STROMBERG CARLSON

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PROGRAMMERS' REFERENCE MANUAL

for the

INTEGRATED GRAPHICS SOFTWARE SYSTEM

Volume 1

APPLICATIONS PROGRAMMERS' GUIDE

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PREFACE

This manual is intended as a programming guide to the Integrated Graphics Software (IGS) system used with the S-C 4060. The IGS is a comprehensive system utilizing a library of subroutines to provide various graphic display functions. The manual described the capabilities and modes of operation of the IGS. It also lists each subroutine by name, outlines its function, specifies the calling sequence, and provides additional information useful in applications programming.

Although the IGS system is FORTRAN-oriented, it may be called from assembly language, COBOL, PL/I, or any other symbolic language compatible with the subroutine linkage conventions. It is assumed that the programmer is familiar with the basic features of the FORTRAN language.

All communication involving any or all of the system as described in this manual is to be directed to Stromberg Datagraphics Inc.

Although the design and implementation of the IGS system was the result of a cooperative effort between Stromberg Datagraphics Inc. and the RAND Corp., the major portion of the detailed analysis and all of the programming effort was contributed by the RAND Corp.

1. INTRODUCTION

The IGS software package allows an installation's host computer to accept data and graphic formatting instructions; perform necessary scaling, conversions, and translations; and create meta-language output and write it onto magnetic tape or some other output medium. The meta-language information is then read by an S-C 4060 Product Control Unit (PCU) for conversion to the sequence of hardware commands required to produce the graphic display.

2. DESCRIPTION OF IGS

IGS LIBRARY SUBROUTINES

The basic geometry library subroutines provided by the IGS system may be used to display joined line segments (LINESG), independent line segments (SEGMTG), plotted points (POINTG), circles and arcs (CIRARG). A subroutine to display multiple line segments (MLTPLG) is also provided, facilitating the generation of cross-hatching, shading, grids, multiple dots, etc. Other subroutines are available to draw linear or non-linear grids (GRIDG) and provide associated labels (LABELG) and titles (TITLEG). A supporting subroutine (SETUPG) may be called to compute appropriate arguments for GRIDG. Another subroutine (GRAPHG) may be used to produce an entire graph (with grid, labels, titles, and plotted data) from a single call.

In addition to the geometric subroutines, discussed above, the IGS system library provides a subroutine (NUMBRG) for displaying numeric data in various formats.

Two subroutines are provided for displaying strings of text. One of these (LEGNDG) begins the display at a specified x, y coordinate and the other (TEXTG) begins at the current position determined by the previous display. Both of these subroutines allow modifications to be made (via the SETSMG subroutine) in character size, line and character orientation, character spacing, character font and case, etc. Either the standard Charactron characters or special "vector" characters may be displayed (see "Character Display," below). Vector characters may be drawn with any of four line widths; and their size, orientation, and skew angle are not restricted by the IGS system.

MODE SETS

A principal feature of the IGS system is the mode array, a 200-word communication region in the user's program. The mode array, which is named by the user, contains all status information pertaining to the current task being performed by the system. Such information consists of scale factors; character size and orientation; line width, texture, and density; margin sets; hard copy size; grid type; label format and positions; conversion factors; and various flags and other required values. IGS subroutines use the mode array for the direct storage and retrieval of all information on which they operate to perform their functions. None of these values are retained within any of the subroutines (see Figure 1), and standard default values are stored in the mode array when the system is initialized.

The address of the mode array is included in the argument string of the calling statement for each IGS subroutine. This enables the system to operate within time-sharing or other multiprogramming environments.

A number of different mode arrays may be defined, rather than only one, and each may be called individually by the main program. This capability can be useful in the creation of separate output tapes for several different types of displays.

By reducing the number of arguments that must be included in the subroutine calls, the use of the mode array greatly simplifies the programming of graphic displays. Consider a subroutine to display a line of characters. Only the x, y location of the first character, the number of characters to be displayed, and the address of the character string need be specified explicitly in the subroutine call. All other parameters, such as character size, character spacing, line spacing, etc., are obtained by the subroutine automatically from the mode array. Subroutine SETSMG is provided to allow changes to be made in a mode array, and such changes remain in effect until superseded by later changes or until the IGS system is reinitialized to the standard default values.

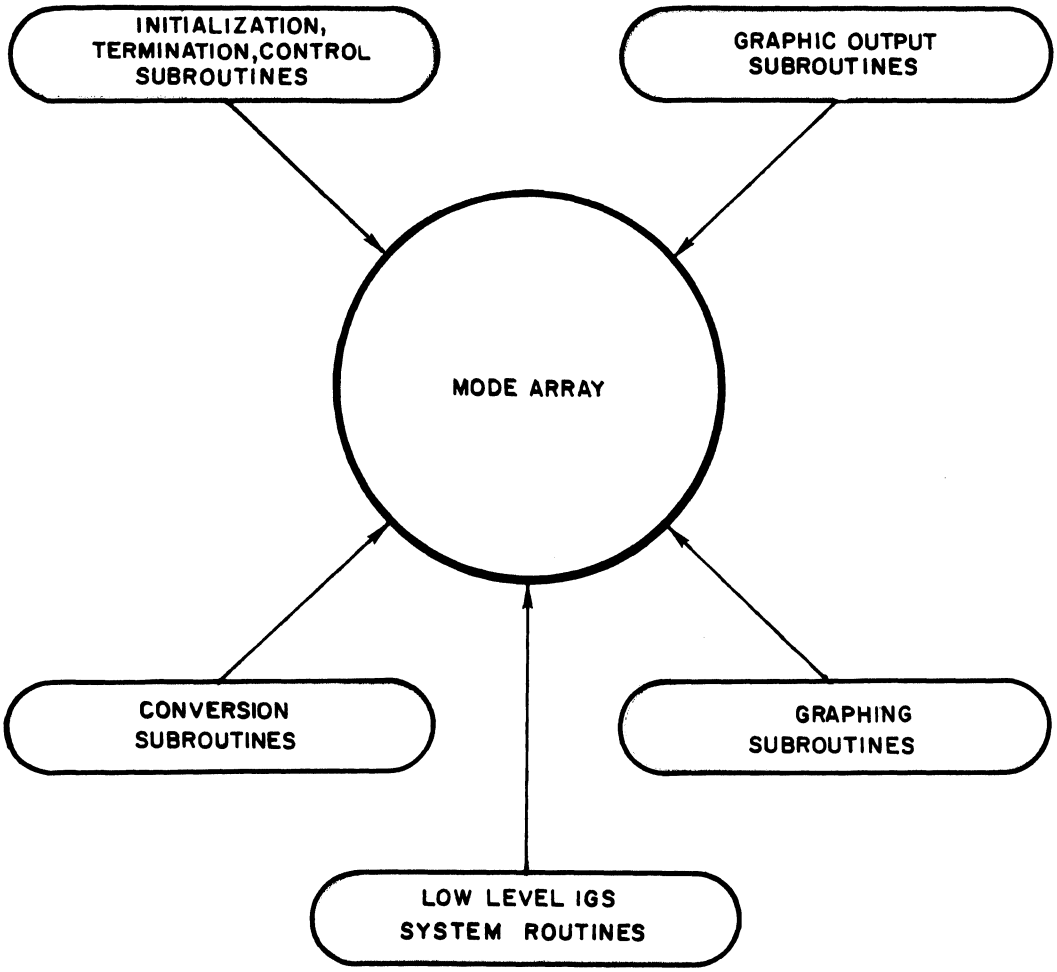


Figure 1. IGS Configuration

DEFAULT CONDITIONS

When the IGS system is initialized by subroutine MODESG, or the mode array is reset by subroutine RSETMG, all mode array parameters are automatically set to default values that will provide standard graphic displays for each display mode and function. The standard default values for mode array parameters are listed in the description of subroutine GETSMG (in Section 4 of this manual).

CHARACTER DISPLAY

Characters displayed on the S-C 4060 may be either Charactron or vector characters. Charactron characters are created within the Charactron tube by passing a beam of electrons through a stencil-like etched matrix containing the set of characters shown in Appendix E. The characters selected for each display appear at designated locations on the CRT face of the Charactron tube where they are recorded on film and, optionally, on hard copy. Although the displayed characters are selected sequentially within the Charactron tube, all characters comprising a given display appear to be present simultaneously on the face of the CRT.

Like Charactron characters, vector characters are displayed on the face of the CRT. However, each vector character is formed by causing an electron beam to trace a series of short line segments to "draw" the shape of the desired character. This process requires more time and storage space in the host computer than the Charactron method does, but allows virtually unlimited flexibility in character fonts. Vector characters may be drawn in any of four standard line widths, and the character fonts may be designed by the user in the form of font tables. The IGS system places no restriction on the number of fonts or the number of characters per font.

Character strings may be either "plotted" or "typed." A plotted string of one or more characters may be displayed beginning at a specified x, y location, but a typed string must begin at the current x, y location established by the previous display.

The display area occupied by a character is defined by its "envelope," which includes both horizontal and vertical clearance. The "location" of each character is considered to be the centroid of its envelope. (See Figure 2).

PLOTTING MODE

As mentioned above, plotted character strings may be placed at any desired x, y coordinates on the CRT raster. The displayed location of the first (or only) character of the string is independent of the location of the previous display. The plotting mode is entered by a call to subroutine LEGNDG, and either Charactron or vector characters may be plotted.

TYPING MODE

In the typing mode, the displayed location of the first character of a string depends on the displayed location of the last character in the previous display (or on the current display location established by a call to subroutine LINESG). The distance between any two adjacent characters is normally equal to the width of one character. Either Charactron or vector characters may be typed using subroutine TEXTG.

In both the plotting and the typing mode, mode set values may be specified to determine various display parameters. Left, right, top, and bottom margins may be set; a page may be ejected when the text exceeds the limits of the defined display area; character size, spacing, case, font, and orientation; and line spacing and orientation may be specified via the mode array designated in the subroutine call. Figures 3, 4, and 5 illustrate some of these options.

Because the location of a displayed character is at its center, some caution is necessary when vector characters are to be typed. A vector character cannot be displayed if a portion of the character would lie outside the addressable area of the raster. This restriction does not apply to Charactron characters.

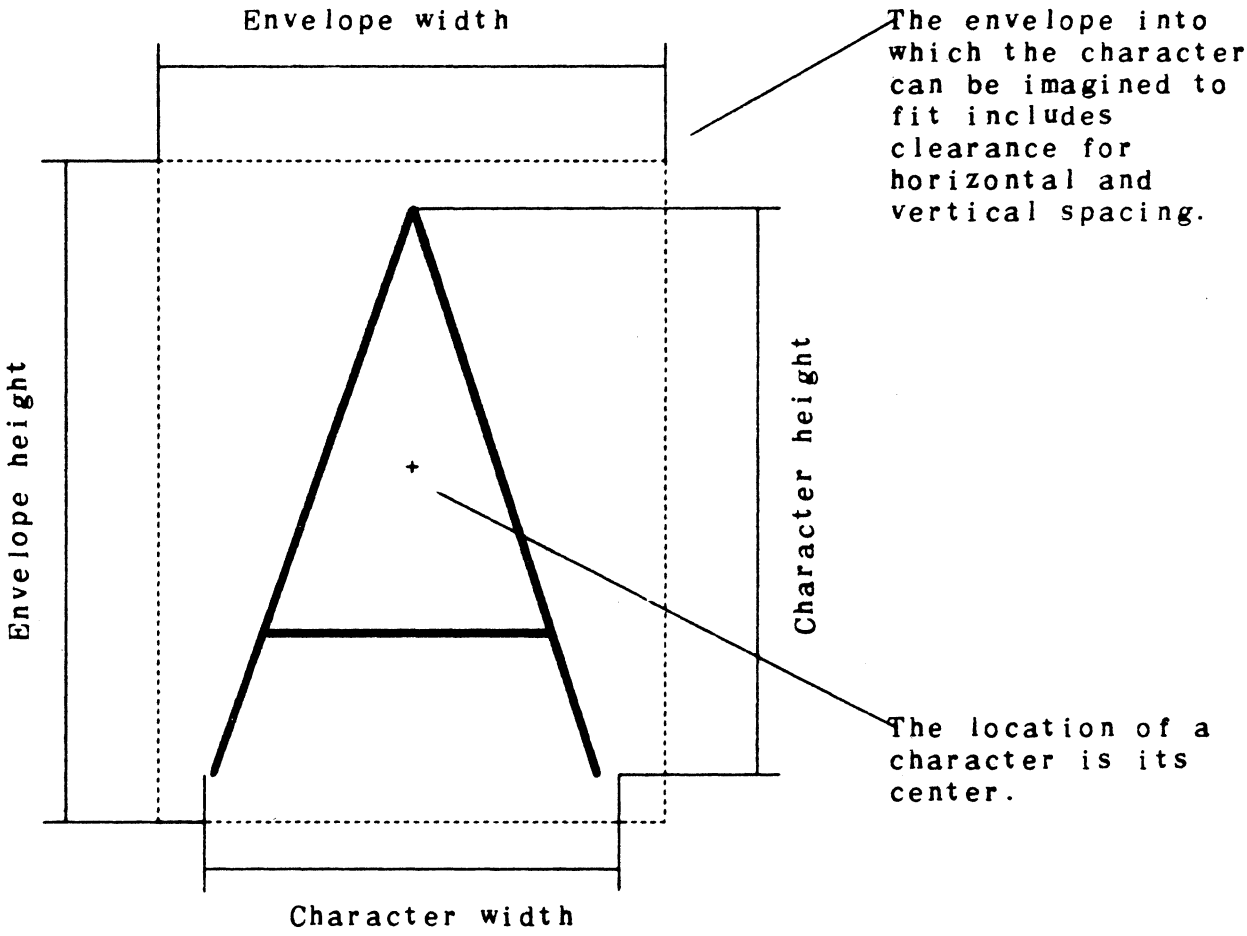
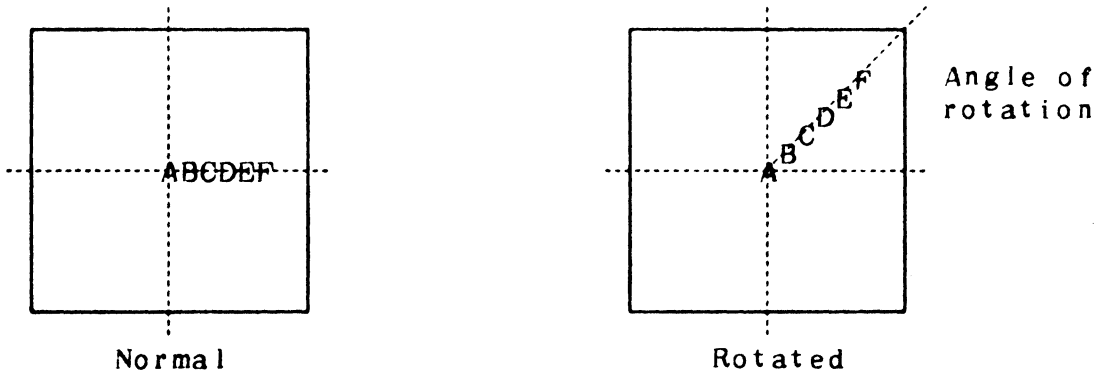
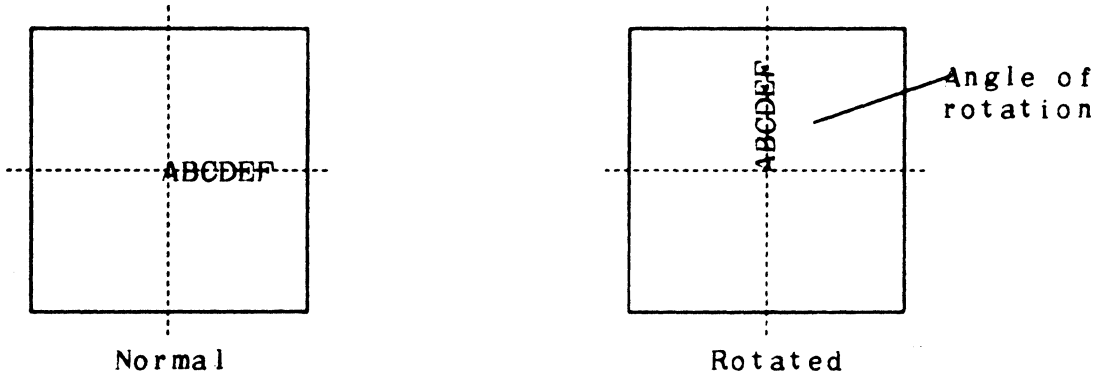


Figure 2. The Character Envelope



NOTE–Changing the line orientation does not effect the character orientation.

Figure 3. Line Orientation



NOTE–Changing the character orientation also changes the line orientation.

Figure 4. Character Orientation

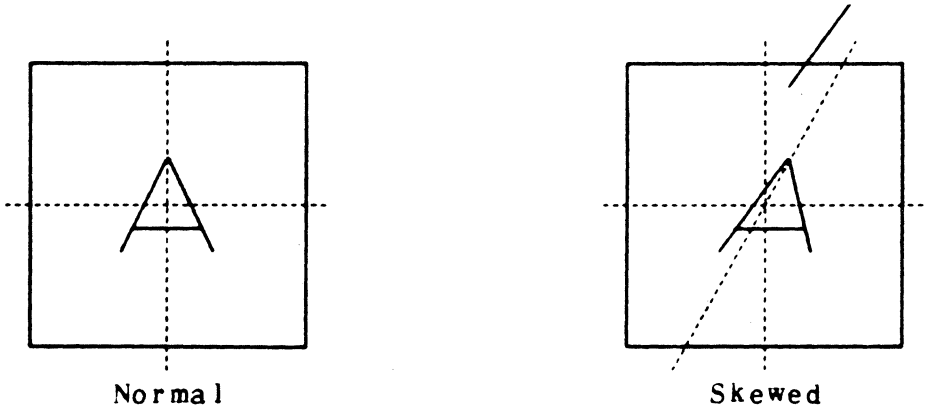


Figure 5. Skew Angle

The Stromberg Datagraphics Inc. character set is much larger than the character sets normally provided by standard keypunch machines. For this reason, special control characters have been provided in the IGS system to allow a display program to access any character of the S-C 4060 character matrix. A control character consists of a dollar-sign character followed by an identification character. All of the control characters and their functions are given in Appendix F.

By using the standard FORTRAN set of 48 characters and specifying one of the three case subsets listed in Figure 6, it is possible to access any of the S-C 4060 Charactron characters. In the plotting mode, the case may be specified only by means of the SETSMG subroutine. In the typing mode, the case may be specified either by a call to SETSMG or by embedding an appropriate control character in the display character string ($L for lower case, $U for upper case, and $S for the special case). The upper case is the default for both the plotting mode and the typing mode.

OBJECT SPACE AND SUBJECT SPACE

The working area of the raster on the face of the Charactron CRT is rectangular, with 3072 addressable points in the vertical direction and 4096 in the horizontal. The horizontal or vertical distance between any two adjacent addressable raster points is termed a "raster unit," the fundamental unit of distance on the raster. The "origin" of the raster (point (0, 0)) is at the lower left corner, and the point having the highest numerical address (point (4095, 3071)) is at the upper right corner.

The IGS system allows locations on the raster to be addressed directly in terms of raster unit coordinates, but for many applications it is more convenient to consider the raster in terms of normalized values. For example, the default condition assumes a normalized rectangular plotting area of 1.000 by 1.333. In this case, 1.000 is equivalent to 3071 raster units and 1.333 is equivalent to 4095 raster units.

UPPER CASE	LOWER CASE	SPECIAL CASE	UPPER CASE	LOWER CASE	SPECIAL CASE
A	a	α	Y	Y	←
B	b	β	Z	Z	→
C	c	∧ (carat)	0	0	0 (circle)
D	d	δ	1	1	.
E	e		2	2	.
F	f	%	3	3	.
G	g	γ	4	4	•
H	h	>	5	5	
I	i	$\int$	6	6	
J	j	∂	7	7	
K	k	°	8	8	
L	l	<	9	9	
M	m	#	blank	blank	blank
N	n	¬ (logical inverse)	.	.	
O	o	|	,	,	
P	p	π	, (close quote)	"	‘ (open quote)
Q	q	– (under score)	$	¢	
R	r	□	(	[	{
S	s	Σ	)	]	}
T	t	~ (tilde)	/	?	\
U	u	◊ (lozenge)	- (minus)	— (hyphen)	—(bar)
V	v	Δ	+	!	±
W	w		*	;	@
X	x		=	:	&

Figure 6. Character Case Equivalents

The values that determine the normalized plotting area may be any pair of positive numbers set by a call to subroutine SETSMG. For example, to establish a normalized plotting area of 3.0 by 4.0 the following statements must be given:

```
CALL SETSMG (Z, 19, 4.0)
CALL SETSMG (Z, 20, 3.0)
```

where Z identifies the mode array.

19 and 20 are the locations in the mode array in which the normalized units are to be stored.

4.0 and 3.0 are the values of the normalized units.

The following calls will redefine the plotting area in terms of raster units:

```
CALL SETSMG (Z, 19, 4095.)
CALL SETSMG (Z,20,3071.)
```

OBJECT SPACE

For most graphic work it is frequently necessary to subdivide the plotting area into one or more sub-areas. A given job may require all graphic output to be confined to a specific sub-area on the raster. Such a sub-area is termed the "object space" and is defined in terms of the normalized values.

Object space is established by a call to the subroutine OBJCTG. For example, if the normalized values are 1.000 (vertical) and 1.333 (horizontal), which is the default condition, and the object space is to consist of the upper left quarter of the raster, then the object space is defined by the following call:

```
CALL OBJECTG (Z, 0.,.5,.6667,1.)
```

where Z identifies the mode array.

0. is the minimum X-axis value.

.5 is the minimum Y-axis value.

.6667 is the maximum X-axis value.

1. is the maximum Y-axis value.

If the normalized values are established as 100. (horizontal) and 100. (vertical) and the object space is to consist of the upper left quarter of the raster, then the object space is defined as follows:

```
CALL OBJCTG (Z, 0.0, 50.0, 50.0, 100.0)
```

SUBJECT SPACE

Graphs and other drawings are usually constructed in terms of units that are not related to raster units or normalized values. For example, a graph showing a relationship between distance and time might be expressed in terms of meters and seconds. The most convenient units for dealing with blocks of printed test are lines (vertical) and characters (horizontal). These and units such as volts, dollars, months, inches, etc, are termed "data units." To facilitate the positioning of lines and characters relative to data units, the IGS system provides for a working area called "subject space."

Physically, the subject space is bounded by the object space (see Figure 7). Regardless of what units or ranges of values are chosen to define the subject space, the bounds of the defined object space will not be exceeded.

Example (see Figure 8):

To set up the subject space for a graph whose range of values in the horizontal direction is in years, from 1950 to 1980, and in the vertical direction is in dollars, from $1000 to $10,000, the statement

```
CALL SUBJEG (Z, 1950., 1000., 1980., 10000.)
```

must be made. Once the subject space has been defined, the range of permissible values for arguments in subsequent call statements is established also. In the present example, a call (to a plotting subroutine) that specified a horizontal coordinate value of 1949 would result in an error because the minimum horizontal value defining the subject space was 1950.

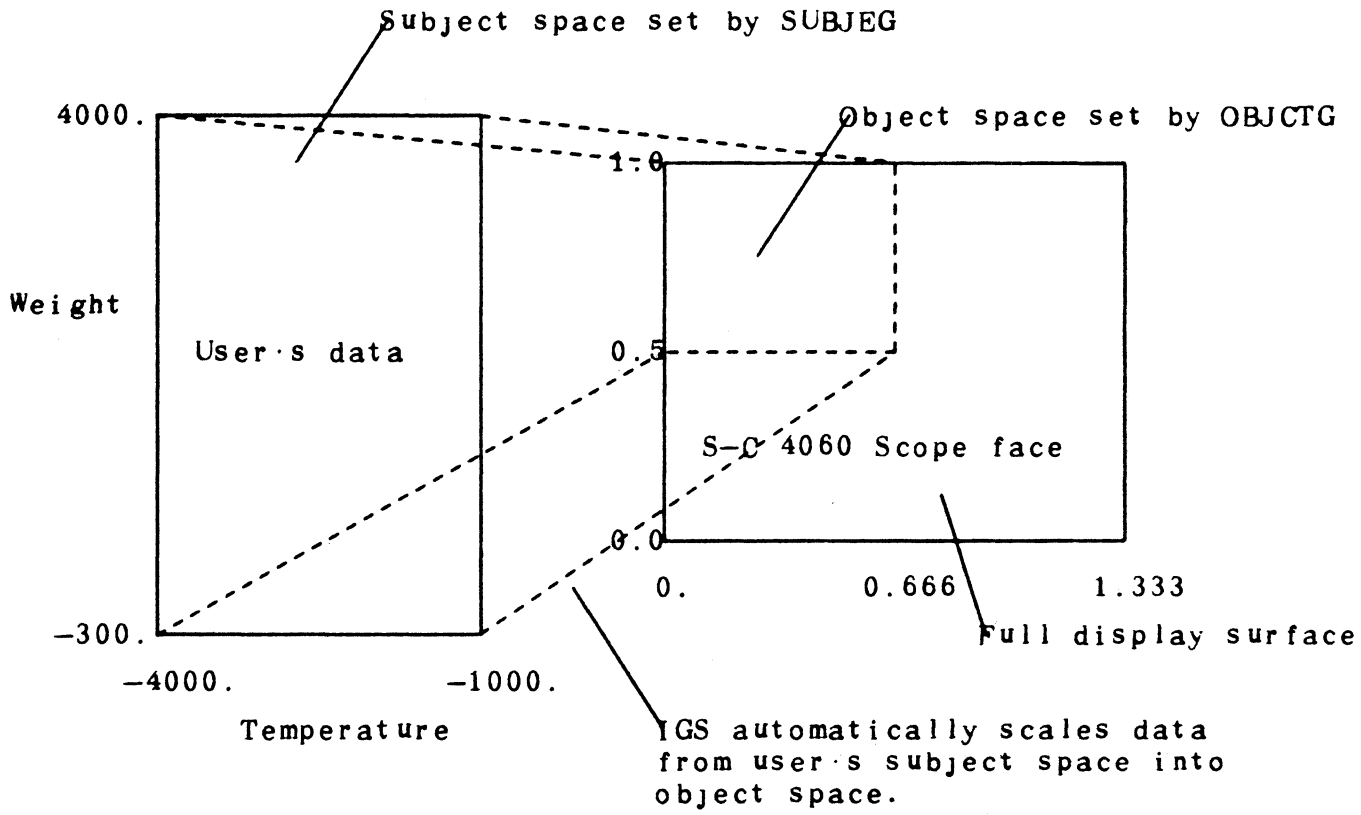


Figure 7. Subject and Object Space

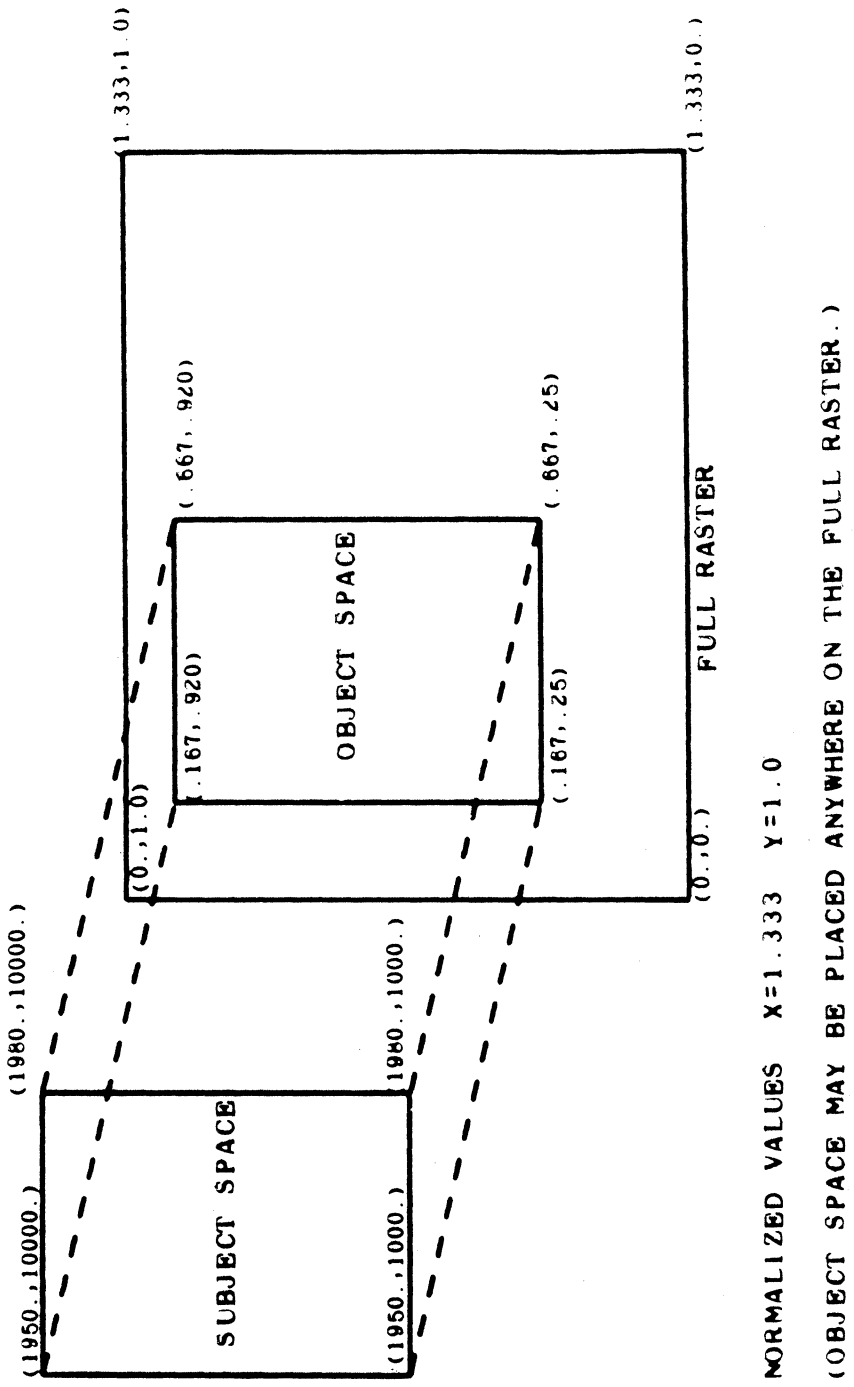


Figure 8. Subject Space and Object Space for Example on Page 2-11

Example (see Figure 9):

It is often necessary to transfer a sketch or schematic from a sheet of paper to microfilm. This can be done by scaling the drawing and transferring the measurements directly to the arguments of the IGS subroutine calls without the necessity of applying conversion factors. In such a case, it would be desirable for the object space to have the same aspect ratio as the sheet of paper from which the drawing is to be scaled. Assuming that the paper measures 8.5 by 11.0 inches and plotting area has the default normalized values, the object space could be established by the statement.

```
CALL OBJCTG (Z, .455, 0., 1.333,1.)
```

This would place the object space at the right-hand side of the normalized plotting area. The subject space could be established to correspond to the dimensions of the sheet of paper (8.5 by 11.0 in.) by the statement

```
CALL SUBJEG (Z, 0., 0., 8.5,11.)
```

The scaling and transferring of dimensions could then be done directly in inches.

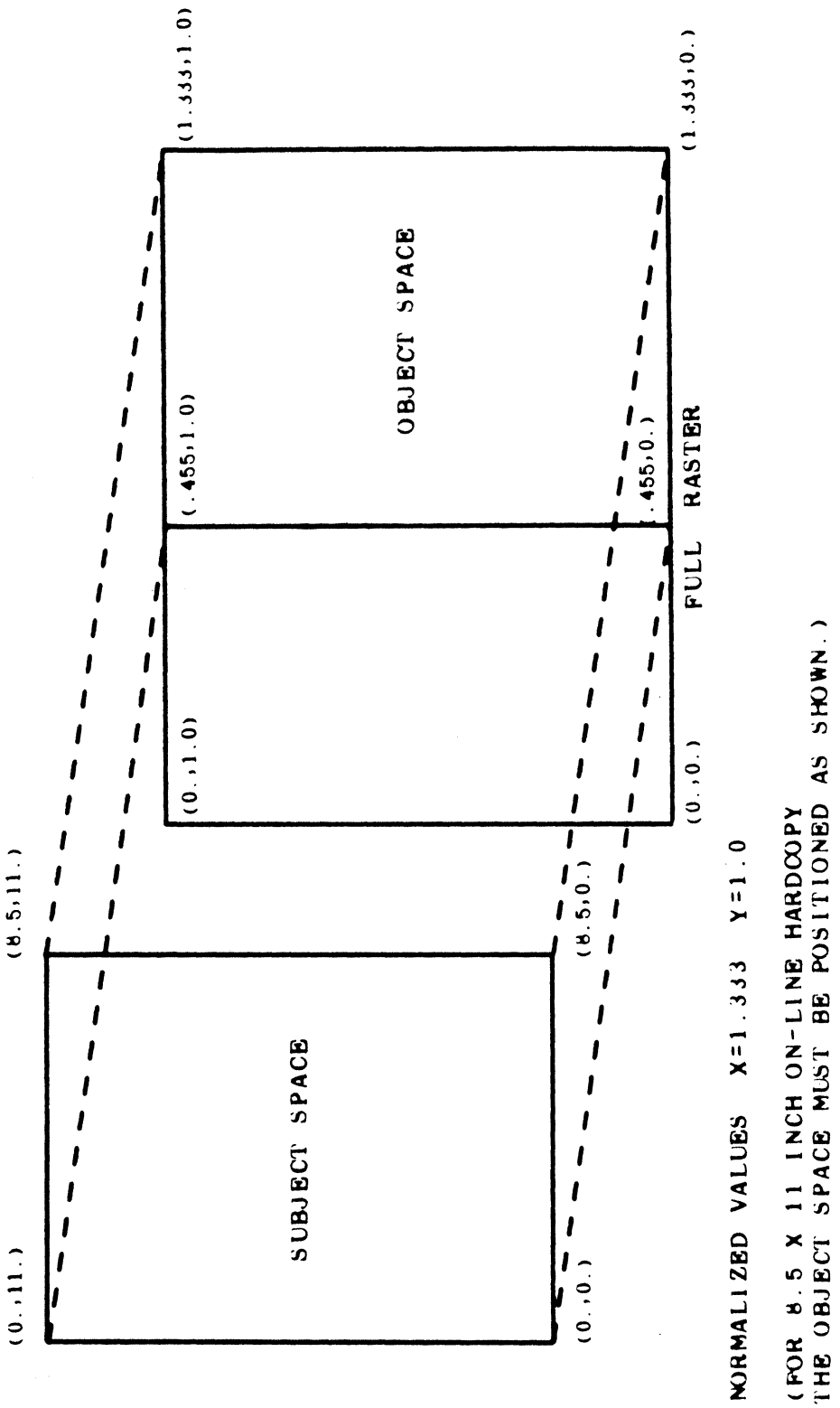


Figure 9. Subject Space and Object Space for Example on Page 2-14

3. IGS SUBROUTINES

LIST OF SUBROUTINES

The following list itemizes each IGS general graphic subroutine and briefly describes its function.

Initialization, Termination, and Control Subroutines

Name	Function
MODESG	Initializes the IGS system. This must be the first IGS subroutine called by a graphics program.
SUBJEG	Sets up the subject space coordinate system.
OBJCTG	Sets up the normalized object space.
SETSMG	Sets a mode array value.
GETSMG	Retrieves a mode array value.
RSETMG	Resets all parameters of the mode array to their default values.
TABSG	Sets typing tab positions
PAGEG	Controls frame advance and form flash.
EXITG	Terminates graphic output. This must be the last IGS subroutine called by a graphics program.
VECIG	Initializes a vector character font.

Graphic Output Subroutines

Name	Function
CIRARG	Draws a circle or arc.
LEGNDG	Displays (plots) characters.
LINESG	Draws joined line segments.
MLTPLG	Draws multiple line segments
NUMBRG	Displays (plots) numeric data
POINTG	Plots symbols.
SEGMTG	Draws line segments
TEXTG	Types characters

Graphing Subroutines

Name	Function
GRIDG	Draws a grid.
LABELG	Labels a grid.
TITLEG	Titles a grid.
SETUPG	Computes optimum grid parameters.
GRAPHG	Draws a complete graph.

Conversion Subroutines

Name	Function
CONVTG	Converts a character string to numeric form.
FMTSG	Converts numeric data to a character string.

IGS SUBROUTINE CONVENTIONS

The following conventions have been adopted for the IGS system:

1. All general graphic subroutine names end with a "G."
2. All system subroutines end with "ZZ." These subroutines willnot be of general interest to the typical user. See Ref. 6.
3. All functions end with a "Z." See Ref. 6.
4. The first argument of each call to any graphic subroutine must identify the mode array that is to be used by that subroutine. This array must be properly defined in the user's program. It is recommended that this array be given a single character name for programmer convenience.
5. All variables in a mode array are real.
6. Unless otherwise specified via a call to SETSMG, all coordinate values in calls to graphic subroutines are real.
7. No variable-length calls are used.
8. Wherever possible, the subroutines are coded in ASA standard FORTRAN.
9. The IGS system does not necessitate modification of the host computer system. This does not preclude modification of the host system to suit special requirements of a particular installation.

The general format of the IGS subroutine descriptions is as follows:

1. Purpose. A brief statement of the purpose of the subroutine is given.
2. Call. The calling sequence needed to call the subroutine is described in detail. FORTRAN notation is used to indicate integer or real arguments. Arguments beginning with A-H or O-Z are real; those beginning with I-N are integer.

3. Special. If the user may make any special calls to the subroutine, these are given.

4. Mods. Any modifications that can be made to the functioning of the subroutine (via calls to SETSMG) are given.

5. Uses. Any other subroutines called by the subroutine are listed.

6. Notes. Information not included under 5. above, such as the language the subroutine is coded in, is given under "Notes."

4. IGS SUBROUTINE DESCRIPTIONS

INITIALIZATION, TERMINATION, AND CONTROL SUBROUTINES

The FORTRAN "program" outlined below illustrates the use of the IGS housekeeping subroutines. Refer to the individual subroutine descriptions for information regarding the arguments in the calling sequences.

Before attempting to create any graphic output, the user's program must dimension the appropriate mode array and initialize the IGS system through a call to MODESG. Subroutine MODESG sets all the default values in the mode array and opens the output file. The referenced mode array in the user's program must be 200 words long.

```
DIMENSION Z (200)
CALL MODESG (Z,O)
```

The user's program should then set up its coordinate system. A call to SUBJEG will change the subject space and a call to OBJCTG will change the object space. Both of these calls are optional and need not be used if the default coordinate system is adequate for the display.

```
CALL SUBJEG (Z,XMIN, YMIN,XMAX, YMAX)
CALL OBJCTG (Z,XMIN, YMIN,XMAX, YMAX)
```

The graphics system may then be tailored to suit the particular needs of the user's program, by mode set calls. These calls are not necessary if the default mode array values are acceptable.

```
CALL SETSMG (Z,NO,VALUE)
```

The user's program may then create any desired displays by means of calls to appropriate graphic subroutines. When a display is complete, subroutine PAGEG must be called to record the display and advance the film.

```
CALL PAGEG (Z, 0, 1, 1)
```

After PAGEG returns control to the user's program, the next display may be created. Mode array parameters may be changed via calls to SETSMG, or RSETMG may be called to reset the mode array to the standard default values.

```
CALL RSETMG (Z)
```

If typewriter simulation is to be done, tabs may be set by a call to TABSG.

```
CALL TABSG (Z, NTABS, TABS)
```

When all graphic outputs has been completed and recorded, EXITG must be called to terminate graphic output.

```
CALL EXITG (Z)
```

The user's program may then terminate its execution in the normal manner if there is nothing left to be done.

```
CALL EXIT
END
```

```
C*****************************SUBROUTINE MODESG*********************************
C INITIALIZE THE SYSTEM.  (MODESG)
C
C PURPOSE    THIS ROUTINE IS USED TO INITIALIZE THE GRAPHICS SYSTEM.  IT
C            OPENS ANY FILES NEEDED, SETS ALL DEFAULT VALUES IN THE MODE
C            SET ARRAY, AND MAY BE MODIFIED TO DO ANY ACCOUNTING NEEDED.
C            THE USER MUST CALL MODESG TO INITIALIZE THE SYSTEM BEFORE
C            CALLING ANY OTHER GRAPHIC SUBROUTINES.
C
C CALL       CALL MODESG(Z,ITAPE)
C                 Z MUST BE AN ARRAY IN THE USER'S PROGRAM, 200 WORDS
C                      LONG.  ALL MODE SETS AND SYSTEM COMMUNICATION
C                      POINTERS ARE STORED IN THIS ARRAY.  THE USER MUST
C                      BE CAREFUL NOT TO DESTROY IT.
C                 ITAPE SPECIFIES THE FORTRAN TAPE UNIT TO WRITE THE
C                      S-C 4060 OUTPUT ONTO.  IF ITAPE=0, THE DEFAULT
C                      TAPE UNIT WILL BE SELECTED.
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINES RSETMG,PACKZZ,ERRZZ,METAZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            THIS SUBROUTINE MAY BE MODIFIED BY EACH INSTALLATION TO SUIT
C            ITS PARTICULAR NEEDS.
```

```
C*****************************SUBROUTINE SUBJEG*********************************
C SET UP SUBJECT SPACE.  (SUBJEG)
C
C PURPOSE    THIS ROUTINE IS USED TO SET UP THE LIMITS OF THE USER'S
C            COORDINATE SYSTEM  (SUBJECT SPACE).  IT THEN CALCULATES THE
C            SCALE FACTORS NEEDED.
C
C CALL       CALL SUBJEG(Z,XMIN,YMIN,XMAX,YMAX)
C                 Z IS THE MODE SET ARRAY.
C                 XMIN IS THE MINIMUM X-COORDINATE OF THE USER'S DATA.
C                 YMIN IS THE MINIMUM Y-COORDINATE OF THE USER'S DATA.
C                 XMAX IS THE MAXIMUM X-COORDINATE OF THE USER'S DATA.
C                 YMAX IS THE MAXIMUM Y-COORDINATE OF THE USER'S DATA.
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINES ERRZZ,XMODZ,YMODZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            XMIN, YMIN, XMAX, AND YMAX ARE THE BOUNDS OF THE USER'S
C            DATA.  XMIN AND YMIN NEED NOT NECESSARILY BE LESS THAN XMAX
C            OR YMAX.  HOWEVER, XMIN MUST NOT EQUAL XMAX OR YMIN EQUAL
C            YMAX.
C
C            SUBJEG RECOMPUTES THE PAGE MARGINS AND TAB SETS SO THAT THEY
C            STAY IN THE SAME POSITIONS RELATIVE TO THE NEW SUBJECT
C            SPACE.
```

```
C*****************************SUBROUTINE OBJCTG*********************************
C SET UP OBJECT SPACE.  (OBJCTG)
C
C PURPOSE    THIS ROUTINE IS USED TO SET UP THE SIZE OF THE DISPLAY SCOPE
C            TO USE (OBJECT SPACE).  IT THEN CALCULATES THE SCALE FACTORS
C            NEEDED.
C
C CALL       CALL OBJCTG(Z,XMIN,YMIN,XMAX,YMAX)
C                 Z IS THE MODE SET ARRAY.
C                 XMIN IS THE MINIMUM X-COORDINATE OF THE SCREEN IN
C                      NORMALIZED OBJECT SPACE.
C                 YMIN IS THE MINIMUM Y-COORDINATE OF THE SCREEN IN
C                      NORMALIZED OBJECT SPACE.
C                 XMAX IS THE MAXIMUM X-COORDINATE OF THE SCREEN IN
C                      NORMALIZED OBJECT SPACE.
C                 YMAX IS THE MAXIMUM Y-COORDINATE OF THE SCREEN IN
C                      NORMALIZED OBJECT SPACE.
C
C SPECIAL    TWO FUNCTIONS ARE PROVIDED TO CONVERT SUBJECT SPACE
C            COORDINATES INTO NORMALIZED OBJECT SPACE.
C                 1.  TO CONVERT X-AXIS SUBJECT SPACE TO NORMALIZED
C                     OBJECT SPACE, USE THE FOLLOWING FUNCTION:
C                          X NORMALIZED OBJECT SPACE = XNORMZ(Z,X)
C                 2.  TO CONVERT Y-AXIS SUBJECT SPACE TO NORMALIZED
C                     OBJECT SPACE, USE THE FOLLOWING FUNCTION.
C                          Y NORMALIZED OBJECT SPACE = YNORMZ(Z,Y)
C
C MODS       NORMALIZED OBJECT SPACE IS BASED UPON A MAXIMUM VALUE OF 1.0
C            IN THE Y-AXIS AND 1.333 IN THE X-AXIS.  IF THE USER WANTS TO
C            CHANGE THESE VALUES, HE MAY DO SO BY MAKING A MODE SET CALL.
C            HE MUST THEN BE CAREFUL TO USE HIS NEW NORMALIZED OBJECT
C            SPACE WHEREVER NORMALIZED OBJECT SPACE IS REQUIRED.
C            THE MODE SET CALLS ARE AS FOLLOWS:
C                 1.  TO CHANGE THE MAXIMUM X-AXIS NORMALIZED OBJECT
C                     SPACE, GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,19,XMAX)
C                               XMAX IS THE NEW NORMALIZED X-AXIS OBJECT
C                               SPACE.
C                          XMAX = 1.333 IS THE DEFAULT VALUE.
C                 2.  TO CHANGE THE MAXIMUM Y-AXIS NORMALIZED OBJECT
C                     SPACE, GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,20,YMAX)
C                               YMAX IS THE NEW NORMALIZED Y-AXIS OBJECT
C                               SPACE.
C                          YMAX = 1.0 IS THE DEFAULT VALUE.
C
C USES       SUBROUTINES METAZZ,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            XMAX AND YMAX MUST BE GREATER THAN XMIN AND YMIN
C            RESPECTIVELY.
```

```
C*****************************SUBROUTINE SETSMG*********************************
C SET MODE VALUES.  (SETSMG)
C
C PURPOSE    THIS ROUTINE IS USED TO SET A SINGLE VALUE IN THE MODE SET
C            ARRAY.  MODES THAT ARE SET STAY IN EFFECT UNTIL THEY ARE
C            SPECIFICALLY RESET, OR UNTIL THE SYSTEM IS RE-INITIALIZED.
C
C            ALL MODE SETS HAVE A DEFAULT VALUE ASSOCIATED WITH THEM.
C            THIS DEFAULT VALUE IS SET BY THE INITIALIZATION CALL TO
C            MODESG AND BY CALLS TO RSETMG.
C
C CALL       CALL SETSMG(Z,NO,VALUE)
C                 Z IS THE MODE SET ARRAY.
C                 NO IS A NUMBER IDENTIFYING THE PARTICULAR MODE SET
C                   PARAMETER.
C                 VALUE IS THE MODE SET VALUE.
C
C USES       SUBROUTINE ERRZZ
C                                                                 DEFAULT
C  NO FUNCTION           DESCRIPTION                             VALUE SET BY
C
C  14 SCALE FLAG         TYPE OF SCALING TO DO.                    1.  SYSTEM
C                             0.-REAL SUBJECT SPACE UNITS.
C                             1.-REAL ABSOLUTE RASTER UNITS.
C                             2.-INTEGER ABSOLUTE RASTERS.
C                             3.-REAL NORMALIZED OBJECT
C                                SPACE.
C  19 MAX X-NORM.        SCOPE SIZE IN NORMALIZED OBJECT        1.333 SETSMG
C                        SPACE.
C  20 MAX Y-NORM.        SCOPE SIZE IN NORMALIZED OBJECT           1.  SETSMG
C                        SPACE.
C  23 X-LINEAR FLAG      FLAG FOR LINEAR SCALING IN X-AXIS.        0.  SETSMG
C                             0.-LINEAR
C                             1.-NONLINEAR
C  24 Y-LINEAR FLAG      FLAG FOR LINEAR SCALING IN Y-AXIS.        0.  SETSMG
C                             0.-LINEAR
C                             1.-NONLINEAR
C  30 LINE WIDTH         NO. TIMES NORMAL WIDTH.                   1.  SETSMG
C                             .5   2 RASTERS
C                             1.0  4 RASTERS
C                             2.0  8 RASTERS
C                             4.0 16 RASTERS
C  31 LINE TEXTURE       SIZE OF DASHED LINE.                      0.  SETSMG
C                             0.-SOLID
C                             1.-32 RASTER UNITS.
C                             2.-64 RASTER UNITS.
C                             3.-128 RASTER UNITS.
C                             4.-256 RASTER UNITS.
C  42 CURRENT WIDTH      CHARACTER WIDTH IN SUBJECT SPACE.        31.  SETSMG
C  43 CURRENT HEIGHT     CHARACTER HEIGHT IN SUBJECT SPACE.       51.  SETSMG
C  44 PAGE EJECTION      EJECT TO A NEW PAGE IF LINES RUN          0.  SETSMG
C                        OFF THE BOTTOM OR TOP MARGINS.
C                             0.-NO
C                             1.-YES
C  45 CHARACTER SIZE     NO. TIMES NORMAL SIZE FOR TYPING.         1.  SETSMG
C                             .75   23X38 RASTERS
C                             1.0   31X51 RASTERS
C                             1.25  39X64 RASTERS
C                             1.5   47X77 RASTERS
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C   46 TYPING ORIEN.      TYPING ORIENTATION IN DEGREES.          0.   SETSMG
C                         BOTH CHARACTER AND LINE ORIENTATION
C                         ARE SET.  0. IS A VERTICAL CHARACTER
C                         AND A HORIZONTAL LINE TO THE RIGHT.
C                         COUNTER CLOCKWISE IS POSITIVE.
C                         0. AND 90. ARE ALLOWED FOR
C                         CHARACTRON CHARACTERS.
C   47 CHARACTER SPACING  NO. TIMES TO SPACE CHARACTERS.          1.0  SETSMG
C   48 VACANT
C   49 LINE SPACING       NO. TIMES CURRENT CHARACTER HEIGHT     -1.   SETSMG
C                         TO SPACE LINE UPON EJECTION.
C                              + VALUE, SPACE LINE UP.
C                              - VALUE, SPACE LINE DOWN.
C   50 LINE ORIENTATION   ANGLE IN DEGREES AT WHICH A LINE OF    0.   SETSMG
C                         CHARACTERS IS TO BE DISPLAYED.  0.
C                         IS HORIZONTAL, TO THE RIGHT.
C                         COUNTER CLOCKWISE ANGLES ARE
C                         POSITIVE.
C   51 CHARACTER FONT     CHARACTER FONT TO USE FOR TYPING.       0.   SETSMG
C                              0.-CHARACTRON
C                              1.-STANDARD VECTOR
C   52 CHARACTER CASE     CHARACTER CASE FOR TYPING.              0.   SETSMG
C                              0.-UPPER CASE
C                              1.-LOWER CASE
C                              2.-SPECIAL CASE
C   53 PLOT CHAR SIZE     NO. TIMES NORMAL SIZE FOR PLOTTING.     1.   SETSMG
C                              .75   23X38 RASTER UNITS.
C                              1.0   31X51 RASTER UNITS.
C                              1.25  39X64 RASTER UNITS.
C                              1.5   47X77 RASTER UNITS.
C   54 PLOT CHAR ORIEN.   PLOT CHARACTER ORIENTATION IN           0.   SETSMG
C                         DEGREES.  0. IS UPRIGHT.  COUNTER
C                         CLOCKWISE IS POSITIVE.
C                              0. - UPRIGHT
C                              90. - HORIZONTAL
C   55 PLOT CHAR. CASE    CHARACTER CASE FOR PLOTTING.            0.   SETSMG
C                              0.-UPPER CASE
C                              1.-LOWER CASE
C                              2.-SPECIAL CASE
C   60 LEFT MARGIN        MARGIN IN SUBJECT SPACE.                0.   SETSMG
C   61 RIGHT MARGIN       MARGIN IN SUBJECT SPACE.             4095.   SETSMG
C   62 BOTTOM MARGIN      MARGIN IN SUBJECT SPACE.                0.   SETSMG
C   63 TOP MARGIN         MARGIN IN SUBJECT SPACE.             3071.   SETSMG
C   77 FORMAT WIDTH       FORMAT WIDTH-USED BY NUMBRG.            -    SETSMG
C   78 FORMAT DECIMALS    FORMAT DECIMAL-USED BY NUMBRG.          -    SETSMG
C   79 FORMAT             FORMAT-USED BY NUMBRG                   -    SETSMG
C                              1. - I FORMAT
C                              2. - F FORMAT
C                              3. - E FORMAT
C                              4. - A FORMAT
C   80 PL/I FLAG          PL/I CALLS.                             0.   SETSMG
C                              0.-NO
C                              1.-YES
C   81 CHARACTER ADDRESS  N'TH CHARACTER OF A STRING TO BEGIN     1.   SETSMG
C                         ADDRESSING WITH.
C   82 TYPE OF ARC        METHOD TO USE IN DRAWING AN ARC.        0.   SETSMG
C                              0.-LINES
C                              1.-POINTS
C   83 ROUNDNESS OF ARC   DEGREES BETWEEN TWO ADJACENT POINTS     5.   SETSMG
```

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C                       OF AN ARC.
C   84 PLOT CHARACTER   CHARACTER TO USE FOR PLOTTING.        POINT SETSMG
C   85 SCIENTIFIC FMT   SPECIFIES SCIENTIFIC OR E FORMAT.       0.  SETSMG
C                           0.-E FORMAT
C                           1.-SCIENTIFIC NOTATION
C   88 VOID MARK        PUT VOID MARK ON BAD OUTPUT.            0.  SETSMG
C                           0. - YES
C                           1. - NO
C   90 HARDCOPY MODE    TYPE OF HARDCOPY TO PRODUCE.            1.  SETSMG
C                           0.-NONE
C                                (OBJECT SPACE IS RESET TO
C                                XMIN=0., XMAX=1.33333,
C                                YMIN=0., YMAX=1.)
C                           1.-11 X 14
C                                (OBJECT SPACE IS RESET TO
C                                XMIN=0., XMAX=1.33333,
C                                YMIN=0., YMAX=1.)
C                           2.-8 1/2 X 11
C                                (OBJECT SPACE IS RESET TO
C                                XMIN=0., XMAX =.72967,
C                                YMIN=0., YMAX=1.)
C                           3.-STRIP CHART
C                                (OBJECT SPACE IS RESET TO
C                                XMIN=0., XMAX=1.,
C                                YMIN=0., YMAX=1.)
C   91 FILM ADVANCE     DISTANCE TO ADVANCE FILM IN PERFS.      6.  SYSTEM
C   92 FORMS FLASH      AUTOMATIC FORMS FLASH.                  0.  SETSMG
C                           0.-OFF
C                           1.-ON
C   93 FRAME MARKS      AUTOMATIC FRAME MARKS.                  3.  SETSMG
C                           0.-NONE
C                           1.-CORNER MARKS
C                           2.-ID
C                           3.-CORNER MARKS AND ID
C   94 LINE DENSITY     DENSITY OF LINES.                       0.  SETSMG
C                           0.-NORMAL
C                           1.-LIGHT
C   95 FAST PLOT        SPEED TO PLOT CHARACTERS.               0.  SETSMG
C                           0.-NORMAL
C                           1.-FAST
C  100 AXES FLAG        EMPHASIS OF MAJOR AXES.                 0.  SETSMG
C                           0.-EMPHASIZE BOTH
C                           1.-EMPHASIZE X=0 ONLY
C                           2.-EMPHASIZE Y=0 ONLY
C                           3.-NO EMPHASIS
C  102 X TICK MARKS     LENGTH OF X-AXIS TICK MARK IN           0.  SETSMG
C                       NORMALIZED OBJECT SPACE.
C  103 Y TICK MARKS     LENGTH OF Y-AXIS TICK MARK IN           0.  SETSMG
C                       NORMALIZED OBJECT SPACE.
C  104 X-AXIS LABEL     NO. TIMES CHARACTER HEIGHT TO          -1.5 SETSMG
C                       POSITION X-AXIS LABEL.
C                           + LABEL ABOVE GRID
C                           - LABEL BELOW GRID
C                           0. LABEL AT Y=0
C  105 Y-AXIS LABEL     NO. TIMES CHARACTER WIDTH TO           -1.5 SETSMG
C                       POSITION Y-AXIS LABEL.
C                           + LABEL RIGHT SIDE OF GRID
C                           - LABEL LEFT SIDE OF GRID
C                           0. LABEL AT X=0
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C 106 LEFT MARGIN        RELATIVE GRID MARGIN IN NORMALIZED    0.15 SETSMG
C                        OBJECT SPACE.
C 107 RIGHT MARGIN       RELATIVE GRID MARGIN IN NORMALIZED    0.15 SETSMG
C                        OBJECT SPACE.
C 108 BOTTOM MARGIN      RELATIVE GRID MARGIN IN NORMALIZED    0.15 SETSMG
C                        OBJECT SPACE.
C 109 TOP MARGIN         RELATIVE GRID MARGIN IN NORMALIZED    0.15 SETSMG
C                        OBJECT SPACE.
C 110 SQUARE GRID        FORCE VALUES FOR A SQUARE GRID TO      0.  SETSMG
C                        BE CALCULATED.
C                             0.-NOT FORCED TO BE SQUARE.
C                             1.-MUST BE SQUARE.
C 111 X-AXIS DENSITY     MIN DISTANCE BETWEEN X-AXIS GRID    .01009SETSMG
C                             LINES IN NORMALIZED OBJECT
C                             SPACE.
C 112 Y-AXIS DENSITY     MIN DISTANCE BETWEEN Y-AXIS GRID    .01660SETSMG
C                             LINES IN NORMALIZED OBJECT
C                             SPACE.
C 113 MIN X-TITLE        NORMALIZED OBJECT SPACE UNAVAILABLE    -   LABELG
C                             FOR TITLES.
C 114 MIN Y-TITLE        NORMALIZED OBJECT SPACE UNAVAILABLE    -   LABELG
C                             FOR TITLES.
C 115 MAX X-TITLE        NORMALIZED OBJECT SPACE UNAVAILABLE    -   LABELG
C                             FOR TITLES.
C 116 MAX Y-TITLE        NORMALIZED OBJECT SPACE UNAVAILABLE    -   LABELG
C                             FOR TITLES.
C 131 SKEW ANGLE         VECTOR CHARACTER SKEW ANGLE IN         0.  SETSMG
C                        DEGREES.
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINES METAZZ,ERRZZ,SUBJEG,OBJCTG
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
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C*****************************SUBROUTINE GETSMG*********************************
C RETRIEVE MODE VALUES.  (GETSMG)
C
C PURPOSE    THIS ROUTINE IS USED TO RETRIEVE A SINGLE VALUE FROM THE
C            MODE SET ARRAY.
C
C CALL       CALL GETSMG(Z,NO,VALUE)
C                 Z IS THE MODE SET ARRAY.
C                 NO IS A NUMBER IDENTIFYING THE PARTICULAR MODE SET
C                   PARAMETER.
C                 VALUE WILL CONTAIN THE MODE SET VALUE ON RETURN.
C
C                                                              DEFAULT
C  NO FUNCTION           DESCRIPTION                          VALUE SET BY
C
C   1 INITIALIZATION     TELLS WHETHER ARRAY IS INITIALIZED.    -   SYSTEM
C   2 MIN-X              SUBJECT SPACE.                         0.  SUBJEG
C   3 MIN-Y              SUBJECT SPACE.                         0.  SUBJEG
C   4 MAX-X              SUBJECT SPACE.                      4095.  SUBJEG
C   5 MAX-Y              SUBJECT SPACE.                      3071.  SUBJEG
C   6 MIN-X              NORMALIZED OBJECT SPACE.               0.  OBJCTG
C   7 MIN-Y              NORMALIZED OBJECT SPACE.               0.  OBJCTG
C   8 MAX-X              NORMALIZED OBJECT SPACE.            1.333  OBJCTG
C   9 MAX-Y              NORMALIZED OBJECT SPACE.               1.  OBJCTG
C  10 X-OFFSET           SCALING FACTORS COMPUTED BY SYSTEM.    0.  SYSTEM
C  11 Y-OFFSET           SCALING FACTORS COMPUTED BY SYSTEM.    0.  SYSTEM
C  12 X-SCALE            SCALING FACTORS COMPUTED BY SYSTEM.    1.  SYSTEM
C  13 Y-SCALE            SCALING FACTORS COMPUTED BY SYSTEM.    1.  SYSTEM
C  14 SCALE FLAG         TYPE OF SCALING TO DO.                 1.  SYSTEM
C                             0.-REAL SUBJECT SPACE UNITS.
C                             1.-REAL ABSOLUTE RASTER UNITS.
C                             2.-INTEGER ABSOLUTE RASTERS.
C                             3.-REAL NORMALIZED OBJECT
C                                SPACE.
C  17 LAST X             CURRENT POINT POSITION IN SUBJECT      -   SYSTEM
C                        SPACE.  (NOTE-THIS VALUE WILL CONTAIN
C                        THE X LOCATION OF THE FIRST
C                        CHARACTER WHEN CHARACTRON CHARACTERS
C                        ARE DISPLAYED.  IT WILL CONTAIN THE
C                        LOCATION OF THE 'NEXT' CHARACTER
C                        WHEN VECTOR CHARACTERS ARE DISPLAYED.)
C  18 LAST Y             CURRENT POINT POSITION IN SUBJECT      -   SYSTEM
C                        SPACE.  (NOTE-THIS VALUE WILL CONTAIN
C                        THE Y LOCATION OF THE FIRST
C                        CHARACTER WHEN CHARACTRON CHARACTERS
C                        ARE DISPLAYED.  IT WILL CONTAIN THE
C                        LOCATION OF THE 'NEXT' CHARACTER
C                        WHEN VECTOR CHARACTERS ARE DISPLAYED.)
C  19 MAX X-NORM.        SCOPE SIZE IN NORMALIZED OBJECT     1.333  SETSMG
C                        SPACE.
C  20 MAX Y-NORM.        SCOPE SIZE IN NORMALIZED OBJECT        1.  SETSMG
C                        SPACE.
C  21 MAX-X              SCOPE SIZE-IN ABSOLUTE RASTER UNITS 4095.  SETSMG
C  22 MAX-Y              SCOPE SIZE-IN ABSOLUTE RASTER UNITS 3071.  SYSTEM
C  23 X-LINEAR FLAG      FLAG FOR LINEAR SCALING IN X-AXIS.     0.  SETSMG
C                             0.-LINEAR
C                             1.-NONLINEAR
C  24 Y-LINEAR FLAG      FLAG FOR LINEAR SCALING IN Y-AXIS.     0.  SETSMG
C                             0.-LINEAR
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C                              1.-NONLINEAR
C   25 LOG(MIN-X)          LOG OF SUBJECT SPACE.                    -    SYSTEM
C   26 LOG(MIN-Y)          LOG OF SUBJECT SPACE.                    -    SYSTEM
C   27 LOG(MAX-X)          LOG OF SUBJECT SPACE.                    -    SYSTEM
C   28 LOG(MAX-Y)          LOG OF SUBJECT SPACE.                    -    SYSTEM
C   30 LINE WIDTH          NO. TIMES NORMAL WIDTH.                  1.   SETSMG
C                              .5   2 RASTERS
C                              1.0  4 RASTERS
C                              2.0  8 RASTERS
C                              4.0 16 RASTERS
C   31 LINE TEXTURE        SIZE OF DASHED LINE.                     0.   SETSMG
C                              0.-SOLID
C                              1.-32 RASTER UNITS.
C                              2.-64 RASTER UNITS.
C                              3.-128 RASTER UNITS.
C                              4.-256 RASTER UNITS.
C   40 NORMAL WIDTH        NORMAL CHARACTER WIDTH IN              .01009SYSTEM
C                              NORMALIZED OBJECT SPACE.
C   41 NORMAL HEIGHT       NORMAL CHARACTER HEIGHT IN             .0166 SYSTEM
C                              NORMALIZED OBJECT SPACE.
C   42 CURRENT WIDTH       CHARACTER WIDTH IN SUBJECT SPACE.        31.  SETSMG
C   43 CURRENT HEIGHT      CHARACTER HEIGHT IN SUBJECT SPACE.       51.  SETSMG
C   44 PAGE EJECTION       EJECT TO A NEW PAGE IF LINES RUN         0.   SETSMG
C                          OFF THE BOTTOM OR TOP MARGINS.
C                              0.-NO
C                              1.-YES
C   45 CHARACTER SIZE      NO. TIMES NORMAL SIZE FOR TYPING.        1.   SETSMG
C                              .75   23X38 RASTERS
C                              1.0   31X51 RASTERS
C                              1.25  39X64 RASTERS
C                              1.5   47X77 RASTERS
C   46 TYPING ORIEN.       TYPING ORIENTATION IN DEGREES.           0.   SETSMG
C                          BOTH CHARACTER AND LINE ORIENTATION
C                          ARE SET.  0. IS A VERTICAL CHARACTER
C                          AND A HORIZONTAL LINE TO THE RIGHT.
C                          COUNTER CLOCKWISE IS POSITIVE.
C                          0. AND 90. ARE ALLOWED FOR
C                          CHARACTRON CHARACTERS.
C   47 CHARACTER SPACING   NO. TIMES TO SPACE CHARACTERS.           1.0  SETSMG
C   48 VACANT
C   49 LINE SPACING        NO. TIMES CURRENT CHARACTER HEIGHT       -1.  SETSMG
C                          TO SPACE LINE UPON EJECTION.
C                              + VALUE, SPACE LINE UP.
C                              - VALUE, SPACE LINE DOWN.
C   50 LINE ORIENTATION    ANGLE IN DEGREES AT WHICH A LINE OF      0.   SETSMG
C                          CHARACTERS IS TO BE DISPLAYED.  0.
C                          IS HORIZONTAL, TO THE RIGHT.
C                          COUNTER CLOCKWISE ANGLES ARE
C                          POSITIVE.
C   51 CHARACTER FONT      CHARACTER FONT TO USE FOR TYPING.        0.   SETSMG
C                              0.-CHARACTRON
C                              1.-STANDARD VECTOR
C   52 CHARACTER CASE      CHARACTER CASE FOR TYPING.               0.   SETSMG
C                              0.-UPPER CASE
C                              1.-LOWER CASE
C                              2.-SPECIAL CASE
C   53 PLOT CHAR SIZE      NO. TIMES NORMAL SIZE FOR PLOTTING.      1.   SETSMG
C                              .75   23X38 RASTER UNITS.
C                              1.0   31X51 RASTER UNITS.
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C                          1.25  39X64 RASTER UNITS.
C                          1.5   47X77 RASTER UNITS.
C  54 PLOT CHAR ORIEN.  PLOT CHARACTER ORIENTATION IN          0.  SETSMG
C                       DEGREES.  0. IS UPRIGHT.  COUNTER
C                       CLOCKWISE IS POSITIVE.
C                            0. - UPRIGHT
C                            90. - HORIZONTAL
C  55 PLOT CHAR. CASE   CHARACTER CASE FOR PLOTTING.           0.  SETSMG
C                            0.-UPPER CASE
C                            1.-LOWER CASE
C                            2.-SPECIAL CASE
C  60 LEFT MARGIN       MARGIN IN SUBJECT SPACE.               0.  SETSMG
C  61 RIGHT MARGIN      MARGIN IN SUBJECT SPACE.            4095.  SETSMG
C  62 BOTTOM MARGIN     MARGIN IN SUBJECT SPACE.               0.  SETSMG
C  63 TOP MARGIN        MARGIN IN SUBJECT SPACE.            3071.  SETSMG
C  64 CHARACTERS/LINE   NO. CHARACTERS PER LINE              132.  SYSTEM
C  65 LINES/PAGE        NO. LINES PER PAGE.                   60.  SYSTEM
C  66 NO. TABS          NO. TABS IN EFFECT                     0.  TABSG
C  67 TAB 1             TAB SET IN X-COORD. SUBJECT SPACE.     0.  TABSG
C  68 TAB 2             TAB SET IN X-COORD. SUBJECT SPACE.     0.  TABSG
C   .  .  .             TAB SET IN X-COORD. SUBJECT SPACE.     .   TABSG
C   .  .  .             TAB SET IN X-COORD. SUBJECT SPACE.     .   TABSG
C  76 TAB 10            TAB SET IN X-COORD. SUBJECT SPACE.     0.  TABSG
C  77 FORMAT WIDTH      FORMAT WIDTH-USED BY NUMBRG.           -   SETSMG
C  78 FORMAT DECIMALS   FORMAT DECIMAL-USED BY NUMBRG.         -   SETSMG
C  79 FORMAT            FORMAT-USED BY NUMBRG                  -   SETSMG
C                            1. - I FORMAT
C                            2. - F FORMAT
C                            3. - E FORMAT
C                            4. - A FORMAT
C  80 PL/I FLAG         PL/I CALLS.                            0.  SETSMG
C                            0.-NO
C                            1.-YES
C  81 CHARACTER ADDRESS N'TH CHARACTER OF A STRING TO BEGIN    1.  SETSMG
C                       ADDRESSING WITH.
C  82 TYPE OF ARC       METHOD TO USE IN DRAWING AN ARC.       0.  SETSMG
C                            0.-LINES
C                            1.-POINTS
C  83 ROUNDNESS OF ARC  DEGREES BETWEEN TWO ADJACENT POINTS    5.  SETSMG
C                       OF AN ARC.
C  84 PLOT CHARACTER    CHARACTER TO USE FOR PLOTTING.       POINT  SETSMG
C  85 SCIENTIFIC FMT    SPECIFIES SCIENTIFIC OR E FORMAT.      0.  SETSMG
C                            0.-E FORMAT
C                            1.-SCIENTIFIC NOTATION
C  88 VOID MARK         PUT VOID MARK ON BAD OUTPUT.           0.  SETSMG
C                            0. - YES
C                            1. - NO
C  89 TAPE UNIT         OUTPUT TAPE NUMBER                    10.  MODESG
C  90 HARDCOPY MODE     TYPE OF HARDCOPY TO PRODUCE.           1.  SETSMG
C                            0.-NONE
C                                 (OBJECT SPACE IS RESET TO
C                                 XMIN=0., XMAX=1.33333,
C                                 YMIN=0., YMAX=1.)
C                            1.-11 X 14
C                                 (OBJECT SPACE IS RESET TO
C                                 XMIN=0., XMAX=1.33333,
C                                 YMIN=0., YMAX=1.)
C                            2.-8 1/2 X 11
C                                 (OBJECT SPACE IS RESET TO
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C                                   XMIN=0., XMAX =.72967,
C                                   YMIN=0., YMAX=1.)
C                              3.-STRIP CHART
C                                   (OBJECT SPACE IS RESET TO
C                                   XMIN=0., XMAX=1.,
C                                   YMIN=0., YMAX=1.)
C   91 FILM ADVANCE       DISTANCE TO ADVANCE FILM IN PERFS.     6.   SYSTEM
C   92 FORMS FLASH        AUTOMATIC FORMS FLASH.                 0.   SETSMG
C                              0.-OFF
C                              1.-ON
C   93 FRAME MARKS        AUTOMATIC FRAME MARKS.                 3.   SETSMG
C                              0.-NONE
C                              1.-CORNER MARKS
C                              2.-ID
C                              3.-CORNER MARKS AND ID
C   94 LINE DENSITY       DENSITY OF LINES.                      0.   SETSMG
C                              0.-NORMAL
C                              1.-LIGHT
C   95 FAST PLOT          SPEED TO PLOT CHARACTERS.              0.   SETSMG
C                              0.-NORMAL
C                              1.-FAST
C   96 FRAME COUNT        NO. FRAMES PRODUCED                    0.   SYSTEM
C  100 AXES FLAG          EMPHASIS OF MAJOR AXES.                0.   SETSMG
C                              0.-EMPHASIZE BOTH
C                              1.-EMPHASIZE X=0 ONLY
C                              2.-EMPHASIZE Y=0 ONLY
C                              3.-NO EMPHASIS
C  102 X TICK MARKS       LENGTH OF X-AXIS TICK MARK IN          0.   SETSMG
C                         NORMALIZED OBJECT SPACE.
C  103 Y TICK MARKS       LENGTH OF Y-AXIS TICK MARK IN          0.   SETSMG
C                         NORMALIZED OBJECT SPACE.
C  104 X-AXIS LABEL       NO. TIMES CHARACTER HEIGHT TO         -1.5  SETSMG
C                         POSITION X-AXIS LABEL.
C                              + LABEL ABOVE GRID
C                              - LABEL BELOW GRID
C                              0. LABEL AT Y=0
C  105 Y-AXIS LABEL       NO. TIMES CHARACTER WIDTH TO          -1.5  SETSMG
C                         POSITION Y-AXIS LABEL.
C                              + LABEL RIGHT SIDE OF GRID
C                              - LABEL LEFT SIDE OF GRID
C                              0. LABEL AT X=0
C  106 LEFT MARGIN        RELATIVE GRID MARGIN IN NORMALIZED    0.15  SETSMG
C                         OBJECT SPACE.
C  107 RIGHT MARGIN       RELATIVE GRID MARGIN IN NORMALIZED    0.15  SETSMG
C                         OBJECT SPACE.
C  108 BOTTOM MARGIN      RELATIVE GRID MARGIN IN NORMALIZED    0.15  SETSMG
C                         OBJECT SPACE.
C  109 TOP MARGIN         RELATIVE GRID MARGIN IN NORMALIZED    0.15  SETSMG
C                         OBJECT SPACE.
C  110 SQUARE GRID        FORCE VALUES FOR A SQUARE GRID TO      0.   SETSMG
C                         BE CALCULATED.
C                              0.-NOT FORCED TO BE SQUARE.
C                              1.-MUST BE SQUARE.
C  111 X-AXIS DENSITY     MIN DISTANCE BETWEEN X-AXIS GRID    .01009SETSMG
C                              LINES IN NORMALIZED OBJECT
C                              SPACE.
C  112 Y-AXIS DENSITY     MIN DISTANCE BETWEEN Y-AXIS GRID    .01660SETSMG
C                              LINES IN NORMALIZED OBJECT
C                              SPACE.
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C 113 MIN X-TITLE       NORMALIZED OBJECT SPACE UNAVAILABLE   -    LABELG
C                            FOR TITLES.
C 114 MIN Y-TITLE       NORMALIZED OBJECT SPACE UNAVAILABLE   -    LABELG
C                            FOR TITLES.
C 115 MAX X-TITLE       NORMALIZED OBJECT SPACE UNAVAILABLE   -    LABELG
C                            FOR TITLES.
C 116 MAX Y-TITLE       NORMALIZED OBJECT SPACE UNAVAILABLE   -    LABELG
C                            FOR TITLES.
C 131 SKEW ANGLE        VECTOR CHARACTER SKEW ANGLE IN        0.   SETSMG
C                       DEGREES.
C 132 X-MULT            VECTOR CHARACTER MULTIPLE OF          1.   SYSTEM
C                       STANDARD CHARACTER WIDTH.
C 133 Y-MULT            VECTOR CHARACTER MULTIPLE OF          1.   SYSTEM
C                       STANDARD CHARACTER HEIGHT.
C 134 SKEW FACTOR       TAN(SKEW ANGLE)                       0.   SYSTEM
C 135 ROTATION ANGLE    VECTOR CHARACTER ROTATION ANGLE IN    0.   SYSTEM
C                       RADIANS.
C 136 FONT NUMBER       VECTOR CHARACTER FONT NUMBER.         -    SYSTEM
C 137 CHARS/CASE        NUMBER OF VECTOR CHARACTERS PER CASE  0.   SYSTEM
C 138 X-DISP            VECTOR CHARACTER ENVELOPE CENTER      -    SYSTEM
C 139 Y-DISP            VECTOR CHARACTER ENVELOPE CENTER      -    SYSTEM
C 140 WIDTH ADJ         VECTOR CHAR. WIDTH ADJUSTMENT         -    SYSTEM
C 141 HEIGHT ADJ        VECTOR CHAR. HEIGHT ADJUSTMENT        -    SYSTEM
C 143 NO. OF CASES      VECTOR CHARACTER FONT CASES.          -    SYSTEM
C 146 PACKING FLAG      VECTOR CHARACTER PACKING FLAG.        -    SYSTEM
C                            0. = 1 WORD/COORD.
C                            1. = 1 BYTE/COORD.
C 147 CHARACTER TYPE    TYPE OF CHARACTERS IN FONT.           -    SYSTEM
C                            0. - VECTOR
C                            1. - STROKE
C 150 POINTER           POINTER TO CURRENT VECTOR CHARACTER   -    SYSTEM
C                       FONT.
C
C SPECIAL   NONE
C
C MODS      NONE
C
C
C NOTES     THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

```
C*****************************SUBROUTINE RSETMG*********************************
C RESET ALL DEFAULT VALUES IN MODE SET ARRAY.  (RSETMG)
C
C PURPOSE    THIS ROUTINE RESETS ALL VALUES IN THE MODE SET ARRAY TO
C            THEIR PROPER DEFAULT VALUES.
C
C CALL       CALL RSETMG(Z)
C                 Z IS THE MODE SET ARRAY.
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINES METAZZ,SETSMG
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            THE HARDCOPY MODE SET WILL NOT BE RESET.
```

```
C*****************************SUBROUTINE TABSG*********************************
C SET UP TYPING TABS.  (TABSG)
C
C PURPOSE    THIS SUBROUTINE IS CALLED TO SET UP TYPING TABS.  ITS
C            FUNCTION IS VERY SIMILAR TO THE SETTING OF TABS ON A
C            TYPEWRITER.  THE MAIN DIFFERENCES ARE THAT THE TABS ARE SET
C            TO AN X-COORDINATE LOCATION RATHER THAN TO A CHARACTER
C            POSITION, AND THE TAB IS ACTUATED BY A SPECIAL TAB CHARACTER
C            RATHER THAN BY MANUALLY HITTING A TAB KEY.
C
C CALL       CALL TABSG(Z,NTABS,TABS)
C                 Z IS THE MODE SET ARRAY.
C                 NTABS IS THE NUMBER OF TABS TO BE SET.  A MAXIMUM OF
C                      TEN TABS IS ALLOWED.
C                 TABS IS AN ARRAY OF 'NTABS' X-COORDINATES SPECIFYING
C                      THE TABS TO SET.
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINES METAZZ,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            EACH TAB CHARACTER ENCOUNTERED IN A CHARACTER STRING CAUSES
C            A TAB TO THE NEXT TAB SET.  IF THERE ARE NO MORE TABS, IT
C            SKIPS TO THE RIGHT MARGIN.  THE NEXT CHARACTER ENCOUNTERED
C            WILL CAUSE AN EJECTION TO A NEW LINE.  EACH NEW LINE RESETS
C            THE TAB COUNTER IN THE SAME WAY THAT A CARRIAGE RETURN
C            RESTARTS THE TABBING SEQUENCE ON A TYPEWRITER.
```

```
C*****************************SUBROUTINE PAGEG*********************************
C CONTROL FORMS FLASH AND FRAME ADVANCE.  (PAGEG)
C
C PURPOSE    THIS SUBROUTINE IS CALLED TO DO A FORMS FLASH (IF REQUESTED)
C            PRODUCE HARDCOPY (IF REQUIRED), AND ADVANCE THE FRAME.  THE
C            FORMS FLASH CAUSES THE FORMS OVERLAY TO BE 'SHOT' ONTO THE
C            CURRENT FRAME.  FRAME ADVANCE SIGNALS THE COMPLETION OF THE
C            CURRENT PICTURE AND ADVANCES THE FILM.
C
C CALL       CALL PAGEG(Z,NFORM,NCOPY,NADVAN)
C                 Z IS THE MODE SET ARRAY.
C                 NFORM SPECIFIES WHETHER OR NOT THE FORMS FLASH IS
C                      WANTED.
C                      NFORM=0, NO FORMS FLASH.
C                      NFORM>0, FLASH THE FORMS 'NFORM' TIMES.
C                 NCOPY SPECIFIES THE NUMBER OF HARDCOPIES TO MAKE OF THE
C                      FRAME.  (NCOPY=0, NO COPIES ARE MADE.)
C                 NADVAN SPECIFIES THE NUMBER OF FRAMES TO ADVANCE.  IF
C                      NADVAN=0, THE FRAME IS NOT ADVANCED.  (1 ADVANCE
C                      IS NORMAL.)
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINES METAZZ,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

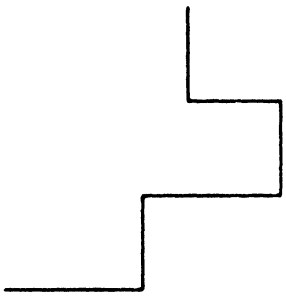
```
C*****************************SUBROUTINE EXITG*********************************
C TERMINATE THE GRAPHIC OUTPUT.  (EXITG)
C
C PURPOSE    THIS SUBROUTINE DOES ALL THE CLEANUP NECESSARY FOR
C            TERMINATING A GRAPHIC JOB.  IT CLOSES FILES AS NEEDED, AND
C            DOES WHATEVER ACCOUNTING IS NECESSARY.  IT MUST BE THE LAST
C            GRAPHIC SUBROUTINE CALLED BEFORE THE JOB IS TERMINATED.
C
C CALL       CALL EXITG(Z)
C                 Z IS THE MODE SET ARRAY.
C
C SPECIAL    THE FOLLOWING CALL MAY BE USED BY THE SYSTEM PROGRAMMER TO
C            ABNORMALLY TERMINATE THE USER.  THE CALL IS THE SAME AS THE
C            ABOVE EXCEPT THAT THE REFERENCE TO THE MODE SET ARRAY IS NOT
C            REQUIRED.  THE CALL IS AS FOLLOWS:
C                 CALL EXITG(0)
C
C MODS       NONE
C
C USES       SUBROUTINES METAZZ,PACKZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            THIS SUBROUTINE MAY BE MODIFIED BY EACH INSTALLATION TO SUIT
C            ITS PARTICULAR NEEDS.
C
C            EACH INSTALLATION WILL HAVE THE OPTION OF ALLOWING THE
C            PROGRAMMER TO MAKE THE CALL HIMSELF, OR TO MODIFY THEIR
C            SYSTEM TO MAKE THE CALL FOR HIM.  SYSTEM PROGRAMMERS MAY
C            ALSO WANT TO MODIFY THEIR SYSTEMS TO GIVE THE SPECIAL EXIT
C            CALL IN THE EVENT THAT THE USER'S PROGRAM ABNORMALLY
C            TERMINATES.
```

```
C*****************************SUBROUTINE VECIG*********************************
C INITIALIZE A VECTOR CHARACTER FONT.  (VECIG)
C
C PURPOSE    THIS SUBROUTINE INITIALIZES A VECTOR CHARACTER FONT AS
C            FOLLOWS:
C                 1)  IT SETS THE ADDRESS OF THE FONT IN THE MODE SET
C                     ARRAY(MODE 150).
C                 2)  IT SETS OTHER FONT INFORMATION IN THE MODE SET
C                     ARRAY(MODES 136-147).
C                 3)  IT CALCULATES AND SETS THE MULTIPLIERS NECESSARY TO
C                     PRODUCE THE FONT TO THE CURRENT CHARACTER WIDTH AND
C                     HEIGHT(MODES 132 & 133.  THESE ARE ALSO SET
C                     BY SETSMG).
C
C CALL       CALL VECIG(Z,FONT)
C                 Z IS THE MODE SET ARRAY.
C                 FONT IS THE NAME ASSIGNED TO THE BEGINNING OF DATA
C                      FOR THIS FONT.
C
C SPECIAL    NONE
C
C
C USES       SUBROUTINES SCALZZ,SETSMG,UNSCZZ, FUNCTION  LOCZ
C
C NOTES      THE NAME OF EACH FONT TO BE INITIALIZED MUST APPEAR ON AN
C            'EXTERNAL' CARD IN FORTRAN IV.
C
C            ONLY ONE FONT MAY BE IN EFFECT AT ANY ONE TIME.  IN ORDER TO
C            CHANGE TO A NEW FONT, THIS SUBROUTINE MUST BE CALLED.
C
C            THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

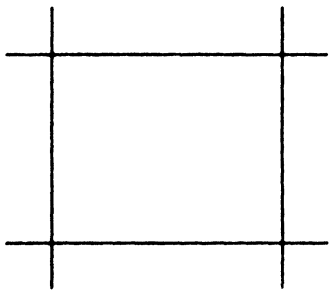
GRAPHIC OUTPUT SUBROUTINES

The following call statements refer to the subroutines which perform the printing, plotting, and line drawing functions.

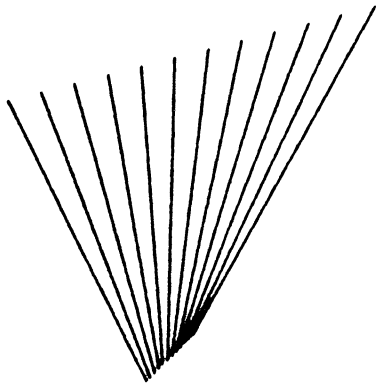
The following diagrams give a pictorial view of what each graphic output subroutine does.



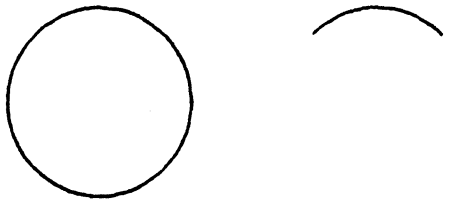
Draw joined lines–LINESG



Draw line segments–SEGMTG



Draw multiple lines–MLTPLG



Draw circles and arcs–CIRARG

Plot points–POINTG

A
BC
DEfg
h*/K

Display characters–LEGNDG,TEXTG

27
36.293
0.263E+06
$0.263X10^{+06}$

Display numeric data–NUMBRG

Figure 10. Graphic Output Subroutines

```
C*****************************SUBROUTINE CIRARG*********************************
C DRAW A CIRCLE OR AN ARC.  (CIRARG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO DRAW A CIRCLE OR ARC.  SINCE
C            A CURVED LINE CANNOT BE DRAWN, THE CIRCLE OR ARC IS
C            APPROXIMATED BY DRAWING SHORT LINE SEGMENTS.
C
C CALL       CALL CIRARG(Z,XC,YC,RADIUS,START,ARC)
C                 Z IS THE MODE SET ARRAY.
C                 XC,YC IS THE X,Y LOCATION OF THE CENTER POINT OF THE
C                      ARC.
C                 RADIUS IS THE RADIUS OF CURVATURE.  IT SHOULD BE IN THE
C                      SAME UNITS AS THE X COORDINATES.
C                 START IS THE STARTING ANGLE IN DEGREES.  COUNTERCLOCK-
C                      WISE ANGLES ARE POSITIVE.  (0. DEGREES IS
C                      HORIZONTAL AND TO THE RIGHT.)
C                 ARC IS THE NUMBER OF DEGREES OF ARC TO DISPLAY.  FOR
C                      EXAMPLE, AN ARC OF 720. WOULD CAUSE TWO COMPLETE
C                      CIRCLES TO BE DRAWN, ONE ON TOP OF THE OTHER.
C
C SPECIAL    NONE
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO CHANGE THE ANGLE BETWEEN TWO SUCCESSIVE POINTS,
C                     GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,83,ANGLE)
C                               ANGLE IS THE ANGLE IN DEGREES BETWEEN TWO
C                                    POINTS ON THE ARC.
C                               ANGLE = 5. IS THE DEFAULT VALUE.
C                 2.  TO DRAW THE ARC WITH POINTS RATHER THAN LINE
C                     SEGMENTS, GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,82,1.)
C                     TO RESET IT TO DRAW THE ARC WITH LINE SEGMENTS,
C                     GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,82,0.)
C                     NOTE-WHEN AN ARC IS DRAWN WITH POINTS, ALL THE MODE
C                     SETS DESCRIBED IN 'POINTG' ARE IN EFFECT.  POINTS
C                     WILL BE PLOTTED AT THE STARTING AND ENDING POINTS
C                     OF AN ARC.  THIS MEANS THAT IF A 360. ARC IS
C                     SPECIFIED, A POINT WILL BE DISPLAYED AT 0. AND AT
C                     360. (THE SAME LOCATION).
C
C USES       SUBROUTINES LINESG,POINTG.
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            ALL MODE SETS DESCRIBED IN SUBROUTINE LINESG WILL BE IN
C            EFFECT IF THE CIRCLE IS DRAWN WITH LINE SEGMENTS, AND ALL
C            MODE SETS DESCRIBED IN SUBROUTINE POINTG WILL BE IN EFFECT
C            IF THE CIRCLE IS DRAWN WITH POINTS.
```

```
C*****************************SUBROUTINE LEGNDG*********************************
C DISPLAY CHARACTERS.  (LEGNDG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO DISPLAY CHARACTERS.  IF THE
C            CHARACTERS GO BEYOND THE RIGHT MARGIN, THE LINE IS EJECTED
C            TO THE LEFT MARGIN.  IF THE LINE GOES BEYOND THE BOTTOM
C            MARGIN, THE LINE IS EJECTED TO THE TOP.
C
C CALL       CALL LEGNDG(Z,X,Y,N,CHAR)
C                 Z IS THE MODE SET ARRAY.
C                 X,Y IS THE LOCATION OF THE CENTER OF THE FIRST
C                      CHARACTER.
C                 N IS THE NUMBER OF CHARACTERS TO DISPLAY.  (N => 1)
C                 CHAR IS THE NAME OF A VARIABLE OR AN ARRAY WHICH
C                      CONTAINS THE CHARACTER STRING TO DISPLAY.
C
C SPECIAL    NONE
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO CHANGE THE CHARACTER SIZE, GIVE THE FOLLOWING
C                     CALL:
C                          CALL SETSMG(Z,45,SIZE)
C                               SIZE SPECIFIES THE SIZE OF THE CHARACTERS
C                                    RELATIVE TO NORMAL SIZE.  (.75, 1.0,
C                                    1.25, AND 1.5 ARE ALLOWED FOR
C                                    CHARACTRON CHARACTERS.)
C                               SIZE = 1.0 IS THE DEFAULT VALUE.
C                 2.  TO CHANGE THE CHARACTER WIDTH(VECTOR CHARACTERS
C                     ONLY), GIVE THE FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,42,W)
C                               W IS THE CHARACTER WIDTH IN SUBJECT SPACE
C                                    UNITS.
C                               W = 31. IS THE DEFAULT VALUE.
C                 3.  TO CHANGE THE CHARACTER HEIGHT(VECTOR CHARACTERS
C                     ONLY), GIVE THE FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,43,H)
C                               H IS THE CHARACTER HEIGHT IN SUBJECT
C                                    SPACE UNITS.
C                               H = 51. IS THE DEFAULT VALUE.
C                 4.  TO CHANGE THE LINE AND CHARACTER ORIENTATION, GIVE
C                     THE FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,46,ORIEN)
C                               ORIEN SPECIFIES THE ORIENTATION OF THE
C                                    LINE AND CHARACTERS.  0. AND 90. ARE
C                                    ALLOWED FOR CHARACTRON CHARACTERS.
C                                    0. IS THE NORMAL UPRIGHT POSITION.
C                                    THE ANGLE OF ORIENTATION IS POSITIVE
C                                    IN THE COUNTERCLOCKWISE DIRECTION.
C                               ORIEN = 0. IS THE DEFAULT VALUE.
C                 5.  TO CHANGE THE CHARACTER SPACING, GIVE THE FOLLOWING
C                     CALLS:
C                          CALL SETSMG(Z,47,+-SPACE)
C                               SPACE SPECIFIES THE CHARACTER SPACING IN
C                                    THE TYPING DIRECTION.  PLUS OR MINUS
C                                    SPACING MAY BE SET.
C                               SPACE = 1. IS THE DEFAULT VALUE.
C                 6.  TO SPECIFY THE NUMBER OF LINES TO SPACE UP OR DOWN
C                     IF THE CHARACTERS GO BEYOND THE RIGHT MARGIN AND
```

```
C                CAUSE THE LINE TO BE EJECTED TO THE LEFT MARGIN,
C                GIVE THE FOLLOWING CALL:
C                     CALL SETSMG(Z,49,+-SPACE)
C                          SPACE SPECIFIES THE NUMBER OF LINES TO
C                               SPACE UP OR DOWN.  THIS IS EQUI-
C                               VALENT TO SETTING THE NUMBER OF
C                               LINES TO SPACE FOR A CARRIAGE RETURN
C                               ON A TYPEWRITER.  A MINUS SPACING
C                               CAUSES THE LINE TO BE SPACED DOWN
C                               THE PAGE, AND A POSITIVE SPACING
C                               CAUSES IT TO MOVE UP THE PAGE.
C                          SPACE = -1. IS THE DEFAULT VALUE.
C             7.   TO CHANGE THE LINE ORIENTATION, GIVE THE
C                FOLLOWING CALL:
C                     CALL SETSMG(Z,50,ANGLE)
C                          ANGLE SPECIFIES THE ANGLE IN DEGREES
C                               AT WHICH THE LINE OF CHARACTERS IS
C                               TO BE DISPLAYED.  (0. DEGREES IS
C                               HORIZONTAL AND TO THE RIGHT.)
C                               COUNTERCLOCKWISE ANGLES ARE
C                               POSITIVE.
C                          ANGLE = 0. IS THE DEFAULT VALUE.
C                          NOTE-THIS CALL DOES NOT CHANGE THE
C                          CHARACTER ORIENTATION.
C             8.   TO SPECIFY THE MARGINS OF THE PAGE, GIVE THE
C                FOLLOWING MODE SET CALLS:
C                     CALL SETSMG(Z,60,XLEFT)
C                          XLEFT SPECIFIES THE LEFT MARGIN OF THE
C                               PAGE IN SUBJECT SPACE COORDINATES.
C                          XLEFT = 0. IS THE DEFAULT VALUE.
C                     CALL SETSMG(Z,61,RIGHT)
C                          RIGHT SPECIFIES THE RIGHT MARGIN OF THE
C                               PAGE IN SUBJECT SPACE COORDINATES.
C                          RIGHT = 4095. IS THE DEFAULT VALUE.
C                     CALL SETSMG(Z,62,BOTTOM)
C                          BOTTOM SPECIFIES THE BOTTOM MARGIN OF THE
C                               PAGE IN SUBJECT SPACE COORDINATES.
C                          BOTTOM = 0. IS THE DEFAULT VALUE.
C                     CALL SETSMG(Z,63,TOP)
C                          TOP SPECIFIES THE TOP MARGIN OF THE
C                               PAGE IN SUBJECT SPACE COORDINATES.
C                          TOP = 3071. IS THE DEFAULT VALUE.
C             9.   TO CHANGE THE CHARACTER FONT, GIVE THE FOLLOWING
C                CALL:
C                     CALL SETSMG(Z,51,FONT)
C                          FONT = 0., CHARACTRON CHARACTERS.
C                                 1., VECTOR CHARACTERS.
C                                 2.,3.,...,N. WILL BE DEFINED LATER.
C                          FONT = 0. IS THE DEFAULT VALUE.
C                NOTE-ALL MODE SETS DESCRIBED IN SUBROUTINE LINESG
C                ARE IN EFFECT FOR VECTOR CHARACTERS.
C            10.   TO SET THE SKEW ANGLE(VECTOR CHARACTERS
C                ONLY), GIVE THE FOLLOWING MODE SET CALL:
C                     CALL SETSMG(Z,131,ANG)
C                          ANG IS THE SKEW ANGLE IN DEGREES AND MUST
C                               BE BETWEEN +90. AND -90. DEGREES.
C                               ANG = POSITIVE INDICATES SKEWING TO
C                                     THE LEFT.
C                               ANG = NEGATIVE INDICATES SKEWING TO
```

```
C                                        THE RIGHT.
C                              ANG = 0. IS THE DEFAULT VALUE.
C                    11.  TO SPECIFY THE CHARACTER CASE BY A MODE SET RATHER
C                         THAN BY SPECIAL CONTROL CHARACTERS, GIVE THE
C                         FOLLOWING MODE SET CALL:
C                              CALL SETSMG(Z,52,CASE)
C                                   CASE = 0., UPPER CASE
C                                          1., LOWER CASE
C                                          2., SPECIAL CASE
C                              CASE = 0. IS THE DEFAULT VALUE.
C                    12.  TO SPECIFY THAT A FRAME ADVANCE BE GIVEN IF THE
C                         LINE GOES BEYOND THE TOP OR BOTTOM MARGINS, GIVE
C                         THE FOLLOWING MODE SET CALL.
C                              CALL SETSMG(Z,44,1.)
C                         TO RESET TO THE DEFAULT CONDITION WHERE NO FRAME
C                         ADVANCE IS GIVEN, GIVE THE FOLLOWING CALL:
C                              CALL SETSMG(Z,44,0.)
C                    13.  TO SPECIFY THE FORM OF THE X,Y COORDINATES USED IN
C                         THE CALL, GIVE THE FOLLOWING MODE SET CALL:
C                              CALL SETSMG(Z,14,TYPE)
C                                   TYPE SPECIFIES THE FORM OF THE X,Y
C                                        COORDINATES.
C                                        0.-X,Y ARE REAL SUBJECT SPACE UNITS.
C                                        1.-X,Y ARE REAL ABSOLUTE RASTER
C                                             UNITS.
C                                        2.-X,Y ARE INTEGER ABSOLUTE RASTER
C                                             UNITS.
C                                        3.-X,Y ARE REAL NORMALIZED OBJECT
C                                             SPACE UNITS.
C
C USES       SUBROUTINES METAZZ,ERRZZ,VECSZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

```
C*****************************SUBROUTINE LINESG*********************************
C DRAW JOINED LINES.  (LINESG)
C
C PURPOSE    THIS ROUTINE IS USED TO DRAW CONNECTED LINE SEGMENTS,
C            JOINING POINTS IN AN X,Y ARRAY.
C
C CALL       CALL LINESG(Z,N,X,Y)
C                 Z IS THE MODE SET ARRAY.
C                 N IS THE NUMBER OF X,Y COORDINATES.  (N-1 JOINED LINE
C                      SEGMENTS WILL BE DRAWN.)
C                 X,Y ARE AN ARRAY OF X,Y COORDINATES.  A LINE IS DRAWN
C                      BETWEEN EACH POINT IN THE ARRAY.
C
C SPECIAL    TO DRAW A LINE FROM THE CURRENT POINT POSITION TO AN X,Y
C            LOCATION--
C                 CALL LINESG(Z,1,X,Y)
C            TO POSITION THE CURRENT POINT TO AN X,Y LOCATION WITHOUT
C            DISPLAYING ANYTHING--
C                 CALL LINESG(Z,0,X,Y)
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO SPECIFY THE LINE WIDTH, GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,30,TIMES)
C                               TIMES SPECIFIES THE LINE WIDTH RELATIVE
C                                    TO NORMAL LINE WIDTH OF 4 RASTERS.
C                                    TIMES = 0.5, ONE HALF TIMES NORMAL.
C                                            1.0, NORMAL.  (4 RASTERS)
C                                            2.0, TWO TIMES NORMAL.
C                                            4.0, FOUR TIMES NORMAL.
C                               TIMES = 1. IS THE DEFAULT VALUE.
C                 2.  TO SPECIFY THAT A DASHED LINE BE DRAWN, GIVE THE
C                     FOLLOWING CALL:
C                          CALL SETSMG(Z,31,DASH)
C                               DASH SPECIFIES THE DASH SIZE.
C                                    0., SOLID LINE.
C                                      1., 32 RASTERS.
C                                      2., 64 RASTERS.
C                                      3., 128 RASTERS.
C                                      4., 256 RASTERS.
C                               DASH = 0. IS THE DEFAULT VALUE.
C                 3.  TO SPECIFY THE LINE DENSITY, GIVE THE FOLLOWING
C                     MODE SET CALL:
C                          CALL SETSMG(Z,94,DEN)
C                               DEN = 0., NORMAL DENSITY
C                                     1., LIGHT DENSITY
C                               DEN = 0. IS THE DEFAULT VALUE.
C                 4.  TO SPECIFY THE FORM OF THE X,Y COORDINATES USED IN
C                     THE CALL, GIVE THE FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,14,TYPE)
C                               TYPE SPECIFIES THE FORM OF THE X,Y
C                                    COORDINATES.
C                                    0.-X,Y ARE REAL SUBJECT SPACE UNITS.
C                                    1.-X,Y ARE REAL ABSOLUTE RASTER
C                                         UNITS.
C                                    2.-X,Y ARE INTEGER ABSOLUTE RASTER
C                                         UNITS.
C                                    3.-X,Y ARE REAL NORMALIZED OBJECT
C                                         SPACE UNITS.
```

```
C*****************************SUBROUTINE MLTPLG*********************************
C DRAW MULTIPLE LINE SEGMTNTS.  (MLTPLG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO DRAW MULTIPLE LINE SEGMENTS.  TWO
C            LINES ARE FIRST SPECIFIED TO BE DRAWN.  NEXT, THE NUMBER OF
C            LINE SEGMENTS TO BE DRAWN BETWEEN THE TWO LINES IS GIVEN.
C            THIS ROUTINE IS VERY USEFUL IN DRAWING GRID LINES, CROSS-
C            HATCHING, AND SHADING.  THIS ROUTINE IS NOT LIMITED TO
C            DRAWING PARALLEL LINES; THE TWO DELIMITING LINES MAY BE AT
C            ANY ORIENTATION TO EACH OTHER.
C
C CALL       CALL MLTPLG(Z,N,X1,Y1,X2,Y2,X3,Y3,X4,Y4)
C                 Z IS THE MODE SET ARRAY.
C                 N SPECIFIES THE NUMBER OF LINES TO DRAW BETWEEN THE
C                      TWO GIVEN LINES.  IF N = 0, ONLY THE TWO GIVEN
C                      LINES WILL BE DRAWN.
C                 X1,Y1 AND X2,Y2 ARE TWO POINTS SPECIFYING A LINE.
C                 X3,Y3 AND X4,Y4 ARE TWO POINTS SPECIFYING A LINE.
C
C SPECIAL    NONE
C
C MODS       ALL MODE SETS DESCRIBED IN LINESG ARE APPLICABLE TO THIS
C            SUBROUTINE.
C
C USES       SUBROUTINES METAZZ,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            MLTPLG HAS MANY USES NOT AT FIRST APPARENT.  IT IS A
C            CONVENIENT MEANS OF DRAWING ANY TWO LINE SEGMENTS WITH A
C            SINGLE CALL.  IF THE DELIMITING LINE SEGMENTS ARE VERY
C            SHORT, THE VECTORS DRAWN WILL APPEAR AS POINTS.  THIS GIVES
C            THE USER A WAY OF PLOTTING MANY POINTS WITH A SINGLE CALL--
C            EXACTLY WHAT ONE DESIRES WHEN HE IS DOING SHADING.  IT
C            SHOULD BE NOTED THAT THE TWO DELIMITING LINES NEED NOT BE
C            PARALLEL.
```

```
C*****************************SUBROUTINE NUMBRG*********************************
C DISPLAY NUMERIC DATA.  (NUMBRG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO DISPLAY INTEGER OR REAL NUMBERS.
C
C CALL       TO DISPLAY AN INTEGER NUMBER IN I FORMAT--
C                 CALL NUMBRG(Z,X,Y,IFMT,INTG)
C                      Z IS THE MODE SET ARRAY.
C                      X,Y IS THE X,Y LOCATION AT WHICH TO DISPLAY THE
C                           NUMBER.  IT IS THE X,Y LOCATION OF THE
C                           CENTER OF THE LEFT-MOST CHARACTER.
C                      IFMT IS THE NUMBER OF DIGITS TO DISPLAY.
C                      INTG IS THE NUMBER TO DISPLAY.
C
C            TO DISPLAY A REAL NUMBER IN F FORMAT--
C                 CALL NUMBRG(Z,X,Y,FMT,REAL)
C                      Z IS THE MODE SET ARRAY.
C                      X,Y IS THE X,Y LOCATION AT WHICH TO DISPLAY THE
C                           NUMBER.  IT IS THE X,Y LOCATION OF THE
C                           CENTER OF THE LEFT-MOST CHARACTER.
C                      FMT SPECIFIES THE FORMAT.  IT IS OF THE FORM W.D,
C                           WHERE W SPECIFIES THE FIELD WIDTH, AND D
C                           THE NUMBER OF DECIMAL PLACES.  (D < 10)
C                      REAL IS THE NUMBER TO DISPLAY.
C
C            TO DISPLAY A REAL NUMBER IN E FORMAT--
C                 CALL NUMBRG(Z,X,Y,-FMT,REAL)
C
C            TO DISPLAY CHARACTERS IN A FORMAT--
C                 CALL NUMBRG(Z,X,Y,-IFMT,CHARS)
C
C SPECIAL    A SPECIAL CALL IS PROVIDED TO ALLOW THE FORMAT TO BE
C            SPECIFIED BY MODE SETS:
C                 CALL NUMBRG(Z,X,Y,0,VALUE)
C                      VALUE IS THE VARIABLE TO BE DISPLAYED.  THE FORMAT
C                           MUST BE SPECIFIED BY MODE SET CALLS PRIOR TO
C                           THE CALL TO NUMBRG.  THE MODE SET CALLS ARE
C                           AS FOLLOWS:
C                                CALL SETSMG(Z,77,WIDTH)
C                                     WIDTH IS THE FIELD WIDTH.
C                                CALL SETSMG(Z,78,DEC)
C                                     DEC IS THE NUMBER OF DECIMAL
C                                          PLACES.
C                                CALL SETSMG(Z,79,FMT)
C                                     FMT IS THE FORMAT TO DISPLAY THE
C                                          NUMBER IN.
C                                          FMT = 1., I FORMAT
C                                                2., F FORMAT
C                                                3., E FORMAT
C                                                4., A FORMAT
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO DISPLAY NUMBERS IN SCIENTIFIC NOTATION RATHER
C                     THAN E FORMAT, GIVE THE FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,85,1.)
C                     TO RESET TO THE DEFAULT CONDITION OF E FORMAT,
C                     GIVE THE FOLLOWING CALL:
C                          CALL SETSMG(Z,85,0.)
```

```
C                2.  ALL MODE SETS DESCRIBED IN LEGNDG ARE ALSO
C                    APPLICABLE TO THIS SUBROUTINE.
C
C USES       SUBROUTINES LEGNDG,FMTSG,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            THE CODING OF THIS SUBROUTINE TAKES ADVANTAGE OF THE FACT
C            THAT NON-ZERO FLOATING POINT NUMBERS ARE LARGER THAN
C            REASONABLE VALUES FOR INTEGERS BECAUSE THE CHARACTERISTIC OF
C            A FLOATING POINT NUMBER IS IN THE LEFT PART OF THE WORD.  IF
C            THE USER'S MACHINE DOES NOT HAVE THIS FORMAT, THE SPECIAL
C            CALL MUST BE USED.
```

```
C*****************************SUBRCUTINE POINTG*********************************
C PLOT POINTS.  (POINTG)
C
C PURPOSE    THIS ROUTINE IS USED TO PLOT AN ARRAY OF POINTS.
C
C CALL       CALL POINTG(Z,N,X,Y)
C                 Z IS THE MODE SET ARRAY.
C                 N IS THE NUMBER OF POINTS, (N => 1).
C                 X,Y ARE ARRAYS OF 'N' X AND Y COORDINATE PAIRS TO PLOT.
C
C SPECIAL    NONE
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO SPECIFY A NEW PLOTTING SYMBOL (THE DEFAULT
C                     CHARACTER IS A NORMAL SIZE POINT), CHANGE THE MODE
C                     SET AS FOLLOWS:
C                          CALL SETSMG(Z,84,VALUE)
C                               VALUE MUST CONTAIN THE CHARACTER,
C                                    LEFT JUSTIFIED, TO USE FOR PLOTTING.
C                     TO RESET TO THE DEFAULT VALUE OF A POINT, GIVE THE
C                     FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,84,0.)
C                 2.  TO CHANGE THE PLOTTING CHARACTER SIZE, GIVE THE
C                     FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,53,SIZE)
C                               SIZE SPECIFIES THE SIZE OF THE CHARACTERS
C                                    RELATIVE TO NORMAL SIZE.  (.75, 1.0,
C                                    1.25, AND 1.5 ARE ALLOWED.)
C                               SIZE = 1.0 IS THE DEFAULT VALUE.
C                 3.  TO CHANGE THE PLOT CHARACTER ORIENTATION, GIVE THE
C                     FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,46,ORIEN)
C                               ORIEN SPECIFIES THE ORIENTATION OF THE
C                                    CHARACTER.  ORIEN = 0. OR 90. ARE
C                                    ALLOWED.  0. IS THE NORMAL UPRIGHT
C                                    POSITION.  THE ANGLE OF ORIENTATION
C                                    IS POSITIVE IN THE COUNTERCLOCKWISE
C                                    DIRECTION.
C                               ORIEN = 0. IS THE DEFAULT VALUE.
C                 4.  TO CHANGE THE PLOT CHARACTER CASE, GIVE THE
C                     FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,55,CASE)
C                               CASE = 0., UPPER CASE
C                                      1., LOWER CASE
C                                      2., SPECIAL CASE
C                               CASE = 0. IS THE DEFAULT VALUE.
C                 5.  TO SPECIFY THE FORM OF THE X,Y COORDINATES USED IN
C                     THE CALL, GIVE THE FOLLOWING MODE SET CALL:
C                          CALL SETSMG(Z,14,TYPE)
C                               TYPE SPECIFIES THE FORM OF THE X,Y
C                                    COORDINATES.
C                                    0.-X,Y ARE REAL SUBJECT SPACE UNITS.
C                                    1.-X,Y ARE REAL ABSOLUTE RASTER
C                                         UNITS.
C                                    2.-X,Y ARE INTEGER ABSOLUTE RASTER
C                                         UNITS.
C                                    3.-X,Y ARE REAL NORMALIZED OBJECT
C                                         SPACE UNITS.
```

```
C*****************************SUBROUTINE SEGMTG*********************************
C DRAW LINE SEGMENTS.  (SEGMTG)
C
C PURPOSE    THIS ROUTINE IS USED TO DRAW NONCONTIGUOUS LINE SEGMENTS.
C            THE INITIAL X,Y COORDINATES OF EACH SEGMENT ARE SPECIFIED
C            IN THE ARRAYS X1,Y1; THE TERMINAL X,Y COORDINATES ARE
C            SPECIFIED IN THE ARRAYS X2,Y2.
C
C CALL       CALL SEGMTG(Z,N,X1,Y1,X2,Y2)
C                 Z IS THE MODE SET ARRAY.
C                 N IS THE NUMBER OF LINE SEGMENTS TO DRAW.  IF N > 1,
C                      X1,Y1 AND X2,Y2 MUST BE ARRAYS OF POINTS.
C                 X1,Y1 ARE ARRAYS CONTAINING THE STARTING POINTS OF
C                      EACH LINE.
C                 X2,Y2 ARE ARRAYS CONTAINING THE TERMINAL POINTS OF
C                      EACH LINE.
C
C SPECIAL    NONE
C
C MODS       ALL MODE SETS DESCRIBED IN LINESG ARE ALSO APPLICABLE TO
C            THIS SUBROUTINE.
C
C USES       SUBROUTINES METAZZ,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

```
C*****************************SUBROUTINE TEXTG*************************************
C TYPE CHARACTERS.  (TEXTG)
C
C PURPOSE    THIS IS USED TO TYPE CHARACTERS.  TYPING BEGINS AT THE
C            CURRENT POINT POSITION.  IF THE CHARACTERS GO BEYOND THE
C            RIGHT MARGIN, THE LINE IS EJECTED TO THE LEFT MARGIN.  TEXTG
C            IS SIMILIAR IN FUNCTION TO LEGNDG.  THE ONLY DIFFERENCE IS
C            THAT LEGNDG BEGINS TYPING AT A SPECIFIED X,Y COORDINATE
C            WHILE TEXTG BEGINS TYPING WHERE THE PREVIOUS DISPLAY LEFT
C            OFF.
C
C CALL       CALL TEXTG(Z,N,CHAR)
C                 Z IS THE MODE SET ARRAY.
C                 N IS THE NUMBER OF CHARACTERS TO DISPLAY.  (N =>1)
C                 CHAR IS THE NAME OF A VARIABLE OR AN ARRAY WHICH
C                      CONTAINS THE CHARACTER STRING TO DISPLAY.
C
C SPECIAL    NONE
C
C MODS       ALL MODE SETS DESCRIBED IN LEGNDG ARE ALSO APPLICABLE TO
C            THIS SUBROUTINE.
C
C USES       SUBROUTINES METAZZ,ERRZZ,VECSZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            SUBROUTINE LINESG MAY BE USED TO POSITION THE BEAM TO ANY
C            SPECIFIED LOCATION.
```

GRAPH SUBROUTINES

The composition of a graph may be broken down into three separate parts: a grid of lines, labels to indicate the values of the x and y grid lines, and titles to describe the variables being plotted. Data may then be plotted on the graph by using any of the graphic output subroutines such as POINTG or LINESG.

A special subroutine, SETUPG, has been provided to aid the user in computing arguments that will result in aesthetically pleasing graphs when used in calls to the graph subroutines. All of these subroutines are then combined in subroutine GRAPHG to draw, label, title, and plot data for an entire graph.

```
C*****************************SUBROUTINE GRIDG*************************************
C DRAW A GRID.  (GRIDG)
C
C PURPOSE    THIS SUBROUTINE IS CALLED TO CONSTRUCT A CARTESIAN GRID.
C            THE SUBROUTINE DRAWS ALL THE LINES NEEDED, AND EMPHASIZES
C            THE MAJOR GRID DIVISIONS AS DIRECTED.
C
C            GRIDG PRESUMES THAT THE USER HAS SET UP HIS SUBJECT SPACE
C            WITH A CALL TO SUBJEG AND THAT HE HAS ALSO ESTABLISHED HIS
C            OBJECT SPACE WITH A CALL TO OBJCTG.  THE OBJECT SPACE SHOULD
C            BE DEFINED SO THAT A MARGIN IS LEFT AROUND THE GRID SINCE
C            THE GRID WILL FILL THE ENTIRE OBJECT SPACE.
C
C CALL       CALL GRIDG(Z,DX,DY,IXTH,JYTH)
C                 Z IS THE MODE SET ARRAY.
C                 DX,DY ARE THE X,Y GRID INTERVALS IN USER COORDINATES.
C                      IF DX OR DY = 0., NO GRID LINES ARE DRAWN FOR IT.
C                      (DX CONTROLS SPACING BETWEEN THE VERTICAL GRID
C                      LINES AND DY THE HORIZONTAL.)  THE GRID LINES ARE
C                      DRAWN WITH 0.5 TIMES NORMAL LINE WEIGHT.
C
C                      IF THE USER'S X-AXIS SUBJECT SPACE DECREASES FROM
C                      LEFT TO RIGHT, OR THE Y-AXIS SUBJECT SPACE
C                      DECREASES FROM BOTTOM TO TOP, DX OR DY MUST BE
C                      NEGATIVE.
C
C                      IF THE 0-AXIS LIES WITHIN THE GRID, DX OR DY ARE
C                      DRAWN FROM THE ZERO AXIS OUTWARD.  OTHERWISE, THEY
C                      ARE DRAWN FROM LEFT TO RIGHT OR FROM BOTTOM TO
C                      TOP.
C                 IXTH,JYTH SPECIFY THE I'TH X-GRID LINE AND THE J'TH Y-
C                      GRID LINE TO EMPHASIZE.  IF IXTH OR JYTH = 0., NO
C                      LINES ARE EMPHASIZED FOR IT.  THE EMPHASIS LINES
C                      ARE DRAWN WITH 2. TIMES NORMAL LINE WEIGHT.
C
C SPECIAL    A LOG GRID CAN BE DRAWN BY MAKING ONE OF THE MODE SETS
C            DESCRIBED BELOW.  THE SUBJECT SPACE MUST BE POSITIVE AND
C            SHOULD BE A POWER OF TEN.  TO DRAW A LOG GRID, MAKE THE
C            INDICATED MODE SET CALL AND THEN CALL GRIDG.  THE ARGUMENTS
C            HAVE THE FOLLOWING SPECIAL MEANINGS FOR LOG GRIDS:
C                 DX,DY ARE IGNORED AND MAY BE DUMMY ARGUMENTS IF THE
C                      GRID IN LOG IN X OR Y.
C                 IXTH,JYTH SPECIFY WHETHER THE MAJOR CYCLE LINES ARE TO
C                      BE EMPHASIZED.  IF ZERO, NO EMPHASIS IS DONE.  IF
C                      GREATER THAN ZERO, EMPHASIS IS DONE.
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO CONTROL THE EMPHASIS OF THE MAJOR AXES, GIVE THE
C                     FOLLOWING CALL:
C                          CALL SETSMG(Z,100,EMPH)
C                               EMPH SPECIFIES THE EMPHASIS TO BE DONE.
C                                    EMPH=0., EMPHASIZE X=0, Y=0 AXES.
C                                         1., EMPHASIZE X=0 AXIS ONLY.
C                                         2., EMPHASIZE Y=0 AXIS ONLY.
C                                         3., NO EMPHASIS.
C                               EMPH = 0. IS THE DEFAULT VALUE.
C                     NOTE-THE EMPHASIS LINES ARE DRAWN WITH 4. TIMES
C                     NORMAL LINE WEIGHT.  THE EMPHASIS LINE WILL NOT BE
```

```
C                    DRAWN IF THE ZERO AXIS LIES OUTSIDE OF THE GRID.
C                    FOR NONLINEAR GRIDS THE MAJOR AXES ARE DEFINED AS
C                    THE X=1, Y=1 AXES.
C                2.  TO DRAW A LOG GRID IN THE X-AXIS, GIVE THE
C                    FOLLOWING MODE SET CALL:
C                         CALL SETSMG(Z,23,1.)
C                    TO RETURN TO THE DEFAULT CONDITION OF A LINEAR
C                    GRID, GIVE THE FOLLOWING CALL:
C                         CALL SETSMG(Z,23,0.)
C                    NOTE-BE SURE TO SET UP THE SUBJECT SPACE FOR THE
C                    LOG GRID BEFORE MAKING THIS MODE SET CALL.
C                3.  TO DRAW A LOG GRID IN THE Y-AXIS, GIVE THE
C                    FOLLOWING MODE SET CALL:
C                         CALL SETSMG(Z,24,1.)
C                    TO RETURN TO THE DEFAULT CONDITION OF A LINEAR
C                    GRID, GIVE THE FOLLOWING CALL:
C                         CALL SETSMG(Z,24,0.)
C                    NOTE-BE SURE TO SET UP THE SUBJECT SPACE FOR THE
C                    LOG GRID BEFORE MAKING THIS MODE SET CALL.
C
C USES       SUBROUTINES SETSMG,MLTPLG,SEGMTG,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

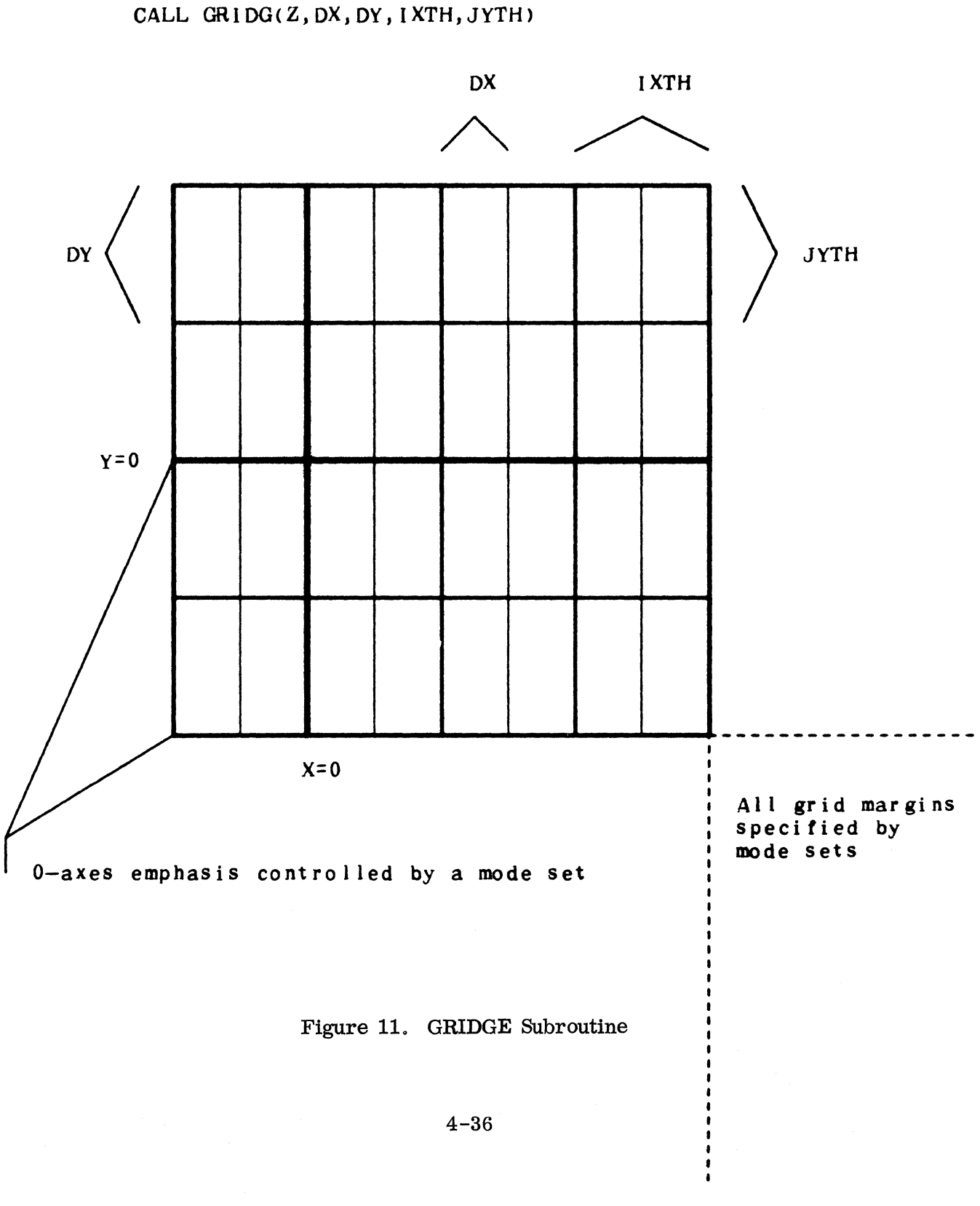


Figure 11. GRIDGE Subroutine

```
C*****************************SUBROUTINE LABELG*********************************
C LABEL A GRID.  (LABELG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO LABEL THE AXES OF A GRID DRAWN BY
C            SUBROUTINE GRIDG.  THE USER MAY LABEL EITHER THE X OR Y AXIS
C            WITH NUMERIC OR ALPHANUMERIC LABELS.  THE Y-AXIS WILL BE
C            LABELED TO THE LEFT OF THE GRID AND THE X-AXIS WILL BE
C            LABELED BELOW IT.
C
C CALL       TO CREATE ALPHANUMERIC LABELS--
C                 CALL LABELG(Z,IAXIS,DLXY,NCHAR,CHARS)
C                      Z IS THE MODE SET ARRAY.
C                      IAXIS SPECIFIES THE AXIS TO LABEL.
C                           IAXIS=0, LABEL THE X-AXIS.
C                                 1, LABEL THE Y-AXIS.
C                      DLXY SPECIFIES THE X INTERVAL IF IAXIS=0, OR THE Y
C                           INTERVAL IF IAXIS=1, IN USER COORDINATES
C                           (SUBJECT SPACE) BETWEEN EACH LABEL.
C
C                           IF THE X-AXIS DECREASES FROM LEFT TO RIGHT,
C                           OR THE Y-AXIS FROM BOTTOM TO TOP, THEN DLXY
C                           MUST BE NEGATIVE.
C
C                           FOR LABELING LOG GRIDS, DLXY SPECIFIES THE
C                           CYCLE LINES TO LABEL.  FOR EXAMPLE, DLXY=1.
C                           MEANS LABEL EACH CYCLE LINE AND DLXY=3. EVERY
C                           THIRD LINE.
C                      NCHAR SPECIFIES THE NUMBER OF CHARACTERS TO
C                           DISPLAY FOR EACH CYCLE OF THE LABEL.
C                      CHAR CONTAINS THE CHARACTERS TO USE FOR THE LABEL.
C                           THE USER IS ASSUMED TO KNOW HOW MANY LINES
C                           WILL BE LABELED SO THAT CHAR WILL CONTAIN
C                           ENOUGH CHARACTERS FOR ALL LABELS.  FOR
C                           EXAMPLE, IF NCHAR = 3 AND FOUR LINES ARE TO
C                           BE LABELED, CHAR MUST CONTAIN 12 CHARACTERS.
C
C            TO CREATE INTEGER NUMERIC LABELS IN I FORMAT--
C                 CALL LABELG(Z,IAXIS,DLXY,0,IFMT)
C                      IFMT SPECIFIES THE NUMBER OF DIGITS TO DISPLAY.
C
C            TO CREATE REAL NUMERIC LABELS IN F FORMAT--
C                 CALL LABELG(Z,IAXIS,DLXY,0,FMT)
C                      FMT SPECIFIES THE FORMAT.  IT IS OF THE FORM W.D,
C                           WHERE W SPECIFIES THE FIELD WIDTH AND D THE
C                           NUMBER OF DECIMAL PLACES.  (D < 10)
C
C            TO CREATE REAL NUMERIC LABELS IN E FORMAT--
C                 CALL LABELG(Z,IAXIS,DLXY,0,-FMT)
C
C SPECIAL    NONE
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO SPECIFY THAT A TICK MARK BE DRAWN ABOVE THE X-
C                     AXIS LABELS OR BESIDE THE Y-AXIS LABELS, GIVE THE
C                     FOLLOWING MODE SET CALLS:
C                          CALL SETSMG(Z,102,XSIZE)
C                               XSIZE SPECIFIES THE LENGTH OF THE TICK
C                                    MARK FOR THE X-AXIS LABEL IN
```

```
C                                   NORMALIZED OBJECT SPACE.  IF XSIZE
C                                   = 0., NO TICK MARK IS DRAWN.
C                              XSIZE = 0. IS THE DEFAULT VALUE.
C                         CALL SETSMG(Z,103,YSIZE)
C                              YSIZE SPECIFIES THE LENGTH OF THE TICK
C                                   MARK FOR THE Y-AXIS LABEL IN
C                                   NORMALIZED OBJECT SPACE.  IF YSIZE
C                                   = 0., NO TICK MARK IS DRAWN.
C                              YSIZE = 0. IS THE DEFAULT VALUE.
C                    NOTE-ALL MODES DESCRIBED IN SUBROUTINE LINESG ARE
C                    IN EFFECT WHEN THE TICK MARKS ARE DRAWN.  IF XSIZE
C                    OR YSIZE ARE POSITIVE, THE TICK MARKS ARE DRAWN
C                    INSIDE THE GRID.  IF MINUS, THE TICK MARKS ARE
C                    DRAWN OUTSIDE THE GRID.
C                    NOTE-TO DRAW TICK MARKS ALONE WITHOUT A LABEL,
C                    SET NCHAR=1, AND DEFINE CHARS TO CONTAIN AS MANY
C                    HOLLERITH BLANKS AS THERE ARE LABELS.
C                2.  TO SPECIFY THE LOCATIONS AT WHICH TO LABEL, GIVE
C                    THE FOLLOWING MODE SET CALLS:
C                         CALL SETSMG(Z,104,XPLACE)
C                              XPLACE SPECIFIES THE DISTANCE FROM THE
C                                   X-AXIS TO THE LABEL AS A MULTIPLE OF
C                                   CHARACTER HEIGHT.
C                                   XPLACE = 0., LABEL AT Y = 0 MAJOR
C                                        AXIS.  (NOTE-THIS MAY CAUSE THE
C                                        LABEL TO FALL INSIDE OF THE
C                                        GRID.)
C                                   XPLACE > 0. (+), LABEL THE X-AXIS
C                                        ABOVE THE GRID.
C                                   XPLACE < 0. (-), LABEL THE X-AXIS
C                                        BELOW THE GRID.
C                              XPLACE = -1.5 IS THE DEFAULT VALUE.
C                         CALL SETSMG(Z,105,YPLACE)
C                              YPLACE SPECIFIES THE DISTANCE FROM THE
C                                   Y-AXIS TO THE LABEL AS A MULTIPLE OF
C                                   CHARACTER WIDTH.
C                                   YPLACE = 0., LABEL AT X=0 MAJOR
C                                        AXIS.  (NOTE-THIS MAY CAUSE THE
C                                        LABEL TO FALL INSIDE OF THE
C                                        GRID.)
C                                   YPLACE > 0. (+), LABEL THE Y-AXIS ON
C                                        THE RIGHT SIDE OF THE GRID.
C                                   YPLACE < 0. (-), LABEL THE Y-AXIS ON
C                                        THE LEFT SIDE OF THE GRID.
C                              YPLACE = -1.5 IS THE DEFAULT VALUE.
C                3.  TO CHANGE THE CHARACTER SIZE OR FONT, GIVE THE MODE
C                    SET CALLS DESCRIBED IN SUBROUTINE LEGNDG.
C
C USES       SUBROUTINES SETSMG,MLTPLG,LEGNDG,NUMBRG,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            THE CODING OF THIS SUBROUTINE TAKES ADVANTAGE OF THE FACT
C            THAT NON-ZERO FLOATING POINT NUMBERS ARE LARGER THAN
C            REASONABLE VALUES FOR INTEGERS BECAUSE THE CHARACTERISTIC OF
C            A FLOATING POINT NUMBER IS IN THE LEFT PART OF THE WORD.  IF
C            THE USER'S MACHINE DOES NOT HAVE THIS FORMAT, THE ROUTINE
C            WILL HAVE TO BE RECODED.
```

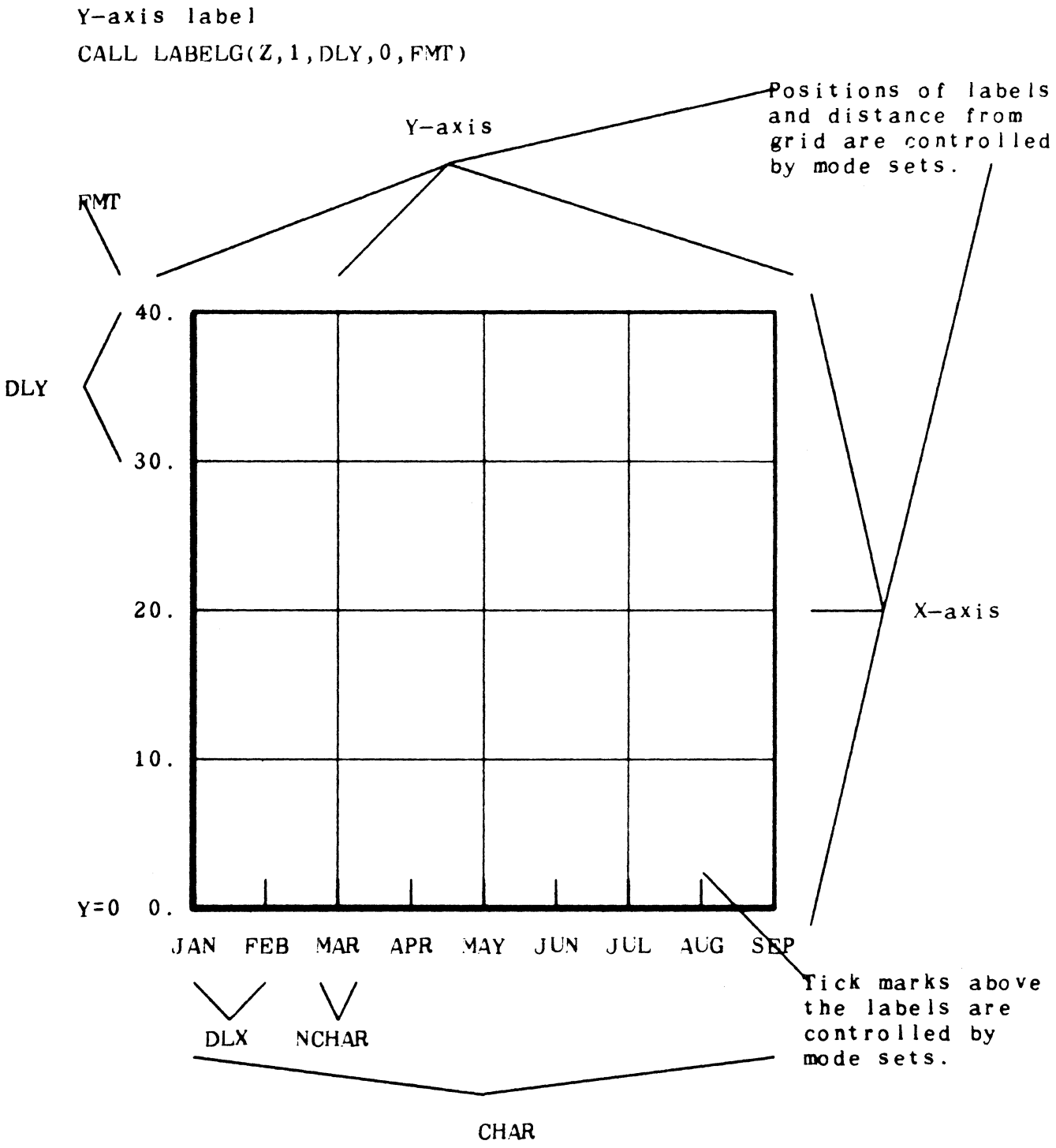


Figure 12. LABELG Subroutine

```
C*****************************SUBROUTINE TITLEG*********************************
C TITLE A GRID.  (TITLEG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO TITLE THE X AND Y AXES AND TO
C            TITLE THE GRAPH.  IT AUTOMATICALLY CENTERS THE TITLES FOR
C            THE USER.  THIS SUBROUTINE IS INTENDED TO BE A QUICK, EASY
C            METHOD OF TITLING A GRAPH.  USERS WHO WANT FULL
C            CONTROL OVER THE TITLING OF THEIR GRAPHS SHOULD USE
C            SUBROUTINE LEGNDG.
C
C CALL       CALL TITLEG(Z,NX,XCHAR,NY,YCHAR,NT,TCHAR)
C                 Z IS THE MODE SET ARRAY.
C                 NX SPECIFIES THE NUMBER OF CHARACTERS IN THE X-AXIS
C                      TITLE.  IF NX=0, THE X-AXIS IS NOT TITLED.  THE
C                      TITLE WILL BE CENTERED BELOW THE GRID.
C                 XCHAR CONTAINS THE 'NX' CHARACTERS TO USE FOR THE X-
C                      AXIS TITLE.  IF NX=0, XCHAR SHOULD BE A DUMMY
C                      ARGUMENT.
C                 NY SPECIFIES THE NUMBER OF CHARACTERS IN THE Y-AXIS
C                      TITLE.  IF NY=0, THE Y-AXIS IS NOT TITLED.  THE
C                      LINE ORIENTATION WILL BE 90., AND THE TITLE
C                      WILL BE VERTICALLY CENTERED TO THE LEFT OF THE
C                      GRID.
C                 YCHAR CONTAINS THE 'NY' CHARACTERS TO USE FOR THE Y-
C                      AXIS TITLE.  IF NY=0, YCHAR SHOULD BE A DUMMY
C                      ARGUMENT.
C                 NT SPECIFIES THE NUMBER OF CHARACTERS IN THE GRAPH
C                      TITLE.  IF NT=0, THE GRAPH IS NOT TITLED.  THE
C                      GRAPH WILL BE TITLED BELOW THE X-AXIS TITLE AND
C                      CENTERED ON THE PAGE.
C                 TCHAR CONTAINS THE 'NT' CHARACTERS TO USE FOR THE GRAPH
C                      TITLE.  IF NT=0, TCHAR SHOULD BE A DUMMY ARGUMENT.
C
C SPECIAL    NONE
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  THE AREA AVAILABLE FOR TITLING IS OBTAINED FROM THE
C                     MODE SET ARRAY.  NORMALLY, THESE VALUES ARE STORED
C                     IN THE MODE SET ARRAY BE SUBROUTINES GRIDG OR
C                     LABELG.  IF SUBROUTINES GRIDG OR LABELG HAVE NOT
C                     BEEN CALLED, THE USER MUST SUPPLY THE VALUES
C                     HIMSELF.  THE FOLLOWING MODE SET CALLS WILL
C                     ACCOMPLISH THIS:
C                          CALL SETSMG(Z,113,XMIN)
C                               XMIN SPECIFIES THE MINIMUM X-LOCATION IN
C                                    NORMALIZED OBJECT SPACE OCCUPIED BY
C                                    THE GRAPH, INCLUDING LABELS.
C                          CALL SETSMG(Z,114,YMIN)
C                               YMIN SPECIFIES THE MINIMUM Y-LOCATION IN
C                                    NORMALIZED OBJECT SPACE OCCUPIED BY
C                                    THE GRAPH, INCLUDING LABELS.
C                          CALL SETSMG(Z,115,XMAX)
C                               XMAX SPECIFIES THE MAXIMUM X-LOCATION IN
C                                    NORMALIZED OBJECT SPACE OCCUPIED BY
C                                    THE GRAPH, INCLUDING LABELS.
C                          CALL SETSMG(Z,116,YMAX)
C                               YMAX SPECIFIES THE MAXIMUM Y-LOCATION IN
C                                    NORMALIZED OBJECT SPACE OCCUPIED BY
```

```
C                                   THE GRAPH, INCLUDING LABELS.
C                  2.  TO SPECIFY THE LOCATIONS AT WHICH TO TITLE, GIVE
C                      THE FOLLOWING MODE SET CALLS:
C                           CALL SETSMG(Z,104,XPLACE)
C                                XPLACE SPECIFIES THE DISTANCE FROM THE
C                                     GRID TO THE X-AXIS TITLE AS A
C                                     MULTIPLE OF CHARACTER HEIGHT.  IT
C                                     ALSO SPECIFIES THE DISTANCE FROM THE
C                                     X-AXIS TITLE TO THE GRAPH TITLE.
C                                     XPLACE > 0. (+), TITLE ABOVE THE
C                                          GRID.
C                                     XPLACE < 0. (-), TITLE BELOW THE
C                                          GRID.
C                                XPLACE = -1.5 IS THE DEFAULT VALUE.
C                           CALL SETSMG(Z,105,YPLACE)
C                                YPLACE SPECIFIES THE DISTANCE FROM THE
C                                     Y-AXIS TO THE TITLE AS A MULTIPLE OF
C                                     CHARACTER WIDTH.
C                                     YPLACE > 0. (+), TITLE ON THE RIGHT
C                                          SIDE OF THE GRID.
C                                     YPLACE < 0. (-), TITLE ON THE LEFT
C                                          SIDE OF THE GRID.
C                                YPLACE = -1.5 IS THE DEFAULT VALUE.
C                  3.  TO CHANGE THE CHARACTER SIZE OR FONT, GIVE THE MODE
C                      SET CALLS DESCRIBED IN SUBROUTINE LEGNDG.
C
C USES       SUBROUTINES SETSMG,LEGNDG,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

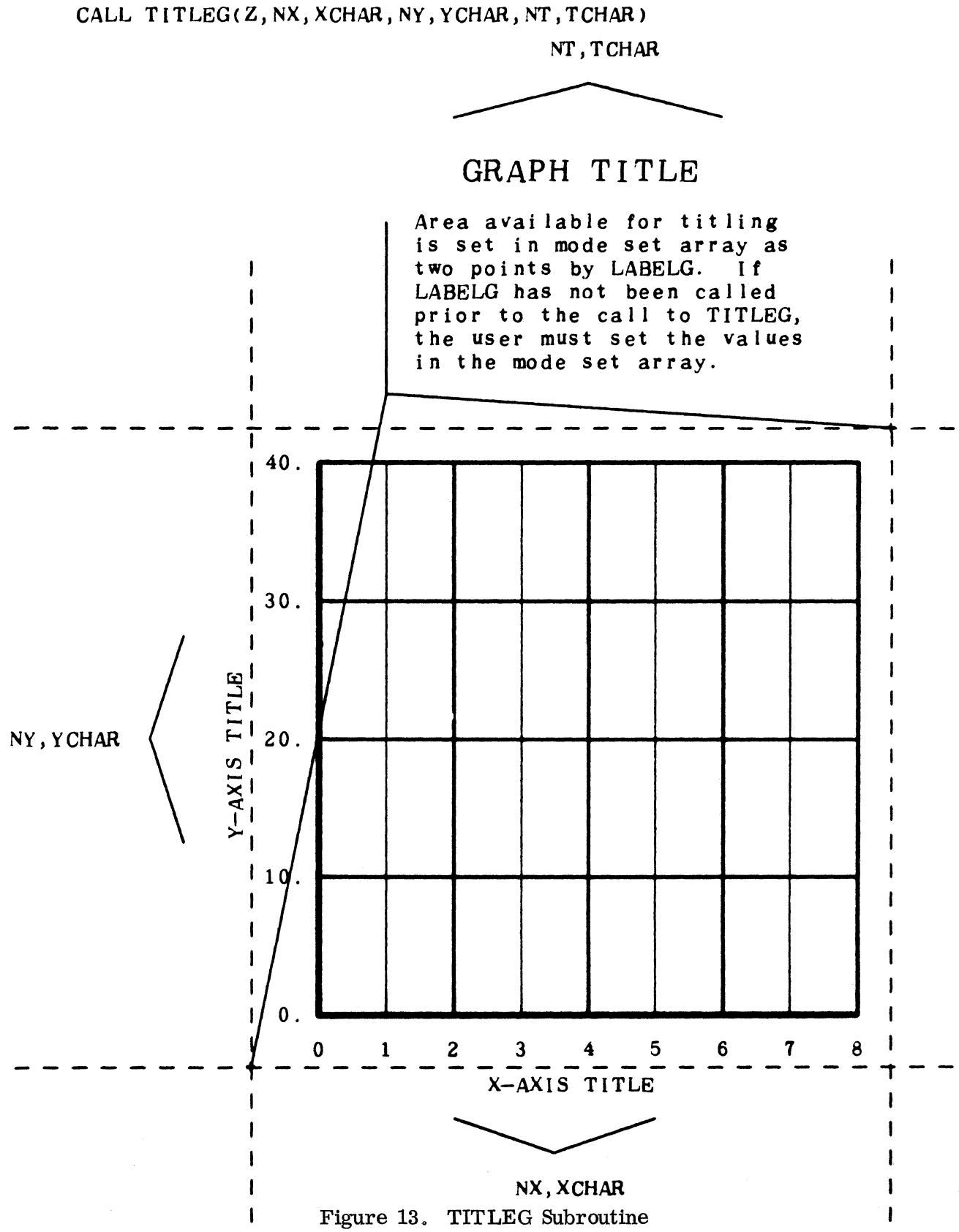


Figure 13. TITLEG Subroutine

```
C*****************************SUBROUTINE SETUPG*********************************
C COMPUTE APPROPRIATE ARGUMENTS FOR THE GRID ROUTINES.  (SETUPG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO COMPUTE VALUES TO BE SUBSEQUENTLY
C            INCLUDED IN CALLS TO THE GRIDG AND LABELG SUBROUTINES.  IT
C            ALSO GIVES THE USER THE OPTION OF HAVING HIS SUBJECT AND
C            OBJECT SPACE ADJUSTED FOR A MORE AESTHETIC GRAPH.  IF THE
C            OBJECT SPACE IS ADJUSTED, THE SIZE OF THE DISPLAY SURFACE IS
C            REDUCED SO THAT A MARGIN IS LEFT AROUND THE GRID.  THIS ALSO
C            CAUSES THE SCALING FACTORS TO BE RECOMPUTED SO THAT ALL
C            SUBSEQUENT CALLS TO GRAPHIC OUTPUT SUBROUTINES WILL RESULT
C            IN THE DATA BEING SCALED INTO THE AREA OF THE GRID.  IF,
C            AFTER CALLING SETUPG, THE USER WANTS TO DRAW OUTSIDE OF THE
C            GRID, HE MUST BE CAREFUL TO EITHER CALL OBJCTG TO RESET THE
C            DISPLAY SURFACE, OR USE THE SPECIAL MODE SET INDICATING
C            ABSOLUTE RASTER UNITS.
C
C            IN MANY INSTANCES, PARTICULARLY WHERE THE USER MUST COMPUTE
C            THE RANGE OF HIS DATA, IT IS VERY DIFFICULT TO DETERMINE
C            BEFOREHAND JUST WHAT THE ARGUMENTS FOR THE GRID ROUTINES
C            SHOULD BE TO DRAW AN AESTHETICALLY PLEASING GRAPH.  THIS
C            SUBROUTINE LOOKS AT THE RANGE OF THE USER'S DATA AND
C            COMPUTES APPROPRIATE ARGUMENTS FOR THE GRID ROUTINES.
C
C            THE USER MUST CALL SUBROUTINE SUBJEG FIRST TO ESTABLISH HIS
C            SUBJECT SPACE SO THAT SETUPG WILL KNOW THE LIMITS OF HIS
C            DATA.  THE USER'S SUBJECT SPACE MUST NOT BE NEGATIVE.  THAT
C            IS, THE X-AXIS MUST INCREASE FROM LEFT TO RIGHT, AND THE
C            Y-AXIS FROM BOTTOM TO TOP.  SETUPG WORKS FOR BOTH LINEAR AND
C            NONLINEAR GRIDS.
C
C CALL       CALL SETUPG(Z,MODE,DX,DY,IXTH,JYTH,DLX,DLY,XFMT,YFMT)
C                 Z IS THE MODE SET ARRAY.
C                 MODE SPECIFIES WHETHER THE USER'S SUBJECT SPACE AND THE
C                      GRID MARGINS ARE TO BE ADJUSTED.
C                      MODE=0, DON'T DO ANY ADJUSTMENT.
C                           1, ADJUST BOTH THE SUBJECT AND OBJECT SPACE.
C                           2, ADJUST ONLY THE SUBJECT SPACE.
C                           3, ADJUST ONLY THE OBJECT SPACE.
C                      NOTE-THE USER MUST CALL SUBROUTINE SUBJEG WITH THE
C                      MINIMUM AND MAXIMUM LIMITS OF HIS DATA BEFORE
C                      CALLING SETUPG.
C                 DX,DY WILL CONTAIN THE X,Y GRID INTERVALS TO USE IN
C                      SUBSEQUENT CALLS TO SUBROUTINE GRIDG.
C                 IXTH,JYTH WILL CONTAIN NUMBERS SPECIFYING THE X AND Y
C                      GRID LINES TO EMPHASIZE.  THESE VALUES ARE ALSO
C                      USED IN CALLS TO SUBROUTINE GRIDG.
C                 DLX,DLY WILL CONTAIN THE X AND Y INTERVALS BETWEEN THE
C                      AXES LABELS.  THESE VALUES ARE USED IN SUBSEQUENT
C                      CALLS TO SUBROUTINE LABELG.
C                 XFMT,YFMT WILL CONTAIN THE NUMERIC FORMATS OF THE
C                      LABELS.  THESE VALUES ARE ALSO USED IN CALLS TO
C                      SUBROUTINE LABELG.
C
C SPECIAL    NONE
C
C MODS       THE FOLLOWING MODIFICATIONS CAN BE MADE TO THE SUBROUTINE
C            WITH MODE SETS:
C                 1.  TO FORCE SETUPG TO COMPUTE VALUES WHICH WILL RESULT
```

```
C                    IN A SQUARE GRID, GIVE THE FOLLOWING MODE SET
C                    CALL:
C                         CALL SETSMG(Z,110,1.)
C                    TO RESET THE MODE TO ITS DEFAULT VALUE SO THAT A
C                    SQUARE GRID IS NOT MANDATORY, GIVE THE FOLLOWING
C                    MODE SET CALL:
C                         CALL SETSMG(Z,110,0.)
C                2.  TO ADJUST THE DENSITY OF THE GRID LINES, GIVE THE
C                    FOLLOWING MODE SET CALLS:
C                         CALL SETSMG(Z,111,XDEN)
C                              XDEN SPECIFIES THE DENSITY OF THE X-AXIS
C                                   (VERTICAL) GRID INTERVAL LINES.  THE
C                                   DENSITY IS EXPRESSED AS A MINIMUM
C                                   DISTANCE BETWEEN GRID LINES IN
C                                   NORMALIZED OBJECT SPACE.
C                              XDEN = .01009 IS THE DEFAULT VALUE.
C                         (ABOUT ONE CHARACTER WIDTH)
C                         CALL SETSMG(Z,112,YDEN)
C                              YDEN SPECIFIES THE DENSITY OF THE Y-AXIS
C                                   (HORIZONTAL) GRID INTERVAL LINES.
C                                   THE DENSITY IS EXPRESSED AS A
C                                   MINIMUM DISTANCE BETWEEN GRID LINES
C                                   NORMALIZED OBJECT SPACE.
C                              YDEN = .016607 IS THE DEFAULT VALUE.
C                         (ABOUT ONE CHARACTER HEIGHT)
C                3.  TO RESET THE GRID MARGINS, GIVE ANY OF THE
C                    FOLLOWING CALLS:
C                         CALL SETSMG(Z,106,XLEFT)
C                              XLEFT IS THE AMOUNT OF LEFT MARGIN, IN
C                                   NORMALIZED OBJECT SPACE, TO LEAVE.
C                              XLEFT = .15 IS THE DEFAULT VALUE.
C                         CALL SETSMG(Z,107,RIGHT)
C                              RIGHT IS THE AMOUNT OF RIGHT MARGIN, IN
C                                   NORMALIZED OBJECT SPACE, TO LEAVE.
C                              RIGHT = .15 IS THE DEFAULT VALUE.
C                         CALL SETSMG(Z,108,BOTTOM)
C                              BOTTOM IS THE AMOUNT OF BOTTOM MARGIN, IN
C                                   NORMALIZED OBJECT SPACE, TO LEAVE.
C                              BOTTOM = .15 IS THE DEFAULT VALUE.
C                         CALL SETSMG(Z,109,TOP)
C                              TOP IS THE AMOUNT OF TOP MARGIN, IN
C                                   NORMALIZED OBJECT SPACE, TO LEAVE.
C                              TOP = .15 IS THE DEFAULT VALUE.
C
C USES      SUBROUTINES SUBJEG,OBJCTG,ERRZZ
C
C NOTES     THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

```
C*****************************SUBROUTINE GRAPHG*********************************
C CONSTRUCT A COMPLETE GRAPH.  (GRAPHG)
C
C PURPOSE    THIS SUBROUTINE IS USED TO CONSTRUCT AN ENTIRE GRAPH,
C            COMPLETE WITH GRID, LABELS, TITLES, AND PLOTTED DATA.  IT
C            REQUIRES ONLY A MINIMUM AMOUNT OF INFORMATION FROM THE USER,
C            AND MAKES ALL THE DECISIONS NEEDED TO CREATE THE GRAPH.
C
C            BOTH THE SUBJECT AND OBJECT SPACE WILL NORMALLY BE RESET BY
C            A CALL TO THIS SUBROUTINE.  THIS ALLOWS SUBSEQUENT CALLS TO
C            BE MADE TO POINTG OR LINESG TO PLOT MORE THAN ONE VARIABLE
C            ON THE GRAPH.  THE SUBJECT SPACE WILL NOT BE RESET IF 'NO',
C            THE NUMBER OF POINTS TO PLOT, IS ZERO.  THE OBJECT SPACE
C            WILL NOT BE RESET IF THE GRID MARGINS ARE SET TO ZERO IN THE
C            MODE SET ARRAY.
C
C CALL       CALL GRAPHG(Z,NO,X,Y,NX,XCHAR,NY,YCHAR,NT,TCHAR)
C                 Z IS THE MODE SET ARRAY.
C                 NO SPECIFIES THE NUMBER OF X,Y COORDINATES TO PLOT.
C                      IF NO = 0, ONLY THE GRAPH IS DRAWN AND NO POINTS
C                      ARE PLOTTED.  THIS ALSO PREVENTS THE SUBJECT SPACE
C                      FROM BEING RESET.  NO=1 IS NOT LEGAL.
C                 X,Y ARE ARRAYS OF 'NO' X AND Y COORDINATES TO PLOT.
C                      IF NO=0, X AND Y SHOULD BE DUMMY ARGUMENTS.
C                 NX SPECIFIES THE NUMBER OF CHARACTERS IN THE X-AXIS
C                      TITLE.  IF NX=0, THE X-AXIS IS NOT TITLED.  THE
C                      TITLE WILL BE CENTERED BELOW THE GRID.
C                 XCHAR CONTAINS THE 'NX' CHARACTERS TO USE FOR THE X-
C                      AXIS TITLE.  IF NX=0, XCHAR SHOULD BE A DUMMY
C                      ARGUMENT.
C                 NY SPECIFIES THE NUMBER OF CHARACTERS IN THE Y-AXIS
C                      TITLE.  IF NY=0, THE Y-AXIS IS NOT TITLED.  THE
C                      LINE ORIENTATION WILL BE 90., AND THE TITLE
C                      WILL BE VERTICALLY CENTERED TO THE LEFT OF THE
C                      GRID.
C                 YCHAR CONTAINS THE 'NY' CHARACTERS TO USE FOR THE Y-
C                      AXIS TITLE.  IF NY=0, YCHAR SHOULD BE A DUMMY
C                      ARGUMENT.
C                 NT SPECIFIES THE NUMBER OF CHARACTERS IN THE GRAPH
C                      TITLE.  IF NT=0, THE GRAPH IS NOT TITLED.  THE
C                      GRAPH WILL BE TITLED BELOW THE X-AXIS TITLE AND
C                      CENTERED ON THE PAGE.
C                 TCHAR CONTAINS THE 'NT' CHARACTERS TO USE FOR THE GRAPH
C                      TITLE.  IF NT=0, TCHAR SHOULD BE A DUMMY ARGUMENT.
C
C SPECIAL    NONE
C
C MODS       ALL THE MODE SETS DESCRIBED IN SETUPG,GRAPHG,LABELG,TITLEG,
C            AND POINTG ARE ALSO APPLICABLE TO THIS SUBROUTINE.
C
C USES       SUBROUTINES SUBJEG,SETUPG,GRIDG,LABELG,TITLEG,POINTG,ERRZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            THE CALL TO GRAPHG RESETS THE GRID MARGINS IN THE MODE SET
C            ARRAY TO ZERO.  GRAPHG RESETS THE OBJECT SPACE BASED UPON
C            THE CURRENT OBJECT SPACE AND THE AMOUNT OF GRID MARGIN
C            SPECIFIED IN THE MODE SET ARRAY.  IF GRAPHG DID NOT SET THE
C            GRID MARGINS TO ZERO, SUBSEQUENT CALLS TO IT WOULD CONTINUE
```

```
C           TO DECREASE THE SIZE OF THE OBJECT SPACE, RESULTING IN
C           SMALLER AND SMALLER GRAPHS.
C
C           GRAPHG MAKES NO CALL TO PAGEG TO ADVANCE THE FRAME.  THIS
C           CALL IS LEFT TO THE USER SO THAT HE CAN ADD TO THE GRAPH
C           WITH SUBSEQUENT CALLS.
```

CONVERSION SUBROUTINES

Two conversion routines are provided in IGS, one to convert character strings to numeric, and one to convert numeric data to a character string.

```
C*****************************SUBROUTINE CONVTG*********************************
C CONVERT CHARACTERS TO NUMERIC.  (CONVTG)
C
C PURPOSE    THIS SUBROUTINE CONVERTS A CHARACTER STRING TO A REAL OR
C            INTEGER NUMBER.
C
C CALL       CALL CONVTG(Z,IFMT,IW,IN,OUT)
C                 Z IS THE MODE SET ARRAY.
C                 IFMT SPECIFIES THE CONVERSION TO BE DONE.
C                      IFMT = 1, CONVERT TO INTEGER.
C                             2, CONVERT TO REAL.
C                             3, CONVERT TO REAL IF A DECIMAL POINT OR
C                                'E' IS ENCOUNTERED.  OTHERWISE CONVERT
C                                TO INTEGER.
C                 IW SPECIFIES THE NUMBER OF CHARACTERS IN THE INPUT
C                      STRING.
C                 IN IS THE ADDRESS OF THE CHARACTER STRING TO CONVERT.
C                 OUT WILL CONTAIN THE CONVERTED INTEGER OR REAL NUMBER.
C
C SPECIAL    NONE
C
C MODS       NONE
C
C USES       SUBROUTINE GETCZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
```

```
C*****************************SUBROUTINE FMTSG*********************************
C CONVERT NUMERIC DATA TO CHARACTERS.  (FMTSG)
C
C PURPOSE    THIS SUBROUTINE IS CALLED TO CONVERT A NUMBER, EITHER REAL
C            OR INTEGER, INTO A CHARACTER STRING.
C
C CALL       CALL FMTSG(Z,IFMT,IW,ID,VALUE,CHARS)
C                 Z IS THE MODE SET ARRAY.
C                 IFMT SPECIFIES THE TYPE OF NUMBER TO CONVERT.
C                      IFMT=1, CONVERT AN INTEGER NUMBER TO I FORMAT.
C                           2, CONVERT A REAL NUMBER TO F FORMAT.
C                           3, CONVERT A REAL NUMBER TO E FORMAT.
C                 IW SPECIFIES THE FIELD WIDTH OF THE CONVERTED NUMBER.
C                 ID SPECIFIES THE NUMBER OF DECIMAL PLACES.  (ID=0 IF
C                      IFMT=1)
C                 VALUE IS THE NUMBER TO CONVERT.  IT MAY BE EITHER REAL
C                      OR INTEGER, DEPENDING UPON WHAT IFMT IS SET TO.
C                 CHARS WILL CONTAIN THE CHARACTER STRING UPON RETURN.
C                      IT MUST BE AN ARRAY LARGE ENOUGH TO CONTAIN 'IW'
C                      CHARACTERS.
C
C SPECIAL    NONE
C
C MODS       TO CONVERT TO SCIENTIFIC NOTATION RATHER THAN E FORMAT, GIVE
C            THE FOLLOWING MODE SET CALL:
C                 CALL SETSMG(Z,85,1.)
C            TO RESET IT TO THE DEFAULT E FORMAT, GIVE THE FOLLOWING
C            CALL:
C                 CALL SETSMG(Z,85,0.)
C
C USES       SUBROUTINES IFMZZ,PUTCZZ,GETCZZ
C
C NOTES      THIS SUBROUTINE IS WRITTEN IN FORTRAN IV.
C
C            IF THE NUMBER CANNOT BE CONVERTED PROPERLY, CHARS WILL
C            CONTAIN ASTERISKS (*) ON RETURN.
```

APPENDIX A.

SAMPLE PROGRAM

```
C DIMENSION THE MODE SET ARRAY.
C SINCE THIS IS A SAMPLE PROGRAM, THERE WILL BE NO GREAT SIGNIFICANCE
C IN THE DATA THAT IS PLOTTED.
      DIMENSION Z(200)
      DIMENSION X(100),Y(100)
C INITIALIZE IGS WITH A CALL TO MODESG.
      CALL MODESG(Z,0)
C SET FOR 8 1/2 X 11 OUTPUT.
      CALL SETSMG(Z,90,2.)
C COMPUTE SOME POINTS TO PLOT.
      DO 100 I = 1,100
      X(I) = (I-1)*10
  100 Y(I) = (I-1)*10
C THE DEFAULT PLOTTING SYMBOL IS A POINT.  I DON'T WANT A POINT FOR MY
C PLOT SYMBOL SO I WILL CHANGE IT WITH A MODE SET CALL.
      CALL SETSMG(Z,84,1H+)
C NOW I WILL PLOT +'S INSTEAD OF POINTS.
C I WILL NOW CALL ON GRAPHG TO DRAW, LABEL, AND TITLE THE GRAPH, AND
C PLOT 1024 POINTS OF X,Y COORDINATES.
      CALL GRAPHG(Z, 100,X,Y,14,14HTIME--IN HOURS,18,18HDISTANCE--IN MIL
     1ES,16,16HTIME VS DISTANCE)
C COMPUTE SOME MORE POINTS TO PLOT ON THE SAME GRAPH.
      DO 200 I = 1,100
      X(I) = (100-I)*10
  200 Y(I) = (I-1)*10
C I WANT TO LABEL THE TOP AND RIGHT SIDE OF THE GRID.  I MUST MAKE THE
C APPROPRIATE MODE SETS FOR THE LABEL POSITION.
      CALL SETSMG(Z,104,1.)
      CALL SETSMG(Z,105,1.)
C I WILL NOW LABEL THE X-AXIS.
      CALL LABELG(Z,0,200.,0,4)
C AND LIKEWISE FOR THE Y-AXIS.
      CALL LABELG(Z,1,100.,0,4)
C THEN TO ADD SOME TITLES.
      CALL TITLEG(Z,21,21HDISTANCE--IN FURLONGS,19,19HTIME--IN FORTNIGHT
     1S,0,0)
C I SHOULD CHANGE THE PLOT SYMBOL SO I WON'T CONFUSE MY DATA.
      CALL SETSMG(Z,84,1HX)
C AND THEN PLOT THE DATA.
      CALL POINTG(Z,100,X,Y)
C NOW I WILL ADVANCE THE FRAME AND GET ONE COPY.
      CALL PAGEG(Z,0,1,1)
C I AM DONE.  I MUST CALL EXITG TO TERMINATE THE GRAPHIC OUTPUT.
      CALL EXITG(Z)
      CALL EXIT
      END
```

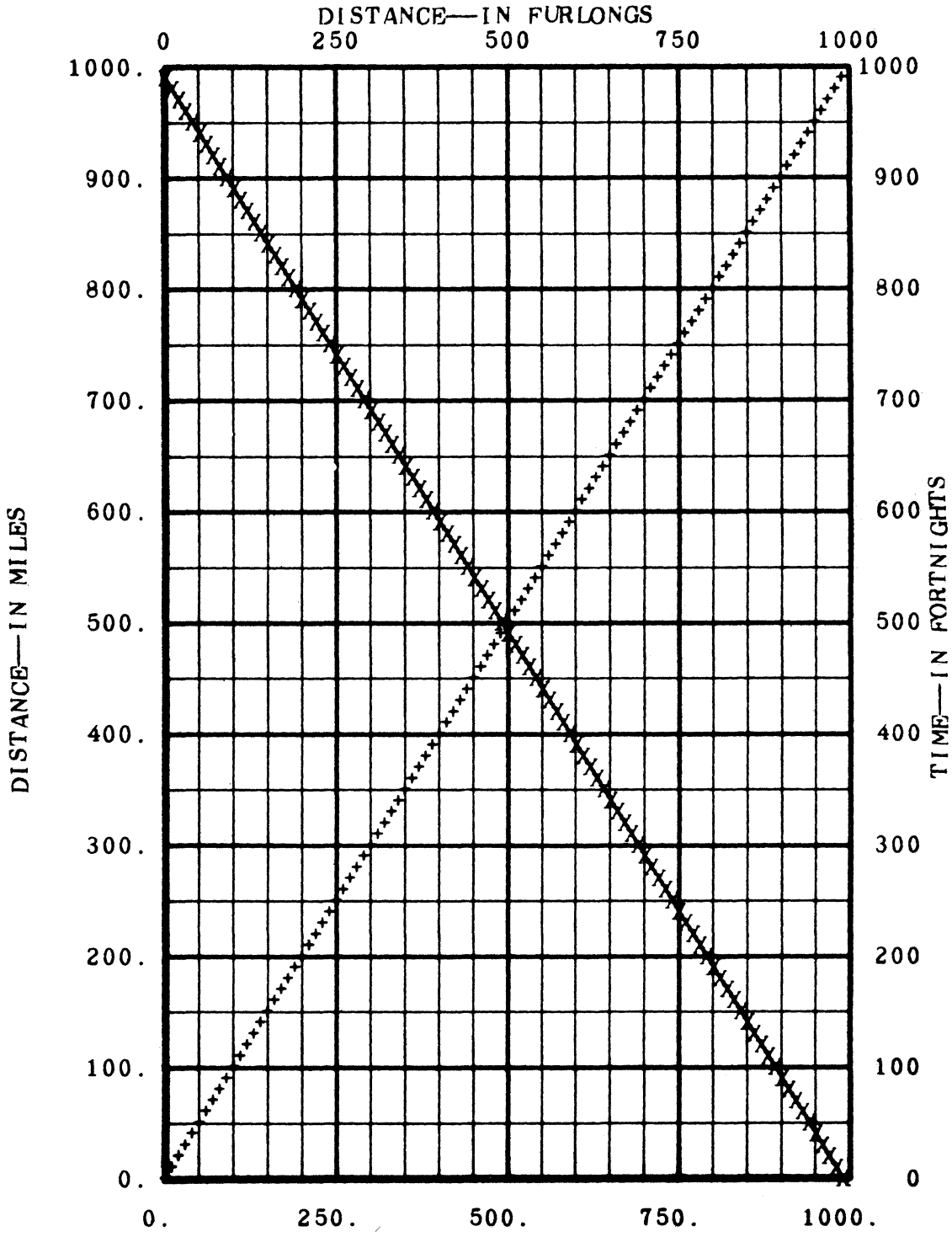


Figure 14. Distance In Furlongs

C
C APPENDIX B.
C
C IGS ERROR CODES
C
C THIS TABLE DESCRIBES THE MEANING OF EACH POSSIBLE IGS ERROR
C MESSAGE. WHEN AN ERROR OCCURS, SUBROUTINE ERRZZ IS CALLED TO PRINT
C OUT AN ERROR MESSAGE. THE ERROR MESSAGE WILL READ AS FOLLOWS:
C BAD BAD BAD, ERROR NO. 'NO' = VALUE(I) VALUE(F) VALUE(A) FRAME XX
C CONTROL IS RETURNED AFTER THE MESSAGE IS PRINTED--THE JOB IS NOT
C TERMINATED.
C

NO	SUBROUTINE	VALUE	DESCRIPTION
1	GETSMG	NO	ILLEGAL MODE SET NUMBER IN CALL.
2	LEGNDG	N	ILLEGAL CHARACTER COUNT IN CALL.
3	LINESG	NO	ILLEGAL NUMBER IN CALL.
4	MODESG	ITAPE	ILLEGAL TAPE NO. IN CALL.
5	NUMBRG	FMT	ILLEGAL FORMAT IN CALL.
6	OBJCTG	-	MAX X OR Y LE MIN X OR Y IN CALL.
7	PAGEG	-	ILLEGAL ARGUMENTS IN CALL.
8	POINTG	N	ILLEGAL NUMBER IN CALL.
9	SEGMTG	N	ILLEGAL NUMBER IN CALL.
10	TABSG	N	ILLEGAL NUMBER IN CALL.
11	MLTPLG	NLINES	ILLEGAL NUMBER IN CALL.
12	GRIDG	-	GRID TOO SMALL TO DRAW.
13	LABELG	-	ILLEGAL FORMAT IN CALL.
14	TITLEG	-	ILLEGAL ARGUMENTS IN CALL.
15	SETUPG	-	ILLEGAL ARGUMENTS IN CALL.
16	SUBJEG	-	MAX X OR Y EQ MIN X OR Y.
17	LABELG	-	ILLEGAL ARGUMENTS IN CALL.
18	LABELG	-	GRID TOO SMALL TO LABEL.
19	LABELG	-	ZERO SUBJECT SPACE.
20	GRIDG	-	ILLEGAL ARGUMENTS IN CALL.
21	SETUPG	-	NOT ENOUGH ROOM TO DRAW A GRID.
22	SETUPG	-	DENSITY LE 0.
23	SETSMG	N	ILLEGAL MODE SET NO. IN CALL.
24	SETUPG	-	GRID WILL NOT FIT ON PAGE.
25	TEXTG	N	ILLEGAL CHARACTER COUNT IN CALL.
26	LABELG	-	LABELS WILL NOT FIT ON PAGE.
27	PACKZZ	-	NO INITIALIZATION CALL TO MODESG.
28	GRAPHG	N	ILLEGAL ARGUMENT IN CALL.
29	SUBJEG	-	MINUS VALUE FOR LOG GRID.
30	SETUPG	-	TOO MANY CYCLES IN LOG GRID.
31	VECTZZ	-	NO VECTOR CHARACTER FONT INITIALIZED.
32	SCALZZ	X	BAD X-COORDINATE.
33	SCALZZ	Y	BAD Y-COORDINATE.
34	VECTZZ	CHAR.	CHARACTER NOT IN FONT.
35	TITLEG	-	NOT ENOUGH ROOM TO TITLE GRID.
36	VECTZZ	CHAR	REQUEST FOR NON-EXISTENT VECTOR CHAR CASE.

```
C
C                              APPENDIX C.
C
C          SUMMARY OF S-C 4060 GRAPHIC FEATURES
C
C
C                                8 1/2 X 11"        11 X 14"      STRIP CHART
C
C PAPER SIZE                     8 1/2 X 11"        11 X 14"        9.9 X 11"
C
C IMAGE SIZE
C  HARD COPY                     7.2 X 9.9"       13.2 X 9.9"       9.9 X 9.9"
C  FILM                        .545 X .75"       1.00 X .75"       .75 X .75"
C
C FILM ADVANCE DIST.             .75 X 0."         1.12 X 0."        .75 X 0."
C
C SIZE IN RASTER UNITS          2241 X 3072       4096 X 3072       3072 X 3072
C
C CHARACTERS/LINE, LINES/PAGE
C  SMALL (.75 NORMAL)             96 X 80           176 X 80          132 X 80
C  NORMAL (1. NORMAL)              72 X 60           132 X 60           99 X 60
C  MEDIUM (1.25 NORMAL)            57 X 48           105 X 48           79 X 48
C  LARGE  (1.5 NORMAL)             48 X 40            88 X 40           66 X 40
C
C CHARACTRON CHAR. SIZES-RASTERS
C  SMALL (.75 NORMAL)             23 X 38 RASTERS = .075 X .113"
C  NORMAL (1. NORMAL)              31 X 51 RASTERS = .10 X .150 "
C  MEDIUM (1.25 NORMAL)            39 X 64 RASTERS = .125 X .188"
C  LARGE  (1.5 NORMAL)             47 X 77 RASTERS = .15 X .225 "
C LINE WEIGHTS
C  LIGHT                                    2 RASTERS = .0064" (ON
C  NORMAL                                   4 RASTERS = .013"   HARDCOPY)
C  HEAVY                                    8 RASTERS = .026"
C  HEAVIEST                                16 RASTERS = .051"
C
C POINT DIAMETERS
C  SMALL                                    2 RASTERS = .0064" (ON
C  NORMAL                                   4 RASTERS = .013"   HARDCOPY)
C  MEDIUM                                   8 RASTERS = .026"
C  LARGE                                   16 RASTERS = .051"
```

Summary of S-C 4060 graphic features

Line widths	Normal line density	Light line density
Light		
Normal		
Medium		
Heavy		

Line dash size

1.

2.

3.

4.

CHARACTRON character orientation

NORMAL

ROTATED

CHARACTRON character size

Small ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghij

Normal ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghij

Medium ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghij

Large ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghij

CHARACTRON plotting point size

Small	+ + +
Normal	+ + +
Medium	+ + +
Large	+ + +

Appendix D

SCORS COMPATIBILITY

Although the design of IGS is considerably different from that of SCORS, there is a degree of compatibility. A few of the lowest level SCORS subroutines have been rewritten to produce S-C 4060 Meta-language input. Although the S-C 4060 can process the SCORS input directly, there are two reasons why an installation might not want this. First, there is a marginal benefit in making the operation of the S-C 4060 easier by having only one type of input. More important, a large SCORS program need not be rewritten in IGS to access the full S-C 4060 features. IGS and SCORS calls can be intermixed to modify the output of the SCORS program. Also, separate parts of the program can be written in IGS, and then added to an existing SCORS program.

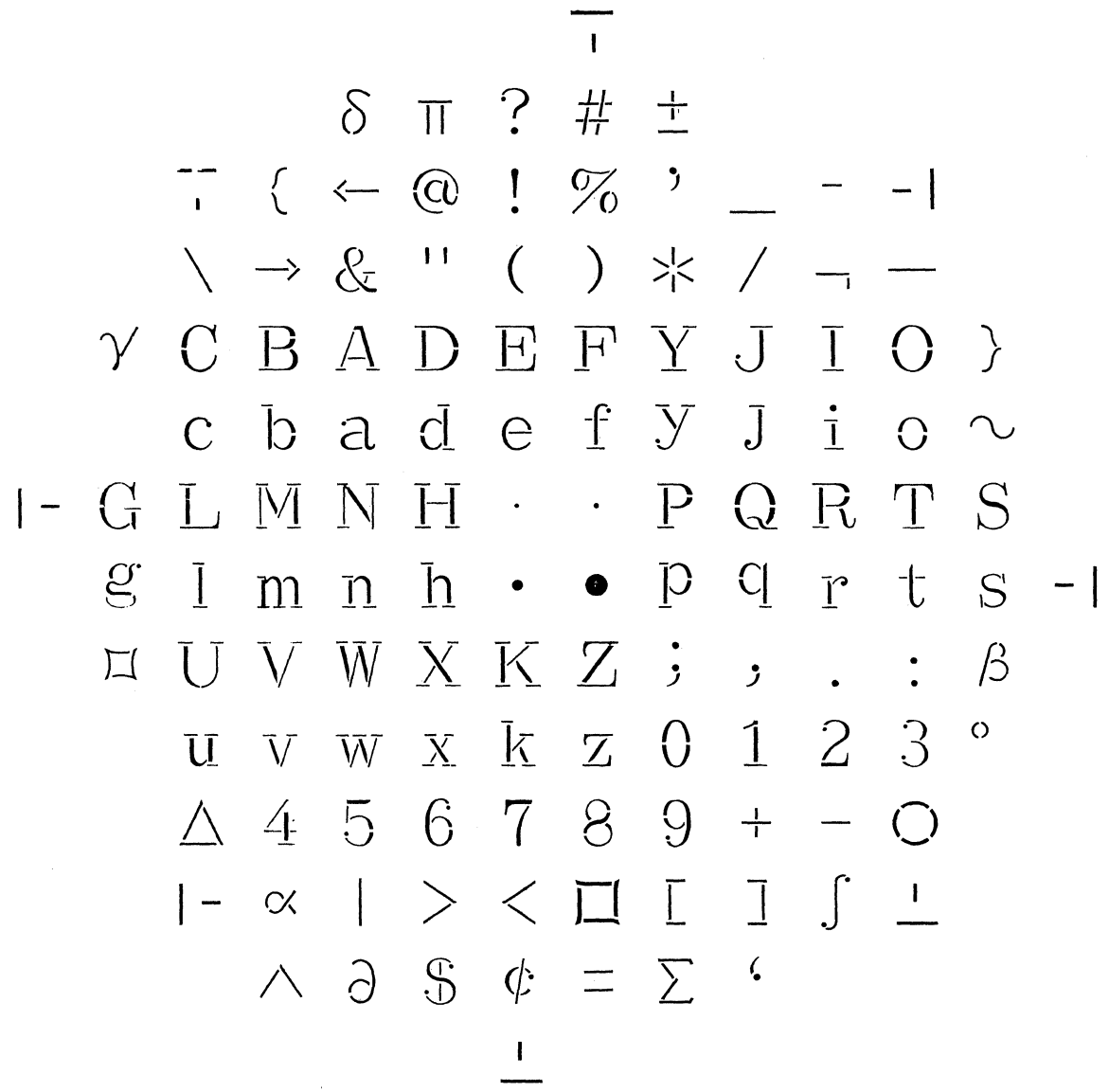
In this sense the IGS System is "compatible" with the S-C 4020 SCORS package — with some elaboration. Basically, it means that existing programs calling on the SCORS subroutines to produce S-C 4020 output will, under IGS, produce comparable meta-language output for the S-C 4060. If the SCORS user wants to use any of the IGS subroutines directly to take advantage of the S-C 4060 hardware features, he must reference the SCORS mode set array in his calls to IGS. The SCORS mode set array is kept in labeled common and is named "AMODES".

For the purpose of IGS compatibility, SCORS will be defined exactly as detailed in the "Programmers' Reference Manual S-C 4020 Computer Recorder", Document No. 9500056, October 1964, Revised August, 1965, Stromberg Datagraphics Inc.

It should be noted that IGS cannot protect the programmer who took advantage of his knowledge of the inner workings of the lower level SCORS subroutines to accomplish things not described in the above document.

APPENDIX E

S-C 4060 CHARACTRON CHARACTER SET



```
C
C                              APPENDIX F.
C
C     THE FOLLOWING SPECIAL CONTROL CHARACTERS MAY BE TYPED WITHIN A
C CHARACTER STRING TO OBTAIN THE FUNCTIONS DESCRIBED.  THE LIST IS
C EXPANDABLE AND NEW FUNCTIONS WILL BE ADDED AS THE NEED ARISES.
C
C     CHARACTER   FUNCTION
C
      $N          NULL-THE $N WILL BE IGNORED.  THE NULL IS USEFUL IF
C                 THE USER WANTS TO ACTUALLY TYPE ANY OF THE SPECIAL
C                 CHARACTERS.  FOR EXAMPLE, IF THE USER WANTED TO TYPE
C                 THE CHARACTERS '$N', HE MUST SEPERATE THEM WITH THE
C                 NULL AS FOLLOWS:  '$$NN'.
C     $T          TAB-CAUSES A TAB TO THE NEXT TAB POSITION, OR TO THE
C                 RIGHT MARGIN IF THERE ARE NO MORE TABS.
C     $E          EJECT-SAME AS A CARRIAGE RETURN ON A TYPEWRITER.  IT
C                 EJECTS THE LINE TO THE LEFT MARGIN.
C     $U          UPPER-SET CHARACTER CASE TO UPPER.
C     $L          LOWER-SET CHARACTER CASE TO LOWER.
C     $S          SPECIAL-SET CHARACTER CASE TO SPECIAL.
C     $C          UPPER CASE NEXT CHARACTER ONLY.  (CAPITALIZE)
C     $B          BACKSPACE
C     $P          NEW PAGE
C     $+          SUPERSCRIPT- SHIFT LINE UP 1/2 SPACE.
C     $-          SUBSCRIPT-SHIFT LINE DOWN 1/2 SPACE.
```

Appendix G

USING VECTOR CHARACTERS

By means of vector characters, one may "type" characters which do not exist in the CHARACTRON set (e.g., cyrillic, hebrew or chinese) or whose style is different (e.g., english script). One may also alter vector character size or orientation without the limitations which exist for CHARACTRON characters, and one may skew vector characters and alter their width or height separately; operations that do not exist with CHARACTRON characters (see figure 4).

Two things are required to produce vector characters: subroutines to produce and manipulate them, and the specification for a font in the form required by the subroutines. The standard IGS package includes all vector character subroutines and one font (named FONT 2). To prepare other fonts see Ref. 6.

The next step, given a vector character font, is to use it. Proceed as follows:

1) Indicate that the font is defined outside this program.
   Example: EXTERNAL FNAME
2) Initialize the font
   Example: CALL VECIG (Z, FNAME), where
   Z is the mode array
   FNAME is the name of an array containing the font
3) Set the character font mode for vector characters.
   Example: Call SETSMG (Z , 51, 1.)
4) Use LEGNDG and TEXTG to output vector characters.

Note that LEGNDG and TEXTG output either CHARACTRON or vector characters depending on the setting of mode 51. To return to CHARACTRON characters, reset mode 51 to zero. To change vector character fonts, simply initialize another font to designate it as the font currently in use (see sample program in Appendix H).

```
C                              APPENDIX H
C
C    TWO SAMPLE VECTOR CHARACTER SUBROUTINES:
C      1) INITIALIZING AND SWITCHING FONTS
C      2) USING VECTOR CHARACTERS.
C
C
C
C         SAMPLE ROUTINE NO. 1 FOR VECTOR CHARACTERS.
C
C THIS ROUTINE ILLUSTRATES HOW TO INITIALIZE A VECTOR CHARACTER FONT,
C  HOW TO SWITCH BETWEEN CHARACTRON CHARACTERS AND VECTOR CHARACTERS,
C  AND HOW TO SWITCH FROM ONE VECTOR CHARACTER FONT TO ANOTHER.
C
C
      DIMENSION Z(200)
C
C EXTERNAL THE VECTOR CHARACTER FONT NAMES.
      EXTERNAL FONT2,FANCY
C INITIALIZE IGS
      CALL MODESG(Z,0)
C SET FOR NEW PAGE ON OVERFLOW
      CALL SETSMG(Z,44,1.)
C LABEL THE PAGE WITH CHARACTRON CHARACTERS
      CALL LEGNDG(Z,0.,3071.,31,31H S$LWAPPING VECTOR CHARACTERS$U)
C INITIALIZE VECTOR CHARACTER FONT 'FONT2'
      CALL VECIG(Z,FONT2)
C CHANGE TO USING VECTOR CHARACTERS
      CALL SETSMG(Z,51,1.)
C TYPE WITH VECTOR CHARACTER FONT 'FONT2'
      CALL LEGNDG(Z,31.,3000.,32,32HV$LECTOR CHARACTERS FROM $UFONT2)
C  NOTE THAT I MUST START HALF A CHARACTER WIDTH IN FROM THE MARGIN
C
C  INSTEAD OF CALCULATING HALF A CHARACTER WIDTH, I CAN LET
C   IGS DO IT FOR ME BY CALLING FOR A LINE EJECT($E)
      CALL LEGNDG(Z,0.,3000.,20,20H$ELINE EJECTED FONT2)
C CHANGE VECTOR CHARACTER FONT TO 'FANCY'
      CALL VECIG(Z,FANCY)
C TYPE SOME VECTOR CHARACTERS FROM 'FANCY' STARTING WHERE WE LEFT OFF
      CALL TEXTG(Z,22,22HFANCY FONT STARTS HERE)
C MORE FANCY FONT
      CALL LEGNDG(Z,0.,2000.,17,17H$EMORE FANCY FONT)
C BACK TO CHARACTRON
      CALL SETSMG(Z,51,0.)
      CALL TEXTG(Z,20,20H$EBACK TO CHARACTRON)
C THRU
      CALL EXITG(Z)
      CALL EXIT
      END
C
```

```
C                        APPENDIX   (CONTINUED)
C
C         SAMPLE ROUTINE NO. 2 FOR VECTOR CHARACTERS.
C
C THIS ROUTINE ILLUSTRATES HOW TO USE VECTOR CHARACTERS.
C
C
      DIMENSION Z(200)
C EXTERNAL THE VECTOR CHARACTER FONT NAME.
      EXTERNAL FONT2
C INITIALIZE IGS
      CALL MODESG(Z,0)
C SET FOR NEW PAGE ON OVERFLOW
      CALL SETSMG(Z,44,1.)
C LABEL THE PAGE WITH CHARACTRON CHARACTERS
      CALL LEGNDG(Z,0.,3071.,28,28H U$LSING VECTOR CHARACTERS$U)
C INITIALIZE VECTOR CHARACTER FONT 'FONT2'
      CALL VECIG(Z,FONT2)
C CHANGE TO USING VECTOR CHARACTERS
      CALL SETSMG(Z,51,1.)
C CHANGE SIZE TO 2.7 TIMES NORMAL
      CALL SETSMG(Z,45,2.7)
      CALL TEXTG(Z,15,15H$ELARGE FONT2$E)
C RETURN SIZE TO NORMAL
      CALL SETSMG(Z,45,1.)
C MAKE CHARACTERS 2 TIMES NORMAL WIDTH
C  GET CURRENT WIDTH
      CALL GETSMG(Z,42,V)
      V2 = 2.* V
C  SET WIDTH AND TYPE MESSAGE
      CALL SETSMG(Z,42,V2)
      CALL TEXTG(Z,12,12H$ETWO WIDE$E)
C RETURN WIDTH TO NORMAL
      CALL SETSMG(Z,42,V)
C MAKE HEIGHT 3 TIMES NORMAL
C  GET CURRENT HEIGHT
      CALL GETSMG(Z,43,V)
      V3 = 3.* V
C  SET NEW HEIGHT AND TYPE MESSAGE
      CALL SETSMG(Z,43,V3)
      CALL TEXTG(Z,14,14H$ETHREE HIGH$E)
C  RETURN HEIGHT TO NORMAL
      CALL SETSMG(Z,43,V)
C ROTATE THE CHARACTERS 29 DEGREES CLOCKWISE.
      CALL SETSMG(Z,46,-29.)
      CALL TEXTG(Z,20,20H$EROTATED 29 DEGREES)
C  RESET ANGLE
      CALL SETSMG(Z,46,0.)
C SKEW CHARACTERS 30 DEGREES TO THE RIGHT (CLOCKWISE)
      CALL SETSMG(Z,131,-30.)
      CALL TEXTG(Z,23,23H$ESKEW 30 DEGREES RIGHT)
C THRU
      CALL EXITG(Z)
      CALL EXIT
      END
```

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C                              APPENDIX
C
C    TWO SAMPLE VECTOR CHARACTER SUBROUTINES
C      1  INITIALIZING AND SWITCHING FONTS
C      2  USING VECTOR CHARACTERS.
C
C
C
C          SAMPLE ROUTINE NO. 1 FOR VECTOR CHARACTERS.
C
C THIS ROUTINE ILLUSTRATES HOW TO INITIALIZE A VECTOR CHARACTER FONT,
C  HOW TO SWITCH BETWEEN CHARACTRON CHARACTERS AND VECTOR CHARACTERS,
C  AND HOW TO SWITCH FROM ONE VECTOR CHARACTER FONT TO ANOTHER.
C
C
      DIMENSION Z 200
C
C EXTERNAL THE VECTOR CHARACTER FONT NAMES.
      EXTERNAL FONT2,FANCY
C INITIALIZE IGS
      CALL MODESG Z,0
C SET FOR NEW PAGE ON OVERFLOW
      CALL SETSMG Z,44,1.
C LABEL THE PAGE WITH CHARACTRON CHARACTERS
      CALL LEGNDG Z,0.,3071.,31,31H S$LWAPPING VECTOR CHARACTERS$U
C INITIALIZE VECTOR CHARACTER FONT :FONT2:
      CALL VECIG Z,FONT2
C CHANGE TO USING VECTOR CHARACTERS
      CALL SETSMG Z,51,1.
C TYPE WITH VECTOR CHARACTER FONT :FONT2:
      CALL LEGNDG Z,31.,3000.,32,32HV$LECTOR CHARACTERS FROM $UFONT2
C  NOTE THAT I MUST START HALF A CHARACTER WIDTH IN FROM THE MARGIN
C
C  INSTEAD OF CALCULATING HALF A CHARACTER WIDTH, I CAN LET
C   IGS DO IT FOR ME BY CALLING FOR A LINE EJECT $E
      CALL LEGNDG Z,0.,3000.,20,20H$ELINE EJECTED FONT2
C CHANGE VECTOR CHARACTER FONT TO :FANCY:
      CALL VECIG Z,FANCY
C TYPE SOME VECTOR CHARACTERS FROM :FANCY: STARTING WHERE WE LEFT OFF
      CALL TEXTG Z,22,22HFANCY FONT STARTS HERE
C MORE FANCY FONT
      CALL LEGNDG Z,0.,2000.,17,17H$EMORE FANCY FONT
C BACK TO CHARACTRON
      CALL SETSMG Z,51,0.
      CALL TEXTG Z,20,20H$EBACK TO CHARACTRON
C THRU
      CALL EXITG Z
      CALL EXIT
      END
C
```

```
C                        APPENDIX    CONTINUED
C
C         SAMPLE ROUTINE NO. 2 FOR VECTOR CHARACTERS.
C
C THIS ROUTINE ILLUSTRATES HOW TO USE VECTOR CHARACTERS.
C
C
      DIMENSION Z 200
C EXTERNAL THE VECTOR CHARACTER FONT NAME.
      EXTERNAL FONT2
C INITIALIZE IGS
      CALL MODESG Z,0
C SET FOR NEW PAGE ON OVERFLOW
      CALL SETSMG Z,44,1.
C LABEL THE PAGE WITH CHARACTRON CHARACTERS
      CALL LEGNDG Z,0.,3071.,28,28H U$LSING VECTOR CHARACTERS$U
C INITIALIZE VECTOR CHARACTER FONT :FONT2:
      CALL VECIG Z,FONT2
C CHANGE TO USING VECTOR CHARACTERS
      CALL SETSMG Z,51,1.
C CHANGE SIZE TO 2.7 TIMES NORMAL
      CALL SETSMG Z,45,2.7
      CALL TEXTG Z,13,13H$ELARGE FONT2
C RETURN SIZE TO NORMAL
      CALL SETSMG Z,45,1.
C MAKE CHARACTERS 2 TIMES NORMAL WIDTH
C  GET CURRENT WIDTH
      CALL GETSMG Z,42,V
      V2 > 2.* V
C  SET WIDTH AND TYPE MESSAGE
      CALL SETSMG Z,42,V2
      CALL TEXTG Z,10,10H$ETWO WIDE
C RETURN WIDTH TO NORMAL
      CALL SETSMG Z,42,V
C MAKE HEIGHT 3 TIMES NORMAL
C  GET CURRENT HEIGHT
      CALL GETSMG Z,43,V
      V3 > 3.* V
C  SET NEW HEIGHT AND TYPE MESSAGE
      CALL SETSMG Z,43,V3
      CALL TEXTG Z,12,12H$ETHREE HIGH
C  RETURN HEIGHT TO NORMAL
      CALL SETSMG Z,43,V
C ROTATE THE CHARACTERS 29 DEGREES COUNTER CLOCKWISE
      CALL SETSMG Z,46,29.
      CALL TEXTG Z,20,20H$EROTATED 29 DEGREES
C  RESET ANGLE
      CALL SETSMG Z,46,0.
C SKEW CHARACTERS 30 DEGREES TO THE RIGHT  CLOCKWISE
      CALL SETSMG Z,131,-30.
      CALL TEXTG Z,23,23H$ESKEW 30 DEGREES RIGHT
C THRU
      CALL EXITG Z
      CALL EXIT
      END
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REFERENCES

1. S-C 4020 Computer Recorder, Product Specification, Document No. 281001-241, May 1964, Stromberg Datagraphics Inc.

2. Programmers Reference Manual S-C 4020 Computer Recorder, Document No. 9500056, October 1964, revised August, 1965, Stromberg Datagraphics Inc.

3. S-C 4060 Stored Program Recording System, Description and Specifications, Document No. 9500209, October 1966, Stromberg Datagraphics Inc.

4. Graphic Specifications for Standard Graphic Output Subroutines as proposed by the SHARE Standard Graphic Output Language Committee, August 8, 1966.

5. American Standard Fortran, Anerican Standards Association, Approved March 7, 1966.

6. Programmer's Reference Manual, Integrated Graphics Software System, Vol. 2, Systems Programmer's Guide.

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