π | ρ | μ | ν | ξ | ζ |
| M                | %= | [ | = | ° | ] | > | ≥ | f | § | < | ≤ | ≠ | ∈ | α | ~ | ⊥ | x | ð | V |
| P                | † | ‡ | † | ‡ | § | " | ? |
| S                | @ | ⟨ | ® | ¢ | $ | } | _ | − | # | | ~ | |
| T                | ∀ | ∃ | 3 | 2 | 0 | n | ≤ | c | ∈ | ∈ | | |
| W                | ← | ↓ | → | ← | ← | → | ↑ |
| D                | |

### Non-Alphabetic First Character

| Second Character | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | + | − | * | / | = | . | ( |
| 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 13 BY 10 REDUCE 2
SET FONT DUPLEX
SET TITLE SIZE 2.4
TITLE 'UC Roman ABCDEFGHIJKLMNOP'!
MORE 'QRSTUVWXYZ'
TITLE 'LC Roman ABCDEFGHIJKLMNOP'
CASE 'LLLLLLLLLLLLLLLLL'
MORE 'QRSTUVWXYZ'
CASE 'LLLLLLLLLLLL'
TITLE 'Keyboard CT. ( | & ! $ * ); - / , % _'
CASE 'SS'
TITLE 'Keyboard U . # @ " - 0 1 2 3 4 5 6 7 8 9'
CASE 'PP'
TITLE 'UC Greek ABCDEFGHIJKLMNOP'
MORE 'QRSTUVWXYZ'
CASE 'FFFFFFFFFFFFF'
TITLE 'LC Greek ABCDEFGHIJKLMNOP'
MORE 'QRSTUVWXYZ'
CASE 'GGGGGGGGGGGGGGG'
TITLE 'Math Sym ABCDEFGHIJKLMNOPQRSTUVWXYZ'
CASE 'MMMMMMMMMMMMMMMMMMMMMMMMM'
TITLE 'More Math 02+-*/=.()AEFGIKLMNU'
CASE 'MMMMMMMMMMMMMMMMTTTTTTTTTTTTTTTTTTTTTTT'
TITLE 'Plot Sym 0123456789'
CASE '000000000000'
TITLE 'Special IUDLRBPFBEB( )LRPHLDUO/
CASE 'PWWWWWDPSSSSSSSPKMKDDS'
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 $ \cdot ( \; | \; & \; ! \; \$ \; \* \; ) \; \; ' \; " \; - \; / \; , \; \% \; _$
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 Ζ 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 ξ
Math Sym ≈ [ ≈ ° ] > ≥ ≤ < ≠ θ α ∼ ∩ × ∩ \nMore Math ∞ √ ± + ÷ ≡ \ A B C \ C C \ C E \ E \ U
Plot Sym + × © □ + × + × + 0
Special ? ↑ ↓ ← → ← ≡ ‹ † ( ) [ ] {} § η ξ ° _ ─ \\n
- 50 -
<table>
<thead>
<tr>
<th>Char</th>
<th>Character Pair</th>
<th>Description</th>
<th>Char</th>
<th>Character Pair</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>U.C. A</td>
<td></td>
<td>AL</td>
<td>L.C. A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>U.C. B</td>
<td></td>
<td>BL</td>
<td>L.C. B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>U.C. C</td>
<td></td>
<td>CL</td>
<td>L.C. C</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>U.C. D</td>
<td></td>
<td>DL</td>
<td>L.C. D</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>U.C. E</td>
<td></td>
<td>EL</td>
<td>L.C. E</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>U.C. F</td>
<td></td>
<td>FL</td>
<td>L.C. F</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>U.C. G</td>
<td></td>
<td>GL</td>
<td>L.C. G</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>U.C. H</td>
<td></td>
<td>HL</td>
<td>L.C. H</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>U.C. I</td>
<td></td>
<td>IL</td>
<td>L.C. I</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>U.C. J</td>
<td></td>
<td>JL</td>
<td>L.C. J</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>U.C. K</td>
<td></td>
<td>KL</td>
<td>L.C. K</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>U.C. L</td>
<td></td>
<td>LL</td>
<td>L.C. L</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>U.C. M</td>
<td></td>
<td>ML</td>
<td>L.C. M</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>U.C. N</td>
<td></td>
<td>NL</td>
<td>L.C. N</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>U.C. O</td>
<td></td>
<td>OL</td>
<td>L.C. O</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>U.C. P</td>
<td></td>
<td>PL</td>
<td>L.C. P</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>U.C. Q</td>
<td></td>
<td>QL</td>
<td>L.C. Q</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>U.C. R</td>
<td></td>
<td>RL</td>
<td>L.C. R</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>U.C. S</td>
<td></td>
<td>SL</td>
<td>L.C. S</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>U.C. T</td>
<td></td>
<td>TL</td>
<td>L.C. T</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>U.C. U</td>
<td></td>
<td>UL</td>
<td>L.C. U</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>U.C. V</td>
<td></td>
<td>VL</td>
<td>L.C. V</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>U.C. W</td>
<td></td>
<td>WL</td>
<td>L.C. W</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>U.C. X</td>
<td></td>
<td>XL</td>
<td>L.C. X</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>U.C. Y</td>
<td></td>
<td>YL</td>
<td>L.C. Y</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>U.C. Z</td>
<td></td>
<td>ZL</td>
<td>L.C. Z</td>
<td></td>
</tr>
</tbody>
</table>

Other Keyboard Characters

<table>
<thead>
<tr>
<th>Char</th>
<th>Description</th>
<th>Numeral</th>
</tr>
</thead>
<tbody>
<tr>
<td>~</td>
<td>Blank</td>
<td>0</td>
</tr>
<tr>
<td>^</td>
<td>Greater Than</td>
<td>&gt;</td>
</tr>
<tr>
<td></td>
<td>Cent Sign</td>
<td>?</td>
</tr>
<tr>
<td>.</td>
<td>Question Mark</td>
<td>:</td>
</tr>
<tr>
<td>&lt;</td>
<td>Period</td>
<td>;</td>
</tr>
<tr>
<td>(</td>
<td>Less Than</td>
<td>#</td>
</tr>
<tr>
<td>)</td>
<td>@</td>
<td>@</td>
</tr>
<tr>
<td>+</td>
<td>Plus Sign</td>
<td>&amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Line</td>
</tr>
<tr>
<td>&amp;</td>
<td>Ampersand</td>
<td>&quot;</td>
</tr>
<tr>
<td>!</td>
<td>Exclamation Mark</td>
<td>!</td>
</tr>
<tr>
<td>$</td>
<td>Dollar Sign</td>
<td>$</td>
</tr>
<tr>
<td>*</td>
<td>Asterisk</td>
<td>*</td>
</tr>
<tr>
<td>)</td>
<td>Right Parenthesis</td>
<td>)</td>
</tr>
<tr>
<td>;</td>
<td>Semi-Colon</td>
<td>;</td>
</tr>
<tr>
<td>+</td>
<td>Not</td>
<td>+</td>
</tr>
<tr>
<td>-</td>
<td>Minus Sign</td>
<td>-</td>
</tr>
<tr>
<td>/</td>
<td>Slash Mark</td>
<td>/</td>
</tr>
<tr>
<td>,</td>
<td>Comma</td>
<td>,</td>
</tr>
<tr>
<td>%</td>
<td>Percent</td>
<td>%</td>
</tr>
<tr>
<td>_</td>
<td>Underline</td>
<td>_</td>
</tr>
<tr>
<td></td>
<td>Numeral 0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Numeral 1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Numeral 2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Numeral 3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Numeral 4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Numeral 5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Numeral 6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Numeral 7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Numeral 8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Numeral 9</td>
<td>9</td>
</tr>
<tr>
<td>Char Pair</td>
<td>Character Description</td>
<td>Char Pair</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Upper Case Greek</td>
<td></td>
<td>Lower Case Greek</td>
</tr>
<tr>
<td>AH</td>
<td>U.C. Alpha</td>
<td>AF</td>
</tr>
<tr>
<td>BH</td>
<td>U.C. Beta</td>
<td>BF</td>
</tr>
<tr>
<td>CH</td>
<td>U.C. Chi</td>
<td>CF</td>
</tr>
<tr>
<td>DH</td>
<td>U.C. Delta</td>
<td>DF</td>
</tr>
<tr>
<td>EH</td>
<td>U.C. Epsilon</td>
<td>EF</td>
</tr>
<tr>
<td>FH</td>
<td>U.C. Phi</td>
<td>FF</td>
</tr>
<tr>
<td>GH</td>
<td>U.C. Gamma</td>
<td>GF</td>
</tr>
<tr>
<td>HH</td>
<td>U.C. Eta</td>
<td>HF</td>
</tr>
<tr>
<td>IH</td>
<td>U.C. Iota</td>
<td>IF</td>
</tr>
<tr>
<td>KH</td>
<td>U.C. Kappa</td>
<td>KF</td>
</tr>
<tr>
<td>LH</td>
<td>U.C. Lambda</td>
<td>LF</td>
</tr>
<tr>
<td>MH</td>
<td>U.C. Mu</td>
<td>MF</td>
</tr>
<tr>
<td>NH</td>
<td>U.C. Nu</td>
<td>NF</td>
</tr>
<tr>
<td>OH</td>
<td>U.C. Omicron</td>
<td>OF</td>
</tr>
<tr>
<td>PH</td>
<td>U.C. Pi</td>
<td>PF</td>
</tr>
<tr>
<td>QH</td>
<td>U.C. Theta</td>
<td>QF</td>
</tr>
<tr>
<td>RH</td>
<td>U.C. Rho</td>
<td>RF</td>
</tr>
<tr>
<td>SH</td>
<td>U.C. Sigma</td>
<td>SF</td>
</tr>
<tr>
<td>TH</td>
<td>U.C. Tau</td>
<td>TF</td>
</tr>
<tr>
<td>UH</td>
<td>U.C. Upsilon</td>
<td>UF</td>
</tr>
<tr>
<td>WH</td>
<td>U.C. Omega</td>
<td>WF</td>
</tr>
<tr>
<td>XH</td>
<td>U.C. Xi</td>
<td>XF</td>
</tr>
<tr>
<td>YH</td>
<td>U.C. Psi</td>
<td>YF</td>
</tr>
<tr>
<td>ZH</td>
<td>U.C. Zeta</td>
<td>ZF</td>
</tr>
<tr>
<td>Subscripts and Superscripts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0X</td>
<td>Enter Subscr Mode</td>
<td>U</td>
</tr>
<tr>
<td>1X</td>
<td>Leave Subscr Mode</td>
<td>0U</td>
</tr>
<tr>
<td>2X</td>
<td>Enter Superscr Mode</td>
<td>1U</td>
</tr>
<tr>
<td>3X</td>
<td>Leave Superscr Mode</td>
<td>2U</td>
</tr>
<tr>
<td>Size Changes</td>
<td></td>
<td>3U</td>
</tr>
<tr>
<td>0Y</td>
<td>Increase Size</td>
<td>4U</td>
</tr>
<tr>
<td>1Y</td>
<td>Decrease Size</td>
<td>5U</td>
</tr>
<tr>
<td>2Y</td>
<td></td>
<td>6U</td>
</tr>
<tr>
<td>Position Save/Restore</td>
<td></td>
<td>1V</td>
</tr>
<tr>
<td>0Z</td>
<td>Save Position-1</td>
<td>2V</td>
</tr>
<tr>
<td>1Z</td>
<td>Restore Pos-1</td>
<td>3V</td>
</tr>
<tr>
<td>2Z</td>
<td>Save Position-2</td>
<td>4V</td>
</tr>
<tr>
<td>3Z</td>
<td>Restore Pos-2</td>
<td>5V</td>
</tr>
<tr>
<td>4Z</td>
<td>Save Position-3</td>
<td>6V</td>
</tr>
<tr>
<td>5Z</td>
<td>Restore Pos-3</td>
<td></td>
</tr>
<tr>
<td>Char Pair</td>
<td>Character Description</td>
<td>Char Pair</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>IM</td>
<td>Integral Sign</td>
<td>00</td>
</tr>
<tr>
<td>XM</td>
<td>Times Sign</td>
<td>10</td>
</tr>
<tr>
<td>:M</td>
<td>Division Sign</td>
<td>20</td>
</tr>
<tr>
<td>EM</td>
<td>Approximately Equal</td>
<td>30</td>
</tr>
<tr>
<td>PM</td>
<td>Partial Derivative</td>
<td>40</td>
</tr>
<tr>
<td>DM</td>
<td>Del</td>
<td>50</td>
</tr>
<tr>
<td>JM</td>
<td>Line Integral</td>
<td>60</td>
</tr>
<tr>
<td>+M</td>
<td>Group Plus</td>
<td>70</td>
</tr>
<tr>
<td>*M</td>
<td>Group Multiply</td>
<td>80</td>
</tr>
<tr>
<td>QM</td>
<td>Proportional to</td>
<td>90</td>
</tr>
<tr>
<td>SM</td>
<td>Plus or Minus</td>
<td></td>
</tr>
<tr>
<td>2M</td>
<td>Square Root</td>
<td></td>
</tr>
<tr>
<td>&lt;M</td>
<td>Less or Equal</td>
<td></td>
</tr>
<tr>
<td>&gt;M</td>
<td>Greater or Equal</td>
<td></td>
</tr>
<tr>
<td>=M</td>
<td>Not Equal</td>
<td></td>
</tr>
<tr>
<td>0M</td>
<td>Infinity</td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>Membership Symbol</td>
<td></td>
</tr>
<tr>
<td>NT</td>
<td>Membership Negation</td>
<td></td>
</tr>
<tr>
<td>ET</td>
<td>Existential Quant.</td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>Intersection</td>
<td></td>
</tr>
<tr>
<td>AT</td>
<td>Universal Quant.</td>
<td></td>
</tr>
<tr>
<td>UT</td>
<td>Union</td>
<td></td>
</tr>
<tr>
<td>&lt;T</td>
<td>Contained in</td>
<td></td>
</tr>
<tr>
<td>&gt;T</td>
<td>Contains</td>
<td></td>
</tr>
<tr>
<td>LT</td>
<td>Contained in/Equal</td>
<td></td>
</tr>
<tr>
<td>RT</td>
<td>Contains/Equal</td>
<td></td>
</tr>
<tr>
<td>IP</td>
<td>Interbang</td>
<td></td>
</tr>
<tr>
<td>UW</td>
<td>Up Arrow</td>
<td></td>
</tr>
<tr>
<td>DW</td>
<td>Down Arrow</td>
<td></td>
</tr>
<tr>
<td>LW</td>
<td>Left Arrow</td>
<td></td>
</tr>
<tr>
<td>RW</td>
<td>Right Arrow</td>
<td></td>
</tr>
<tr>
<td>BW</td>
<td>Left/Right Arrow</td>
<td></td>
</tr>
<tr>
<td>DP</td>
<td>Dagger</td>
<td></td>
</tr>
<tr>
<td>FP</td>
<td>Double Dagger</td>
<td></td>
</tr>
<tr>
<td>BS</td>
<td>Left Angle Bracket</td>
<td></td>
</tr>
<tr>
<td>ES</td>
<td>Right Angle Bracket</td>
<td></td>
</tr>
<tr>
<td>(S</td>
<td>Left Bracket</td>
<td></td>
</tr>
<tr>
<td>)S</td>
<td>Right Bracket</td>
<td></td>
</tr>
<tr>
<td>LS</td>
<td>Left Brace</td>
<td></td>
</tr>
<tr>
<td>RS</td>
<td>Right Brace</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>New Paragraph</td>
<td></td>
</tr>
<tr>
<td>HK</td>
<td>H-Bar</td>
<td></td>
</tr>
<tr>
<td>LK</td>
<td>Lambda-Bar</td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>Degrees</td>
<td></td>
</tr>
<tr>
<td>UD</td>
<td>Underscore</td>
<td></td>
</tr>
<tr>
<td>OD</td>
<td>Overscore</td>
<td></td>
</tr>
<tr>
<td>/</td>
<td>Backwards Slash</td>
<td></td>
</tr>
</tbody>
</table>
INDEX

abbreviation ... 3
ACTION
  commands ... 11
Akima, Hiroshi ... 17
algorithm ... 17
ALIAS ... 12, 17
ALL ... 27-29, 36, 38
ANGLE ... 12, 18-19, 41
APL ... 1
apostrophes ... 18
arithmetic ... 1
ARROW ... 10, 12-13
AXIS ... 10
  labels ... 28
BAR
  SIZE ... 10
BARGRAPH ... 11-13
BASE ... 28, 39-41
BASIC ... 27, 33
Beach, Robert ... 2
BIN ... 11, 21, 26
BINS ... 21, 23
BOTTOM ... 6, 12, 18, 27-29,
  36, 38, 45
BOX ... 12
  SIZE ... 10
Braces ... 11
Brackets ... 11
brightness ... 35

calendar ... 7, 40-41
card
  LENGTH ... 10
cards ... 47
CASE ... 8, 12, 18, 48-49
center ... 12, 18-19
centimeters ... 42
character
  generator ... 8
    set ... 7, 33, 47
    spacing ... 7, 19
CIRCLE ... 12, 14, 33
clear
  screen ... 9
COLOR ... 10
columns ... 30
comments ... 3
conflicting
  keywords ... 3
CONTINUOUS ... 27, 31
control
  commands ... 25
cordinate
  system ... 6
cordinate system ... 6
CRT ... 2
cusps ... 17
DASHES ... 12-13, 15-16, 28,
  44
data ... 6-7, 16, 18-19
  Commands ... 20
  coordinate
    system ... 13-15
    fitting ... 1
    points ... 21
DATA system ... see
"coordinate system"
DDNAME ... 27, 31
decade ... 40
device-generated
  characters ... 7-8
DIAMOND ... 10, 12, 14
dimension ... 47
discontinuity ... 17
DOTDASH ... 12-13, 15-16,
  28, 44
DOTS ... 12-13, 15-16, 28,
  44
DUMMY ... 28, 37
DUMP ... 25
DUPLEX ... 7, 27, 33
DX ... 21, 23
DY ... 21, 23
e to the i pi ... 20
ECHO ... 28, 37

- 54 -
Electrostatic  
Plotter ... See Versatec  
ELLIPSE ... 10, 12, 15, 33  
END ... 25  
English ... 2  
Error  
   bars ... 16-17, 21  
exponential ... 40  
   notation ... 3  
EXTENDED ... 27, 33  
EXTERNAL ... 27, 31  
FANFOLD ... 27, 31  
fatness ... 13  
Field  
   separators ... 3  
FILE ... 33  
FLAGS ... 25, 28  
FLAIR ... See Flare  
FLARE ... 10, 12-13, 29  
FONT ... 9-10  
FORMAT ... 10  
Fortran ... 25, 47  
   unit ... 33  
FULSCR ... 31  
function  
   evaluation ... 1  
FUNNY ... 12, 16  
gencom ... 17  
GENERAL ... 12, 16  
Greek ... 8, 20, 48-49  
GRID ... 10  
HISTOGRAM ... 11-12, 15, 22  
HORIZONTAL ... 27, 34  
IBM  
   3179 ... 31  
Imagen ... 2, 31  
inches ... 7, 42, 45-46  
INDEX ... 12, 18-19  
input  
   format ... 3  
INTENSITY ... 10  
interactive ... 25, 27, 31  
   terminals ... 8  
interface ... 47  
INTERNAL ... 27, 31  
interpretation of  
   input ... 28  
isosceles  
triangle ... 13  
JOIN ... 11-12, 16  
Julian ... 41  
Keyboard ... 49  
labels ... 28-29, 39  
language ... 47  
Lawton, Anthony ... 17  
LEFT ... 6, 12, 18, 27-29, 36, 38, 45  
legal  
   input ... 3  
LESS ... 12-13  
level ... 16, 22  
limitations ... 47  
limits ... 17, 47  
line  
   segments ... 16  
   texture ... 28  
   width ... 35  
linear ... 7, 22, 28, 39  
LIST ... 25-26  
logarithmic ... 7, 28, 39-40  
Lower  
   case ... 11, 20, 48  
math symbol ... 49  
MODE ... 9  
months ... 28, 39-40  
MORE ... 12, 18  
multiple  
   commands ... 3  
NASA ... 34  
NEW  
   FRAME ... 7, 9, 11-12, 17, 46  
NODEBUG ... 28  
NOECHO ... 28, 37  
non-decimal ... 41  
normal ... 28, 39  
   distribution ... 22  
NOTRACE ... 28  
NOVECTOR ... 28, 37  
numeric  
   labels ... 36  
OFF ... 28, 46  
OFF ... 27-29  
ON ... 27-29, 34  
ORDER ... 10  
OUTLINE ... 10, 28-29
Output ... 2

pair ... 37
dpaper clip ... 4

PATTERN ... 12-13, 15-16,
28, 39, 44

PAUSE ... 25

PDS ... 17, 27, 31

permanence ... 9

pica ... 8

PLOT ... 11-12, 17

AXES ... 12, 18

ccharacter ... 28

symbols ... 44

plot symbol ... 49

plotter ... See Versatec,
Tektronix, etc.

point buffer ... 43, 47

POINTS ... 12, 23

POWER ... 40

probability ... See "normal"
publication ... 33

quotes ... 19

random

access ... 4

RBC ... 17

rectangle ... 14

REDUCE ... 10, 28, 42-43

treduction ... 7

RETURN ... 25

REXX ... 2

RIGHT ... 6, 12, 18, 27-29,
36, 38, 45

Roman ... 20, 48-49

ROUND ... 40
	nround numbers ... 39

scaling ... 28, 39

function ... 40

semi-axis ... 30, 33

semicolon ... 3

separator ... 21

SEQUENTIAL ... 27, 31-32

SET

ARROW ... 13, 27-28

AXES ... 29

AXIS ... 27, 29

BAR ... 27, 29

BOX ... 27, 30

CARD ... 27, 30

CIRCLE ... 27, 30

COLOR ... 27, 30

Commands ... 26

DEVICE ... 2, 6-7, 9, 27,
31

DIAMOND ... 15, 27, 32

ELLIPSE ... 15, 27, 32

FONT ... 27, 33

FORMAT ... 27, 34

GRID ... 9, 27, 34

INTENSITY ... 27, 35

LABELS ... 27, 29, 35

LIMITS ... 7, 19, 28, 36,
46-47

MODE ... 28, 36-37

ORDER ... 21, 28, 37, 43

OUTLINE ... 28-29, 38

SCALE ... 7, 22, 28, 39

SIZE ... 6, 28, 41, 46

STORAGE ... 43

SYMBOL ... 28, 43

TEXTURE ... 13, 15, 28,
44

TICKS ... 28-29, 45

TITLE ... 28, 45

SIZE ... 8

WINDOW ... 6-7, 9, 28, 45

sideways ... 27, 31-32

SIZE ... 10

SMOOTH ... 11, 21-22, 26

SOLID ... 12-13, 15-16, 28,
44

SPACES ... 12, 18-19

spacing between

characters ... 7

Speakeasy ... 1

SPLINE ... 12, 16

Stand-Alone Program ... 46

standard deviation ... 22

subscript ... 49

superscript ... 20, 48

SYMBOL ... 27-28, 34, 37

TDMAIN ... 27

Tektronix ... 2, 8, 17, 31
TEXT ... see also
"coordinate system", 6,
12, 16, 18
coordinate
system ... 13-15, 42
text-editing ... 2
texture ... 10, 16
tick
marks ... 28
ticks ... 10, 28-29, 39, 45
time ... 25, 41
Title ... 7, 11-12, 18-19,
48-49
size ... 10
top ... 6, 12, 18, 27-29,
36, 38, 45
trace ... 28
U.G. ... 2, 20, 27, 31, 37,
44, 48
ugopen ... 31
units ... 28, 42
upper
case ... 11, 48
user ... 28, 39
vector ... 28, 37
characters ... 7
versatec ... 2, 31, 35
vertical ... 27, 34
vgt ... 34
vm/cms ... 34
weight ... 22
window ... 6-7, 10
world system ... see
"coordinate system"
X ... 21, 23
XDATA ... 12, 18
Xedit ... 2
XMAX ... 28, 36
XMIN ... 28, 36
Y ... 21, 23
YDATA ... 12, 18
years ... 28, 39, 41
YMAX ... 28, 36
YMIN ... 28, 36
[ ... 11
40lx ... see Tektronix