TOP DRAWER

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CONTENTS

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 similiar device.   (See the
SET DEVICE command.)   The second type is the graphic out-
put--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[1] (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 Versa-
tec 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 key-
words 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 fo;e pf 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 com-
mand should be used as one of the first cards.

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

1.2   INPUT

Input for Top Drawer is a data file which is normally pre-
pared 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 key-
words, which are English or technical words, and values.
The command language is limited, and the syntax is not Eng-
lish, 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 charac-
ter.) Top Drawer reads commands from left to right, so
parameters follow the keyword they modify.   Independant key-
words 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 explic-
itly terminated.

A semicolon (;) ends the current command.   In this way, mul-
tiple 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.
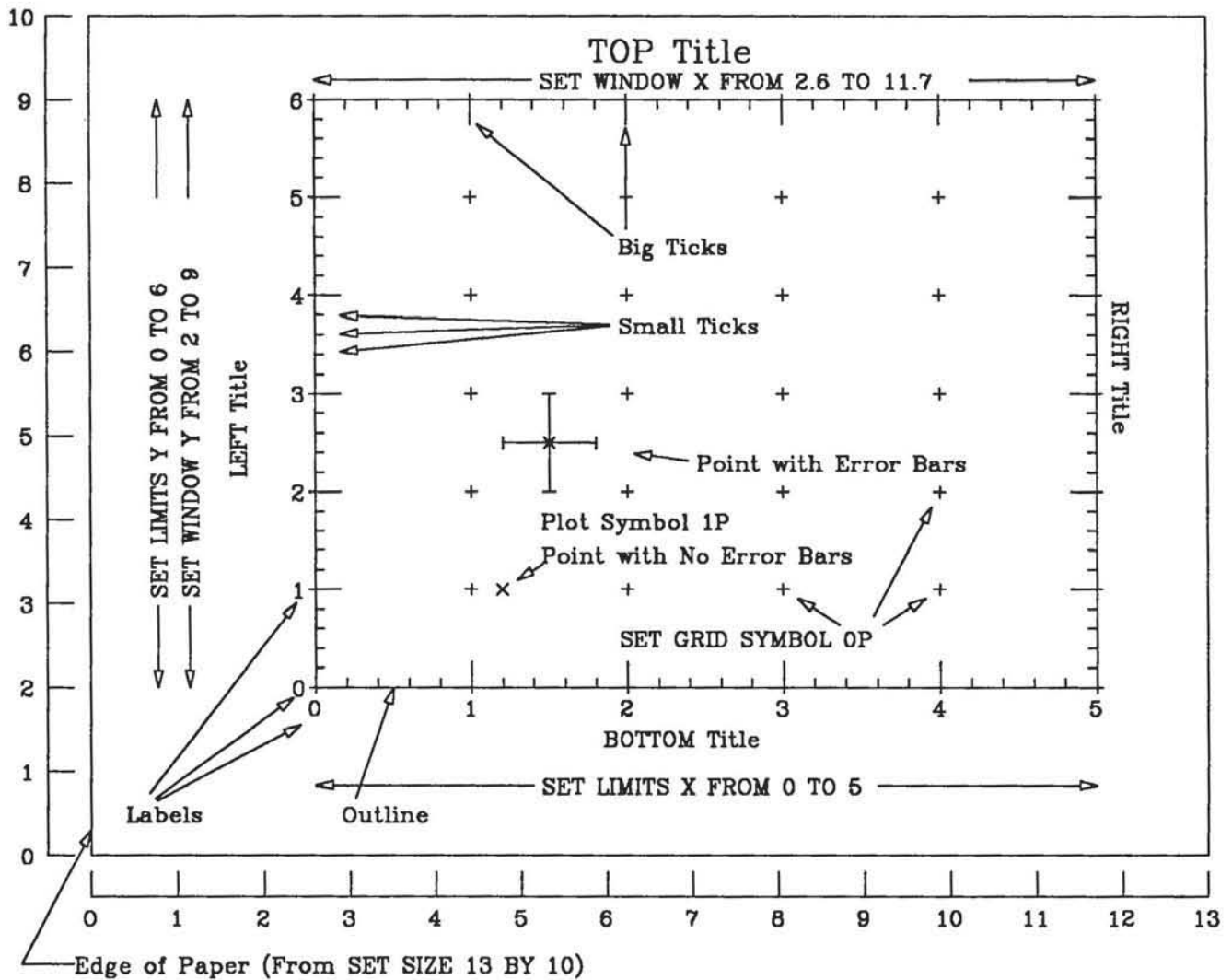
1.5 COORDINATE SYSTEMS

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 calen-
dar scales, and others could be defined by the user. Param-
eters 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 suffi-
cient, and the old system is retained.   The DATA system and
the window become undefined when the TEXT system is rede-
fined.

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 con-
vention used in Top Drawer is that character size is speci-
fied 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 par-
ticular 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 "vec-
tor" characters.

1.6.2   <u>Device-Generated</u> <u>and</u> <u>Vector</u> <u>Characters</u>

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 individu-
ally 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 speci-
fied 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 char-
acters.   Examples are mathematical formulae and Greek char-
acters,   which do   not exist in the   character generators of
the graphic devices used by Top Drawer.   An inelegant solu-
tion 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.

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

1.8   COMMANDS

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

DATA commands give points to be entered into Top Drawer
    storage, or they specify operations to be performed on
    the stored data.   The basic DATA command is the data
    point, which can give coordinate values, error-bar val-
    ues, 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 distribu-
    tion.

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 indi-
    cates 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] [{FLAIR|FLARE} fff]

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

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

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

PLOT [POINTS nl [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 speci-
fied at all, the values from the SET DIAMOND SIZE com-
mand 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. Other-
wise, 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 val-
ues 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 nl [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 speci-
    fied, Top Drawer chooses an appropriate value, depend-
    ing 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 condi-
    tions, 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 parame-
    ter 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 dis-
     continuities suggested by J.R. Manning (Computer Jour-
     nal 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-
     ted 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 sym-
     bols.   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 con-
    venience.   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 charac-
ter 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 esth-
etic 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 preceeding card.   Each
pair of characters, the first from the TITLE card and
the second from the CASE card, makes a character pair
which will be interpreted according to the U.G.
extended- character-set specifications, described in
the U.G. writeup (CGTM No.   170) and briefly listed in
Appendix A.

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 mod-
    ified 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 nl [TO] n2]

        {X|Y|DX|DY} [{BINS|POINTS}[nl [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

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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 nl [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 nl 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 repeat-
    edly transforms the points and the residuals, using
    running medians, running means, quadratic interpola-
    tion, 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] nl [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 com-
mon 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   <u>LIST</u>

    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 com-
    mand 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   COLOR
    [WHITE|RED|GREEN|BLUE|YELLOW|MAGENTA|CYAN|BLACK]

    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 '80A1').

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

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

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

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

SET 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 outine.

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

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

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

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

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

SET TITLE [SIZE n]      sets size for titles

SET WINDOW [X xxx [TO] xxx] [Y yyy [TO] yyy]
SET WINDOW [X nl OF n2] [Y nl 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 con-
    sists of the outline, ticks, and labels.   The axes
    are drawn at the first HIST, JOIN, PLOT, or PLOT AXES
    command, using the axis parameters in effect at the
    time.

OFF prevents drawing the outline, labels, and ticks.   ON
    allows all three: the outline, ticks and labels
    may or may not be drawn, depending on the SET
    OUTLINE, SET TICKS and SET LABELS commands. (The book-
    keeping for SET AXES and for these latter three
    commands is kept separately by Top Drawer.   Both the
    axis and the individual element must be ON for the ele-
    ment 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 con-
    venience.   They are equivalent.

Examples:

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

5.3   SET BAR

SET BAR [SIZE] xxx

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

Example:

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

5.4   SET BOX

SET BOX [SIZE dx [dy]]

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

5.5   SET CARD

SET CARD [LENGTH] length

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

Example:

SET CARD LENGTH 80 (Read 80 columns)

5.6   SET CIRCLE

SET CIRCLE [SIZE dx [dy]]

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

5.7   SET COLOR

SET   COLOR
[WHITE|RED|GREEN|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]

    keyword   Device

    IBM 3179   IBM 3179 Color Graphics Terminal
    IMAGEN   Any of the Imagen 240 printers.
    IMPRT10   Same as IMAGEN
    IMGN240   Same as IMAGEN
    IMGN300   Any of the Imagen 300 printers.
    TEKTRONIX   Tektronix 401x graphics terminal
    4013   Same as TEKTRONIX
    V1100   Versatec Plotter Model 1100
    VERSATEC   SLAC On-Line Versatec Plotter

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

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

If a 'string' is given, it is passed as the argument to
    subroutine UGOPEN, concatenated at the end of the
    argument options specified by the other keywords.
    See the U.G. writeup (CGTM No. 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 rec-
tangular 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 sup-
    ported 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 "Plot-
    ting 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 lim-
    its.   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 comand.

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 pre-
vious 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 posi-
tions.

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.

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extended-character- set pair, as for the SYMBOL com-
mand.

For instance,

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

is equivalent to

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

and to

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

and to

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

Note that the OO 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 'pat-
    terned' 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} [nl [n2]] [BASE n]
        [LINEAR|LOGARITHMIC|MONTHS|YEARS|USER n|
         NORMAL [MEAN x] [DEVIATION s]]

Scaling for each axis is independent. nl and n2 specify the
    type and spacing of labels and ticks. If nl 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 ($|nl|+1$) intervals (and $|nl|+2$ 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 nl gives big ticks at major intervals. Positive n2
    gives big ticks for subintervals. Negative gives
    small ticks. The default values are nl=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*ROUND*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 plot-
ted. 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 interme-
diate 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 pat-
terns which specify the positions of intermediate ticks
and labels, according to the following scheme:

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

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

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 there-
after. 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 meas-
     ures 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 meas-
     ured 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 spac-
     ing of 0.508 cm, which is the same as 0.2 inches.

If the UNITS parameter and the xxx by yyy size are kept con-
     stant,   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 dimen-
     sions, 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 mini-
     mum reduce value in any case can be calculated by know-
     ing 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

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

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 preceed 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   charac-
ter   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" "O" as in the letter
"O") for which the center of the symbol is plot-
ted at the specified point.   This is not true of many
other symbols, such as the period, which are not plot-
ted 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 gener-
    ation.

Example:

    SET TITLE SIZE 4.5

5.29   SET WINDOW

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

        SET WINDOW [X nl OF n2] [Y nl 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 writ-
    ten 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.

Second Character

Alphabetic First 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	Α	Β	Χ	Δ	Ε	Φ	Γ	Φ	I		K	Λ	M	N	O	Π	Θ	P	Σ	T	Υ		Ω	Ξ	Ψ	Z
G	α	β	χ	δ	ε	φ	γ	φ	ι		κ	λ	μ	ν	ο	π	θ	ρ	σ	τ	υ		ω	ξ	ψ	ζ
K								ħ					⅄													
M	≅	⌈	≃	°	⌉		>	≧	∫	∮		<	≦	≠		⊕		∝	~	⊥				×	∂	∇
P	'		†	!	‡		⟡								§	"			?							
S	@	⟨	¢	$	⟩						{	¬		#		}		^	_		∥	`				
T	∀			∃	⊇	⊃		∩			⊆	⊂	∈	∉					∪							
W		↔		↓								←						→		↑						
D												—						—								

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

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UC Roman A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

LC Roman a b c d e f g h i j k l m n o p q r s t u v w x y z

Keyboard ¢ ⌃ . (+ | & ! $ *) ; " – / , % _

Keyboard > ? : # @ ' = "   0 1 2 3 4 5 6 7 8 9

UC Greek Α Β Χ Δ Ε Φ Γ Η Ι Κ Λ Μ Ν Ο Π Θ Ρ Σ Τ Υ Ω Ξ Ψ Ζ

LC Greek α β χ δ ε φ γ η ι κ λ μ ν ο π θ ρ σ τ υ ω ξ ψ ζ

Math Sym ≅ ⌈ ≃ ° ⌉ > ≥ ∫ ∮ < ≤ ≠ ⊕ ∝ ∼ ⊥ × ∂ ∇

More Math ∞ √ ± ∓ ⊗ ÷ ≡ · ⌊ ⌋ ∀ ∃ ⊇ ⊃ ∩ ⊆ ⊂ ∈ ∉ ∪

Plot Sym + × ◇ □ ✦ ⋈ ⊞ ✗ ※ Ο

Special   ⇡ ↑ ↓ ← → ↔ ▤ ‡ 〈 〉 [ ] { } § ℏ λ ° _ ‾ \

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

Other Keyboard Characters

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

Char Pair	Character Description	Char Pair	Character Description
Upper Case Greek		**Lower Case Greek**	
AH	U.C. Alpha	AF	L.C. Alpha
BH	U.C. Beta	BF	L.C. Beta
CH	U.C. Chi	CF	L.C. Chi
DH	U.C. Delta	DF	L.C. Delta
EH	U.C. Epsilon	EF	L.C. Epsilon
FH	U.C. Phi	FF	L.C. Phi
GH	U.C. Gamma	GF	L.C. Gamma
HH	U.C. Eta	HF	L.C. Eta
IH	U.C. Iota	IF	L.C. Iota
KH	U.C. Kappa	KF	L.C. Kappa
LH	U.C. Lambda	LF	L.C. Lambda
MH	U.C. Mu	MF	L.C. Mu
NH	U.C. Nu	NF	L.C. Nu
OH	U.C. Omicron	OF	L.C. Omicron
PH	U.C. Pi	PF	L.C. Pi
QH	U.C. Theta	QF	L.C. Theta
RH	U.C. Rho	RF	L.C. Rho
SH	U.C. Sigma	SF	L.C. Sigma
TH	U.C. Tau	TF	L.C. Tau
UH	U.C. Upsilon	UF	L.C. Upsilon
WH	U.C. Omega	WF	L.C. Omega
XH	U.C. Xi	XF	L.C. Xi
YH	U.C. Psi	YF	L.C. Psi
ZH	U.C. Zeta	ZF	L.C. Zeta

Subscripts and Superscripts

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

Size Changes

0Y	Increase Size
1Y	Decrease Size

Position Save/Restore

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

Blanks of Various Widths

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

Char Pair	Character Description	Char Pair	Character Description

Mathematical Symbols

		Plot Symbols	
IM	Integral Sign	OO	Plot Sym V Cross
XM	Times Sign	1O	Plot Sym D Cross
:M	Division Sign	2O	Plot Sym Diamond
EM	Approximately Equal	3O	Plot Sym Square
PM	Partial Derivative	4O	Plot Sym F Diamond
DM	Del	5O	Plot Sym F Square
JM	Line Integral	6O	Plot Sym F V Cross
+M	Group Plus	7O	Plot Sym F D Cross
*M	Group Multiply	8O	Plot Sym Star
QM	Proportional to	9O	Plot Sym Octagon
SM	Plus or Minus		
2M	Square Root		Other Special Symbols
<M	Less or Equal		
>M	Greater or Equal	IP	Interbang
=M	Not Equal	UW	Up Arrow
OM	Infinity	DW	Down Arrow
		LW	Left Arrow

More Mathematical Symbols

		RW	Right Arrow
		BW	Left/Right Arrow
MT	Membership Symbol	DP	Dagger
NT	Membership Negation	FP	Double Dagger
ET	Existential Quant.	BS	Left Angle Bracket
IT	Intersection	ES	Right Angle bracket
AT	Universal Quant.	(S	Left Bracket
UT	Union	)S	Right Bracket
<T	Contained in	LS	Left Brace
>T	Contains	RS	Right Brace
LT	Contained in/Equal	PP	New Paragraph
RT	Contains/Equal	HK	H-Bar
		LK	Lambda-Bar
		DM	Degrees
		UD	Underscore
		OD	Overscore
		/	Backwards Slash

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