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GRAPH Presentation Graphing System Reference Manual

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GRAPH Reference Manual

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This document applies to GRAPH Versions 1.2 and later

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CHAPTER 1

INTRODUCTION

1.1 WHAT IS GRAPH?

The GRAPH program and interface described in this document provide a a fully-featured presentation graphing system for use with the Alpha Micro Graphics Operating System (AMIGOS). The GRAPH system interface allows incorporation of chart creation, storage, retrieval, and modification into a program application. For more information regarding AMIGOS, please see the *AMIGOS Reference Manual*.

1.2 PREREQUISITES

The GRAPH software requires AMOS/L 1.3C or later, or AMOS/32 1.0 or later as the host operating system and AMIGOS version 1.1 or later for the graphics interface. For complete compatibility information, see the current *AMIGOS Release Notes*.

1.3 INSTALLATION INSTRUCTIONS

The GRAPH software is a part of the AMIGOS product and as such is contained in the AMIGOS software media. GRAPH software installation instructions are included in the *AMIGOS Release Notes*.

1.4 AUDIENCE

This reference manual is intended for application programmers and assumes you are familiar with the AMIGOS software, the AMOS operating system and the AlphaBASIC, AlphaC, or Assembler programming languages.

1.5 DOCUMENTATION

This document is a part AMIGOS's documentation library which consists of these books:

- *AMIGOS Reference Manual* - gives a brief introduction to graphics systems in general and includes detailed information for all AMIGOS functions.

- *AMIGOS Release Notes* - contains all the information you need to get AMIGOS and GRAPH up and running on your computer.

- *GRAPH Reference Manual* - describes how to use the GRAPH software with AMIGOS to let your application make, store, retrieve and modify charts.

1.6 REFERENCE BOOKS

During development of the AMIGOS and GRAPH software, the books listed below have proven to be excellent resources for information about graphics.

- *Computer Graphics*. Written by Donald Hearn and M. Pauline Baker. Published in 1986 by Prentice-Hall, Inc.

- *Principles of Interactive Computer Graphics*, second edition. Written by William M. Newman, Robert F. Sproull. Published in 1979 by McGraw-Hill Book Company.

- *Computer Graphics A Programming Approach*. Written by Steven Harrington. Published in 1983 by McGraw-Hill Book Company.

- *Fundamentals of Interactive Computer Graphics*. Written by J. D. Foley and A. Van Dam. Published in 1982 by Addison-Wesley Publishing Company, Inc.

- *Raster Graphics Handbook*. Written and published by Conrac Corporation in 1980.

- *PostScript Language Tutorial and Cookbook.* Written by Adobe Systems Incorporated. Published in 1985 by Addison-Wesley Publishing Company, Inc.

- *PostScript Language Reference Manual.* Written by Adobe Systems Incorporated. Published in 1985 by Addison-Wesley Publishing Company, Inc.

- *PostScript Language Program Design.* Written by Adobe Systems Incorporated. Published in 1988 by Addison-Wesley Publishing Company, Inc.

Alpha Microsystems documents you may need to refer to are:

- *AMOS Monitor Calls Reference Manual*

- *AlphaBASIC User's Manual*
- *AlphaBASIC PLUS User's Manual*
- *AlphaBASIC XCALL Subroutine User's Manual*
- *AMOS Terminal System Programmer's Manual*

1.7 HOW THIS BOOK IS ORGANIZED

The *GRAPH Reference Manual* is organized into five chapters and one appendix.

Chapter 2 "General Concepts" introduces you to terms and ideas particular to the GRAPH software.

Chapter 3 "The GRAPH Interface" describes Assembler, AlphaBASIC and AlphaC call definitions, memory requirements, the GRAPH parameter and data structures.

Chapter 4 "GRAPH Function Calls" describes the function calls associated with GRAPH.

Chapter 5 "GDF File Keyword Definition" provides the currently supported keywords defining the graph definition file format.

Appendix A "Error Codes Reported by GRAPH" lists the error codes, and corresponding meaning, which are returned by the GRAPH software.

1.8 PRINTING CONVENTIONS

Like other Alpha Micro documents, this book uses standard symbols and abbreviations to make the information easier to read and understand.

SYMBOL	DESCRIPTION
`type`	This mono-spaced courier type face is used when illustrating the function format. For example: `CALL GO.IMP(A6)`
{}	Optional elements in a function are enclosed within braces. When these symbols appear in a sample, they designate elements you may omit from the call.

CHAPTER 2

GENERAL CONCEPTS

GRAPH is organized as a collection of subroutines which may be used by an application program to create presentation charts and graphs on a variety of output devices with data supplied by an application program. GRAPH uses the AMIGOS device-independent graphics interface to provide flexibility in output options. A chart created on a CRT based display may be output on a laser printer or plotter without additional change or programming effort.

2.1 OVERVIEW

The program GRAPH.SYS is the heart of the GRAPH system. It contains all of the subroutines required to create and display charts. GRAPH makes use of the AMIGOS graphics operating system which must be loaded in system memory before GRAPH may be used. You may load GRAPH.SYS into the user's partition or it may reside in system memory.

The file GRFSYM.M68 is used by assembly language programmers to define all of the calls and data structures provided by GRAPH.

AlphaBASIC programs may access GRAPH.SYS through use of the GRFSBR.SBR external subroutine. The file GRFSYM.BSI may be INCLUDEd in your AlphaBASIC program to define the calls and variables used.

The AlphaC program interface to the GRAPH system is provided by the file GRAPH.H which may be included in your AlphaC program. In addition, the compiled object module must be linked with the GRFCLB.LIB library file to complete the interface.

The following sequence of events typifies a normal communication session with GRAPH. The sequence assumes a chart was previously created and resides on disk as CHART.GDF. Please refer to the *AMIGOS Reference Manual* for more detailed information regarding AMIGOS functions.

1. Allocate a GCB (graphics control block) and perform an AMIGOS GOPWK (open workstation) call to initialize the desired output device.

2. Perform an AMIGOS GCLRW (clear workstation) call to clear and initialize the workstation.

3. Perform a GRAPH GO.IMP call to determine how much impure memory is required.

4. Allocate the required memory.

5. Perform a GRAPH GO.INI call to initialize the impure memory area.

6. Open the file CHART.GDF for input and perform a GRAPH GO.LOD call to load the chart into the impure space.

7. Perform various storage and retrieval calls to GRAPH to return and store data values and/or chart parameters as necessary. This allows your program to modify chart values without regard to impure area layout.

8. Perform a GRAPH GO.DSP call to display the modified chart on the output device.

9. Open a file for output and perform a GRAPH GO.SAV call to store the modified chart on disk.

10. Close all files and perform an AMIGOS GCLWK call to close the output workstation.

It is not necessary to load a chart from an existing file. Your program may perform all initialization steps and simply provide data and chart parameters for display.

2.2 DATA TYPES AND ORGANIZATION

The underlying purpose of the GRAPH system is to present the user's data in as clear a manner as possible. This data may be provided to GRAPH from any source the user wants. All data must be supplied in AMOS compatible 6-byte floating point format.

Each data point on a chart is represented by a corresponding X and Y coordinate pair. In all charts except X-Y, only the Y portion is used to represent the data value. A group of data points corresponding to a particular theme is referred to as a "Range" of data. Up to eight data ranges may be defined and plotted on a single chart. Thus, on a line chart, eight data ranges would appear as eight separate line plots, one for each range.

GRAPH supports both positive and negative data values within the range of floating point limits imposed by the system. Certain chart types cannot support negative data points. These chart types accumulate a total which assumes a total greater than the previous value. An example is the pie chart where it would be difficult to display a pie wedge representing a negative percentage of the total.

2.3 CHART STYLES

GRAPH displays six basic chart styles:

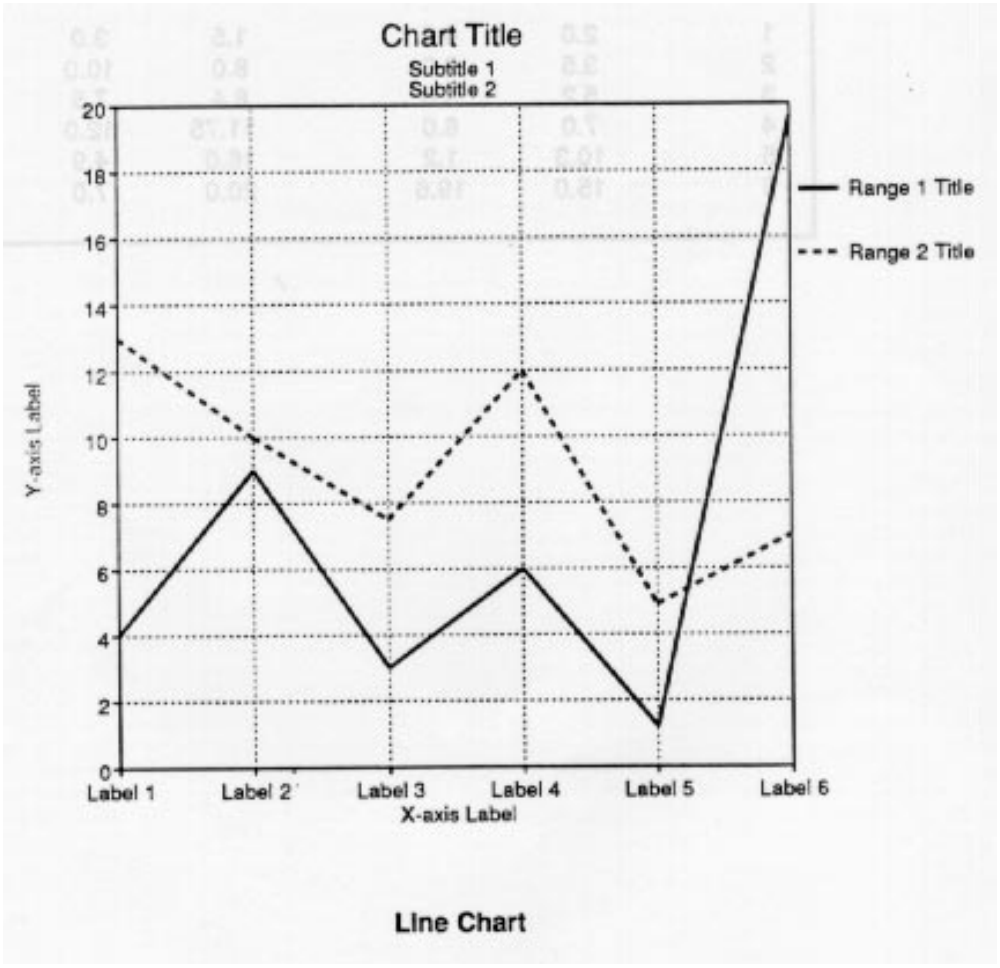
Line Charts	Pie Charts
Clustered Bar Charts	Area Charts
Stacked Bar Charts	X-Y Charts

In the following examples, each chart consists of two data ranges comprised of six data points each with the following values:

Data Point	Range 1 X	Range 1 Y	Range 2 X	Range 2 Y
1	2.0	4.0	1.5	3.0
2	3.5	9.0	8.0	10.0
3	5.2	3.0	8.4	7.5
4	7.0	6.0	11.75	12.0
5	10.3	1.2	16.0	4.9
6	15.0	19.6	20.0	7.0

2.3.1 Line Chart

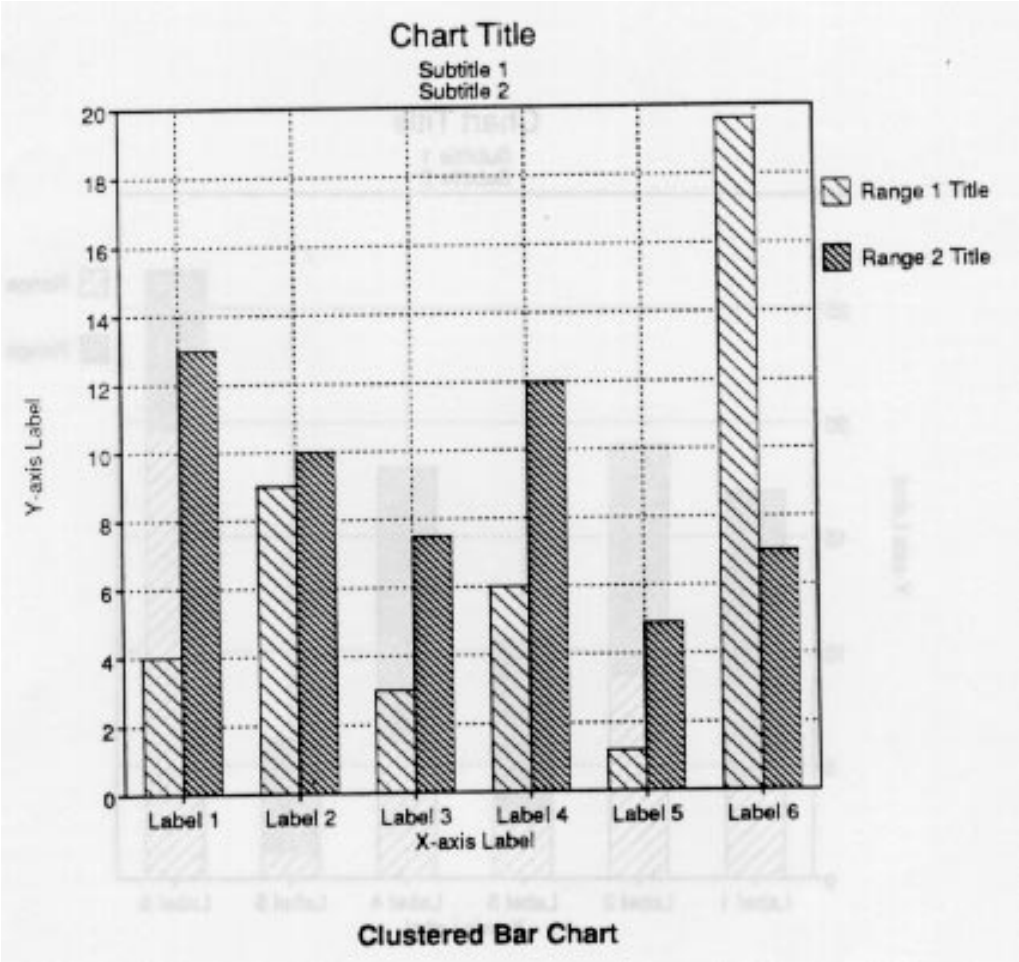
Line charts consist of a set of data points connected with a line. You can specify marker output such that each data point is represented by a symbol, such as a dot, star, plus, etc. In addition, you can specify a line type of zero to show only the marked data points. Each data range may be drawn in a different color.



Line Chart

2.3.2 Clustered Bar Chart

The clustered bar chart, or simply bar chart, consists of a filled rectangular area to represent the Y magnitude of the data points. Multiple data ranges are displayed adjacent to each other for comparison purposes. Each range may be represented by a variable color.

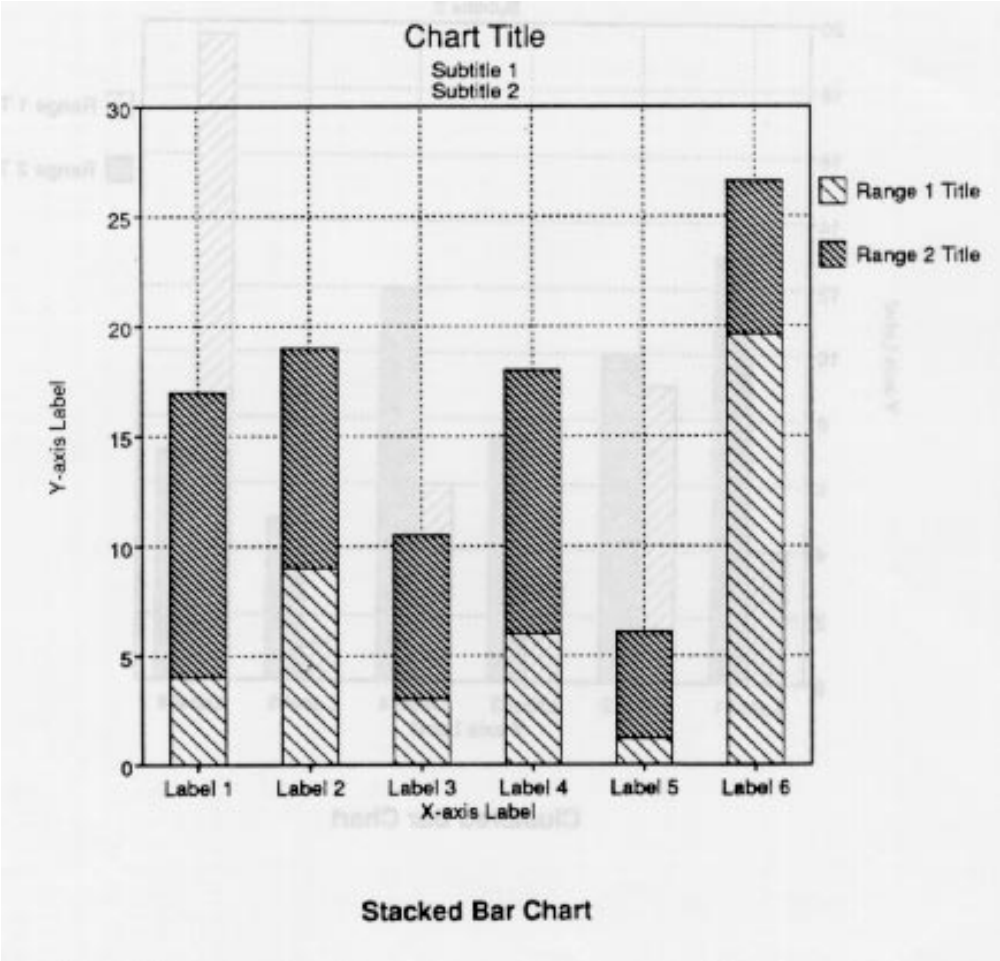


Clustered Bar Chart

2.3.3 Stacked Bar Chart

The stacked bar chart is similar to the clustered bar chart except the Y-data point values from each range are added and stacked one on top of another to show a cumulative total.

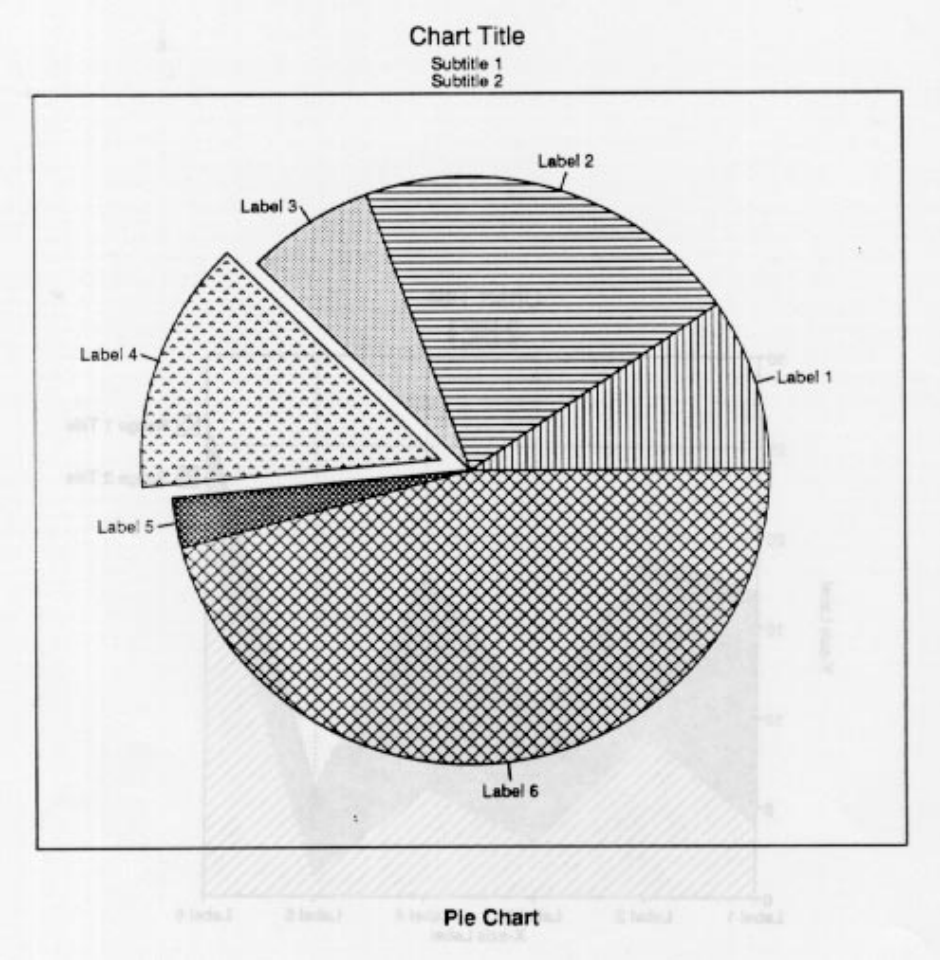
Positive and negative data values are accumulated separately, with the total of positive values displayed above the X axis, and the total of all negative values displayed below the X axis.



Stacked Bar Chart

2.3.4 Pie Chart

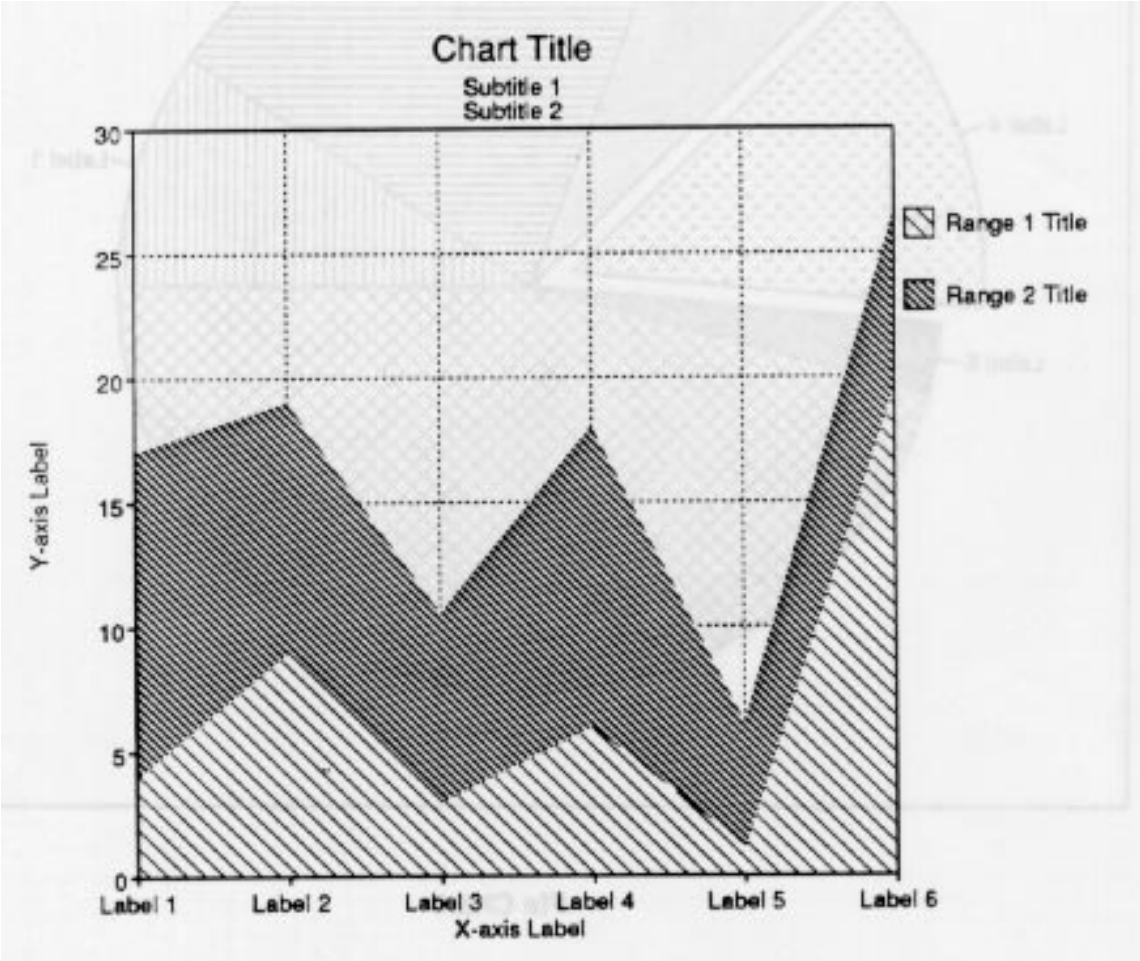
The pie chart represents a single range of data as a pie-wedge percentage of the range total. The color of each sector may be selected. Negative data values are ignored in pie charts.



2.3.5∞Area Chart

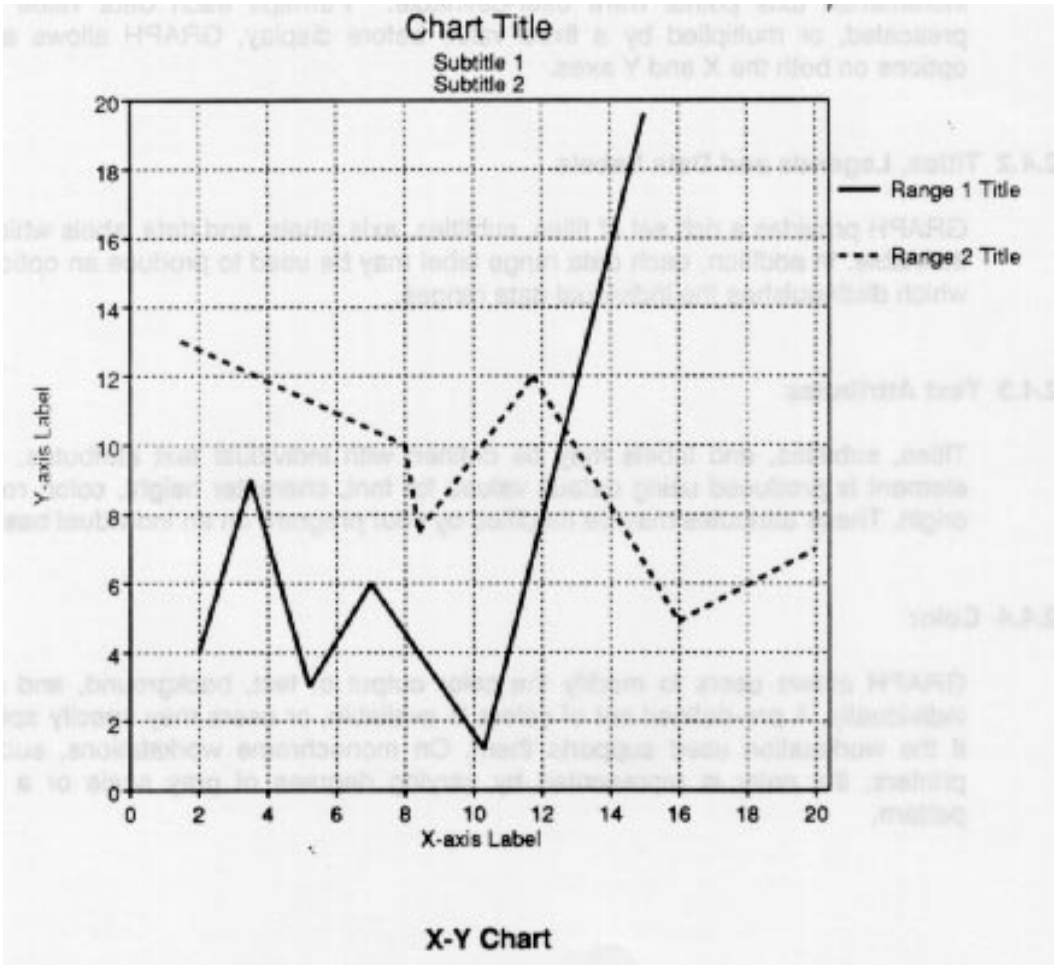
The area chart is similar to the stacked bar chart except that the Y-data values are linked together in a filled area which tends to more dramatically show trends in the data pattern.

Positive and negative data values are accumulated separately, with the total of positive values displayed above the X axis, and the total of all negative values displayed below the X axis.



2.3.6 X-Y Chart

The X-Y chart is used for relational plotting of coordinate pairs. The data points are linked with a line which may be blanked or altered in the same manner as the line chart.



X-Y Chart

2.4 CHART OPTIONS

GRAPH is able to produce a chart from a minimum set of parameters. Many of the chart features such as axis scaling, headings, subtitles, text color, and legend output are produced as defaults when displaying a chart. You can alter these parameters to produce customized charts.

2.4.1 Axis Scaling

When given a set of data points to plot, GRAPH calculates the minimum and maximum range of the data and creates X and Y axes with scales to accommodate the entire data range. Users need not be concerned with scale values in order to produce an initial chart. However, in many applications it is necessary to modify the starting and ending values of an axis. In addition, the data might be more easily understood if the incremental axis points were user-definable. Perhaps each data value should be prescaled, or multiplied by a fixed value before display. GRAPH allows all of these options on both the X and Y axes.

2.4.2 Titles, Legends and Data Labels

GRAPH provides a rich set of titles, subtitles, axis labels, and data labels which are user definable. In addition, each data range label may be used to produce an optional legend which distinguishes the individual data ranges.

2.4.3 Text Attributes

Titles, subtitles, and labels may be defined with individual text attributes. Each text element is produced using default values for font, character height, color, rotation, and origin. These attributes may be modified by your program on an individual basis.

2.4.4 Color

GRAPH allows users to modify the color output of text, background, and data areas individually. A pre-defined set of colors is available, or users may specify special colors if the workstation used supports them. On monochrome workstations, such as laser printers, the color is represented by varying degrees of gray scale or a specific fill pattern.

2.4.5 Data Point Markers

GRAPH allows you to specify optional marker types to represent each data point. Using these markers, and specifying a zero line type, allows your program to produce scatter charts when in line or X-Y mode.

2.5 CHART STORAGE AND RETRIEVAL

GRAPH provides two calls, GO.LOD and GO.SAV, to allow storage and retrieval of completed charts. GRAPH stores the chart on disk in a simple keyword text format. This file is referred to as a Graph Definition File and is generally given an extension of .GDF. You do not need to access this file directly as all subsequent access may be be performed by GRAPH. The data in the GDF file is not keyed to a particular program or output device. It is a universal exchange file which may be used by another program to display the same chart on a different output device.

2.5.1 User Text

It might be convenient for a particular application program to store some additional data in the GDF file so that it may retrieve that data when loading the chart during a subsequent session. An example of this requirement might be a program which charts a column of data from a spreadsheet containing many columns. Upon loading the chart at a later date, it would be convenient for the program to determine which column the data came from. In this case, the program would need to store the column number in the GDF file for later retrieval.

Since many different programs are able to create and modify charts through use of the GRAPH interface, the information stored in the GDF file by one program must be able to be discerned from that which was placed there by another program. In addition, all user information which is not used by the current program must be passed to any new modified GDF files. These functions are performed by the User Text Pointer System within GRAPH.

Within the impure area controlled by GRAPH are 100 pointers which are initialized with a value of zero. Each application program is assigned a unique number in the range of 1 to 99. When a program wishes to store or retrieve information in the GDF file, it initializes its appropriate pointer with an index to a text buffer which resides in the user's memory space. Once this pointer is initialized, any information in the GDF file which corresponds to that pointer number is loaded or stored from the user's text buffer. All other user text in the GDF file is ignored.

Before loading a GDF file, your program initializes its text buffer pointer through use of the GO.SUP call. If the GDF file is to be updated, your program opens a new file for output and informs GRAPH that this file is active during the load process. As user text is retrieved from the GDF file, all text which is not associated with this program's unique pointer is passed directly to the output file. In this way, any other program's unique data is preserved.

The user text area may be any size you want. It is layed out as a series of text strings, each terminated with a null. The final string is terminated with a byte of -1 (377 octal) to indicate the logical end of the buffer. Each string is stored in the GDF file as a separate line.

CHAPTER 3

THE GRAPH INTERFACE

The program interface to the GRAPH system is provided by the file GRFSYM.M68 which is COPYed by an assembly language program to define the call and data structures associated with the system.

The AlphaBASIC program interface to the GRAPH system is provided by the file GRFSYM.BSI, which your AlphaBASIC program incorporates via the INCLUDE statement to define the call and data structures associated with the system. All calls to GRAPH.SYS are performed through the GRFSBR.SBR external subroutine.

The AlphaC program interface to the GRAPH system is provided by the file GRAPH.H which you must "include" in your AlphaC program. In addition, the compiled object module must be linked with the GRFCLB.LIB library file to complete the interface.

3.1 CALL DEFINITIONS

At the base of the GRAPH.SYS module, just after the standard program header, are a series of jumps to specific routines in GRAPH. The offsets are defined in GRFSYM.M68. The implementation and operation of these calls is described in detail in Chapter 4, "GRAPH Function Calls." Briefly, the call offsets are:

GO.IMP	Return impure memory size required for operation of GRAPH with a specified number of data points.
GO.INI	Initialize user allocated impure area.
GO.DSP	Display Chart currently residing in impure area.
GO.LOD	Load a previously saved chart from disk into impure area.
GO.SAV	Save current chart in impure area onto disk.
GO.GGP	Get current graph parameter list from impure area and place in a user specified area.
GO.PGP	Put a user specified parameter list into the impure parameter list area.

GO.GRD	Get a range of data from the impure area and place it in a user specified data area.
GO.PRD	Put a user specified data area into an impure area data range.
GO.CSR	Clear a single range of data in the impure area.
GO.CAR	Clear all data ranges in the impure area.
GO.SUP	Load a user text index pointer in the impure area.

3.2 MEMORY REQUIREMENTS AND USAGE

The GRAPH interface was designed to provide flexibility in interface for a variety of existing software packages. Since many of these programs do not allocate memory consistently with the standard AMOS memory allocation methods, it was necessary to define a universal means of providing GRAPH with its necessary impure memory.

When a program uses GRAPH, it must first ask GRAPH how much memory is required. The user program does this through use of the GO.IMP call. Once GRAPH reports the required memory size, it is the user program's responsibility to allocate a contiguous area of memory in a manner consistent with that program's operation. Once the area is allocated, GRAPH is informed of its location through use of the GO.INI call.

Since AlphaBASIC allocates free memory from the top down, AlphaBASIC programs must pre-allocate the impure area through use of a MAPped unformatted variable. The size of this area may be determined through use of the GO'IMP call but the impure area itself may not be dynamically allocated.

The impure memory is not directly accessed or modified by the user program. Instead, various calls to GRAPH return elements from the area and place elements into the area. The layout of the impure memory area is not available to the user program. By using this method, updates and changes to the GRAPH system will not necessitate recompilation or assembly of programs which use it.

The user program allocates two defined memory areas in order to exchange data and parameters with the impure area. The definition of each of these areas follows.

3.3 GRAPH PARAMETER STRUCTURE

A data structure of size GP.SIZ is used to exchange chart parameters with GRAPH. A call to GRAPH to get or put this area results in the entire area being moved. The definition of each element within this area follows.

Each text element is defined with individual text attributes. The format of a text element is:

0	font
2	character height
4	color
6	rotation
10	offset x
12	offset y
14	text
14+	text size

GRAPH.SYS will normally display all text in a default location using default attributes. Specifying a non-zero attribute causes the default to be overridden by the new attribute. In addition, the user is able to preset an overall default set of attributes to be used if individual attributes are not specified. For more information, see the description of the parameter text attribute area (GP.TXA) below.

3.3.1 GP.TTL - Chart Title

The GP.TTL - chart title may be up to 60 characters in length and must be terminated by a null byte. The title appears centered at the top of the chart. This is a text element with individual text attributes as described above.

3.3.2 GP.ST1 - Subtitle 1

GP.ST1 - subtitle 1 may be up to 60 characters in length and must be terminated with a null byte. It appears centered directly below the title. This is a text element with individual text attributes as described above.

3.3.3 GP.ST2 - Subtitle 2

GP.ST2 - subtitle 2 may be up to 60 characters in length and must be terminated with a null byte. It appears centered directly below subtitle 1. This is a text element with individual text attributes as described above.

3.3.4 GP.FOT - Footnote

The GP.FOT - footnote may be up to 60 characters in length and is terminated with a null byte. It appears in the lower right corner of the display area. This is a text element with individual text attributes as described above.

3.3.5 GP.XLB - X-axis Label

The X-axis label may be up to 60 characters in length and must be terminated with a null byte. It appears centered directly below the scale values on the X-axis. This is a text element with individual text attributes as described above.

3.3.6 GP.YLB - Y-axis Label

The Y-axis label may be up to 60 characters in length and must be terminated with a null byte. It appears centered directly to the left of the scale values on the Y-axis. This is a text element with individual text attributes as described above.

3.3.7 GP.YST - Y-axis Start Value

The GP.YST value is a floating point number specifying the Y-axis starting value. A value of zero causes GRAPH to default to the lowest Y value determined from the data to be charted. This value may not appear exactly since GRAPH may select an increment value which does not cause a stop at the specified value. In this case, GRAPH selects the closest increment which will display as much data as possible.

3.3.8 GP.YEN - Y-axis End Value

GP.YEN is a floating point number specifying the Y-axis ending value. A value of zero causes GRAPH to default to the highest Y value determined from the data to be charted. This value may not appear exactly since GRAPH may select an increment value which does not cause a stop at the specified value. In this case, GRAPH selects the closest increment which will display as much data as possible.

3.3.9 GP.YIN - Y-axis Increment

GP.YIN is a floating point number specifying the increment used between tick marks on the Y axis. A value of zero will cause GRAPH to select an increment based on the range and values of the data to be charted.

3.3.10 GP.YPR - Y-axis Prescale

This floating point number specifies a constant value to be multiplied by each Y-axis increment for easier readability. A value of zero or one indicates no prescaling is in effect.

3.3.11 GP.XST - X-axis Start Value

GP.XST is a floating point number specifying the X-axis starting value. A value of zero causes GRAPH to default to the lowest X value determined from the data to be charted. This value may not appear exactly since GRAPH may select an increment value which does not cause a stop at the specified value. In this case, GRAPH selects the closest increment which will display as much data as possible. This parameter is only effective in X-Y charts.

3.3.12 GP.XEN - X-axis End Value

GP.XEN is a floating point number specifying the X-axis ending value. A value of zero causes GRAPH to default to the highest X value determined from the data to be charted. This value may not appear exactly since GRAPH may select an increment value which does not cause a stop at the specified value. In this case, GRAPH selects the closest increment which will display as much data as possible. This parameter is only effective in X-Y charts.

3.3.13 GP.XIN - X-axis Increment

GP.XIN is a floating point number specifying the increment used between tick marks on the X axis. A value of zero will cause GRAPH to select an increment based on the range and values of the data to be charted. This parameter is only effective in X-Y charts.

3.3.14 GP.XPR - X-axis Prescale

GP.XPR is a floating point number specifying a constant value to be multiplied by each X-axis increment for easier readability. A value of zero or one indicates no prescaling is in effect. This parameter is only effective in X-Y charts.

3.3.15 GP.TXA - Default Text Attributes

GP.TXA stores the default text attributes for subsequent text commands. These attributes are used if the individual text attributes items are zero. A value of zero in any field causes GRAPH to use the default attribute for the current operation. This area is used by the GDF file load routine to track the currently active attributes set through use of the GTA keyword. The format of this area is:

0	font
2	character height
4	color
6	rotation
10	offset x
12	offset y

3.3.16 GP.FAP - Fill Area Pattern Table

GP.FAP stores a list of fill pattern indices to be used in bar, stacked bar, area, and pie charts. Up to 64 fill patterns may be stored. For bar, stacked bar, and area charts, the first 8 patterns are used to represent the 8 data ranges allowed.

For pie charts, each successive data element retrieves the next fill pattern from this list. If over 64 segments are used, the table will start over at location 0 and proceed forward. A value of zero in any location causes a solid fill in the current color.

On monochrome devices, solid fills are represented by gray scales corresponding to the desired color. Unlike color devices, fill patterns are always generated at full intensity. That is, gray scales are not used to represent color within a fill pattern.

3.3.17 GP.TYP - Type of Chart

GP.TYP determines the chart type to be displayed as defined by the following list:

1 Line Chart
2 Clustered Bar Chart
3 Stacked Bar Chart
4 Pie Chart
5 Area Chart
6 X-Y Chart

All other values default to type 1.

3.3.18 GP.XTP - X-axis Type

The GP.XTP byte defines the X-axis type to be displayed. Currently, only linear axis scales are allowed and this variable has no effect.

3.3.19 GP.YTP - Y-axis Type

The GP.YTP byte defines the Y-axis type to be displayed. Currently, only linear axis scales are allowed and this variable has no effect.

3.3.20 GP.XGR - X-axis Grid Type

The GP.XGR byte defines the type of grid to be displayed on the X-axis as defined by the following list:

0 No grid
1 Dotted grid

3.3.21 GP.YGR - Y-axis Grid Type

The GP.YGR byte defines the type of grid to be displayed on the Y-axis as defined by the following list:

0 No grid
1 Dotted grid

3.3.22 GP.TCL - Text Color

The GP.TXL byte defines the color of all text on the chart as defined by the following list:

0 Black
1 White
2 Blue
3 Magenta
4 Red
5 Yellow
6 Green
7 Cyan

Additional colors may be specified if the workstation in use supports them.

3.3.23 GP.BCL - Background Color

The GP.BCL byte defines the color of the chart background as defined by the following list:

0 Black
1 White
2 Blue
3 Magenta
4 Red
5 Yellow
6 Green
7 Cyan

Additional colors may be specified if the workstation in use supports them.

3.4 GP.LGN - LEGEND TYPE

The GP.LGN byte defines the type of legend to be output on the chart. The legend is keyed to the color of each range and displays the data range title. Legend types are:

0 No Legend
1 Standard Legend

3.4.1 GP.MRK - Data Point Marker Type

The GP.MRK byte defines the type of marker to be displayed at each data point in a line or X-Y type chart. The marker types may be selected from the following list:

0 No Marker Output
1 Dot
2 Plus
3 Star
4 circle
5 cross

3.5 GRAPH DATA STRUCTURE

The GRAPH impure area is capable of storing eight ranges of data in a dynamic manner. Each data range may have a different number of data points, and it is the responsibility of GRAPH to maintain this data within the impure area. The user program deals with one range of data at a time.

A range data memory area is allocated by the user program to exchange with the GRAPH impure area in much the same manner as the parameter area. This area consists of a fixed area defining the data range characteristics, and a variable length area containing the data itself.

The following offsets are defined in GRFSYM.M68 pertaining to the data range.

3.5.1 GR.NUM - Data Range Number

GR.NUM is a 16-bit value containing the data range number identifying the data area. This number may be in the range of 0 to 7. Any other value will cause unpredictable results.

3.5.2 GR.CNT - Count of Data Points

GR.CNT is a 16-bit number containing the total count of active data elements following the fixed portion of the data range area. The user may allocate more memory than required to contain the data elements. When requesting a data range from the GRAPH impure area, it is the user's responsibility to ensure that enough memory has been allocated to contain all of the data elements.

3.5.3 GR.FLG - Data Range Flag

GR.FLG is a 16-bit flag used to define various data range characteristics. This flag contains the following element:

Bit 0	GR$HDR	When this bit is set (=1), the GO.GRD call will return the range header only.

3.5.4 GR.CLR - Data Range Color

The GR.CLR byte defines the color of lines and fill areas to represent this range of data on the display device. The color values area defined as follows:

0	Black
1	White
2	Blue
3	Magenta
4	Red
5	Yellow
6	Green
7	Cyan

Additional colors may be specified if the workstation in use supports them.

3.5.5 GR.LST - Data Range Linestyle

The GR.LST byte defines the linestyle to be used in line and X-Y type charts to represent this range of data. The linestyles available are:

0	No Line Output
1	Solid Line
2	Dashed
3	Dotted
4	Dash-Dot
5	Long Dash
6	Long Dash-Dot

3.5.6 GR.TTL - Data Range Title

The GR.TTL field may be up to 40 characters in length and must be terminated with a null byte. It appears in the legend output to title a range of data. If the legend is enabled, and this field is null, no legend output will occur. This is a text element with individual text attributes as described above.

3.5.7 GR.DAT - Data Offset

The GR.DAT offset defines the size of the preceding fixed area and the location of the base of the data area. The data elements start at this location and extend as far as necessary to define all elements. Each data element is composed of the X and Y data values and several items to define the characteristics of the data.

3.5.8 Data Element Structure

Each data element is GE.SIZ bytes in length and contains:

- GE.FLG - Data Element Flag
- GE.TYP - Data Element Type
- GE.DTX - X Data Value
- GE.DTY - Y Data Value
- GE.LBL - Data Point Label

GE.FLG - Data Element Flag

The GE.FLG byte contains flags describing the data contained in the cell. The associated flag values are:

GE$XVL	X data is valid
GE$YVL	Y data is valid
GE$EXP	Explode pie segment
GE$PRC	Display percentage on pie segment

GE.TYP - Data Element Type

The GE.TYP byte contains a description of the data type contained in the cell as follows:

0 6-byte AMOS floating point
1 8-byte IEEE floating point (currently unsupported)

GE.DTX - X Data Value

GE.DTX is an 8-byte variable that contains the X data value in floating point.

GE.DTY - Y Data Value

GE.DTY is an 8-byte variable that contains the Y data value in floating point.

GE.LBL - Data Point Label

The GE.LBL variable may be up to 20 characters in length and must be terminated with a null byte. The data point labels from the first range are used to label the X-axis tick marks in all charts except Pie and X-Y. This is a text element with individual text attributes as described above.

CHAPTER 4

GRAPH FUNCTION CALLS

GRAPH provides twelve function calls which are defined as offsets in GRFSYM.M68. Each function requires one or more registers to be initialized prior to calling GRAPH. Each function call returns a status in register D6. A successful return is indicated by the Z flag being set and a value of zero in D6. If the Z flag is not set, D6 contains an error code. For complete details regarding error codes, refer to Appendix A, "Error Codes Reported By Graph."

Function calls are performed by initializing any required registers, and performing a subroutine call from a specific offset from the base of GRAPH.SYS. The following example assumes that the variable GRFPNT(A5) contains a pointer to the base of GRAPH.SYS in memory.

```
        MOV         #100.,D1          ; set up maximum data count
        MOV         GRFPNT(A5),A6     ; get pointer to GRAPH.SYS
        CALL        GO.IMP(A6)        ; call the appropriate routine
        BEQ         OK                ; all's well if Z flag set

        perform     error handling

OK:     continue
```

4.1 GO.IMP - REPORT IMPURE AREA SIZE

Prior to using GRAPH, it is necessary to allocate an impure memory area for parameter and data storage. The size of this area is variable depending on the total number of data elements to be displayed. GRAPH does not allocate this memory, but rather reports to the user program how much memory is necessary to accommodate the user's data requirements. The user may then allocate this impure area in a manner convenient to the particular application being executed.

Inputs:	D1	Total number of data elements required. This is equivalent to the number of active data ranges times the number of data points in each range.
Outputs:	D1	Size in bytes of required impure area.

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'IMP,num'el,size,status
```

where:

`num'el`	A floating point variable containing the total number of data elements which the user desires to allocate. This is equivalent to the number of active data ranges time the number of data points in each range.
`size`	A floating point variable which will receive the size of the required impure zone.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
goimp(gizsize)     /* get required impure size */
```

where:

`gizsize`	A pointer to a long integer variable which will receive the size of the required impure zone.

Input Parameters:

```
glong *gizsize;                /* pointer to size variable */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.2 GO.INI - INITIALIZE IMPURE AREA

Once the user program has allocated the required impure area, it is necessary to inform GRAPH of its location so that it may be initialized for subsequent use.

Inputs:	A3	Pointer to impure memory area
	D1	Size of impure area. (Returned by GO.IMP call)
Outputs:	--	none

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'INI,giz,status
```

where:

`giz` An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.

`status` A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
goini(giz,size)     /* initialize GIZ */
```

where:

`giz` A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.

`size` A long integer variable which contains the size of the impure area.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
glong size;                    /* size of impure zone */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.3 GO.DSP - DISPLAY CHART

GO.DSP causes the chart currently stored in the impure area to be displayed on a specified output workstation.

Inputs:	A3	Pointer to impure area.
	A4	Pointer to Graphics Control Block (GCB) which has been opened for output for the desired workstation.
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'DSP,giz,gcb,status
```

where:

`giz` An unformatted (type X) variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH subroutine.

`gcb` An unformatted variable containing the Graphics Control Block for a graphics workstation previously open through the use of the AMIGOS G'OPWK (open workstation) call. Refer to the AMIGOS documentation for additional information.

`status` A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
godsp(giz,gcb)     /* Display graph */
```

where:

`giz` A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.

`gcb` A pointer to the Graphics Control Block for a graphics workstation previously open through the use of the AMIGOS G'OPWK (open workstation) call. Refer to the AMIGOS documentation for additional information.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
g_gcb *gcb;                     /* Graphics Control Block */
```

Data Types:

```
typedef struct gcb g_gcb;       /* graphics control block */

typedef unsigned glong;          /* 4-byte integer */
```

4.4 GO.LOD - LOAD A GRAPH DEFINITION FILE

GO.LOD loads an existing graph definition file into the impure area. Prior to loading the file, all user text buffer pointers must be initialized through use of the GO.SUP call. User text buffers which are not to be used by this program may be passed to an output file by providing an optional output DDB index in the call. See section 2.5.1 for further details on user text input and output.

Inputs:	A3	Pointer to impure area.
	A4	Pointer to GDF file DDB which has been initialized and open for input.
	A2	Pointer to DDB which has been initialized and open for output if necessary to output unused user text. This register must contain zero if no output is required.
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'LOD,giz,in'file,out'file,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`in'file`	A variable containing a file channel which has been opened for input. The .GDF file defined by this channel will be input to the Graph Impure Zone for further processing.
`out' file`	A variable containing a file channel which has been opened for output. This file will be updated with any user text not assigned to this program through the GO'SUP call. If no output is necessary during the load process, this variable must be null or zero.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
golod(giz,iddb,oddb)     /* load GDF file */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`iddb`	A pointer to a DDB of a file which has been opened for input. The .GDF file defined by this variable will be input to the Graph Impure Zone for further processing.
`oddb`	A pointer to a DDB of a file which has been opened for output. This file will be updated with any user text not assigned to this program through the GO'SUP call. If no output is necessary during the load process, this variable must be null or zero.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
glong *iddb;                   /* pointer to input file ddb */
glong *oddb;                   /* pointer to output file ddb */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.5 GO.SAV - SAVE CURRENT CHART IN GRAPH DEFINITION FILE

GO.SAV causes the current impure area contents to be output to a Graph Definition File. All initialized user pointers will cause output of the associated user text buffers. See Chapter 2,"General Concepts," for more information about text input and output.

Inputs:	A3	Pointer to impure area.
	A4	Pointer to GDF file DDB which has been initialized and open for output.
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'SAV,giz,out'file,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`out' file`	A variable containing a file channel which has been opened for output. The graph definition currently residing in the Graph Impure Zone will be output to this file in GDF file format. Refer to Chapter 5, "GDF File Keyword Definition," for more information on GDF file format.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
gosav(giz,oddb)     /* save GDF file */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`oddb`	A pointer to a DDB for a file which has been opened for output. The graph definition currently residing in the Graph Impure Zone will be output to this file in GDF file format. Refer to Chapter 5, "GDF File Keyword Definition," for more information on GDF file format.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
glong *oddb;                   /* pointer to output file ddb */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.6 GO.GGP - GET GRAPH PARAMETERS

GO.GGP causes the graph parameter list defined in GRFSYM.M68 to be copied from the impure area to a user specified location. The parameters copied reflect the current state of the chart defined in the impure area.

Inputs:	A3	Pointer to impure area.
	A4	Pointer to user parameter buffer.
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'GGP,giz,parameter'list,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`parameter'list`	An unformatted (type X) variable which is to receive the current graph parameters. The format of this area is defined in GRFSYM.BSI.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
goggp(giz,parmbuff)     /* Get graph Parameters */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`parmbuff`	A pointer to a variable which is to receive the current graph parameters. The format of this area is defined in GRAPH.H.

Input Parameters:

```
glong *giz;                     /* pointer to graph impure zone */
glong *parmbuff;                /* pointer to parameter buffer */
```

Data Types:

```
typedef unsigned glong;         /* 4-byte integer */
```

4.7 GO.PGP - PUT GRAPH PARAMETERS

GO.PGP causes a parameter list as defined in GRFSYM.M68 to be copied from a user specified location to the impure area. This results in setting the current charts parameters to a user specified state.

Inputs:	A3	Pointer to impure area.
	A4	Pointer to user parameter buffer.
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'PGP,giz,parameter'list,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`para meter' list`	An unformatted (type X) variable which contains the current graph parameters to be stored in the Graph Impure Zone. The format of this area is defined in GRFSYM.BSI.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
gopgp(giz,parmbuff)     /* Put graph Parameters */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`parmbuff`	A pointer to a variable which contains the current graph parameters to be stored in the Graph Impure Zone. The format of this area is defined in GRAPH.H.

Input Parameters:

```
glong *giz;                     /* pointer to graph impure zone */
glong *parmbuff;                /* pointer to parameter buffer */
```

Data Types:

```
typedef unsigned glong;         /* 4-byte integer */
```

4.8 GO.GRD - GET RANGE OF DATA

The GO.GRD call causes a specified range of data to be copied from the impure area to a user specified data area. This area must be formatted as defined in GRFSYM.M68. Prior to making the call, the user program must set the required data range (0 - 7) in GR.NUM in the data area. If the range flag is set in GR$HDR, only the range header will be returned.

Inputs:	A3	Pointer to impure area.
	A4	Pointer to user data area.
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'GRD,giz,data'range,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`data' range`	unformatted (type X) variable which is to receive a range of data. The format of this area is defined in GRFSYM.BSI.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
gogrd(giz,range)     /* Get range of data */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`range`	A pointer to a variable which is to receive A range of data. The format of this area is defined in GRAPH.H.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
glong *range;                  /* pointer to data range buffer */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.9 GO.PRD - PUT RANGE OF DATA

GO.PRD causes a user specified data area to be copied to a specified data range in the impure area. This results in the current chart data for that data range to be changed to the user data. The data area must conform to the structure defined by GRFSYM.M68. The variables in the fixed part of the data area must be initialized to the required values prior to the call.

Inputs:	A3	Pointer to impure area
	A4	Pointer to user data area
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'PRD,giz,data'range,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`data' range`	An unformatted (type X) variable which contains the range of data be stored in the Graph Impure Zone. The format of this area is defined in GRFSYM.BSI.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
goprd(giz,range)     /* Put range of data */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`range`	A pointer to a variable which contains the range of data be stored in the Graph Impure Zone. The format of this area is defined in GRAPH.H.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
glong *range;                  /* pointer to data range buffer */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.10 GO.CSR - CLEAR SINGLE RANGE OF DATA

GO.CSR cause a user specified data range to be deleted from the impure area.

Inputs:	A3	Pointer to impure area
	D1	Data range to clear (0 - 7)
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'CSR,giz,range,status
```

where:

`giz` An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.

`range` A variable containing the range number to be cleared. This number may be in the range 0 to 7.

`status` A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
gocsr(giz,range)      /* Clear single range */
```

where:

`giz` A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.

`range` A long integer variable containing the range number to be cleared. This number may be in the range 0 to 7.

Input Parameters:

```
glong *giz;                   /* pointer to graph impure zone */
glong range;                  /* range number */
```

Data Types:

```
typedef unsigned glong;       /* 4-byte integer */
```

4.11 GO.CAR - CLEAR ALL RANGES OF DATA

GO.CAR causes all data ranges to be deleted from the impure area.

Inputs: A3 Pointer to impure area.

Outputs: -- None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'CAR,giz,status
```

where:

`giz` An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.

`status` A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
gocar(giz)     /* clear all data ranges */
```

where:

`giz` A pointer to a the Graph Impure Zone used as intermediate storage and work space for GRAPH.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

4.12 GO.SUP - SET USER POINTER

GO.SUP causes the user supplied text buffer index to be associated with a specified user number. The user text buffer is cleared by placing a byte of -1 in the first position of the buffer. For further details on user text input and output, see Chapter 2, "General Concepts."

Inputs:	A3	Pointer to impure area.
	A4	Pointer to user text buffer.
	D1	User pointer number. (1 - 99.)
Outputs:	--	None

AlphaBASIC CALLING SEQUENCE

```
XCALL GRFSBR,GO'SUP,giz,buffer,point'num,status
```

where:

`giz`	An unformatted variable containing the Graph Impure Zone used as intermediate storage and work space for the GRAPH sub-routine.
`buffer`	A string or unformatted variable which will contain the user text.
`point' num`	A variable containing the user pointer number (1 to 99) to associate the text with.
`status`	A floating point variable which will receive the return status of the call. Refer to Appendix A for a description of status and error codes.

AlphaC CALLING SEQUENCE

```
gosup(giz,textbuff,pointnum)     /* Set user pointer */
```

where:

`giz`	A pointer to the Graph Impure Zone used as intermediate storage and work space for GRAPH.
`textbuff`	A pointer to a string variable which will contain the user text.
`pointnum`	A long integer variable containing the user pointer number (1 to 99) to associate the text with.

Input Parameters:

```
glong *giz;                    /* pointer to graph impure zone */
glong *textbuff;               /* pointer to text buffer */
glong pointnum;                /* user pointer number for text */
```

Data Types:

```
typedef unsigned glong;        /* 4-byte integer */
```

CHAPTER 5

GDF FILE KEYWORD DEFINITION

Graph definition (GDF) files consist of a series of single line definitions that define both the content and the format of the graph to be generated. Each line of the file contains a keyword and an argument, separated by a space. Blank lines are ignored.

The following keywords which define the graph format are supported:

5.1 GRAPH PARAMETER KEYWORDS

The parameter portion of the graph definition file is made up of keywords which affect the overall appearance and style of the graph.

5.1.1 GTY - Type of graph

GTY allows you to specify the type of graph you wish to have generated. The valid arguments for this keyword are:

1 = line graph
2 = column chart
3 = stacked column chart
4 = pie chart
5 = area graph
6 = X-Y graph

5.1.2 GYT - Y-axis type

The GYT keyword allows you to specify the type of Y-axis that is used. Currently, only linear axes are supported and a value in this variable has no effect.

5.1.3 GYS - Y-axis start

The GYS field allows you to specify a minimum value for the Y-axis. Any data points that lie below this minimum will be truncated. This allows you to eliminate spurious data values, preventing the graph from being compressed due to a few points. This keyword takes a floating point number as an argument. A value of zero is taken as no maximum specified, causing the maximum to be based on the data to be charted.

5.1.4 GYE - Y-axis end

The GYE field allows you to specify a maximum value for the Y-axis. Any data points that lie beyond this maximum will be truncated. This allows you to eliminate spurious data values, preventing the graph from being compressed due to a few points. This keyword takes a floating point number as an argument. A value of zero is taken as no maximum specified, causing the maximum to be based on the data to be charted.

5.1.5 GYI - Y-axis increment

The GYI keyword allows you to specify the increment that will be used between tick marks along the Y-axis. Specify the value to be used as a floating point number following the keyword. A value of zero is taken as no increment specified, causing a system default increment to be chosen based on the data to be charted.

5.1.6 GYP - Y-axis prescale value

The GYP keyword allows you to specify a value to be used to prescale all supplied data values. This value will be used to multiply all data, allowing you to choose the correct magnitude for displaying the data values. A value of zero is taken as no prescale specified, causing all supplied data to be used unchanged.

5.1.7 GYG - Y-axis grid type

The GYG keyword allows you to specify the type of Y-axis grid (if any) that is to be displayed within the chart area. A grid can help the viewer determine the precise position of a data point. The types of grids supported are:

0 = no grid
1 = dotted grid

5.1.8 GXT - X-axis type

The GXT keyword allows you to specify the type of X-axis that is used. Currently, only linear axes are supported and a value in this variable has no effect.

5.1.9 GXS - X-axis start

The GXS field allows you to specify a minimum value for the X-axis. Any data points that lie below this minimum will be truncated. This allows you to eliminate spurious data values, preventing the graph from being compressed due to a few points. This keyword takes a floating point number as an argument. A value of zero is taken as no maximum specified, causing the maximum to be based on the data to be charted.

5.1.10 GXE - X-axis end

The GXE field allows you to specify a maximum value for the X-axis. Any data points that lie beyond this maximum will be truncated. This allows you to eliminate spurious data values, preventing the graph from being compressed due to a few points. This keyword takes a floating point number as an argument. A value of zero is taken as no maximum specified, causing the maximum to be based on the data to be charted.

5.1.11 GXI - X-axis increment

The GXI keyword allows you to specify the increment that will be used between tick marks along the X-axis. Specify the value to be used as a floating point number following the keyword. A value of zero is taken as no increment specified, causing a system default increment to be chosen based on the data to be charted.

5.1.12 GXP - X-axis prescale value

The GXP keyword allows you to specify a value to be used to prescale all supplied data values. This value will be used to multiply all data, allowing you to choose the correct magnitude for displaying the data values. A value of zero is taken as no prescale specified, causing all supplied data to be used unchanged.

5.1.13 GXG - X-axis grid type

The GXG keyword allows you to specify the type of X-axis grid (if any) that is to be displayed within the chart area. A grid can help the viewer determine the precise position of a data point. The types of grids supported are:

0 = no grid
1 = dotted grid

5.1.14 GTC - Text color

The GTC field allows you to specify the color in which all text will be rendered. This keyword takes a single numeric integer argument specifying the text color. The values for the colors are shown below. If no GTC command is included in the GDF file, the text defaults to white.

0 = Black
1 = White
2 = Blue
3 = Magenta
4 = Red
5 = Yellow
6 = Green
7 = Cyan

5.1.15 GBC - Background color

The GBC field allows you to specify the color in which the background will be rendered. This keyword takes a single numeric integer argument specifying the color. The values for the colors are shown below. If no GBC command is included in the GDF file, the background defaults to black.

0 = Black
1 = White
2 = Blue
3 = Magenta
4 = Red
5 = Yellow
6 = Green
7 = Cyan

5.1.16 GMT - Data point marker type

The GMT keyword allow the definition of a marker type to be placed at each data point on the graph. The defined marker types are:

0 = no marker
1 = dot (.)
2 = plus (+)
3 = star (*)
4 = circle (O)
5 = cross (X)
>5 = workstation dependent

5.1.17 LGN - Legend enable

The LGN keyword allows you to enable and disable the legend area. The legend is used to differentiate between data ranges when multiple data ranges are in use. This keyword takes a boolean argument (0 or 1), where 0 disables the legend (the default case) and 1 enables the legend.

5.1.18 GFP - Fill pattern definition

The GFP keyword allows the definition of up to 64 fill patterns to be used in filling area, bar, stacked bar, and pie charts. In pie charts, each data element will use a consecutive fill pattern from this list, starting at position 0. Bar, stacked bar, and area charts will use only the first 8 patterns, one for each data range, starting with location 0.

The first argument must be the starting location of the first fill pattern to be defined, followed by as many fill pattern indices desired. For example, the command:

```
GFP        12,4,7,9
```

defines fill location 12 to use pattern index 4, location 13 using pattern 7, and location 14 using pattern 9.

5.1.19 GTA - Text attributes

The GTA command loads default text attributes for all subsequent text items. Up to six arguments may follow the command. If any argument is zero, the current default attribute associated with its position is used. The order of the arguments is:

```
FONT, HEIGHT, COLOR, ROTATION, OFFSET-X, OFFSET-Y
```

`FONT` is any value font available in the currently active workstation. AMIGOS stroke fonts 1001 through 1009 are also available.

`HEIGHT` is the character height in world coordinates. If zero or missing, the default GRAPH height is used.

`COLOR` specifies a color index for subsequent text. If zero or missing, the default color specified by GTC is used.

`ROTATION` may be specified in 1/10 degree resolution. Internal stroke fonts (1001 through 1009) may be continuously scaled and rotated. Workstation generated fonts (bitmap fonts) may not be rotatable or may only rotate in 90 degree increments. In this case, the closest rotation available will be used.

OFFSET-X, and OFFSET-Y are specified in integer world coordinates in the range 0 to 32767 and allow the repositioning of a subsequent text string relative to its default location. Value of 0 or a missing argument results in the default positioning being used.

5.1.20 GUP - User parameter text line

The GUP keyword defines an application specific text element associated with a specific user parameter number. The first argument is the parameter number in the range 1 to 99. This is followed by a line of text to be store/retrieved from the user parameter buffer.

The following keywords allow you to define textual annotation of the graph. These text fields can contain any printing ASCII characters, including leading and trailing spaces. Control characters are not allowed. All text is generated using the current or default text attributes.

5.1.21 GTL - Title

The GTL keyword allows you to specify a title for the chart of up to 60 characters. The title is displayed at the top of the chart, above the main graph area.

5.1.22 GS1 - Subtitle 1

The GS1 keyword allows you to specify an optional subtitle for the chart of up to 60 characters. This subtitle is displayed at the top of the chart, immediately below the title.

5.1.23 GS2 - Subtitle 2

The GS2 keyword allows you to specify an additional optional subtitle for the chart of up to 60 characters. This subtitle is displayed at the top of the chart, immediately below subtitle number 1.

5.1.24 GFN - Footnote

The GFN keyword allows you to specify up to 60 characters as a footnote, which will be printed at the bottom right of the chart area.

5.1.25 GXL - X-axis label

The GXL keyword allows you to place a label below the X-axis of the chart. Up to 60 characters may be specified.

5.1.26 GYL - Y-axis label

The GYL keyword allows you to place a label alongside the Y-axis of the chart. The text will be placed along the left side of the chart area. Up to 60 characters may be entered. GRAPH will attempt to rotate the text by 90 degrees. If the workstation does not support rotation, the text is placed as a single character per line, one character below the previous.

5.2 GRAPH DATA KEYWORDS

The data portion of the graph definition file is made up of keywords that describe each data range, as well as keywords that describe the data within each range. Each of these commands is made up of letters defining the keyword, with embedded numbers defining the data range ("n") and in some cases the data element number within the range ("m").

5.2.1 GnC - Range color

The GnC field allows you to specify the color to be used for displaying data within range "n". This keyword takes a single numeric integer argument specifying the text color. The values for the colors are shown below. If no GnC command is included in the GDF file, a default color assignment will be made automatically.

0 = Black
1 = White
2 = Blue
3 = Magenta
4 = Red
5 = Yellow
6 = Green
7 = Cyan

5.2.2 GnS - Range linestyle

The GnS field allows you to specify the linestyle to be used for displaying data within range "n". This keyword takes a single numeric integer argument specifying the linestyle. The acceptable values are shown below. If no GnS command is included in the GDF file, the solid linestyle will be used.

1 = solid
2 = dashed
3 = dotted
4 = dash dot
5 = long dash
6 = long dash-dot

5.2.3 GnT - Range title

The GnT keyword allows you to specify up to 40 characters to be used as the title of data range "n". This title will be used within the legend to identify the range of data.

5.2.4 RnDm - Data element

The RnDm keyword allows you to define the value of data element "m" within data range "n". This keyword may be followed by up to 3 arguments. The first two arguments are the X and Y data values in floating point ASCII representation. The Y value may be omitted if this is not an XY chart. In this case, the Y value is equated to the X value. The third argument is the data element flags value. This is a decimal representation of the sum of the data element flag bits described in the section describing GE.FLG.

5.2.5 RnLm - Data Element Label

The RnLm keyword allows you to specify up to 20 characters to be used as the X-axis title of data element "m". This title will be used within pie charts to label each pie segment.

APPENDIX A

ERROR CODES REPORTED BY GRAPH

Each function call to GRAPH returns a status code in register D6. If this code is non-zero, it indicates an error condition. The following decimal error codes are defined:

CODE	SYMBOL	MESSAGE
0	--	No error - normal complettion status.
1-255	--	AMOS file system error.
256	GE$GDF	Unrecognized keyword during GDF file load.
257	GE$NEG	Negative data values not allowed in specified graph type.
258	GE$NDF	Requested data range label has no associated data point stored.
259	GE$AXS	Axis start value exceeds end value.
260	GE$GNF	GRAPH.SYS not found.
261	GE$FUL	Impure data area full.
262	GE$PIM	Parameter variable not large enough.
263	GE$FNO	File channel not open.

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