NASA RASTER GRAPHICS
DISPLAY LIBRARY

Report No. BOGL-87-03

(NASA-CR-181025) RASTER GRAPHICS DISPLAY
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ENGINEERING AND TECHNOLOGY
BRIGHAM YOUNG UNIVERSITY
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RASTER GRAPHICS DISPLAY LIBRARY

A Final Report of NASA Grant NAG-1-391
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Hampton, Virginia 23665

by

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30 June 1987

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Report No. ECGL-87-03
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ALPHABETICAL LIST OF SUBROUTINES ........................................ iii

LIST OF ROUTINES BY FUNCTION ............................................ viii
  Groups and Items Routines ........................................ viii
  Animation Routines ................................................ viii
  Display Device Routines ........................................... ix
  Transformation Routines ........................................... ix
  Text Routines ....................................................... x
  Vector and Scalar Function Routines ........................... x
  Input/Output Routines ........................................... xi
  Raster Routines .................................................... xi
  Hidden Line Removal Routines .................................. xii
  Normal Creation and Manipulation Routines .................. xii
  Clipping Routines ................................................ xii
  Input/Output File Routines .................................... xii
  Initialization Routine (Must be included in all user applications) xii
  Other Routines ..................................................... xii

INTRODUCTION TO THE RASTER GRAPHICS DISPLAY LIBRARY .............. xiv
  Raster Display Systems ........................................... xiv
  A Common Problem of Raster Display Systems .................. xiv
  The Raster Graphics Display Library ............................ xiv
  How To Use This Manual ........................................... xiv

CHAPTER SUMMARIES ........................................................ xvi
  Chapter 1 EXAMPLE PROBLEMS ....................................... xvi
  Chapter 2 TECHNICAL REFERENCES .................................. xvi
  Chapter 3 COMMON BLOCK REFERENCES ............................. xvi
  Chapter 4 INCLUDE FILE REFERENCES .............................. xvi
  Appendix A LINK MAP ................................................ xvi
  Appendix B AN INTRODUCTION TO HIERARCHICAL DATA STRUCTURES ...... xvii
  Appendix C SOFTWARE INSTALLATION ................................ xvii

CHAPTER ONE
EXAMPLE PROBLEMS ........................................................ 1.1
  Why should you go through the examples? .............................. 1.1
  Things you should know ............................................. 1.1
  About the display device and host computer ....................... 1.1
  EXAMPLE 1 ................................................................ 1.2
  EXAMPLE 2 ................................................................ 1.3
  EXAMPLE 3 ................................................................ 1.4
  EXAMPLE 4 ................................................................ 1.6
  EXAMPLE 5 ................................................................ 1.9
  EXAMPLE 6 ................................................................ 1.12
CHAPTER TWO
TECHNICAL REFERENCES

See pages iii and vii for indices of the routines.

CHAPTER THREE
COMMON BLOCKS

CATTRI ............................................. 3.1
CFLAGS ............................................. 3.2
CHFWAS ............................................ 3.4
CLIMIT ............................................. 3.5
CMENRY ............................................ 3.7
HIDSTF ............................................. 3.9
KEEP ............................................... 3.10
MASTER ............................................ 3.11
PIXSTF ............................................ 3.12
RESOLT ............................................ 3.13
VEWSTF ............................................ 3.14
ZBUFER ............................................ 3.15
ZBUFER ............................................ 3.16

CHAPTER FOUR
INCLUDE FILES ..................................... 4.1

ANIM.INC .......................................... 4.2
CVER.INC .......................................... 4.3
FNCT.INC .......................................... 4.4
HIDN.INC .......................................... 4.5
MOVL.INC .......................................... 4.7
MSTR.INC .......................................... 4.8
USER.INC .......................................... 4.10

APPENDIX A
LINK MAP ........................................... A.1

APPENDIX B
AN INTRODUCTION TO HIERARCHICAL DATA STRUCTURES ................................ B.1

Hierarchical Data Structure Terms ............................................. B.2
What Are Groups And Items? ..................................................... B.2

APPENDIX C
SOFTWARE INSTALLATION ........................................... C.1

Installation ........................................... C.2
Bugs, Problems, and Comments ............................................. C.2

TABLE OF CONTENTS ii
### Alphabetized List of Subroutines

<table>
<thead>
<tr>
<th>Subroutine</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTGRP</td>
<td>2.2</td>
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<td>2.91</td>
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</table>
INTHID .............................. 2.92
INTHLR .............................. 2.93
INTSHA .............................. 2.94
ITABLE .............................. 2.95
LCUC ............................... 2.96
LENTXT .............................. 2.97
LITSRC .............................. 2.98
LODCOL .............................. 2.99
MAPWV ............................... 2.100
MAXMIN .............................. 2.101
MODIFY .............................. 2.102
MOV4X4 .............................. 2.103
MOVABS .............................. 2.104
MUL4X4 .............................. 2.105
NEWGRP .............................. 2.106
NORMAL .............................. 2.107
NORMTM .............................. 2.108
NORVEC .............................. 2.109
NRMAVE .............................. 2.110
OPNFLG .............................. 2.111
OUTBOX .............................. 2.112
PCHECK .............................. 2.113
PERDST .............................. 2.114
PIPLIN .............................. 2.115
PIPSRC .............................. 2.116
POLFIL .............................. 2.117
POLSTA .............................. 2.118
POLYS ............................... 2.119
PORMAN .............................. 2.120
PROMPT .............................. 2.121
PRSCP .............................. 2.122
PRSSSTF ............................ 2.123
PURGE .............................. 2.124
PVEC ............................... 2.125
RDINIT .............................. 2.126
READMV .............................. 2.127
REDCHK .............................. 2.128
RESET .............................. 2.129
ROTATE .............................. 2.130
RPLCOP .............................. 2.131
RPLGLOB ............................ 2.132
RUNANI .............................. 2.133
SAVTXT .............................. 2.134
SCALE ............................... 2.135
SETBGC .............................. 2.136

ALPHABETIZED LIST

v
<table>
<thead>
<tr>
<th>Command</th>
<th>Page</th>
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<tbody>
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<td>2.173</td>
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<td>2.174</td>
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<td>Page</td>
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# List of Routines by Function

## Groups and Items Routines

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<th>Page</th>
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## Animation Routines

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ANIMATION ROUTINES (cont.)

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HIDDEN LINE REMOVAL ROUTINES

HIDLIN ........................................... 2.56
INTTHLR ......................................... 2.93
LODCOL ........................................... 2.99
STOREL ........................................... 2.172

NORMAL CREATION AND MANIPULATION ROUTINES

NORMAL .......................................... 2.108
NORMTM .......................................... 2.109
NORVEC .......................................... 2.110
NRMAVE .......................................... 2.111
SMOCLR .......................................... 2.163
SMOGET .......................................... 2.169
SMOSTR .......................................... 2.170
TMPTSN .......................................... 2.180

CLIPPING ROUTINES

CLPLIN .......................................... 2.14
CLPPOL .......................................... 2.15
CLPPZE .......................................... 2.16
GETCLP .......................................... 2.38
POLSTA .......................................... 2.121
SETCLP .......................................... 2.141
ZPLSTA .......................................... 2.190

INPUT/OUTPUT FILE ROUTINES

READMV .......................................... 2.130
REDCCHK .......................................... 2.131
WRITMV .......................................... 2.186
WRTCHK .......................................... 2.187
WRTDRV .......................................... 2.189
WRTGEO .......................................... 2.190

INITIALIZATION ROUTINE (MUST BE INCLUDED IN ALL USER APPLICATIONS)

GRAINT .......................................... 2.50

OTHER ROUTINES

CNTRPT .......................................... 2.18
DISALL .......................................... 2.19
DRWBOR .......................................... 2.29
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GLBAXS .......................................... 2.49
OTHER ROUTINES (cont.)

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Introduction

THE RASTER GRAPHICS DISPLAY LIBRARY

Raster Display Systems

When you use computer graphics to see complex three-dimensional data, your accuracy and productivity increase. Raster display systems show trends and patterns much more clearly than volumes of tabulated data because color and shading can be used to depict realistic scenes.

In engineering applications, color and shading may be used not only to realistically portray an object, but to present additional information. Distorted shapes and color coding of functions include failure criteria, stress or strain components, temperature, and pressure.

A Common Problem of Raster Display Systems

Many applications lack adequate presentation graphics. You may not have a set of software tools that allow you to generate quickly the raster image capabilities you need. Or the algorithms you want may be incorporated in commercial packages or proprietary codes, or be unavailable outside a specialized university environment. What you need is a raster display system that allows you to display the graphics you want.

The Raster Graphics Display Library

The Raster Graphics Display Library (RGDL) is a high level subroutine package that gives you the advanced raster graphics display capabilities you need. RGDL uses FORTRAN source code routines to build subroutines modular enough to use as stand-alone routines in a black box type of environment. With RGDL, you have a set of tools that are easily used, well documented, and error tolerant.

How To Use This Manual

This documentation is divided into four chapters and three appendices. The first chapter contains six examples you should go through if you want to learn how to use RGDL in the fastest, most complete way possible. Chapter two contains a technical reference section, chapter three a common block reference section, and chapter four a reference on include files.

The first appendix, a link map, contains information from MOVIE.BYU software and documentation. MOVIE.BYU is a general purpose computer graphics display system that uses RGDL software.

Appendix B is a section about hierarchical data structures. The third appendix contains installation information and our address.
If you want more information about each section, go to the next page or to the chapter introductions. If you want to make sure the contents on the magnetic tape you received are complete, go to page C.1. For installation information and our address, see page C.2.
Chapter 1  EXAMPLE PROBLEMS

The display library will be introduced to you using six example problems. When you compile and link these examples, you will get an understanding for what you can achieve using the library routines. Each example builds on the previous problem and gets more complicated from one example to the next.

You won't need to type in the example problems, because they are supplied with the software. Make sure you compile and link applications with the proper system flags set. Applications may become very large and some systems require special compiler and link options.

Chapter 2  TECHNICAL REFERENCES

Chapter three contains routines within the display library that you will call to produce raster graphics. The routines are in alphabetical order, each on a separate page. Each user-callable routine is described by function and calling parameters.

Chapter three does not contain a description of all routines in the display library, but rather only those routines that could be called by an applications program.

Chapter 3  COMMON BLOCK REFERENCES

Chapter four contains a common block reference. The chapter lists all common blocks that are used in the display library, and discusses the use of each variable within each common block.

Chapter 4  INCLUDE FILE REFERENCES

Chapter five contains a reference on the include files that are necessary to compile the display library. Each include file and its purpose are listed.

Appendix A  LINK MAP

This appendix contains the link map for MOVIE.BYU version 6. MOVIE.BYU is a general purpose computer graphics display system that uses RGDL software. It uses the display library in addition to other routines, and is an excellent source as an auxiliary reference.

The link map is included to show you the amount of code that may be necessary to perform a function. The link map will also help if you don't have library utilities.
Appendix B  AN INTRODUCTION TO HIERARCHICAL DATA STRUCTURES

Appendix B contains a section about creating new groups. The section will help you understand the hierarchical data structures used in RGDL. You are asked to create new groups in Examples Five and Six of Chapter One.

Appendix C  SOFTWARE INSTALLATION

Appendix C contains installation information. It also gives you the address and phone number of the people you can contact if you find bugs or problems in RGDL software.
Chapter 1

EXAMPLE PROBLEMS

This chapter contains example drivers for the Raster Graphics Subroutine Library. The examples call routines described in chapter two, Technical References. You will learn how to create applications programs that use the graphics library routines. By going through the examples, you will also become familiar with many of the system's capabilities.

Why should you go through the examples?

Because you will save time and headaches. The examples are not busywork. They are six exercises that build on each other to teach you how the Raster Graphics Subroutine Library works.

You should study the examples carefully, then actually compile, link, and run them. You won't need to type them in because they are supplied on tape with the rest of the software.

Things you should know

Make sure you compile and link applications with the correct system flags set. The applications may become very large and some systems require special compiler and link options.

All examples are read in a hard-coded geometry file, EXP9.GEO. A common data base is used so you can follow along with the example problems through more complex operations. Of course, in most cases, you will want to create drivers that prompt for the geometry file names to be read into the data base.

The examples shown do not perform error checking. We strongly suggest you include error checking in applications you write.

About the display device and host computer

The examples will be most useful to you when they are run on a raster display device that allows for screen overlays, such as the Tektronix 4115.

Because no link maps are shown in the examples, the host computer you use should have a library utility. If the host computer does not have a library utility, refer to the link map in the appendix to see what routines must be linked with the drivers.

After the first example, all new additions to the next five exercises are shown in bold.
EXAMPLE 1

PROGRAM RSPEXI

RASTER GRAPHICS SUBROUTINE PACKAGE EXAMPLE 1

THIS EXAMPLE PROBLEM WILL READ IN A GEOMETRY FILE AND
DISPLAY IT IN LINE DRAWING MODE WITH ALL DEFAULTS.

THIS CALL IS NEEDED IN ALL PROGRAMS. IT INITIALIZES THE
GRAPHICS PACKAGE.

CALL GRAINT

READ IN A MOVIE.BYU GEOMETRY FILE CALLED EXP9.GEO. DO NOT READ IN
A FUNCTION OR A DISPLACEMENT FILE.

CALL READMV('EXP9.GEO',' ' , ' ')

DISPLAY LINE DRAWING PICTURE

CALL DISALL
STOP
END
PROGRAM RSPEX2

RASTER GRAPHICS SUBROUTINE PACKAGE EXAMPLE 2

EXAMPLE PROBLEM adds a user defined look from vector to EXAMPLE PROBLEM 1

REAL LOOKAT(3), LOOKFR(3)

This section is needed in all programs. It initializes the graphics package.

CALL GRAINT

READ IN A MOVIE.BYU GEOMETRY FILE CALLED EXP9.GEO. DO NOT READ IN A FUNCTION OR A DISPLACEMENT FILE.

CALL READMV('EXP9.GEO', ' ', ' ')

PROMPT FOR LOOK FROM VECTOR. SET THE LOOK AT POINT TO ZERO, AND CALL THE ROUTINE TO SET UP THE LOOK AT/FROM TRANSFORMATION.

WRITE(*,*), 'ENTER LOOK-FROM VECTOR (X,Y,Z)'
READ(*,*) LOOKFR(1), LOOKFR(2), LOOKFR(3)
LOOKAT(1) = 0.
LOOKAT(2) = 0.
LOOKAT(3) = 0.
CALL ATFROM(LOOKAT, LOOKFR)

COULD ALSO DO THE ATFROM CALL BE GOING THROUGH GLBACT, THIS CALL WOULD LOOK LIKE:

CALL GLBACT('FRM', LOOKAT(1), LOOKAT(2), LOOKAT(3), LOOKFR(1), & 'LOOKFR(2), LOOKFR(3))

GLBACT SHOULD BE USED IF A USER IS RUNNING ANIMATION, SINCE THIS ROUTINE WILL CAPTURE THE LOOK AT/FROM COMMAND AS A MOVEMENT THAT NEEDS TO BE ANIMATED.

DISPLAY LINE DRAWING OF PICTURE

CALL DISALL
STOP
END
EXAMPLE 3

PROGRAM RSPEX3

C

C RASTER GRAPHICS SUBROUTINE PACKAGE EXAMPLE 3
C

C THIS EXAMPLE PROBLEM USES THE I/O ROUTINES FOR ALL
PROMPTS AND USER INPUT. ALSO ADDED IS A USER DEFINED
ROTATION AND TRANSLATION OF PART 1. THE PICTURE IS
DISPLAYED IN LINE DRAWING MODE.
C

CHARACTER*(73) TEXT
CHARACTER*80 FORM
DIMENSION XNUM(40), VALUE(6)
REAL LOOKAT(3), LOOKFR(3)

C--- THIS SECTION IS NEEDED IN ALL PROGRAMS. IT INITIALIZES THE
GRAPHICS PACKAGE.
C

CALL GRAINT

C

READ IN A MOVIE.BYU GEOMETRY FILE CALLED EXP9.GEO. DO NOT READ IN
A FUNCTION OR A DISPLACEMENT FILE.
C

CALL READMV('EXP9.GEO', ' ', ' ')

C PROMPT FOR LOOK FROM VECTOR. SET THE LOOK AT POINT TO ZERO, AND
CALL THE ROUTINE TO SET UP THE LOOK AT/FROM TRANSFORMATION.
PERFORM AN INTERNAL READ FOR THE PROMPT. CALL GETXT WITH THE
PROMPT, WHICH WILL RETURN THE TEXT STRING RESPONSE FROM THE USER -
TEXT, AND THE NUMBER OF CHARACTERS IN TEXT - NCHAR. NEXT, CALL
GETNUM WHICH WILL PARSE THE USER TEXT STRING FOR NUMBERS. XNUM
WILL BE AN ARRAY OF NUMBERS, AND K2 IS THE NUMBER OF NUMBERS
FOUND.
C

WRITE(FORM,100)'ENTER LOOK-FROM VECTOR (X,Y,Z)'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
LOOKAT(1) = 0
LOOKAT(2) = 0
LOOKAT(3) = 0
IF(K2 .EQ 0) THEN
WRITE(FORM,100)'NO LOOK-FROM VECTOR SPECIFIED!'
CALL PROMPT(FORM)
ELSE
LOOKFR(1) = XNUM(1)
LOOKFR(2) = XNUM(2)
LOOKFR(3) = XNUM(3)
CALL ATFROM (LOOKAT,LOOKFR)
END IF
EXAMPLE 3

PROMPT FOR AND PERFORM A ROTATION FOR PART 1

```
WRITE(FORM,100) 'X,Y,Z ROTATION ANGLES (DEGREES) FOR PART 1?'
CALL GETXT(TEXT,NCHAR,FOM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)
```

'1' IS THE PART TO MODIFY.
4 IS THE FLAG INDICATING ROTATION.
VALUE IS AN ARRAY OF NUMBERS CORRESPONDING TO THE ACTION FLAG.

```
CALL MODIFY('1',4,VALUE)
```

PROMPT FOR AND PERFORM A TRANSLATION FOR PART 1.

```
WRITE(FORM,100) 'X,Y,Z TRANSLATION FOR PART 1'
CALL GETXT(TEXT,NCHAR,FOM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)
```

THE ACTION FLAG 5 IS THE TRANSLATION FLAG

```
CALL MODIFY('1',5,VALUE)
```

DISPLAY LINE DRAWING OF PICTURE

```
CALL DISALL
```

Chapter One  EXAMPLE PROBLEMS  1.5
EXAMPLE 4

PROGRAM RSPEX4

RASTER GRAPHICS SUBROUTINE PACKAGE EXAMPLE 4

THIS EXAMPLE PROBLEM TAKES EXAMPLE PROBLEM 3, AND DEFINES FOUR
DIFFERENT VIEW PORTS. THE FIRST VIEW PORT IS DRAWN IN LINE
DRAWING MODE, THE SECOND VIEW PORT IS DRAWN IN HIDDEN LINE MODE,
THE THIRD VIEW PORT IS DRAWN IN SHADED IMAGE MODE. THE FOURTH
VIEW PORT IS DRAWN IN SHADED IMAGE MODE WITH DITHERING.

CHARACTER*(73) TEXT
CHARACTER*80 FORM
DIMENSION XNUM(40),VALUE(6)
REAL LOOKAT(3), LOOKFR(3)

THIS SECTION IS NEEDED IN ALL PROGRAMS. IT INITIALIZES THE
GRAPHICS PACKAGE.

CALL GRAINT

READ IN A MOVIE.BYU GEOMETRY FILE CALLED EXP9.GEO. DO NOT READ IN
A FUNCTION OR A DISPLACEMENT FILE.

CALL READMV('EXP9.GEO',' ',' ')

PROMPT FOR LOOK FROM VECTOR. SET THE LOOK AT POINT TO ZERO, AND
CALL THE ROUTINE TO SET UP THE LOOK AT/FROM TRANSFORMATION.
PERFORM AND INTERNAL READ FOR THE PROMPT. CALL GETXT WITH THE
PROMPT, WHICH WILL RETURN THE TEXT STRING RESPONSE FROM THE USER-
TEST, AND THE NUMBER OF CHARACTERS IN TEXT-NCHAR. NEXT, CALL
GETNUM WHICH WILL PARSE THE USER TEXT STRING FOR NUMBERS. XNUM
WILL BE AN ARRAY OF NUMBERS, AND K2 IS THE NUMBER OF NUMBERS
FOUND.

WRITE(FORM,100) 'ENTER LOOK-FROM VECTOR (X,Y,Z)'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
LOOKAT(1) = 0.
LOOKAT(2) = 0.
LOOKAT(3) = 0.
IF(K2 .EQ. 0) THEN
    WRITE(FORM,100) 'NO LOOK-FROM VECTOR SPECIFIED!'
    CALL PROMPT(FORM)
ELSE
    LOOKFR(1) = XNUM(1)
    LOOKFR(2) = XNUM(2)
    LOOKFR(3) = XNUM(3)
    CALL ATFROM(LOOKAT,LOOKFR)
END IF
EXAMPLE 4

PROMPT FOR AND PERFORM A ROTATION FOR PART 1

```
WRITE(FORM,100) 'X,Y,Z ROTATION ANGLES (DEGREES) FOR PART 1?'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)
CALL MODIFY('I',4,VALUE)
```

PROMPT FOR AND PERFORM A TRANSLATE FOR PART 1

```
WRITE(FORM,100) 'X,Y,Z TRANSLATION FOR PART 1?'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)
CALL MODIFY('I',5,VALUE)
```

SET THE VIEWPORT TO THE UPPER LEFT QUARTER OF THE SCREEN

```
CALL SETPRT(0.,.5,.75)
```

DISPLAY LINE DRAWING OF PICTURE

```
CALL DISALL
```

SET THE VIEWPORT TO THE UPPER RIGHT QUARTER OF THE SCREEN

```
CALL SETPRT(.5,1.,.75)
```

SET THE HIDDEN LINE FLAG ON AND DISPLAY THE PICTURE

```
CALL SETFLG('HIDDEN', .TRUE.)
CALL DISALL
```

SET THE VIEWPORT TO THE LOWER LEFT QUARTER OF THE SCREEN

```
CALL SETPRT(0.,.5,.25)
```

SET THE SHADED IMAGE FLAG AND DISPLAY THE PICTURE

```
CALL SETFLG('SHADED', .TRUE.)
CALL DISALL
```

SET THE VIEWPORT TO THE LOWER RIGHT QUARTER OF THE SCREEN

```
CALL SETPRT(.5,1.,.25)
```

SET THE DITHERING FLAG ON, AND DISPLAY THE RASTER IMAGE OVER
CALL SETFLG('DITHER',.TRUE.)
CALL DISALL

100 FORMAT(A)
   STOP
   END
EXAMPLE 5

PROGRAM RSPEX5

RASTER GRAPHICS SUBROUTINE PACKAGE EXAMPLE 5

THIS EXAMPLE PROBLEM TAKES EXAMPLE PROBLEM 4 AND MODIFIES IT BY CREATING A NEW GROUP. THE COLOR AND SHADING OF PART 1 IS SET, AND THE COLOR OF THE HIGHER GROUP IS SET TO GREEN. THE UPPER RIGHT VIEWPORT IS SHOWN IN FOUR VIEW MODE.

CHARACTER*(73) TEXT
CHARACTER*80 FORM
DIMENSION XNUM(40), VALUE(6)
REAL LOOKAT(3), LOOKFR(3)

THIS SECTION IS NEEDED IN ALL PROGRAMS. IT INITIALIZES THE GRAPHICS PACKAGE.

CALL GRAINT

READ IN A MOVIE.BYU GEOMETRY FILE CALLED EXP9.GEO. DO NOT READ IN A FUNCTION OR A DISPLACEMENT FILE.

CALL READMV('EXP9.GEO',' ',' ',' ')

PROMPT FOR LOOK FROM VECTOR. SET THE LOOK AT POINT TO ZERO, AND CALL THE ROUTINE TO SET UP THE LOOK AT/FROM TRANSFORMATION. PERFORM AND INTERNAL READ FOR THE PROMPT. CALL GETXT WITH THE PROMPT, WHICH WILL RETURN THE TEXT STRING RESPONSE FROM THE USER - TEST, AND THE NUMBER OF CHARACTERS IN TEXT - NCHAR. NEXT, CALL GETNUM WHICH WILL PARSE THE USER TEXT STRING FOR NUMBERS. XNUM WILL BE AN ARRAY OF NUMBERS, AND K2 IS THE NUMBER OF NUMBERS FOUND.

WRITE(FORM,100) 'ENTER LOOK-FROM VECTOR (X,Y,Z)'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
LOOKAT(1) = 0.
LOOKAT(2) = 0.
LOOKAT(3) = 0.
IF(K2 .EQ. 0) THEN
  WRITE(FORM,100) 'NO LOOK-FROM VECTOR SPECIFIED!'
  CALL PROMPT(FORM)
ELSE
  LOOKFR(1) = XNUM(1)
  LOOKFR(2) = XNUM(2)
  LOOKFR(3) = XNUM(3)
  CALL ATFROM(LOOKAT,LOOKFR)
END IF
EXAMPLE 5

PROMPT FOR AND PERFORM A ROTATION FOR PART 1

WRITE(FORM,100) 'X,Y,Z ROTATION ANGLES (DEGREES) FOR PART 1?

CALL GETXT(TEXT,NCHAR,FORM)
CALL GETXT(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)

CALL MODIFY('1',4,VALUE)

PROMPT FOR AND PERFORM A TRANSLATION FOR PART 1

WRITE(FORM,100) 'X,Y,Z TRANSLATION FOR PART 1?

CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)

CALL MODIFY('1',5,VALUE)

CREATE A NEW GROUP (SEE "AN INTRODUCTION TO HIERARCHICAL DATA STRUCTURES" IN APPENDIX B.)

CALL DEFINE('TOP GROUP')

COPY THE GROUP "ROOT" INTO THE NEW GROUP AND CALL THE COPY "COPY ROOT 1"

CALL ADDCAL('ROOT','COPY ROOT 1')

SET THE COLOR OF THE NEW COPY TO GREEN, AND SET THE COLOR OF PART 1 (PART 1 IS REALLY COPY 1) TO RED. ALSO SET THE SHADING ATTRIBUTE OF COPY 1 TO SMOOTH

VALUE(1) = 0.
VALUE(2) = 1.
VALUE(3) = 0.
CALL MODIFY('COPY ROOT 1',8,VALUE)
VALUE(1) = 1.
VALUE(2) = 0.
CALL MODIFY('1',8,VALUE)
VALUE(1) = 2.
CALL MODIFY('1',11,VALUE)

SET THE VIEWPORT TO THE UPPER LEFT QUARTER OF THE SCREEN

CALL SETPRT(0.,.5,.75)

DISPLAY LINE DRAWING OF PICTURE
CALL DISALL

SET THE VIEWPORT TO THE UPPER RIGHT QUARTER OF THE SCREEN
CALL SETPRT(.5,1.,.75)

SET THE HIDDEN LINE FLAG ON AND DISPLAY THE PICTURE IN FOUR
STANDARD VIEWS
CALL SETFLG('HIDDEN', .TRUE.)
CALL FOURVW

SET THE VIEWPORT TO THE LOWER LEFT QUARTER OF THE SCREEN
CALL SETPRT(0.,.5,.25)

SET THE SHADED IMAGE FLAG AND DISPLAY THE PICTURE
CALL SETFLG('SHADED', .TRUE.)
CALL DISALL

SET THE VIEWPORT TO THE LOWER RIGHT QUARTER OF THE SCREEN
CALL SETPRT(.5,1.,.25)

SET THE DITHERING FLAG ON, AND DISPLAY THE RASTER IMAGE OVER
CALL SETFLG('DITHER', .TRUE.)
CALL DISALL

100 FORMAT(A)
STOP
END
EXAMPLE 6

PROGRAM RSPEX6

RASTER GRAPHICS SUBROUTINE PACKAGE EXAMPLE 6

THIS EXAMPLE PROBLEM TAKES EXAMPLE PROBLEM 5 AND MODIFIES IT BY CREATING TWO COPIES OF THE ORIGINAL GEOMETRY FILE. THE USER IS PROMPTED FOR A TRANSLATE OF THE SECOND COPY.

CHARACTER*(73) TEXT
CHARACTER*80 FORM
DIMENSION XNUM(40),VALUE(6)
REAL LOOKAT(3), LOOKFOR(3)

THIS SECTION IS NEEDED IN ALL PROGRAMS. IT INITIALIZES THE GRAPHICS PACKAGE.

CALL GRAINT

READ IN A MOVIE.BYU GEOMETRY FILE CALLED EXP9.GEO. DO NOT READ IN A FUNCTION OR A DISPLACEMENT FILE.

CALL READMV('EXP9.GEO',' ',' ')

PROMPT FOR LOOK FROM VECTOR. SET THE LOOK AT POINT TO ZERO, AND CALL THE ROUTINE TO SET UP THE LOOK AT/FROM TRANSFORMATION. PERFORM AND INTERNAL READ FOR THE PROMPT. CALL GETXT WITH THE PROMPT, WHICH WILL RETURN THE TEXT STRING RESPONSE FROM THE USER - TEST, AND THE NUMBER OF CHARACTERS IN TEXT - NCHAR. NEXT, CALL GETNUM WHICH WILL PARSE THE USER TEXT STRING FOR NUMBERS. XNUM WILL BE AN ARRAY OF NUMBERS, AND K2 IS THE NUMBER OF NUMBERS FOUND.

WRITE(FORM,100) 'ENTER LOOK-FROM VECTOR (X,Y,Z)'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
LOOKAT(1) = 0.
LOOKAT(2) = 0.
LOOKAT(3) = 0.
IF(K2 .EQ. 0) THEN
  WRITE(FORM,100) 'NO LOOK-FROM VECTOR SPECIFIED!'
  CALL PROMPT(FORM)
ELSE
  LOOKFR(1) = XNUM(1)
  LOOKFR(2) = XNUM(2)
  LOOKFR(3) = XNUM(3)
  CALL ATFROM(LOOKAT,LOOKFR)
END IF

PROMPT FOR AND PERFORM A ROTATION FOR PART 1

Chapter One  EXAMPLE PROBLEMS  1.12
WRITE(FORM,100) 'X,Y,Z ROTATION ANGLES (DEGREES) FOR PART 1?'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
LOOKAT(1) = (1) = XNUM(1)
LOOKAT(2) = (2) = XNUM(2)
LOOKAT(3) = (3) = XNUM(3)
CALL MODIFY('1',4,VALUE)

PROMPT FOR AND PERFORM A TRANSLATE FOR PART 1
WRITE(FORM,100) 'X,Y,Z TRANSLATION FOR PART 1?'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)
CALL MODIFY('1',5,VALUE)

CREATE A NEW GROUP (SEE "AN INTRODUCTION TO HIERARCHICAL DATA STRUCTURES" IN APPENDIX B.)
CALL DEFINE('TOP GROUP')
COPY THE GROUP "ROOT" INTO THE NEW GROUP AND CALL THE COPY "COPY ROOT 1"
CALL ADDCAL('ROOT','COPY ROOT 1')
COPY ANOTHER COPY OF ROOT INTO THE NEW GROUP AND CALL THE COPY "COPY ROOT 2"
CALL ADDCAL('ROOT','COPY ROOT 2')
PROMPT THE USER FOR A TRANSLATION OF "COPY ROOT 2"
WRITE(FORM,100) 'X,Y,Z TRANSLATION FOR COPY ROOT 2?'
CALL GETXT(TEXT,NCHAR,FORM)
CALL GETNUM(TEXT,NCHAR,XNUM,K2)
VALUE(1) = XNUM(1)
VALUE(2) = XNUM(2)
VALUE(3) = XNUM(3)
CALL MODIFY('COPY ROOT 2',5,VALUE)

SET THE COLOR OF "COPY ROOT 1" TO GREEN, AND SET THE COLOR OF PART 1(PART 1 IS REALLY COPY 1) TO RED. ALSO SET THE SHADING ATTRIBUTE OF COPY 1 TO SMOOTH
VALUE(1) = 0.
VALUE(2) = 1.
VALUE(3) = 0.
CALL MODIFY('COPY ROOT 1',8,VALUE)
VALUE(1) = 1.
VALUE(2) = 0.
CALL MODIFY('1',8,VALUE)
VALUE(1) = 2.
CALL MODIFY ('1',11,VALUE)

SET THE VIEWPORT TO THE UPPER LEFT QUARTER OF THE SCREEN
CALL SETPRT(0.,.5,.75)
DISPLAY LINE DRAWING OF PICTURE
CALL DISALL

SET THE VIEWPORT TO THE UPPER RIGHT QUARTER OF THE SCREEN
CALL SETPRT(.5,1.,.75)
SET THE HIDDEN LINE FLAG ON AND DISPLAY THE PICTURE IN FOUR
STANDARD VIEWS
CALL SETFLG('HIDDEN',.TRUE.)
CALL FOURVW

SET THE VIEWPORT TO THE LOWER LEFT QUARTER OF THE SCREEN
CALL SETPRT(0.,.5,.25)
SET THE SHADED IMAGE FLAG AND DISPLAY THE PICTURE
CALL SETFLG('SHADED',.TRUE.)
CALL DISALL

SET THE VIEWPORT TO THE LOWER RIGHT QUARTER OF THE SCREEN
CALL SETPRT(.5,1.,.25)
SET THE DITHERING FLAG ON, AND DISPLAY THE RASTER IMAGE OVER
CALL SETFLG('DITHER',.TRUE.)
CALL DISALL

FORMAT(A)
STOP
END
This chapter contains detailed descriptions of all the user-callable subroutines within RGDL. Use the information to write application programs for your needs.

The routines are listed in alphabetical order, each on a separate page. The function is listed at the top of each page, together with the name of the routine. The function of each routine is given, as well as parameters, common blocks, include blocks, and other routines that are used in conjunction with the given routine.

It is unlikely you will use the routines in alphabetical order, so we have provided an index of the routines according to their function on page vi, after the table of contents. An alphabetized index is also given on page iii. The index divided into functions will probably be the easiest way to find an unknown routine with a known function.
DECLARATION: Subroutine ACTGRP (grunam)

FUNCTION: Sets the active group to an existing group.

PARAMETERS

in: grunam The name of an existing group to be set active.
character: grunam(*)
DELCAL

DECLARATION: Subroutine ADDCAL (giname, cpynam)

FUNCTION: Adds a call (item or group) to the active group.

PARAMETERS

  in: giname   Name of group or item to be added to the active group.
        cpynam   Copy name that giname will be referred to.

  character: giname(*), cpynam(*)

COMMON BLOCKS: /CHFWAS/
                 /CLIMIT/
                 /CMEMRY/
ANFILI

DECLARATION: Entry ANFILI (inqnam)

FUNCTION: Returns the animation extension.

An animation file extension of '@#$' indicates that animation is not open.

PARAMETERS

out: inqnam Name of the animation extension.

character: inqnam(3)

SEE ALSO: ANFILS
DECLARATION: Entry ANFILS (newnam)

FUNCTION: Stores the animation extension.

An animation file extension of 'G#' indicates that animation is not open. Use ANIDRV to open animation.

PARAMETERS

in: newnam Name of the new animation extension.

character: newnam(3)

SEE ALSO: ANFILI ANIDRV
DECLARATION: Subroutine ANIDRV

FUNCTION: Drives the animation module. ANIDRV does many basic functions like opening and closing the animation module, setting up subframes, and setting up spline control.

All animation interfacing should be performed through ANIDRV.

COMMON BLOCKS: /CHFWAS/
/DEVI/
/CMEMRY/
DECLARATION: Entry AROCLR

FUNCTION: Clears the displacement arrow arrays.

Call AROCLR once for each part containing displacement vector arrows.
DECLARATION: Subroutine ATFROM (lookat, lookfr)

FUNCTION: Creates the viewing matrix based on the look-from and look-at positions.

Coordinates are in world coordinates.

PARAMETERS

in: lookat Look-at position.
lookfr Look-from position.

real: lookat(3), lookfr(3)

COMMON BLOCKS: /VEWSTF/

SEE ALSO: INQLAF
**DECLARATION:** Subroutine AUTOON

**FUNCTION:** Turns auto center off.

**COMMON BLOCKS:** /DEVI/
/VEWSTF/
DECLARATION: Subroutine BEGANI (aninam)

FUNCTION: Starts the animation, opens necessary files, and initializes all appropriate variables.

PARAMETERS

in: aninam The three character extension names used for animation files.

character: aninam(3)

COMMON BLOCKS: /CHFWAS/
/CLIMIT/
/CMEMRY/
/DEVI/

DECLARATION: Subroutine CAMERA

FUNCTION: Acts as the interface to a camera for animation.

CAMERA gets called after each frame is displayed. You can modify this routine for anything you wish to do after a frame is shown. For example, you may want to interface to a computer-controlled camera.
DECLARATION: Subroutine CENTER

FUNCTION: Sets up the viewing matrix, if not already specified. Also sets up the window and clipping planes to center the model.

The limits of the scene to be displayed must first be set up in SETLIM. Normally, this is done by a call to TRAVRS.

COMMON BLOCKS: /DEVI/ /VEWSTF/ /RESOLT/ 

SEE ALSO: SETLIM GETLIM TRAVRS
DECLARATION: Subroutine CHRNUM (number, lenchr, chrint, nchars)

FUNCTION: Converts integer data into an equivalent character string.

Negative numbers are not allowed.

PARAMETERS

in: 
  lenchr  Maximum length of the string.
  number  The integer number to be made into a character string.

out: 
  chrint  The character string representation of an integer.
  nchars  Maximum number of characters in the string to be returned.

integer: nchars, lenchr, number

character: chrint(*)
DECLARATION: Subroutine CLPLIN (corbeg, corend, w xmin , w xmax, wy min, w ymax, plot)

FUNCTION: Clips lines in x and y.

All coordinates are eye coordinates.

PARAMETERS

in: corbeg X,Y,Z coordinate triplet of beginning point; may be modified after clipping.
    corend X,Y,Z ending triplet of line may be modified after clipping.
    w xmin Minimum X window coordinate.
    w xmax Maximum X window coordinate.
    w ymin Minimum Y window coordinate.
    w ymax Maximum Y window coordinate.

out: plot .TRUE. if line is visible or partly visible.

real: corbeg(3), corend(3), w xmin, w xmax, wy min, w ymax

logical: plot

SEE ALSO: CLPPOL
          CLPPZE
DECLARATION: Subroutine CLPPOL (nedges, cordin, polnin, funcin, clpfun, clpnor, wxmin, wxmax, wymin, wymax, plot)

FUNCTION: CLPPOL clips polygons against the x and y boundaries.

The coordinate, normal, and function arrays must close the polygon. For example, the first vertex location is the same as the nedges + 1 location.

All coordinates are eye coordinates.

PARAMETERS

in: clpfun .TRUE. if clipping function values are being clipped.
clpnor .TRUE. if clipping normals are being clipped.
wxmin Minimum x window coordinate.
wxmax Maximum x window coordinate.
wymin Minimum y window coordinate.
wymax Maximum y window coordinate.
nedges Number of edges in the polygon.
cordin Coordinates of polygon.
cordin(1,1) = X coordinate of first polygon vertex
cordin(2,1) = Y coordinate of first polygon vertex
Cordin may be modified after clipping.
polnin Normals of polygon after clipping.
polnin(1,1) = X component of unit normal at vertex 1
polnin(2,1) = Y component of unit normal at vertex 1
Polnin may be modified after clipping.
funcin Function values of polygon after clipping.
Funcin may be modified after clipping.
out: plot Logical; .TRUE. if polygon is visible after clipping.
real: wxmin, wxmax, wymin, wymax, cordin(3,*), polnin(3,*), funcin(*)
integer: nedges
logical: clpfun, clpnor, plot

SEE ALSO: CLPPZE
CLPLIN
DECLARATION: Subroutine CLPPZE (nedges, cordin, polnin, funcin, clpfun, clpnor, zmin, zmax, plot)

FUNCTION: Clips polygons against the z boundaries.

PARAMETERS

in: 
  clpfun .TRUE. if clipping function values are being clipped.
  clpnor .TRUE. if clipping normals are being clipped.
  zmin Distance from eye to nearest clipping plane.
  zmax Distance from eye to farthest clipping plane.
  nedges Number of edges in the polygon. Nedges may be modified after clipping.
  cordin Coordinates of polygon. Cordin may be modified after clipping.
  polnin Normals of polygon. Polnin may be modified after clipping.
  funcin Function values of polygon. Funcin will be modified after clipping.

out: 
  plot .TRUE. if polygon is visible.

real: 
  zmin, zmax, cordin (3,*), polnin (3,*), funcin (*)

integer: 
  nedges

logical: 
  plot, clpfun, clpnor

SEE ALSO: CLPPOL
         CLPLIN
DECLARATION: Subroutine CNTBAR

FUNCTION: Outputs contour legend bar for contours.

Contours should be set up CNTBAR before calling this routine by calling SETFRN.

SEE ALSO: SETFLG
INQFRN
SETFRN
INQFLG
SETCNT
DECLARATION: Subroutine CNTRPT (nedges, coords, xcentr)

FUNCTION: Calculates a polygon's center point.

    The coordinate array should close the polygon.

PARAMETERS

in: nedges    Number of vertices in a polygon.
     coords    Coordinate array for polygon.

out: xcentr   Coordinate array of center point.

real: coords(3,*), xcentr(3)

integer: nedges
 DECLARATION:  Function COLERR (color)

 FUNCTION:  Calculates the error between the desired color and the next lowest color in the look-up table.

 PARAMETERS

    in:  color    The intensity of either the r, g, or b component of the desired color. (The range of color is from 0.0 to 1.0).

    real:  color
COLORS

DECLARATION: Subroutine COLORS (nedges, aatribt, polfun, coords, polnor, colnod, trnnod)

FUNCTION: Computes color values at polygon nodes according to user-defined light sources.

All coordinates are in the eye coordinate system.

PARAMETERS

in: nedges Number of vertices in the polygon.
aatribt Attribute list for polygon.
coords Coordinate array for polygon vertices.
polfun Polygon function values at the vertices.
polnor Normals of the polygon vertices.

out: colnod Red, green, and blue color intensity at polygon vertices.
trnnod Transparency values of polygon vertices.

real: aatribt(*), colnod(3,*), coords(3,*), polfun(*), trnnod(*), polnor(3,*)

integer: nedges

COMMON BLOCKS: /CFLAGS/
/CATTRI/
/CHFWAS/
/CMEMRY/

Chapter Two TECHNICAL REFERENCES 2.20
DECLARATION: Subroutine COPNUM (sordex, numcop, jroot, jchild, itorgr, cpynam)

FUNCTION: Given the copy number, gets the copy name together with its copy item and parent.

PARAMETERS

out: sordex Sort number associated with the instance.
cpynam Copy name associated with sordex.
jroot Root group number.
jchild Item or group number of the copy name.
itorgr Flag 1 if a group; 0 if an item.
numcop Copy number.

integer: sordex, jroot, jchild, itorgr, numcop

character: cpynam*(*)

SEE ALSO: GETCOP
DECLARATION: Subroutine DEFALT (atlist)

FUNCTION: Sets up a default attributes list.

PARAMETERS:

out: atlist Current attribute list.
real: atlist (maxiaa)

COMMON BLOCKS: /CATTRI/  
/CLIMIT/
**DECLARATION**: Subroutine DEFINE (grunam)

**FUNCTION**: Defines and activate a new group.

**PARAMETERS**

in: grunam  The name of the new group to be activated.

character: grunam(*)
DECLARATION: Subroutine DELETE (cpynam)

FUNCTION: Deletes a call to an instance.

PARAMETERS

  in: cpynam    Copy name to be deleted from the database.
  character: cpynam*(*)

Chapter Two  TECHNICAL REFERENCES  2.24
DECLARATION: Subroutine DISALL

FUNCTION: Displays the picture for all options.

PARAMETERS

COMMON BLOCKS: /DEVI/
/COMEMRY/
/CHFWAS/
/CLIMIT/
DECLARATION: Subroutine DISTXT (string, nchars, r, g, b, ix, iy)

FUNCTION: Displays text strings.

PARAMETERS

in: string  Text string to be displayed.
nchars  Number of characters in string.
r, g, b  Desired color of text (0.0-1.0).
ix, iy  Origin of the string in screen coordinates.

real: r, g, b

integer: nchars, ix, iy

character: string*(*)
DECLARATION: Subroutine DODITH (r,g,b)

FUNCTION: DODITH performs dithering for a pixel.

PARAMETERS

in:  r,g,b  Color components of the pixel (0.0 - 1.0) modified on return.

real: r,g,b
**DECLARATION:** Subroutine DRWABS (ix,iy)

**FUNCTION:** Draws a line from the current location to the specified point (ix,iy).

**PARAMETERS**

in: ix,iy The screen coordinates of the point to be drawn to. The (0,0) point is in the lower left corner, x increases from left to right, and y increases from bottom to top. The ix,iy point should become the current point after the draw command.

integer: ix,iy
DECLARATION: Subroutine DRWBOR

FUNCTION: Draws a border around the current viewport.

*When using DRWBOR, you must put graphics device into and out of the graphics mode.*

SEE ALSO: SETMOD
DECLARATION: Subroutine ERASE

FUNCTION: Clears the current viewport to the background color.
DECLARATION: Subroutine EXTCOP (cpynam, ctm, atlist)

FUNCTION: Extracts transformation and attribute information for an instance.

PARAMETERS

in: cpynam The instance name.

out: atlist Attribute list for the instance.
     ctm Transformation matrix for the instance.

real: atlist(maxatt), ctm(4,4)

character: cpynam(*)

COMMON BLOCKS: /CHFWAS/
                /CLIMIT/
                /CMEMRY/

SEE ALSO: RPLCOP
DECLARATION: Subroutine FNDFRM (chrfrm, keyfrm, subfrm, ierr)

FUNCTION: Finds the keyframe and subframe from a character string of the form keyframe.subframe.

PARAMETERS

in:  chrfrm  A character string defined in the form keyfrm.subfrm.

out: keyfrm  Keyframe number.
        subfrm  Subframe number.
        ierr   Error flag. 0 if operation was successful; 1 if chrfrm was not in the form keyframe.subframe.

integer: subfrm, ierr, keyframe

character: chrfrm*(*)
DECLARATION: Subroutine FOURVW

FUNCTION: FOURVW displays the four standard views.

COMMON BLOCKS: 
/CFLAGS/ 
/RESOLTS/
DECLARATION: Subroutine FRINGE (nlevel, colfnc, fnclcv, valnod, xir, xig, xib)

FUNCTION: Calculates color at a node of a polygon when fringes are on.

Fringes should be set up using SETFRN before calling FRINGE.

PARAMETERS

in: 
colfnc Color at each fringe function level.
fnclcv Function value at each level.
nlevel Number of function levels.
valnod Function value at the node.

out: 
xir Red color component at node.
xig Green color component at node.
xib Blue color component at node.

real: colfnc(3,nlevel), fnclcv(nlevel), xir, xig, xib, valnod

integer: nlevel

SEE ALSO: SETFLG
FRNBAR
INQFRN
SETFRN
INQFLG
DECLARATION: Subroutine FRNBAR

FUNCTION: Displays fringe bar (legend) for color fringes.

Fringes should be set using SETFRN before calling FRNBAR.

SEE ALSO: FRINGE
SETFLG
INQFRN
SETFRN
INQFLG
DECLARATION: Entry GENTXT

FUNCTION: Generates text string for display.

SEE ALSO: TXTDIS
          TXTINT
DECLARATION: Entry GETAGR (i)

FUNCTION: Returns the active group number.

PARAMETERS

out: i Active group number.

integer: i

SEE ALSO: NEWGRP
DECLARATION: Entry GETCLP (znear, zfar, zdist)

FUNCTION: Gets z clipping information.

PARAMETERS

out: znear Distance from eye to the nearest z clipping plane.
zfar Distance from eye to the farthest z clipping plane.
zdist Distance from znear to zfar.

real: znear, zfar, zdist

SEE ALSO: SETCLP
DECLARATION: Subroutine GETCOM (text, nchar, word, n, key, kl)

FUNCTION: Parses a text string for key words.

PARAMETERS

in: n Number of words in the key word array.
word Array of key words that are being looked for.
nchar Number of characters in entered text string.
text Entered text string to be parsed.

out: kl Number of key words found in the text string.
key Array of key word starting locations in the word array that were found in the text string.

integer: n, kl, nchar, key(*)
character: text*75, word(n)*4

SEE ALSO: GETNUM
DECLARATION: Subroutine GETCOP (cpynam, iflag, jroot, jchild, itorgr, sordex, numcop, postfl)

FUNCTION: Given the copy name, gets the copy number and associated indexes.

PARAMETERS

in:  
cpynam  Copy name to get information on.
iflag  1 if adding a copy name.
        2 if deleting a copy name.
        3 if traversing with the copy name to get group and item information.
        4 if purging all calls to an item or group.
        5 if printing the copy names to the screen.

out: postfl  0 if the copy is posted; 1 if unposted.
sordex  Sort number for groups and items.
itorgr  Flag 1 if a group; 0 if an item.
numcop  Copy number associated with the copy name.
jroot  Root group number.
jchild  Item or group number of the copy name.

real: postfl

integer: iflag, sordex, itorgr, numcop

character: cpynam(**)

SEE ALSO: COPNUM
DECLARATION: Entry GETDEF (numcol, red, grn, blu)

FUNCTION: Returns the red, green, and blue color intensities for color number numcol.

All color values are from 0 to 1.

PARAMETERS

out: numcol Number of the default color to return information for.
    red Red intensity default color number numcol.
    green Green intensity default color number numcol.
    blu Blue intensity default color number numcol.

real: red, grn, blu

integer: numcol

SEE ALSO: SETDEF
DECLARATION: Subroutine GETGRU (grpnam, jroot, iflag)

FUNCTION: Gets group name and group number relationships.

PARAMETERS

in: grpnam Name of the group. Grpnam will be in or out depending on iflag option).

iflag 1 if adding a group name to the list.
2 if deleting a group from the list.
3 if getting the name from the number.
4 if getting the number from the name.
5 if listing out defined group names.
6 if changing the name of a group.

out: jroot Number of the group. Jroot will be in or out depending on iflag option).

integer: jroot, iflag

character: grpnam*(*)

SEE ALSO: GETITM
DECLARATION: Subroutine GETITM (itname, jchild, iflag)

FUNCTION: Gets item name and item number relationships.

PARAMETERS

in:  itname  Name of the item. Itname will be in or out depending on iflag option.
     iflag  1 if adding a item name to the list.
           2 if deleting a item from the list.
           3 if getting the name from the number.
           4 if getting the number from the name.
           5 if listing out defined item names.

out:  jchild  Number of the item (in or out depending on iflag option).

integer: jchild, iflag
character: itname*(*)

SEE ALSO: GETGRU
**Declaration:** Entry GETLIM (small, big)

**Function:** Returns the maximum and minimum model coordinates of all parts processed with MAXMIN.

**Parameters**
- **out:**
  - big: Maximum coordinates returned.
  - small: Minimum coordinates returned.
- **real:** small(3), big(3)

**Common Blocks:** /CLIMIT/
/MASTER/

**See Also:** MAXMIN
DECLARATION: Subroutine GETNUM (text, nchar, xnum, k2)

FUNCTION: Parses a text string for numbers.

PARAMETERS

- in: nchar Number of characters in line of entered text.
  text Entered text string to be parsed.
- out: k2 Number of numbers found in the text string.
  xnum Array of numbers found in the text string.
- real: xnum(40)
- integer: k2, nchar
- character: text*73

SEE ALSO: GETCOM
DECLARATION: Entry GETWND (xmin, xmax, ymin, ymax)

FUNCTION: Inquires on the world window bounds. The scene is clipped to these values.

PARAMETERS

out: xmin Minimum x world coordinate for window currently set.
     xmax Maximum x world coordinate for window currently set.
     ymin Minimum y world coordinate for window currently set.
     ymax Maximum y world coordinate for window currently set.

real: xmin, xmax, ymin, ymax

SEE ALSO: SETWND
DECLARATION: Subroutine GETXT (text, nchar, textin)

FUNCTION: Prompts for and retrieves a text string.

PARAMETERS

in: textin Optional prompt string that will be written to display device prior to reading text string. If textin is blank, the prompt will not be displayed.

out: nchar Number of characters in line of entered text.
text Entered text string.

integer: nchar

character: text*73, textin*80
DECLARATION: Subroutine GLBACT (code, val1, val2, val3, val4, val5, val6)

FUNCTION: Provides an interface between global actions and the animate module.

It is not necessary to call GLBACT unless animation is being done.

PARAMETERS

in: code Code that determines the operation performed in GLBACT.

'SCL' Global scales for this subroutine.
'ROT' Global rotate.
'COL' Background color.
'WND' Window.
'PER' Perspective angle.
'DST' Distance.
'FRM' Look-from position or vector.
'ATT' Look-for position.
'CLP' Z-clipping planes.
'VEW' Viewport.
'LIT' Lightsource information.
'FOG' Fog planes.

val1 Val1 through val6 are values needed to perform wanted operation.

real: val1, val2, ... val6

character: code*3

COMMON BLOCKS: /CMEMRY/
/CHFWAS/

Chapter Two TECHNICAL REFERENCES 2.48
**FUNCTION:** Draws the global axis.

**PARAMETERS**

- **in:**
  - `tm` Viewing matrix.
  - `atribt` Attribute list.

- **real:**
  - `tm(4,4)`, `atribt` (maxiaa)

**COMMON BLOCKS:**

- `/CATTRI/`
- `/CFLAGS/`
- `/CLIMIT/`
- `/RESOLT/`
- `/VEWSTF/`
DECLARATION: Subroutine GRAINT

FUNCTION: Initializes the graphics package.

GRAINT must always be called before any other graphics application is called.

COMMON BLOCKS: /CATTRI/
/CHFWAS/
/CLIMIT/
/CMEMRY/
/DEVI/
/VEWSTF/
GTUROX

DECLARATION: Subroutine GTUROX (theta, ctm)

FUNCTION: Concatenates a right-handed rotation about the x-axis to a transformation matrix.

PARAMETERS

in: theta Angle in degrees.
ctm Current transformation matrix that is modified on return.

real: theta, ctm(4,4)

SEE ALSO: GTUROY
GTUROZ
GTUSCL
GTUTRN
INT4X4
DECLARATION: Subroutine GTUROY (theta, ctm)

FUNCTION: Concatenates a right-handed rotation about y-axis to a transformation matrix.

PARAMETERS

in: theta Angle in degrees.
     ctm Current transformation matrix modified on return.

real: theta, ctm(4,4)

SEE ALSO: GTUROX
          GTUROZ
          GTUSCL
          GTUTRN
          INT4X4
DECLARATION: Subroutine GTUROZ (theta, ctm)

FUNCTION: Concatenates a right-handed rotation about z-axis to a transformation matrix.

PARAMETERS

   in: theta  Angle in degrees.
       ctm    Current transformation matrix modified on return.
   real: theta, ctm(4,4)

SEE ALSO: GTUROX
          GTUROY
          GTUSCL
          GTUTRN
          INT4X4
DECLARATION: Subroutine GTUSCL (sx, sy, sz, ctm)

FUNCTION: Concatenates scalings to a transformation matrix.

PARAMETERS

in: sx Scaling in x-direction.
sy Scaling in y-direction.
sz Scaling in z-direction.
ctm Current transformation matrix modified on return.

real: sx, sy, sz, ctm(4,4)

SEE ALSO: GTUROX
           GTUROY
           GTUROZ
           GTUTRN
           INT4X4
DECLARATION: Subroutine GTUTRN (dx, dy, dz, ctm)

FUNCTION: Concatenates a translation to a transformation matrix.

PARAMETERS

in: dx Translation in x-direction.
dy Translation in y-direction.
dz Translation in z-direction.
ctm Current transformation matrix modified on return.

real: dx, dy, dz, ctm(4,4)

SEE ALSO: GTUROX
           GTUROY
           GTUROZ
           GTUSCL
           INT4X4
DECLARATION: Subroutine HIDLIN (prtcol)

FUNCTION: Perform hidden line removal and contour generation.

HIDLIN can be called after all polygons have been loaded with STOREL.

PARAMETERS

in:    prtcol Array of rgb colors for each part in the picture.
real:  prtcol(3,*)

COMMON BLOCKS: /HIDSTF/
/KEEP/

SEE ALSO: STOREL
DECLARATION: Subroutine HIDSUR

FUNCTION: Performs hidden surface removal.

HIDSUR can be called after calls to INTHID and INTHD2, and after all polygons have been packed down.

COMMON BLOCKS: /RESOLT/
                /CMEMRY/
                /CHFWAS/

SEE ALSO: INTHID
          INTHD2
DECLARATION: Subroutine HUDITM (jpar, jitm, jcopy)

FUNCTION: Deletes an item call from the hierarchical data structure.

PARAMETERS:

in: jpar    Parent group number.
jcopy   Instance copy number.
jitm    Item number.

integer: jpar, jcopy, jitm
DECLARATION: Entry INCONG (congin)

FUNCTION: Returns the continuity for the look-at and look-from locations for animation.

PARAMETERS

- **out**: congin  Array of continuity values.
- **real**: congin(maxprt,2)
DECLARATION: Subroutine INITGI (grpdex, grsort, trndex, gstart, sgrcnt, sitcnt, namgrp, namitm, igrupa, ichida, iorga, numcpy, namcpy)

FUNCTION: Initializes groups and items.

PARAMETERS

in: 
  grpdex  Group number array.
  grsort  Group sort array.
  igrupa  Root group array.
  trndex  Transformation number index array.
  gstart  Group start array.
  sgrcnt  Subgroup counter array.
  sitcnt  Subitem counter array.
  namgrp  Group names array.
  namitm  Item names array.
  ichida  Child array.
  iorga  Item or group flag array.
  numcpy  Copy number array.
  namcpy  Copy name array.

integer: 
  namgrp(maxchr,0:maxgrp)
  namitm(maxchr,0:maxitm)
  namcpy(maxchr,0:maxins)
  igrupa(maxins)
  ichida(maxins)
  iorga(maxins)
  numcpy(maxins)
  grpdex(maxins)
  grsort(maxins)
  trndex(maxins)
  gstart(maxgrp)
  sgrcnt(maxgrp)
  sitcnt(maxgrp)
**DECLARATION:**  Entry INQBGC (red, green, blue)

**FUNCTION:**  Returns on the background color.

*All values are from 0 to 1.*

**PARAMETERS**

- **out:**  red  Red intensity of background color.
  green  Green intensity of background color.
  blue  Blue intensity of background color.

- **real:**  red, green, blue

**SEE ALSO:**  SETBGC
DECLARATION: Entry INQBOX (npart, cormax, cormin)

FUNCTION: Returns the x,y,z limits of a bounding box for an instance.

PARAMETERS

in: npart Number of parts in the model.
cormax Maximum x, y, and z coordinates of box.
cormin Minimum x, y, and z coordinates of box.

real: cormax(3), cormin(3)

integer: npart

SEE ALSO: SETBOX
DECLARATION:  Entry INQCNT (iflag)

FUNCTION:  Returns the number of defined contour levels.

PARAMETERS

out:  iflag  Number of contour levels to be displayed.

integer:  iflag

SEE ALSO:  SETCNT
Declaring:

Declaration: Entry INQCON (coninq)

Function: Returns the instance continuities at the keyframes for animation.

Parameters:

out: coninq  Array of continuities.
real: coninq(maxfrm,maxprt)
DECLARATION: Subroutine INQDEV (shaded, polfil, hrdwar)

FUNCTION: Checks to see if the device has special hardware capabilities that are being taken advantage of in display. INQDEV also checks to see if the device can fill polygons or do shading.

PARAMETERS

out: hrdwar .TRUE. if special hardware available.
    polfil .TRUE. if polygon fills available.
    shaded .TRUE. if shaded images possible.

logical: hrdwar, polfil, shaded
DECLARATION: Entry INQDSP (xdis, ydis, zdis, valnod)

FUNCTION: Returns the magnitude of a displacement at a node.

PARAMETERS

in: xdis  X displacement of a node.
ydis  Y displacement of a node.
zdis  Z displacement of a node.

out: valnod  Magnitude of displacement of the node.

real: xdis, ydis, zdis, valnod
INQDST

DECLARATION: Entry INQDST (dist)

FUNCTION: Inquires distance from eye to look-at point.

Use INQDST only in perspective angle mode and when not doing auto center.

PARAMETERS

in: dist Distance from eye to look-at point.
real: dist

COMMON BLOCKS: /VEWSTF/

SEE ALSO: SETDST
DECLARATION: Entry INQFLG (cflag, lflag)

FUNCTION: Inquires on global flags set.

PARAMETERS

in: cflag Key that indicates what is being inquired on one of the following:

'ALIA' Anti-aliasing flag.
'SHDO' Shadow flag.
'AXIS' Axis are to be drawn flag.
'BOUN' Draw bounding box instead of model flag.
'BORD' Draw border flag.
'CENT' Auto center flag.
'COLO' Draw colored lines flag.
'DISP' Displacements are performed flag.
'DITH' Dithering status flag.
'ELEM' Element labeling flag.
'FOUR' Four view flag.
'GLAS' Transparency flag.
'HAZE' Haze/fog flag.
'HIDD' Hidden line flag.
'LABE' Label contours flag.
'LEGE' Display contour legend flag.
'NODE' Node labeling flag.
'NODE' Warped polygons on edge flag.
'OVER' Overlay flag.
'PERA' Perspective or windowing toggle flag.
'PERS' Perspective flag.
'POLY' Polygon clipping flag.
'POOR' Poorman flag.
'SHAD' Shaded images flag.
'SYMM' Symmetric contours or fringes flag.
'VECT' Vector arrows flag.
'WARP' Function warping flag.
'TEXT' Text display flag.
'TK41' Tektronix 4129 hardware flag.
'LABV' Label for views flag.
'PLYF' Polygon fill shaded images flag.

.out: lflag .TRUE. or .FALSE. status of cflag.

integer: iflag
character: cflag(*)

COMMON BLOCKS: /CFLAGS/

SEE ALSO: SETFLG
DECLAARATION: Entry INQFNC (nlevel, valmin, valmax)

FUNCTION: Returns the number of color fringes set, and the minimum and maximum range of fringes.

SETFNC should be called before calling INGFNC.

PARAMETERS

out: nlevel  Number of function levels defined.
     valmin Minimum value of color fringes.
     valmax Maximum value of color fringes.

real: valmin, valmax

integer: nlevel

SEE ALSO: SETFNC
INQFOG

DECLARATION:  Entry INQFOG (dstner, dstfar)

FUNCTION:  Returns the distance to the nearest and farthest fog planes.

PARAMETERS

out:  dstnera  Distance to nearest fog plane.
     dstfar  Distance to farthest fog plane.

real:  dstner, dstfar

SEE ALSO:  SETFOG
DELRARATION: Entry INQFRM (numfrm)

FUNCTION: Returns on the animation keyframe being worked on.

You should call ANFILI before calling INQFRM to see if animation is really going on.

PARAMETERS

out: numfrm The number of the keyframe being worked on.

integer: numfrm

SEE ALSO: SETFRM

ANFILI
DECLARATION: Entry INQFRN (iflag)

FUNCTION: Returns the number of fringe levels.

PARAMETERS

    out: iflag           Number of fringe levels to be displayed.
    integer: iflag       

SEE ALSO: SETFRN
DECLARATION: Entry INQGLB (tm)

FUNCTION: Returns the global transformation matrix.

PARAMETERS
out: tm Transformation matrix.
real: tm(4,4)

SEE ALSO: SETGLB
ROTATE
SCALE
RESET
Subroutine INQLAF (lookat, lookfr, icentr)

Returns the look-at and look-from position. If icentr is .TRUE., INQLAF will return a vector for lookfr.

Parameters

- icentr: .TRUE. if auto-center is on.
- lookat: Look-at position.
- lookfr: Look-from position.
- lookat(3), lookfr(3)
- icentr

Common Blocks: /VEWSTF/
INQLEV

DECLARATION: Entry INQLEV (nlevel, colfnc, fnclv)

FUNCTION: Inquires on the number of function levels, and the function value and color used with each level for fringes.

PARAMETERS

out: nlevel Number of function levels defined.
colfnc Array of colors at each function level.
fnclv Array of function values at each level.

real: colfnc (3,maxlev), fnclv (3,maxlev)

integer: nlevel
**DECLARATION:** Subroutine INQLIT (litnum, xltint, litloc, xltxyz)

**FUNCTION:** Given the light source number, INQLIT returns intensity of the light, whether or not it is at the eye of the observer, and returns its position if not at the eye of the observer.

**PARAMETERS**

- **in:**
  - litnum: Maximum number of lights allowed.

- **out:**
  - xltint: Light source intensity.
  - litloc: Light source location flag:
    - 0: at the eye of the observer
    - 1: at a specified location
    - 2: on a specified vector at infinity
  - xltxyz: x, y, z light source locations.

- **real:** xltint, xltxyz (3)

- **integer:** litnum, litloc

**COMMON BLOCKS:** /CHFWAS/
/CMEMRY/

**SEE ALSO:** LITSRC
DECLAARATION: Entry INQPERS (anginq)

FUNCTION: Inquires perspective angle.

Use INQPERS only if you are in the perspective mode.

PARAMETERS

out: anginq Perspective angle that is currently set (in degrees).

real: anginq

SEE ALSO: SETPER INQFLG
DECLARATION: Entry INQPRT (ileft, iright, ibottm, itop)

FUNCTION: Returns the viewport boundaries.

All coordinates are screen coordinates.

PARAMETERS

out: ileft  Left viewport boundary.
     iright Right viewport boundary.
     ibottm Bottom viewport boundary.
     itop   Top viewport boundary.

integer: ileft, iright, itop, ibottm

SEE ALSO: SETPRT
DECLARATION: Entry INQRAT (speed)

FUNCTION: Returns the instance rates at the keyframes for animation.

PARAMETERS

out: speed Array of rates.
real: speed(maxfrm,maxprt)
DECLARATION: Entry INQREF (ncolor, colfnc)

FUNCTION: Inquires on the reference colors for color fringes.

PARAMETERS

out: ncolor Number of reference colors defined.
colfnc Array of colors at each function level.

real: colfnc (3, maxlev)

integer: ncolor

SEE ALSO: INQLEV
INQFNC
SETREF
DECLARATION: Entry INQSCL (scalex, scaley)

FUNCTION: Inquires on the window to viewport scale factors.

SETSCL must be called before calling this routine.

PARAMETERS

out: scalex  X direction scale factor.
    scaley  Y direction scale factor.

real: scalex, scaley

COMMON BLOCKS: /RESOLT/

SEE ALSO: SETSCL
DECLARATION: Entry INQSPL (splinq)

FUNCTION: Returns the instance on spline flags at the keyframes for animation.

PARAMETERS

out: splinq Array of spline flags for global.
real: splinq(maxfrm,maxprt)
DECLARATION: Entry INQSUB (isub)

FUNCTION: Returns the number of subframes that exist between the frames for animation.

PARAMETERS

out: isub Array of subframes.

integer: isub(maxfrm)

SEE ALSO: INQFRM ANFILI
DECLARATION: Entry INQTEN (teniq)

FUNCTION: Returns the instance tensions at the keyframes for animation.

PARAMETERS

out: teniq  Array of tension for global.

real: teniq(maxfrm, maxprt)
DECLARATION: Entry INQTXT (mesage, xsize, ysize, twodim, xpos, ypos, zpos, xang, yang, zang, r, g, b, xslant, i, nsav)

FUNCTION: Inquires on the text string attributes.

PARAMETERS

\[
\begin{align*}
\text{in: } & i & \quad \text{Index of text string to retrieve.} \\
\text{out: } & \text{nsav} & \quad \text{Total number of stored messages.} \\
& \text{mesage} & \quad \text{The text string array.} \\
& \text{xsize} & \quad \text{X dimension factor.} \\
& \text{ysize} & \quad \text{Y dimension factor.} \\
& \text{twodim} & \quad \begin{cases} 
\text{If .TRUE. message is 2-D.} \\
\text{If .FALSE., strings are in 3-D text.} 
\end{cases} \\
& \text{xpos} & \quad \text{X position of text string in world coordinate.} \\
& \text{ypos} & \quad \text{Y position of text string in world coordinate.} \\
& \text{zpos} & \quad \text{Z position of text string in world coordinate.} \\
& \text{xang} & \quad \text{X directional vector.} \\
& \text{yang} & \quad \text{Y directional vector.} \\
& \text{zang} & \quad \text{Z directional vector. Angle of text string if 2-d.} \\
& \text{r,g,b} & \quad \text{Red, green and blue color values.} \\
& \text{xslant} & \quad \text{Rotation about x-axis for 3-d text string in degrees.} \\
\end{align*}
\]

real: xsize, ysize, twodim, xpos, ypos, xang, yang, zang, r, g, b, xslant

integer: i, nsav

character: *80 mesage

SEE ALSO: SAVTXT
DECLARATION: Subroutine INQUIR (name)

FUNCTION: Inquires and prints attribute list for an item or group.

PARAMETERS

in: name Copy name.
character: name(*)
DECLARATION: Entry INRATG (ratgin)

FUNCTION: Returns the array of rates for global animation parameters.

PARAMETERS

out: ratgin  Array of rates for global values.
real: ratgin(maxfrm,1l+litnum)
DECLARATION: Entry INSPLG (onsgin)

FUNCTION: Inquire on spline flag array for the look-at and look-from locations for animation.

PARAMETERS

out: onsgin Array of on spline flags for instances.
real: onsgin(maxfrm,2)
DECLARATION: Subroutine INT4X4 (trnfm)

FUNCTION: Initializes a transformation matrix to the identity matrix.

PARAMETERS

  out:  trnfm  Transformation matrix initialized to the identity matrix.

  real:  trnfm(4,4)
DECLARATION: Entry INTENG (tengin)

FUNCTION: Returns the tension for the look-at and look-from locations for animation.

PARAMETERS

out: tengin Tension array.

real: tengin(maxprt,2)
DECLARATION: Subroutine INTHD2

FUNCTION: Initializes portions of hidden surface processor.

INTHD2 should only be run before each hidden surface picture after the call to POLYS.

COMMON BLOCKS: /HIDSTF/

SEE ALSO: INTHID
DECLARATION: Subroutine INTHID

FUNCTION: Initializes portions of hidden surface processor.

This routine should be run once for each hidden surface picture, before the call to polys.

COMMON BLOCKS: /CHFWAS/
               /CMEMRY/
               /HIDSTF/
               /PIXSTF/
               /KEEP/

SEE ALSO: INTHD2
DECLARATION: Subroutine INTHLR

FUNCTION: Initializes the hidden line removal process.

*INTHLR must be called before any other hidden line removal routine.*

COMMON BLOCKS: /HIDSTF/
/KEEP/
**DECLARATION:** Subroutine INTSHA (numlit, drknes)

**FUNCTION:** Stores light number and shadow darkness for a light source.

Shadow darkness is linear from 0 to 1.

**PARAMETERS**

- **in:**
  - numlit: Number of light sources being set.
  - drknes: Shadow intensity between 0 and 1. A value of 0 is no shadows, a small value is a dark shadow, and a value close to 1.0 is a very light shadow.

- **real:** drknes

- **integer:** numlit

**COMMON BLOCKS:** /CHFWAS/
/CLIMIT/
/CMEMRY/
DECLARATION: Function ITABLE (r,g,b, errfac)

FUNCTION: Returns the look-up table location of the color nearest the specified color.

PARAMETERS

ian: r,g,b Component intensities of the color looked for (0.0 - 1.0).

errfac Equal to 0.0 for dithering; - 0.5 all other times.

out: itable The nearest location in the color look-up table.

real: r, g, b, errfac

integer: itable
DECLARATION: Subroutine LCUC (text, nchar)

FUNCTION: Converts a text string to be all upper case.

PARAMETERS

in: nchar  Number of characters in text.
    text  Text string to be converted. The text string will be modified on return.
    integer: nchar

character: text*73
DECLARATION: Function LENTXT (text, len)

FUNCTION: Determines the length of a text string.

PARAMETERS

in:  text  Text string.
     len  The dimensioned length of the text string.

out:  lentxt  Location of the last non-blank character in the text string.

integer:  len, lentxt

character:  text*73
DECLARATION: Subroutine LITSRC (nlsrce, amount, jlocat, x, y, z)
FUNCTION: Sets light source parameters.
PARAMETERS
  in: nlsrce  Light source number.
       amount Light source intensity. If the amount is zero, the other parameters are ignored. Amount is a value between 0 and 1.0.
       jlocat - 0 if light source is at the eye of the observer (x,y,z are ignored).
               - 1 if one light source is at infinity (x,y,z are components of a vector pointing from the origin in the light source direction).
               - 2 if the light source is at the user-defined position (x,y,z are the coordinates of the light source position).
       x  x coordinate of light source.
       y  y coordinate of light source.
       z  z coordinate of light source.
real:  amount, x, y, z
integer: nlsrce, jlocat
COMMON BLOCKS: /CHFWAS/
                /CLIMIT/
                /CMEMRY/
SEE ALSO: INQLIT
DECLARATION: Subroutine LODCOL (ipart, prtcol, colors)

FUNCTION: Loads color information for part number being processed.

PARAMETERS

in: ipart Part number currently being processed. This number should be equivalent to the number that is passed into subroutine PIPLIN. Displacement arrows are loaded with part numbers starting at 10001.

prtcol Reference array of rgb colors for each part in the picture. This array should be equivalent to the array that is passed into subroutine HIDLIN.

colors r,g,b color components of part ipart.

real: prtcol(3,*), colors(3)

integer: ipart

SEE ALSO: HIDLIN
Subroutine MAPWV (sx, sy, wxmin, wymin, ivxmin, ivymin, x, y, iy)

Transforms world coordinates into screen coordinates. X and y coordinates should be clipped so they are visible on the screen.

**PARAMETERS**

**in:**
- sx: Window to viewport scale factor in x.
- sy: Window to viewport scale factor in y.
- wxmin: Minimum x-coordinate for window in world.
- wymin: Minimum y-coordinate for window in world.
- ivxmin: Minimum x viewport boundary (0 to 1).
- ivymin: Minimum y viewport boundary (0 to 1).
- x: x world coordinates that is modified on return to x screen coordinate.
- y: y world coordinates.

**out:**
- iy: y screen coordinate rounded to the nearest integer

**real:** sx, sy, wxmin, wymin, ivxmin, ivymin, x, y

**integer:** iy

**SEE ALSO:** INQSCL, INQPRT, GETWND
DECLARATION: Entry MAXMIN (npart, limprt, tm, displc, warp)

FUNCTION: Finds and stores the maximum and minimum coordinates of a part.

Routine compares maximums and minimums to previous limits found from other parts processed by MAXMIN.

PARAMETERS

in: npart Part number to process.
limprt Part limits array.
tm Transformation matrix for part npart.
displc Displacement factor (if used).
warp Function warping value (if used).

real: tm(4,4), displc, warp(3)

integer: npart, limprt(2,maxitm)

COMMON BLOCKS: /CLIMIT/
/MASTER/

SEE ALSO: GETLIM
DECLARATION: Subroutine MODIFY (cpynam, icode, value)

FUNCTION: Modifies transformation matrix or attribute list for copy cpynam.

PARAMETERS

in:  cpynam  Copy name of instance to transform or change attribute list.
    icode  Modification flag.

- 1 if initialize copy's transformation matrix.
- 2 if reorient copy to local axis system.
- 3 if scale copy.
- 4 if rotate copy.
- 5 if translate copy.
- 6 if clearing attribute list for copy.
- 7 if setting polygon order for copy.
- 8 if setting copy color.
- 9 if setting feature angle.
-10 if setting shrink factor.
-11 if setting shading type.
-12 if setting shadow casting.
-13 if setting transparency parameters.
-14 if setting contour flag.
-15 if setting fringe flag.
-16 if setting diffused light intensity.
-17 if setting displacement factor.
-18 if setting post flag.
-19 if setting light source parameters.
-20 if setting warp vector.
-21 if setting dotted hidden lines.
-22 if setting node numbers flag.
-23 if setting element numbering flag.
-24 if setting local origin.
-25 if setting poorman flag.
-26 if displaying coordinate triad.
-27 if setting displacement vector arrows scale factor.

value  Values for transformation or attribute modifications.

real:  value(*)

integer:  icode

character:  cpynam(*)
COMMON BLOCKS:
/CHFWAS/
/CLIMIT/
/CMEMRY/
DECLARATION: Subroutine MOV4X4 (a, b)

FUNCTION: Copies the first matrix into the second matrix.

PARAMETERS

in: a  First 4x4 matrix.
    b  Second 4x4 matrix.

real: a(4,4), b(4,4)
DECLARATION: Subroutine MOVABS (ix, iy)

FUNCTION: Update the current point to the specified screen coordinates.

PARAMETERS

in: ix, iy Screen coordinates of the desired point. (0.0) is the lower left point of the screen.

integer: ix, iy
**DECLARATION:** Subroutine MUL4X4 (a, b, c)

**FUNCTION:** Performs the matrix multiply, \( a \times b = c \).

**PARAMETERS**

- **in:**  
  - \( a \): First 4x4 matrix.
  - \( b \): Second 4x4 matrix.

- **out:**  
  - \( c \): Resulting 4x4 matrix.

- **real:**  
  - \( a(4,4), b(4,4), c(4,4) \)

**SEE ALSO:** INT4X4

MOV4X4
DECLARATION: Entry NEWGRP (numgru)

FUNCTION: Sets up a new active group.

PARAMETERS

in: numgru   Group number of new active group.
integer: numgru

SEE ALSO: GETAGR
Subroutine NORMAL (nedges, coords, xcentr, xn, contst)

Calculates normals at nodes of polygon.

The coordinate array should close the polygon.

**DECLARATION:**

in:  nedges   Number of vertices in polygon.
     coords   Coordinate array for polygon.
     xcentr   Coordinate array of center point.

out:  xn   Normal array for polygon.
      contst  .TRUE. if polygon is concave.

real:  xn(3,*), coords(3,*), xcentr(3)

integer:  nedges

logical:  contst
DECLARATION: Subroutine NORMTM (tm, tmnorm)

FUNCTION: Normalize the columns of a transformation matrix.

PARAMETERS

in: tm A transformation matrix.

out: tmnorm A normalized transformation matrix.

real: tm(4,4), tmnorm(4,4)

SEE ALSO: PIPSRC
DECLARATION: Subroutine NORVEC (vector)

FUNCTION: Normalize a vector.

PARAMETERS

in: vector  The vector to be normalized.
real: vector(3)
DECLARATION: Subroutine NRMAVE (nedges, polnor, avenor)

FUNCTION: Computes the average normal of all the normals of a polygon.

PARAMETERS

in: nedges Number of vertices of the polygon.
    polnor Unaveraged normal array for polygon nodes (assumed to be unit normals).

out: avenor Average unit normal of the polygon.

real: polnor(3,nedges), avenor(3)

integer: nedges
DECLARATION: Subroutine OPNFIL (prmpt, pstrng, fileid, stat, acc, frm, irec, iunit, ierror)

FUNCTION: Opens a disk file.

PARAMETERS

in: prmpt .TRUE. if filename should be prompted for.
      .FALSE. if fileid should be used as the filename.
      pstrng Character string containing prompt.
      fileid Character file id if prompt = .FALSE.
      stat Status of the file to be opened. Must be an allowable file status, such as 'old', 'new', 'scratch' or any other allowable status.
      acc Access of the file to be opened. Must be 'sequential', or 'direct'.
      frm Format of the file to be opened. Must be an allowable file format, such as 'formatted', 'unformatted', or 'binary'.
      irec Record length for direct access files.

out: iunit Device logical number of file opened.
      ierror Error flag.
      -1 if OPNFIL was run successfully.
      -0 if OPNFIL was not run successfully.

integer: irec, iunit, ierror

logical: prmpt

character: fileid(*), pstrng(*), stat(*), frm(*), acc(*)
OUTBOX

**DECLARATION:** Subroutine OUTBOX (npart, tm, atribt)

**FUNCTION:** Displays a bounding box around part npart.

**PARAMETERS**

- **in:**
  - npart: Part number to display bounding box around.
  - tm: Transformation matrix.
  - atribt: Part attribute list information for part npart.

- **real:**
  - tm(4,4), atribt(*)

- **integer:**
  - npart

**COMMON BLOCKS:** /CHFWAS/  
/CLIMIT/  
/CMEMRY/  
/MASTER/  
/CATTRI/
DECLARATION: Subroutine PCHECK (nedge, xx, nornew, jconn, jpoi, numply)

FUNCTION: Divides a concave polygon into numply convex polygons.

It is possible that warped concave polygons will not result in a division into convex polygons.

PARAMETERS

in: nedge Number of sides in original polygon.
nornew Normals at the nodes of the original polygon.
xx Coordinate array of concave polygon.

out: jconn Connectivity of convex polygons.
jpoi Array of number of edges in new convex polygons.
numply Number of polygons after subdivision.

real: xx(3,*)

integer: jconn(vertmx+1,*), jpoi(vertmx+1), nedge, numply, nornew
DECLARATION: Subroutine PERDST

FUNCTION: Sets window based on perspective angle and distance.

SHOULD ONLY BE CALLED IF AUTOCENTER IS NOT ON.

Should be called if in perspective mode, after you have modified either the distance or perspective angle.
DECLARATION: Subroutine PIPLIN (sx, sy, ivxmin, ivymin, wxmin, wxmax, wymin, wymax, zmin, zmax, oldcor, polnor, oldfun, nodes, npolab, tm, atribt, nedges, ipart)

FUNCTION: Transforms, clips, and maps polygons to screen coordinates, and outputs lines and polygons in line drawing mode. If hidden line is on, PIPLIN will store polygons and lines for further processing.

PARAMETERS

in: sx Window to viewport scale factor in x direction.
sy Window to viewport scale factor in y direction.
wxmin Minimum x window coordinate.
wxmax Maximum x window coordinate.
wymin Minimum y window coordinate.
wymax Maximum y window coordinate.
zmin Distance from eye to near clipping plane.
zmax Distance from eye to far clipping plane.
polcor The coordinates of the polygon/line.
tm Transformation matrix (This transformation matrix will also transform coordinates from world to eye system).
atribt Part attribute information for line or polygon.
nedges Number of vertices in current polygon or line.
nodes Array of node numbers for the polygon used for labeling.
npolab Polygon label number.
ipart Part number that line or polygon came from. Used for hidden line removal.
ivxmin Left viewport screen coordinate x.
ivymin Bottom viewport screen coordinate y.
oldcor The coordinates of the line or polygon.
polnor Normals of the polygon. Used with the feature option during hidden line.
oldfun Scalar function values at the vertices. Used for contours.
real: sx, sy, wxmin, wymin, wxmax, wymax, zmin, zmax,
polcor(3, vertmx+l), tm(4,4), atribt(*), ivxmin, ivymin,
oldcor(3, vertmx+l), polnor(3, vertmx+l), oldfun(vertmx+l)

integer: nedges, nodes, npolab, ipart

COMMON BLOCKS: /DEVI/
/CATTRI/
/CFLAGS/

SEE ALSO: PIPSRC
INQSCL
INQPRT
GETWND
INQCNT
GETCLP
NORMAL

Chapter Two  TECHNICAL REFERENCES  2.117
DEcratchment: Subroutine PIPSRC (sx, sy, ivxmin, ivymin, wxmin, wxmax, wymin, wyymax, zmin, zmax, numvrt, polcor, polnor, polfun, tm, tmnorm, atribt, shdlen, shdmin, shdmax)

Function: Transforms, clips and maps to screen coordinates, and stores polygons for later processing by the hidden surface processor.

Parameters

| in: sx      | Window to viewport scale factor in x direction. |
|            | Window to viewport scale factor in y direction. |
| wxmin      | Minimum x window coordinate.                  |
| wxmax      | Maximum x window coordinate.                 |
| wymin      | Minimum y window coordinate.                 |
| wyymax     | Maximum y window coordinate.                 |
| zmin       | Distance from eye to near z clipping plane.   |
| zmax       | Distance from eye to far z clipping plane.    |
| numvrt     | Number of vertices in this polygon.          |
| polcor     | Coordinates of the polygon.                  |
| tm         | Transformation matrix. (This transformation matrix will also transform coordinates from world to eye system.) |
| atribt     | Attribute information for the polygon.       |
| shdlen     | Shadow length.                                |
| tmnorm     | Normalized transformation array.             |
| ivxmin     | Left viewport screen coordinate x.           |
| ivymin     | Bottom viewport screen coordinate y.         |
| polnor     | Normals of the polygon.                      |
| warped     | .TRUE. if checking for warped polygons on edge. |
| polfun     | Polygon function values.                     |

real: tm(4,4), atribt(*), polcor(3,*), polnor(3,*), sx, sy, wxmin, wymin, wxmax, wyymax, zmin, zmax, tmnorm(4,4), ivxmin, ivymin, polfun(*), shdlen

integer: numvrt

logical: warped
**COMMON BLOCKS:**
/DEVI/
/CATTRI/
/CFLAGS/

**SEE ALSO:**
PIPLIN
INQSCN
INQPRT
GETWND
INQFRN
GETCLP
NORMAL
PCHECK
NORMTM
DECLARATION: Subroutine POLFIL (nedges, ix, iy, r, g, b)

FUNCTION: Draws a filled polygon.

PARAMETERS

in: nedges Number of edges in polygon to be output.
    ix,iy Screen coordinate arrays of the polygon.
    r,g,b Color components (0.0 - 1.0) of the polygon.

real: r, g, b

integer: nedges, ix, iy
DECLARATION: Subroutine POLSTA (nedges, coords, wxmin, wxmax, wymin, wymax, polxmx, polxmn, polymx, polymn, istat)

FUNCTION: Gets polygon maximums, minimums, and status (for x and y).

All coordinates are in the eye coordinate system.

PARAMETERS

in: nedges Number of vertices in the polygon or line.
    coords Coordinate array for vertices.
    wxmin Minimum x window coordinate.
    wxmax Maximum x window coordinate.
    wymin Minimum y window coordinate.
    wymax Maximum y window coordinate.

out: istat Status of the polygon.
     - 1 if trivially accept.
     - 2 if trivially reject.
     - 3 if must clip the polygon.
    polxmx Maximum polygon x coordinate.
    polxmn Minimum polygon x coordinate.
    polymx Maximum polygon y coordinate.
    polymn Minimum polygon y coordinate.

real: wxmin, wxmax, wymin, wymax, polxmx, polxmn, polymx, polymn, coords (3,nedges)

integer: nedges, istat

SEE ALSO: CLPPZE
          CLPPOL
          CLPLIN
          ZPLSTA
DECLARATION: Subroutine POLYS (npart, limits, tm, attribt)

FUNCTION: Takes all polygons in part npart, does pre-processing (such as smooth shading and vector arrows) and dumps them into the appropriate pipeline.

PARAMETERS

in: npart Part number to process.
limits Part limits array.
tm Transformation matrix.
attribt Part attribute list for part npart.

real: attribt(*), tm(*,*)

integer: npart, limits

COMMON BLOCKS: /CATTRI/
/CLIMIT/
/CHFWAS/
/MASTER/
/MEMRY/

SEE ALSO: PIPLIN
PIPSRC
DECLAREATION: Subroutine PORMAN (nedges, coords, order, plot)

FUNCTION: Determines if polygons are front or back facing, then flags back facing polygons for elimination.

PARAMETERS

in: nedges Number of vertices for this polygon.
    coords Coordinate information for this polygon.
    order Polygon ordering flag.
        - 0. if poorman is not on for the polygon being processed.
        - 1. if clockwise element ordering.
        - 2. if counterclockwise element ordering.

out: plot If .TRUE., the polygon is front facing and therefore visible.

real: coords(3,nedges), order
integer: nedges
logical: plot
DECLARATION: Subroutine PROMPT (txt)

FUNCTION: Outputs a character string to the display device.

PARAMETERS

in: txt Character string that contains the required prompt.
character: txt*80
DECLARATION: Subroutine PRSPC (coord)

FUNCTION: Transforms point to perspective viewing.

PARAMETERS

in: coord  x, y, z coordinate of point to transform according to perspective. The coordinates of the point are modified on return.

real: coord(3)

COMMON BLOCKS: /VEWSTF/

SEE ALSO: PRSSTF
DECLAIMATION: Subroutine PRSSTF

FUNCTION: Sets up perspective parameters according to the look-at and look-from point.

PRSSTF be called after the look-at and look-from point have been established, and before any calls to PRSPC, PIPIN, or PIPSRC.

COMMON BLOCKS: /VEWSTF/

SEE ALSO: PRSPC
PIPLIN
PIPSRC
DECLARATION: Subroutine PURGE (cpynam)

FUNCTION: Removes a call to an instance wherever listed in the hierarchical data structure.

PARAMETERS

in: cpynam Instance name to be deleted.

character: cpynam(*)
DECLARATION: Subroutine PVEC (point, ctm, dis, sx, sy, ivxmin, ivymin, wxmin, wymin, wxmax, wymax, zmin, zmax, zrange, polfun, atribt, node, npart, ipc)

FUNCTION: Creates and outputs displacement arrows.

PARAMETERS

in: point Coordinates at base of arrow.
dis Displacement array at point.
sx Window to viewport scale factor in x.
sy Window to viewport scale factor in y.
ivxmin Left viewport screen, x coordinate.
ivymin Bottom viewport screen, y coordinate.
wxmin Minimum x window coordinate.
wxmax Maximum x window coordinate.
wymin Minimum y window coordinate.
wymax Maximum y window coordinate.
zmin Distance from eye to near z clipping plane.
zmax Distance from eye to far z clipping plane.
zrange Distance between z clipping planes.
polfun Polygon function values.
atribt Attribute list of polygon containing point.
node Vertex number of point in polygon.
npart Part number of polygon containing point.
ipc Arrow part number.
ctm Transformation matrix for polygon containing point.

real: point(3), ctm(4,4), dis(3), sx, sy, ivxmin, ivymin, wxmin, wymin, wxmax, wymax, zmin, zmax, zrange, polfun(*), atribt(*)

integer: ipc, node, npart

COMMON BLOCKS: /CATTRI/ /CHFWAS/ /CMEMRY/
RDINIT

**DECLARATION:** Subroutine RDINIT

**FUNCTION:** Initializes the graphics device, and initializes the common block /RESOLT/.

**COMMON BLOCKS:** /RESOLT/
DECLARATION: Subroutine READMV (geofil, funfil, dspfil)

FUNCTION: Reads MOVIE.BYU files for database definition.

READMV may be called many times.

PARAMETERS

in: geofil Geometry file name.
    funfil Function file name.
    dspfil Displacement file name.

character: geofil(*), funfil(*), dspfil(*)

COMMON BLOCKS: /CHFWAS/
                /CLIMIT/
                /CMEMRY/
DECLARATION: Entry REDCHK (filnam)

FUNCTION: Reads a checkpoint file.

All database descriptions defined by you before a REDCHK call will be deleted, because the checkpoint file will overwrite the existing database.

PARAMETERS

in: filnam The name of the file to be read in for database definition.

character: filnam(*)

SEE ALSO: WRTCHK
DECLARATION: Subroutine RESET

FUNCTION: Initializes the global transformation matrix.

SEE ALSO: INQGLB
          SETGLB
          ROTATE
          SCALE
DECLARATION: Subroutine ROTATE (rx, ry, rz)

FUNCTION: Performs global rotate about a right handed coordinate system.

PARAMETERS

in: 
  rx  Rotation about the x-axis in degrees.
  ry  Rotation about the y-axis in degrees.
  rz  Rotation about the z-axis in degrees.

real: rx, ry, rz

SEE ALSO: RESET
           SETGLB
           SCALE
           INQGLB
DECLARATION: Subroutine RPLCOP (sordex, ctm, atlist)

FUNCTION: Replaces transformation and attribute information for an instance.

PARAMETERS

in:  sordex  The instance sort number.
    ctm    Transformation matrix for the instance.
    atlist Attribute list for the instance.

real: atlist(maxatt), ctm(4,4)

integer: sordex

COMMON BLOCKS:
/CHFWAS/
/CLIMIT/
/CMEMRY/

SEE ALSO: EXTCOP
DECLARATION: Subroutine RPLGLB (glb4x4, glbatt)

FUNCTION: Sets global attributes to those in the list coming in.

PARAMETERS

in: glb4x4 Global transformation matrix.
    glbatt Global attribute array, defined as follows:

(1) = Red background intensity (0-1).
(2) = Green background intensity (0-1).
(3) = Blue background intensity (0-1).
(4) = Window x minimum (world coordinate).
(5) = Window x maximum (world coordinate).
(6) = Window y center (world coordinate).
(7) = Perspective angle (degrees).
(8) = Distance.
(9) = X look-from point.
(10) = Y look-from point.
(11) = Z look-from point.
(12) = X look-at point.
(13) = Y look-at point.
(14) = Z look-at point.
(15) = Near z clipping plane.
(16) = Far z clipping plane.
(17) = X minimum viewport (0-1).
(18) = X maximum viewport (0-1).
(19) = Y center viewport (0-1).
(20) = Near fog plane.
(21) = Far fog plane.
(22) = Light number.
(23) = Light location flag.
(24) = Light intensity.
(25) = X position for light.
(26) = Y position for light.
(27) = Z position for light.
22 - 27 are repeated for each light source.

real: glb4x4(4,4), glbatt(*)

COMMON BLOCKS:  /CHFWAS/
                /CMEMRY/
DECLARATION: Subroutine RUNANI (begfrm, endfrm, ierr)

FUNCTION: Runs the animation.

PARAMETERS

in:  begfrm  Beginning point to start animation (keyframe.subframe).
     endfrm  Ending point to end animation (keyframe.subframe).

out: ierr  Error flag.
       - 0 if the animation was run successfully.
       - 1 if the animation was not run successfully.

character: begfrm*10, endfrm*10

COMMON BLOCKS: /CMEMRY/
                /DEVI/
                /CLIMIT/
                /CHFWAS/
DECLARATION: Entry SAVTXT (mesage, xsize, ysize, twodim, xpos, ypos, zpos, xang, yang, zang, r, g, b, xslant, n, nsav)

FUNCTION: Saves text string attributes.

PARAMETERS

in:

| n          | Text string number. |
| mesage     | The text string array. |
| xsize      | X dimension factor. |
| ysize      | Y dimension factor. |
| twodim     | If .TRUE., message is 2-D. .False., 3-D text strings. |
| xpos       | X position of text string in world coordinate. |
| ypos       | Y position of text string in world coordinate. |
| zpos       | Z position of text string in world coordinate. |
| xang       | X directional vector. |
| yang       | Y directional vector. |
| zang       | Z directional vector or angle of text string if in 2-d mode. |
| r, g, b    | Red, green and blue color values. |
| xslant     | Rotation about x-axis for 3-d text string in degrees. |

out:

| nsav       | Total number of stored messages. |

real:

| xsize, ysize, twodim, xpos, ypos, xang, yang, zang, r, g, b, xslant |

integer:

| n, nsav |

character:

| mesage(80) |

SEE ALSO: INQTXT
DECLARATION: Subroutine SCALE (sx, sy, sz)

FUNCTION: Performs global scale.

PARAMETERS

in: sx Scaling in the x direction.
sy Scaling in the y direction.
sz Scaling in the z direction.

real: sx, sy, sz

SEE ALSO: RESET
ROTATE
SETGLB
INQGLB
DECLARATION: Entry SETBGC (red, green, blue)

FUNCTION: Set background color.

All values are from 0 to 1. Values are adjusted to those actually found in the color look-up table (if one is being used).

PARAMETERS

in: red Red intensity of background color.
green Green intensity of background color.
blue Blue intensity of background color.

SEE ALSO: SETLUT ITABLE INQBGC
DECLARATION: Entry SETBOX (npart, cormax, cormin)

FUNCTION: Stores the x,y,z limits of a part.

PARAMETERS

in: npart  Part number.
cormax  Maximum x, y, and z coordinates of box.
cormin  Minimum x, y, and z coordinates of box.

real: cormax(3), cormin(3)

integer: npart

SEE ALSO: INQBOX
DECLARATION: Entry SETCLP (znear, zfar)

FUNCTION: Sets z clip information.

PARAMETERS

in: znear Distance from eye to nearest z clipping plane.
    zfar Distance from eye to farthest z clipping plane.

real: znear, zfar

SEE ALSO: GETCLP
DECLARATION: Entry SETCNT (iflag)

FUNCTION: Sets number of contour levels.

PARAMETERS

in: iflag     Number of contour levels to be displayed.

integer: iflag

SEE ALSO: INQCNT
DECLARATION: Subroutine SETCOL (r, g, b, errfac)

FUNCTION: Updates the current color to the specified color.

PARAMETERS

in: r, g, b  New color components (0.0 - 1.0).
    errfac  Equal to 0.0 for dithering; -0.5 all other times.

real: r, g, b, errfac
DECLARATION: Entry SETCON (key, sordex, thecnt)

FUNCTION: Sets instance continuity at a keyframe for animation.

PARAMETERS

in: key    Key frame number.
sordex    Sort index number of the instance.
thecnt    The continuity value at keyframe key.

real: thecnt

integer: key, sordex

SEE ALSO: INQCON
DECLARATION:  Entry SETDEF (numcol, red, grn, blu)

FUNCTION:  Sets the red, green, and blue color components of color number numcol.

All color values are from 0 to 1.

PARAMETERS

in:  numcol  Color number (1 to 6).
    red    Red intensity of default color number numcol.
    grn    Green intensity of a default color number numcol.
    blu    Blue intensity of a default color number numcol.

real:  red, grn, blu

integer:  numcol

SEE ALSO:  GETDEF

SETDEF

Chapter Two  TECHNICAL REFERENCES  2.145
DECLARATION: Entry SETDSP (xvec, yvec, zvec)

FUNCTION: Sets the displacement direction cosine components that will be used with displacement fringes or contours.

PARAMETERS

in: xvec   X component of direction vector.
yvec   Y component of direction vector.
zvec   Z component of direction vector.

real: xvec, yvec, zvec

SEE ALSO: INQDSP
**DECLARATION:** Entry SETDST (dist)

**FUNCTION:** Sets the distance from the eye to the look at point.

*SETDST is only valid when software is in perspective angle mode, and when auto center is off. The function of this routine can also be obtained by adjusting the look-from point.*

**PARAMETERS**

- **in:** dist Distance from eye to look-at point.
- **real:** dist

**COMMON BLOCKS:** /VEWSTF/

**SEE ALSO:** INQDST ATFROM INQFLG
SETFLG

DECLARATION: Entry SETFLG (cflag, lflag)

FUNCTION: Sets global flags.

PARAMETERS

in: cflag    Key to what is being set, which is one of the following:

'ALIA' Anti-aliasing flag.
'SHDO' Shadow flag.
'AXLS' Axis are to be drawn.
'BOUN' Draw bounding box instead of model.
'BORD' Draw border.
'CENT' Auto center flag.
'COLO' Draw colored lines.
'DISP' Displacements are performed.
'DITH' Dithering status.
'ELEM' Element labeling status.
'FOUT' Four view status.
'GLAS' Transparency status.
'HAVE' Haze/fog option.
'HIDD' Hidden line status.
'LAVE' Label contours flag.
'LEGE' Display contour legend.
'NODE' Node labeling status.
'ONED' Warped polygons on edge status.
'OVER' Overlay status.
'PERS' Perspective or windowing toggle status.
'POLY' Polygon clipping performed.
'POOR' Poorman status.
'SHAD' Shaded images status.
'SYMM' Symmetric contours or fringes status.
'VECT' Vector arrows status.
'WARP' Function warping status.
'TEXT' Text display status.
'TK41' Tektronix 4129 hardware status.
'LABV' Label for views status.
'PLYF' Polygon fill shaded images status.

iflag    .TRUE. or .FALSE. status of cflag.

out: iflag    .TRUE. or .FALSE. status of cflag.

logical: iflag

character: cflag*(*)

COMMON BLOCKS: /CFLAGS/

SEE ALSO: INQFLG
**DECLARATION:** Entry SETFNC (nlevel, valmin, valmax)

**FUNCTION:** Sets the number of color fringes to be used, and the minimum and maximum range for fringes.

**PARAMETERS**

- **in:** nlevel Number of function levels to be used.
- **valmin** Minimum value of color fringe.
- **valmax** Maximum value of color fringe.
- **real:** valmin, valmax
- **integer:** nlevel

**SEE ALSO:** INQFNC
SETFOG

DECLARATION: Entry SETFOG (dist1, dist2)

FUNCTION: Sets the distance to the nearest and farthest fog planes.

PARAMETERS

in: dist1: Distance from eye to nearest fog plane.
    dist2: Distance from eye to farthest fog plane.

real: dist1, dist2

SEE ALSO: INQFOG
DECLARATION: Entry SETFRN (iflag)

FUNCTION: Sets number of fringe levels to be displayed.

PARAMETERS

in: iflag Number of fringe levels to be displayed.

integer: iflag

SEE ALSO: INQFRN
DECLARATION:  Entry SETGLB (tm)

FUNCTION:  Saves the transformation matrix that is to be used as the global matrix.

PARAMETERS

   in:   tm       Transformation matrix.
   real: tm(4,4)

SEE ALSO:  INQGLB
           ROTATE
           SCALE
           RESET
DECLARATION: Subroutine SETLIN (cstyle)

FUNCTION: Updates the current linestyle to solid or dashed.

PARAMETERS

in: cstyle Desired linestyle:
    - 'd' for dashed.
    - 's' for solid.

character: cstyle(*)
DECLARATION: Subroutine SETLUT (table).

FUNCTION: Loads the color look-up table.

PARAMETERS

in: table The desired look-up table. The default is 'c', which is for a full color-ramped look-up table.

class: table*(*)

SETLUT
DECLARATION: Subroutine SETMOD (mode)

FUNCTION: Sets the display device to either graphics or alpha mode.

PARAMETERS

in: mode The specified mode:
  = 'graphics' to put device in graphics mode.
  = 'alpha' to put device in alpha mode.

character: mode(*)
DECLARATION: Entry SETPER (setang)

FUNCTION: Sets the perspective angle to the value specified.

*SETPER can only be called if the software is in the perspective angle mode.*

PARAMETERS

in: setang Perspective angle to be set in degrees.
real: setang

SEE ALSO: INQPER
INQFLG
DECLARATION: Entry SETPRT (xmin, xmax, ycen)

FUNCTION: Sets viewport boundaries.

SETPRT calculates minimum and maximum y values enforcing a one-to-one aspect ratio. All coordinates are normalized from 0 to 1. SETPRT checks for illegal input, and will set the viewport to the entire screen if illegal input is detected.

PARAMETERS

in: xmin Minimum x coordinate for viewport.
    xmax Maximum x coordinate for viewport.
    ycen Center y coordinate for viewport.

real: xmin, xmax, ycen

COMMON BLOCKS: /RESOLT/

SEE ALSO: INQPR

SAMPLE CALL: Call SETPRT (0,-5,-75)
Call sets up a viewport in the upper quarter of the screen.
DECLARATION: Entry SETRAT (key, sordex, therat)

FUNCTION: Sets instance rate at a keyframe for animation.

PARAMETERS

in:  
  key  Frame number.
  sordex  Sort index number of instance.
  therat  The rate value at keyframe key.

real:  therat

integer:  key, sordex

SEE ALSO:  INQRAT
SETREF

DECLARATION: Entry SETREF (ncolor, colfnc)

FUNCTION: Sets function value reference colors.

PARAMETERS

in: ncolor Number of reference colors to be used.
colfnc Array of colors at each function level.

real: colfnc (3, maxlev)

integer: ncolor

SEE ALSO: INQREF
DECLARATION: Entry SETSCL

FUNCTION: Sets window to viewport scale factors.

*SETSCl must be called before a call to INQSCL.*

COMMON BLOCKS: /RESOLT/

SEE ALSO: SETPRT
INQPRt
GETWND
SETPND
INQSCL
DECLARATION: Subroutine SETSCN (iy, ixbeg, ixend, r, g, b, errfac)

FUNCTION: Sends a segment of a scanline to the graphics screen.

The graphics device must be in graphics mode before this routine can be called.

PARAMETERS

in: iy Y value of scanline.
    ixbeg Beginning x value of segment.
    ixend Ending x value of segment.
    r,g,b Color arrays for scanline segment.
    errfac Equal to 0.0 for dithering; - 0.5 all other times

real: r(0:ixres), g(0:ixres), b(0:ixres), errfac

integer: iy, ixbeg, ixend

COMMON BLOCKS: /RESOLT/
DECLARATION:  Entry SETSPL (key, sordex, thespl)

FUNCTION:  Sets instance on spline flags for animation.

PARAMETERS

in:  
  key       Key frame number.
  sordex    Sort index number of the instance.
  thespl    The spline flag:
             - 0 for no spline.
             - 1 for spline.

real:  thespl

integer:  key, sordex

SEE ALSO:  INQSPL
DECLARATION: Entry SETSTD

FUNCTION: Sets standard function reference colors.
DECLARATION: Entry SETSUB (keyfrm, number)

FUNCTION: Sets number of subframes between keyframes.

PARAMETERS

in: keyfrm  Beginning keyframe number.
    number  Number of subframes.

integer: keyfrm, number

SEE ALSO: INQSUB
DECLARATION: Entry SETTEN (key, sordex, theten)

FUNCTION: Sets instance tension at a keyframe for animation.

PARAMETERS

in: key Key frame number.
sordex Sort index number of the instance.
theten Tension value at keyframe key.

real: theten

integer: key, sordex

SEE ALSO: INQ TEN
DECLARATION: Entry SETWND (xmin, xmax, ycen)

FUNCTION: Sets window bounds.

SETWND calculates minimum and maximum y values enforcing a one-to-one aspect ratio.

PARAMETERS

in: xmin Minimum x world coordinate for window.
    xmax Maximum x world coordinate for window.
    ycen Center y world coordinate for window.

real: xmin, xmax, ycen

COMMON BLOCKS: /RESOLT/

SEE ALSO: GETWND
DECLARATION: Subroutine SHRINK (shrk, nedges, polcor, xcentr)

FUNCTION: Moves the nodes of a polygon toward the polygon center.

The coordinate array should close the polygon.

PARAMETERS

in: shrk  Shrink factor:
      0 = no shrink.
      1 = full shrink.

nedges  Number of polygon vertices.

polcor  Coordinate array for polygon.

xcentr  Coordinate array of polygon's center point.

real:   shrk, polcor(3,nedges), xcentr(3)

integer: nedges
DECLARATION: Entry SMOCLR (nodbeg, nodend)

FUNCTION: Clears the smooth shading routine.

SMOCLR should be called for each part that is smooth shaded.

PARAMETERS

  in:  
      nodbeg  Node to begin smooth shading.
      nodend  Node to end smooth shading.

  integer:  nodbeg, nodend

SEE ALSO:  SMOSTR
           SMOGET
**DECLARATION:** Entry SMOGET (nedges, nodes, polnor)

**FUNCTION:** Retrieves the smooth normals for a polygon.

Use SMOGET after all of the polygons in a part have been processed with SMOSTR.

**PARAMETERS**

*in:* nedges  Number of edges in the polygon.
nodes  Array of node numbers for the polygon.

*out:* polnor  Smooth normal of each polygon vertex.

*real:* polnor(3,nedges)

*integer:* nodes(nedges), nedges

**SEE ALSO:** SMOSTR
SMOCLR
**DECLARATION:** Entry SMOSTR (nedges, nodes, polnor)

**FUNCTION:** Averages normals for smooth shading.

*Call SMOCLR before making any calls to SMOSTR.*  
*You should call SMOSTR for each polygon in a part.*

**PARAMETERS**

- **in:**
  - nedges: Number of edges in the polygon being smoothed.
  - nodes: Array of node numbers for the polygon.
  - polnor: Normal of each polygon vertex.

- **real:** polnor(3,nedges)
- **integer:** nodes(nedges), nedges

**SEE ALSO:** SMOCLR  
SMOGET
DECLARATION: Entry STCONG (key, icode, thecnt)

FUNCTION: Sets continuity value for spline animation of look-at or look-from point.

PARAMETERS

in:
- key: Keyframe number.
- icode: 1 - look at point, 2 - look from point.
- thecnt: The continuity value at keyframe key (-1 to 1).

real: thecnt

integer: key, icode
STOREL

DECLARATION: Subroutine STOREL (ipart, nedges, polcor, polnor, polfun,
nodes, npolab, atribt)

FUNCTION: Loads a polygon for hidden line removal.

INTHLR must be called previous to calling STOREL. HIDLIN
should be called after all polygons have been processed with
STOREL.

PARAMETERS

in:  
ipart Part number this polygon comes from.
nedges Number of edges in the polygon.
numpol Polygon number currently being processed.
polcor Screen coordinates of the polygon.
polnor Polygon normals at the vertices.
polfun Polygon scalar values at the vertices.
nodes Node number array for the vertices.
npolab Polygon label number.
atribt Part attribute list information for the polygon.

real: polcor(3,*), polnor(3,*), polfun(*), atribt(*)

integer: numpol, nedges, nodes(*)

COMMON BLOCKS: /CATTRI/
/CFLAGS/
/HIDSTF/
/KEEP/

SEE ALSO: INTHLR
HIDLIN
**DECLARATION:** Entry STRATG (key, icode, therat)

**FUNCTION:** Sets rate for global animation at keyframes.

**PARAMETERS**

- **in:**
  - **key**  Keyframe number.
  - **icode** Key to which global animation parameter is being set:
    - 1 = Global scales.
    - 2 = Global rotates.
    - 3 = Background color.
    - 4 = Window.
    - 5 = Perspective angle.
    - 6 = Distance.
    - 7 = Look-from point.
    - 8 = Look-at point.
    - 9 = Z clipping planes.
    - 10 = Viewport.
    - 11 = Fog planes.
    - 12 = Light #1.
    - 13 = Light #2. Continued for each light source.
  - **therat**  The rate value at keyframe key (0 to 1).

- **real:** thespl
- **integer:** key, icode
DECLARATION: Entry STSPLG (key, icode, thespl)

FUNCTION: Sets on spline flag for look-at or look-from point spline animation.

PARAMETERS

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>key</td>
<td>Keyframe number.</td>
</tr>
<tr>
<td></td>
<td>icode</td>
<td>1 - look-at point, 2 - look-from point.</td>
</tr>
<tr>
<td></td>
<td>thespl</td>
<td>The spline value at keyframe key (0 or 1).</td>
</tr>
<tr>
<td>real</td>
<td>thespl</td>
<td></td>
</tr>
<tr>
<td>integer</td>
<td>key</td>
<td>Keyframe number.</td>
</tr>
<tr>
<td></td>
<td>icode</td>
<td>1 - look-at point, 2 - look-from point.</td>
</tr>
</tbody>
</table>
DECLARATION: Entry STTENG (key, icode, theten)

FUNCTION: Sets tension values for spline animation for look-at or look-from point.

PARAMETERS

in: 
- key Key frame number.
- icode 1 = look-at point, 2 = look-from point.
- theten The tension value at keyframe key (-1 to 1).

real: theten

integer: key, icode

SEE ALSO: INTENG
DECLAREATION: Subroutine SUMMARY

FUNCTION: Displays the global attributes set.

COMMON BLOCKS: /CLIMIT/
/DEVI/
/VEWSTF/
/RESOLT/
COMMON BLOCKS: /CATTRI/
/CFLAGS/
/CLIMIT/
/VEWSTF/
DECLARATION: Subroutine TEXT (mesage, xsize, ysize, twodim, xpos, ypos, zpos, xang, yang, zang, r, g, b, atribt, xslant, glbflg, ierr)

FUNCTION: Generates and displays alphanumerical text.

PARAMETERS

in: mesage The text string to be displayed.
    xsize X dimension factor.
    ysize Y dimension factor.
    twodim If .TRUE., 2-D text strings are generated.
          If .FALSE., 3-D text strings are generated.
    xpos X position of text string in model coordinates.
    ypos Y position of text string in model coordinates.
    zpos Z position of text string in model coordinates.
    xang X directional vector coordinate.
    yang Y directional vector coordinate.
    zang Z directional vector coordinate (if 3-d).
          Angle of text string (if 2-d).
    r,g,b Red, green, and blue color values for text string.
    atribt Attribute list.
    xslant Rotation about x-axis for 3-d text string in degrees.
    glbflg If .TRUE., xpos and ypos come in as screen coordinates.
    ierr If ierr = 1, then a character not defined in the character font has been entered.

real: xsize, ysize, xpos, ypos, zpos, xang, yang, zang, atribt(*), xslant, r, g, b

integer: ierr

logical: twodim, glbflg

character: mesage*80
DECLARATION: Subroutine TMPTS (tm, coord)

FUNCTION: Transforms an x,y,z point according to a transformation matrix.

PARAMETERS

    in:  tm    Transformation matrix.
          coord  Coordinate to be transformed. The coordinate is modified on return.

    real: tm(4,4), coord(3)
DECLARATION: Subroutine TMPTSN (tm,coord)

FUNCTION: Transforms a normal vector by a transformation matrix.

PARAMETERS

in:  tm     Transformation matrix.
     coord   Normal to be transformed.

real: tm(4,4), coord(3)
DECLARATION: Subroutine TRAVRS (root, itask, sgorit, grsort, trndex, sgrcnt, sitcnt, gstart, matrix, sgrind, grp.ptr, sortdx, grprec, stkfms, atlist, stkiaa)

FUNCTION: Traverses the groups and items structure for picture processing.

PARAMETERS

in: 
root Root group to be displayed.
itask Task flag: 
0 = auto-center.
1 = process part for display.
2 = write out geometry file.
sgorit Subgroup or subitem flag array.
grsort Group sort array.
sgrcnt Subgroup counter array.
sitcnt Subitem counter array.
gstart Group start array.
matrix Instance transformation (4x4) matrixes.
sgrind Subgroups that have been processed array.
grp.ptr Group pointer at recursive level array.
sortdx Sort index array.
grprec Group recursion counter array.
stkfms Stack of ctm’s array.
stkiaa Attribute stack.
atlist Attribute list transformation index array.

real: matrix(4,4,maxins), stkfms(4,4,maxrec), atlist(maxiaa,maxins), stkiaa(maxiaa,0:maxrec)

integer: sgorit(maxins), grsort(maxins), trndex(maxins), sgrcnt(maxgrp), sitcnt(maxgrp), gstart(maxgrp), sgrind(maxrec), grp.ptr(maxrec), sortdx(maxrec), grprec(maxgrp), itask, root
COMMON BLOCKS: /CATTRI/
/CHFWAS/
/CHFMRY/
/DEVI/
/VEWSTF/
DECLARATION: Entry TXTDIS

FUNCTION: Displays existing text strings.

SEE ALSO: GENTXT
          TXTINT
DECLARATION: Entry TXTINT

FUNCTION: Initializes the text string routines.

SEE ALSO: TXTDIS
          GENTXT
**DECLARATION:**
Subroutine WARPOL (nedges, tmpcor, tmpnor, iconn, ipoin, numpol)

**FUNCTION:**
Subdivides warped polygons that are partly front and partly back facing to the observer.

**PARAMETERS**

- **in:**
  - nedges: Number of vertices in the polygon.
  - tmpcor: Coordinate array of warped polygon.
  - tmpnor: Normals array of warped polygon.

- **out:**
  - iconn: Connectivity array after subdivision of warped polygon.
  - ipoin: Number of vertices in each subdivided polygon.
  - numpol: Number of polygons that the warped polygon was divided into.

- **real:**
  - tmpcor(3,*), tmpnor(3,*)

- **integer:**
  - nedges, iconn(vertmx+1,*), ipoin(*), numpol
DECLARATION: Subroutine WRITMV (npart, limits, tm)

FUNCTION: Stores geometry information for writing a geometry file.

PARAMETERS

in: npart Number of parts to be written to the geometry file.

limits Part limits array.

tm Transformation matrix for npart.

real: limits(2,*), tm(4,4)

integer: npart

COMMON BLOCKS: /MASTER/

SEE ALSO: WRTDRV

WRTGEO
DECLARATION: Entry WRTCHK (filnam)

FUNCTION: Writes a checkpoint file.

PARAMETERS

in: filnam  The name of the file to be used as the checkpoint file.

character: filnam(*)

SEE ALSO: REDCHK
DECLARATION: Entry WRTDRV (geonam)

FUNCTION: Opens file and initializes variables for a geometry file write.

PARAMETERS

in: geonam Name of the geometry file to be written.

character: geonam(*)

SEE ALSO: WRTGEO
DECLARATION: Entry WRTGEO

FUNCTION: Writes out the geometry file after a tree traversal.

SEE ALSO: WRTDRV
DECLARATION: Subroutine ZPLSTA (nedges, coords, zmin, zmax, polzmx, polzmn, istat)

FUNCTION: Gets polygon maximums, minimums, and status for z-clipping.

All coordinates are in the eye coordinate system.

PARAMETERS

in: nedges Number of vertices in the polygon or line.
    coords Coordinate array for vertices.
    zmin Distance to nearest clipping plane.
    zmax Distance to farthest clipping plane.

out: istat Status of the polygon:
       - 1 if trivially accept.
       - 2 if trivially reject.
       - 3 if must clip the polygon.
    polzmx Maximum polygon z coordinate.
    polzmn Minimum polygon z coordinate.

real: coords, zmin, zmax, polzmx, polzmn, coords (3,nedges)

integer: nedges, istat

SEE ALSO: CLPPZE
          CLPPOL
          CLPLIN
          POLSTA
Chapter 3
COMMON BLOCKS

This chapter describes all of the common blocks used in the Raster Graphics Subroutine Package. They are listed in alphabetical order. For each common block, each variable is defined, and the routines accessing the common block are listed.

Information about common blocks is included so you will be aware of common coupled routines. For some applications, you will need to set up the common blocks before an application can call the subroutines that use them.

Common Blocks for Internal Use ONLY

Three common blocks are strictly for internal use. For these common blocks, we have only given the declaration. These common blocks are:

/HIDSTF/
/PIXSTF/
/ZBUFER/

Make sure you don't use these common block names in subroutines you supply yourself.

If you want more information about these common blocks, contact the Engineering Computer Graphic Lab at Brigham Young University. The address is in Appendix C.
COMMON BLOCK: /CATTRI/ (IORDER, IDFFUS, ICOLOR, INNODE, INPOLY, IFEATR, ISHRNK, IWARP, ICONTR, IDASHL, ISHADE, ISHADO, IGLASS, IFRNGE, ILIGHT, IDSPLC, IPOST, IFAST, IDRWAX, IAXORG, IROTAX, IVECTR)

FUNCTION: Contains pointers into the instance attribute array. /CATTRI/ is set up in the subroutine GRAINT.

PARAMETERS:
Points to the:

integer:
IORDER  Polygon ordering information.
IDFFUS   Diffused light.
ICOLOR   Color information.
INNODE   Node numbering flag.
INPOLY   Polygon numbering flag.
IFEATR   Feature angle.
ISHRNK   Shrink factor.
IWARP    Warp vector.
ICONTR   Contour information.
IDASHL   Dashed line flag.
ISHADE   Shading type flag.
ISHADO   Shadow flag.
IGLASS   Transparency information.
IFRNGE   Fringe flag.
ILIGHT   Light information.
IDSPLC   Displacement factor.
IPOST    Post flag.
IFAST    Poorman flag.
IDRWAX   Draw local axis flag.
IAXORG   Local axis origin.
IROTAX   Local axis rotation angles.
IVECTR   Displacement vector arrows Scale factor.
ROUTINES THAT CONTAIN /CATTRI/

COLORS  MODTFM
DEFALT  OUTBOX
DEFPRT  PIPLIN
DSPTXT  PIPSRC
GLBAXS  POLOTL
GRAINT  POLYS
LIGHTS  PVEC
LOCAXS  SHOATR
MODATT  TRAVIN
MODFRM  TRAVRS
COMMON BLOCK: /CFLAGS/ (POLYGN, POORMN, HIDDEN, IALIAS, DITHER, LCOLOR, FOG, LCONTR, LFRING, LGLASS, LS, SHADW, PERSPC, WARPED, LABNOD, LABELE, FSTHID)

**FUNCTION:** Contains system global flags.

**PARAMETERS**

_.TRUE. if doing:

<table>
<thead>
<tr>
<th>Logical</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLYGN</td>
<td>Polygonal data</td>
</tr>
<tr>
<td>POORMN</td>
<td>Poorman</td>
</tr>
<tr>
<td>HIDDEN</td>
<td>Hidden line removal</td>
</tr>
<tr>
<td>IALIAS</td>
<td>Anti-aliasing</td>
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<tr>
<td>DITHER</td>
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<tr>
<td>LCOLOR</td>
<td>Colored lines</td>
</tr>
<tr>
<td>FOG</td>
<td>Fog/haze</td>
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<tr>
<td>LCONTR</td>
<td>Contours</td>
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<tr>
<td>LFRING</td>
<td>Fringes</td>
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<td>LGLASS</td>
<td>Transparency</td>
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<td>LSHADW</td>
<td>Shadows</td>
</tr>
<tr>
<td>PERSPC</td>
<td>Perspective</td>
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<tr>
<td>WARPED</td>
<td>.TRUE. if checking for warps on edge polygons.</td>
</tr>
<tr>
<td>LABNOD</td>
<td>Node labeling</td>
</tr>
<tr>
<td>LABELE</td>
<td>Element labeling</td>
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<tr>
<td>FSTHID</td>
<td>Polygon fill</td>
</tr>
</tbody>
</table>

**Routines that contain /CFLAGS/**

<table>
<thead>
<tr>
<th>Routines</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>CHKPTNT</td>
<td>EDGSHD</td>
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<tr>
<td>COLORS</td>
<td>FLAGIT</td>
</tr>
<tr>
<td>DEBSOR</td>
<td>FOURVW</td>
</tr>
<tr>
<td>DISALL</td>
<td>GLBAXS</td>
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<td>DSPTXT</td>
<td>INTSEC</td>
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<tr>
<td>EDGMAK</td>
<td>LOCAKS</td>
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<tr>
<td>EDGMKP</td>
<td>MAKSHA</td>
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<tr>
<td></td>
<td>PAINT</td>
</tr>
<tr>
<td></td>
<td>PIPLIN</td>
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<tr>
<td></td>
<td>PIPSRC</td>
</tr>
<tr>
<td></td>
<td>POLOTL</td>
</tr>
<tr>
<td></td>
<td>POLOUT</td>
</tr>
<tr>
<td></td>
<td>PREALI</td>
</tr>
<tr>
<td></td>
<td>SEGGEN</td>
</tr>
</tbody>
</table>
COMMON BLOCK: /CHFWAS/ (ILSINT, ILSLOC, ILSXYZ, ILSNEW, ISHDIN, IPRCOL, ICOPIN, ITRNDE, ISGORI, IGRPDE, ISGITO, IGRSOR, IGRUPA, ICHIDA, IORGPA, ISORDX, INCOPY, INPL, IALIST, IMATRI, ISGRCN, ISITCN, IGSTAR, ITSGIC, ISGRIN, IGRPPT, ISORTD, IGRPRE, ISTKFM, IAASTK, IGRNAM, ITMNNAM, ICPNAM, IPSTFL, IFWANI, IANIGL)

FUNCTION: Contains pointers into memory.

PARAMETERS

Points to the:

integer: ILSINT Light source intensities.
ILSLOC Light source location flags.
ILSXYZ Light source coordinates.
ILSNEW Modified light source coordinates.
ISHDIN Shadow intensities.
IPRCOL Part color array used in the hidden line removal algorithm.
ICOPIN Instance copies.
ITRNDE Transformation index.
ISGORI Child numbers.
IGRPDE Parent group.
ISGITO Child flag array.
IGRSOR Group sort array.
IGRUPA Root group array.
ICHIDA Child array.
IORGPA Item or group flag array.
ISORDX Sort array.
INCOPY Copy number.
INPL Part limit array.
IALIST Instance attribute lists.
IMATRI Instance transformation matrices.
ISGRCN Subgroup counter array.
ISITCN Subitem counter array.
IGSTAR Group start array.
ITSGIC Child test array.
ISGRIN  Subgroup counter array.
IGRPFT  Group pointer array.
ISORTD  Recursion sort index array.
IGRPRE  Group recursion test array.
ISTUFM  Transformation stack array.
IAASTU  Attribute stack array.
IGRNAM  Group names array.
ITMNAM  Item names array.
ICPNAM  Instance names array.
IPSTFL  Instance post flag array.
IFWANI  Starting unit number for instance animation.
IANIGL  Unit number for global animation.

ROUTINES THAT CONTAIN /CHFWAS/
COMMON BLOCK: /CLIMIT/ (MAXITM, MAXINS, MAXGRP, MAXMEM, MAXNOD, MAXPOL, MAXVER, MAXREC, MAXUSE, MAXCAL, MAXCHR, MAXIAA, MAXLIT, NP, NJ, NPT, NCON, NPNEW)

FUNCTION: Contains system limits.

PARAMETERS

integer: MAXITM    Maximum number of items allowed.
           MAXINS    Maximum number of instances allowed.
           MAXGRP    Maximum number of groups allowed.
           MAXMEM    Maximum amount of memory allocated.
           MAXNOD    Maximum number of nodes allowed.
           MAXPOL    Maximum number of polygons allowed.
           MAXVER    Maximum number of vertices allowed.
           MAXREC    Maximum number of recursion levels allowed.
           MAXUSE    Maximum amount of memory in use.
           MAXCAL    Maximum number of links in tree structure.
           MAXCHR    Maximum number of characters in a name.
           MAXIAA    Maximum number of words in an attribute list.
           MAXLIT    Maximum number of lights.
           NP        Number of parts read in.
           NT        Number of nodes read in.
           NPT       Number of polygons read in.
           NCON      Number of nodes in connectivity list.
           NPNEW     New number of parts found following tree traversal.

Chapter Three COMMON BLOCKS 3.7
<table>
<thead>
<tr>
<th>ROUTINES THAT CONTAIN /CLIMIT/</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVE</td>
</tr>
<tr>
<td>ADDCAL</td>
</tr>
<tr>
<td>ANILIT</td>
</tr>
<tr>
<td>BEGANI</td>
</tr>
<tr>
<td>CATIAA</td>
</tr>
<tr>
<td>CHKPNT</td>
</tr>
<tr>
<td>DEFAULT</td>
</tr>
<tr>
<td>DEFINE</td>
</tr>
<tr>
<td>DEFPRT</td>
</tr>
<tr>
<td>DELETE</td>
</tr>
</tbody>
</table>
COMMON BLOCK:  
/CMEMRY/  (MEMORY(MXMEM))

FUNCTION:  
Contains the data base for the program.

You should use /CHFWAS/ as pointers into memory to extract information.

PARAMETERS
integer/real:  MEMORY  The data base.

ROUTINES THAT CONTAIN /CMEMRY/

ADDCAL  GETGRU  INQUIR  PURGE
ADDFRM  GETITM  INTHDP  PVEC
ANIDRV  GLBACT  INTHID  READMV
BEGANI  GRAINT  INTSHA  REDGLB
CHKPNT  HIDSUR  LITSRC  RPLCOP
CLRANI  HUDGRP  MAKSHA  RPLCOR
COLORS  HUDITM  MODIFY  RPLGLB
COPNUM  HUGCOP  NEWANI  RUNANI
DISALL  HUGSOR  OPNANI  SHOATR
EXTCOP  HUSORT  OUTBOX  TRAVIN
FRMONE  HUSSTA  POLYS  TRAVRS
GETATT  INQLIT  POSFRM  WRTGLB
GETCOP
In the hidden algorithm:

**COMMON BLOCK: /HIDSTF/**

(EDGPNT, IOFFST, IBUCKY, IFREE, SHDPNT, IOFSHD, ISHADO, ISHADY, IAVAIL)

In the hidden line algorithm:

**COMMON /HIDSTF/**

IPOLST(MAXPOL+1),

& XHOLD(MAXEDG),

& YHOLD(MAXEDG),

& ZHOLD(MAXEDG),

& CCONT(MAXEDG),

& NODNUM(MAXEDG),

& SURF(11,MAXPOL),

& PGRID(3,MAXCOR),

& JNUMBR(MAXCOR),

& JVECLS(2,MAXVEC),

& JVECVP(MAXVEC),

& JVTYPE(MAXVEC),

& VECTOR(9,MAXVEC),

& JVP(4,MAXVEC),

& JXYS(MXGRID,MXGRID,MXBSUR),

& JXIV(MXGRID,MXGRID,MXBVEC),

& XLINE(4,MAXSEG)

**FUNCTION:** For internal use for the hidden line and hidden surface algorithms.

*If you want more information on this common blocks should contact The Engineering Computer Graphics Lab. Brigham Young University.*

**ROUTINES THAT CONTAIN HIDSTF:**

- CLENUP
- DEBSOR
- DMPVEC
- EDGMKP
- GENCNT
- GLSSRT
- HIDLIN
- HIDSRP

- HIDSUR
- HSHEDG
- HSHNOD
- INTHD2
- INTHDP
- INTHID
- INTHLR
- LBLNOD
- LODCNT
- LODINA
- LODSHD
- PREALI
- SEGGEN
- UPDATE

**Chapter Three COMMON BLOCKS 3.10**
COMMON BLOCK: /KEEP/ (NUMPOL, NUMPLS)

FUNCTION: Contains the internal polygon numbers for opaque and shadow polygons used for hidden surface and line removal.

PARAMETERS

integer:

<table>
<thead>
<tr>
<th>NUMPOL</th>
<th>Internal opaque polygon number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMPLS</td>
<td>Internal shadow polygon number.</td>
</tr>
</tbody>
</table>

ROUTINES THAT CONTAIN /KEEP/

HIDLIN
INTHLR
INTHDP
INTHID
POLOUT
SHDOUT
COMMON BLOCK: /MASTER/ (COORDS, ICONEC, NUMVRT, FUNVAL, DSPVAL)

FUNCTION: Contains geometric information.

PARAMETERS

real: COORDS Coordinate Array.
integer: ICONEC Connectivity Array.
        NUMVRT Number of vertices in each polygon array.
real: FUNVAL Function values at the nodes.
      DSPVAL Displacement values at the nodes.

ROUTINES THAT CONTAIN /MASTER/

CHKPNT
GEOMOV
LIMITS
OUTBOX
POLYS
SUMMARY
WRITMV
COMMON BLOCKS: /PIXSTF/ (IBUCKX, IFREEX)

FUNCTION: For internal use in the hidden surface removal algorithm during anti-aliasing.

If you want more information on this common block, contact Engineering Computer Graphics Lab, Brigham Young University.

ROUTINES THAT CONTAIN /PIXSTF/

ALIGLS
DEBSOR
INTHID
STRPIX
COMMON BLOCK:  /RESOLT/  (IXRES, IYRES)

FUNCTION:  Contains the x and y resolution of the display device.
/RESOLT/ is set up in RDINIT.

PARAMETERS

integer:  IXRES  The x resolution of the display device. Resolution starts at zero, so a device with 1024 pixels should have IXRES = 1023.

IYRES  The y resolution of the display device.

ROUTINES THAT CONTAIN /RESOLT/

CENTER  HIDSUR  SUMMRY
CHKPNT  LODINA  VEWPR
FOURVW  LODSHD  WINDOW
GLBAXS  PAINT  WRTGLB

Chapter Three  COMMON BLOCKS  3.14
COMMON BLOCK: /VEWSTF/ (AT, FROM, ZO, VIEWMT)

FUNCTION: Contains the viewing parameters.

PARAMETERS

real: AT The look-at point.
FROM The look-from point.
ZO The distance to the perspective projection plane.
VIEWMT The viewing transformation matrix.

ROUTINES THAT CONTAIN /VEWSTF/

ATFROM INTLIT
CENTER PRSPC
CHKPNT PRSSTF
DSPTXT SHDCTR
GLBAXS SHDHEX
GRAINT TRAVRS
INQLAF
COMMON BLOCK:  /ZBUFER/ IBUF

FUNCTION:  For internal use in the hidden surface algorithm.

If you want more information on this common block, contact Engineering Computer Graphics Lab, Brigham Young University.

ROUTINES THAT CONTAIN /ZBUFER/

ALIGLS
CLRBUF
DEBSOR
INSEG
PAINT
SHADOW
Chapter Four

INCLUDE FILES

This chapter explains the content of each of the include files needed for the Raster Graphics Display Library. The include files contain parameters controlling site and global control, which you should edit to fit your needs.

The subroutine package performs error checking on all arrays that are dimensioned by the parameters in the include files. Error messages will refer you to specific parameters in an include file.
INCLUDE BLOCK: ANIM.INC (MAXFRM, ISTART, ISTGLB, MAXCOM)

FUNCTION: Contains the variables that define parameters for animation.

PARAMETERS

MAXFRM The maximum number of key frames that can be defined.

ISTART Starting logical unit number for disk access for instance animation.

ISTGLB Logical unit number for disk access for global animation.

MAXCOM The maximum number of commands defining a key frame.

ROUTINES THAT USE ANIM.INC

ANIDRV
CHKPNT
CTRLGL
DOSPLN
GETATT
MODGLB
MOVMT
OPNANI
POSFRM
RUNANI
SPLNGL
INCLUDE BLOCK:  CVER.INC (VERTMX)

FUNCTION:  Contains the variable that defines the maximum number of vertices in a polygon.

PARAMETERS

VERTMX  The maximum number of vertices in a polygon.

ROUTINES THAT CONTAIN CVER.INC.

CHECK   GLBAXS   PIPLIN   SHDHEX
CLPLZE   HIDSUR   PIPSRC   SHDOUT
CLPPOL   LINSEC   POLYS    SHDTRN
CLPPZE   LOCAKS   PRESUR   SPLITP
DSPTXT   MAKSHA   PROCHL   STACK
GRAINT   OUTBOX   ROLL     TESTP
GENCNT   PCHECK   SEND     WARPOL
INCLUDE BLOCK: FNCT.INC (MAXLEV, MXCLEV, MXCSEG)

FUNCTION: Contains variables that control fringes and contours.

The software will print error messages if these parameters are exceeded.

PARAMETERS

MAXLEV Maximum number of function levels that can be defined for fringes and contours.

MXCLEV Maximum number of separate contour strings at the same contour level.

MXCSEG Maximum number of contour vectors in a contour level.

ROUTINES THAT CONTAIN FNCT.INC:

AFNCTN DRVTXT LODCNT
CHKPNT FRNBAR ORDCNT
CNTBAR FUNCTN PRGRUN
COLORS GENCNT PROCHL
DMPVEC HIDLIN PVEC
INCLUDE BLOCK: HIDN.INC (IAVVRT, MAXPOL, MAXEDG, MAXCOR, MAXVEC, MXGRID, MXBSUR, MTABLE, MXRESX, MXRESY, MAXFRC, MAXFIL, LITCST, NUMSHD)

FUNCTION: Contains the variables defining maximums for picture processing.

PARAMETERS

IAVVRT Average number of vertices in a polygon (approximate).

MAXPOL Maximum number of polygons in the scene. MAXPOL is used in the visible line and surface algorithms. Regular line drawings are not affected.

MAXEDG Maximum number of edges in the scene. MAXEDG is defined to be MAXPOL*IAVVRT.

MAXCOR Maximum number of vertices (nodes) in the scene.

MAXVEC Maximum number of line segments in the scene. MAXVEC is used for hidden line removal.

MXGRID Maximum number of grid cells in X and Y. MXGRID is used for hidden line removal.

MXBSUR Maximum number of polygons in a bucket. MXBSUR is used for hidden line removal.

MTABLE Maximum length of the hashing table. MTABLE is used for hidden line removal.

MXRESX Maximum resolution of the display device in the x direction.

MXRESY Maximum resolution of the display device in the y direction.

MAXFRC Maximum number of pixel fractions on a scan line for anti-aliasing. MAXFRC is used by the hidden surface algorithm.

MAXFIL Length of the array used for the painters hidden surface algorithm.

LITCST Maximum number of lights casting shadows.

NUMSHD Maximum number of shadow polygons that must be stored in the shadow edge list array.
ROUTINES THAT CONTAIN HIDN.INC.

ANTALI         DMPVEC
CLNUP          EDGMKP
CLRBUF         FRNBAR
DEBSOR
INCLUDE BLOCK: MOVL.INC (IOUT, IIN, LUN, LUN1)

FUNCTION: Contains logical unit numbers for file access.

PARAMETERS

  IOUT  Logical unit numbers for writing to the terminal.
  IIN   Logical unit number for reading from the terminal.
  LUN   Logical unit number for disk file access.
  LUN1  Another logical unit number for disk file access.

Routines that contain MOVL.INC:

GETXT
OPNFIL
PROMPT
INCLUDE BLOCK: MSTR.INC (MXNODE, MAXCON, MXPOLY, LITNUM, ITMNUM, INSNUM, IGRPNM, IRECNM, MAXPRT, MAXATT, MXMEM, CONST)

FUNCTION: Contains the variables that define system wide parameters.

PARAMETERS

MXNODE  Maximum number of coordinates that can be read into the data base.
MAXCON  Maximum number of nodes in the connectivity list that can be read into the data base.
MXPOLY  Maximum number of polygons that can be read into the data base.
LITNUM  Maximum number of light sources that can be defined.
ITMNUM  Maximum number of items that can be defined. This corresponds to the maximum number of parts that can be defined.
INSNUM  Maximum number of instances that can be defined.
IGRPNM  Maximum number of groups that can be defined.
IRECNM  Maximum number of levels in the hierarchical tree structure.
MAXPRT  Maximum number of parts in the scene.
MAXATT  Length of the attribute list for an instance.
MXMEM   Length of the array containing the data base.
CONST   A constant to generate standard ASCII numbers for characters.
<table>
<thead>
<tr>
<th>Routine</th>
<th>First Column</th>
<th>Second Column</th>
<th>Third Column</th>
<th>Fourth Column</th>
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</thead>
<tbody>
<tr>
<td>ADDCAL</td>
<td>DRVTXT</td>
<td>HIDSUR</td>
<td>MAKSHA</td>
<td>REDGLB</td>
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<td>ADDFRM</td>
<td>DSPTXT</td>
<td>HUDGRP</td>
<td>MODFRM</td>
<td>REDONE</td>
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<td>ANIDRV</td>
<td>EXTCOP</td>
<td>HUDITM</td>
<td>MODIFY</td>
<td>RPLCP1</td>
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<tr>
<td>BEGANI</td>
<td>EXTCP1</td>
<td>HUGGCP</td>
<td>MODIFY</td>
<td>RPLGLB</td>
</tr>
<tr>
<td>BNDBOX</td>
<td>FOURVW</td>
<td>HUGSOR</td>
<td>MOVMT</td>
<td>RUNANI</td>
</tr>
<tr>
<td>CCKPN</td>
<td>FRNBAR</td>
<td>HUSORT</td>
<td>NEWANI</td>
<td>SPOATR</td>
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<tr>
<td>CLRANI</td>
<td>GEOMOV</td>
<td>HUSTA</td>
<td>OPNANI</td>
<td>SPOATR</td>
</tr>
<tr>
<td>CNTBAR</td>
<td>GETATT</td>
<td>INQLT</td>
<td>POLYS</td>
<td>SUMMARY</td>
</tr>
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<td>COLORS</td>
<td>GLBACT</td>
<td>INQUIR</td>
<td>POSFRM</td>
<td>TRAVIN</td>
</tr>
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<td>GETCOP</td>
<td>INTHDP</td>
<td>PROCHL</td>
<td>TRAVRS</td>
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<tr>
<td>DISALL</td>
<td>GETGRU</td>
<td>INTSHA</td>
<td>PURGE</td>
<td>WRTMV</td>
</tr>
<tr>
<td>DMPVEC</td>
<td>GETITM</td>
<td>LIMITS</td>
<td>PVEC</td>
<td>WRTGLB</td>
</tr>
<tr>
<td>DOSPLN</td>
<td>GRAINT</td>
<td>LITSRC</td>
<td>READMV</td>
<td>WRTONE</td>
</tr>
</tbody>
</table>
USER.INC

FUNCTION: Contains the variables defining the length of character strings for user responses and database names.

PARAMETERS

LNSIZE The maximum length of an input character string.

MXCHAR The maximum length of a database name.

ROUTINES THAT CONTAIN USER.INC.

GRAINT

SHOATR
Appendix A

LINK MAP

This chapter contains the link map for MOVIE.BYU version 6. MOVIE.BYU is a general purpose computer graphics display system that uses RGDf software. The purpose of this chapter is to aid users that do not have library utilities on their computers.

The link map shows which routines call other routines, and is in the following form:

ROUTINE1
   ROUTINE2
      ROUTINE3
      ROUTINE4
      ROUTINE2*
   ROUTINE3

Here, the program flows in the following way:

1. ROUTINE1 calls ROUTINE2.
2. ROUTINE2 calls ROUTINE3.
3. ROUTINE3 does not call anything, and returns to ROUTINE2 when finished.
4. ROUTINE2 calls ROUTINE4.
5. ROUTINE4 does not call anything, and returns to ROUTINE2 when finished.
6. ROUTINE2 when finished returns to ROUTINE1.
7. ROUTINE1 calls ROUTINE2 again. The calls that ROUTINE2 makes have already been defined, so the line is tagged with a *.
8. ROUTINE2 when finished returns to ROUTINE1.
9. ROUTINE1 calls ROUTINE3. ROUTINE3 has been defined previously, but does not call any other routines; therefore, ROUTINE3 is shown without the *.
10. ROUTINE3 when finished returns to ROUTINE1, which when finished terminates the program.

MOVIE.BYU contains several routines that are not part of the subroutine library. Be aware that this link map is not for you to actually use—it is just for looking.
CLRANI
ANFILS
SETRMOD
ERASE
SETRMOD
PAUSE
GETXT *
PAUSE *
SETRMOD
ERASE
SETRMOD
INQPRRT
SETPRRT
SETRMOD
ERASE
SETRMOD
SETPRRT
GETAGR
GETGRU *
GETXT *
ACTGRP
GETGRU *
FOURVW
INQPRRT
INQLAF
INQBGC
SETPRRT
ATFROM
INT4X4
GTUTRN
GTUROY
INT4X4
MUL4X4
MOV4X4
GTUROX
INT4X4
MUL4X4
MOV4X4
MUL4X4
MOV4X4
DISALL
PRSSTF
GETAGR
INQCINT
INQFRN
TRAVRS
INQCLB
INT4X4
MOV4X4
GLBAXS
MOV4X4
GETWND
INQSCL
INQPRT
GTUTRN

Appendix A  LINK MAP  A.3
INQBGC
PIPLIN
    TMPTS
    CLPPZE
    ZPLSTA
    CLPMAX
        STFITP
        NORVEC
    CLPMIN
        STFITP
        NORVEC
    CLPLZE
    ZPLSTA
    CLPCOR
PRSPC
PORMAN
CLPPOL
    POLSTA
    CLPMIN *
    CLPMAX *
POLOTLL
    MAPPTS
        ZSTRMM
    STOREL
    NRMAVE
SETCOL
    CNTRPT
    MAPWV
MOVABSS
    DRWABS
    CHRNUM
    DISTXT
SETCOL
    CLPLIN
    POLSTA
    CLPCOR
    MAPWV
MOVABSS
    DRWABS
PIPLIN *
MUL4X4
CATIAA
MOV4X4
GTUTRN
LOCAXS
    GETWND
    INQSCL
    INQPRT
    INT4X4
    GTUROX *
    GTUROY *
    GTUROZ
        INT4X4
        MUL4X4
        MOV4X4

Appendix A  LINK MAP  A.4
GTUTRN
MUL4X4
PIPLIN *
MUL4X4
MOV4X4
GTUTRN
CATIAA
DEFPRT *
HRDWAR
WRITMV
POLYS
INQCNT
INQFRN
GETWND
GETCLP
ISHDDS
INQSCL
INQPRT
AROCLR
SMOCLR
INQARP
HRDWAR
INQDSP
CNTRPT
NORMAL
SMOSTR
SMOGET
SHRINK
NORMTM
MOV4X4
NORVEC
PCHECK
STACK
PUSH
NRMAVE
NORVEC
LOKROT
INT4X4
MUL4X4
TMPTS
TESTP
POPP
NORANG
CHECK
SEND
ROLL
PUSH
SEND
NORANG
LINSEC
BOX
SPLITP
PUSH
ROLL *
SEND
TMPTS
TMPTSN
HRDWAR
PIPSRC
  TMPTS
  TMPTSN
  WARPOL
     CNTRPT
     PORMAN
     MAKSHA
     SHDHEX
     SHDTTRN
     CLPPZE *
     PRSPC
     CLPPOL *
     SHDOUT
       MAPWV
       EDGSHD
       LODSHD
       ZSTRMM
       LODSHD *
     PRSPC
     CLPPOL *
     SHDOUT *
     CLPPZE *
     PRSPC
     CLPPOL *
     NRMAVE
     POLOUT
     COLORS
       INQLEV
       CNTRPT
       LIGHTS
       FRINGE
       MAPWV
       EDGMKP
       EDGMAK
       LODINA
       ZSTRMM
       LODINA *
     AROCHK
     PVEC
       ANQDS
       ANQDSP
     ARST
       ARSCAL
       ARROTA
       ROTMAT
       MATR
     MATR
     ARTRAN
     MATR
     ANQLEV
     FRINGE
     SETARC

Appendix A  LINK MAP  A.6
STRPIX
CODPS1
STRPIX
CODNG1
STRPIX
CODPS2
STRPIX
PREALI *
ALIGLS
STRPIX
SETONE
GLASS
INSSEG
GETONE
INSSEG
SETONE
INTSEC
STRPIX
SHADOW
ANTALI
GLASS
INSSEG
PAINT
DRWABS
MOVABS
HAZE
DODITH
SETSCN
SETCOL
UPDATE
CLRBUF
CLRNXT
FRNBAR
INQPRT
INQLEV
DODITH
SETSCN
SETCOL
MOVABS
DRWABS
INQBGC
DSPTXT
GETWND
INQPRT
INT4X4
GTUROZ *
MOV4X4
INQSCL
GTUTRN
INQGLB
MOV4X4
GTUTRN
MUL4X4
PAUSE *
PIPLIN *
CNTBAR
  INQPRT
  GETWND
  INQLEV
  INQBGC
  DSPTXT *
  SETCOL
  MOVABS
  DRWABS
  INQCNT
  HRDWAR
  TXTDIS
  INQTXT
  DSPTXT *
  SETMOD
  INQPRT
  SETMOD
  DSPTXT *
  SETPRT
  ATFROM *
  DISALL *
  INQPRT
  DISALL *
  GETXT *
  GETCOM
  LCUC
  READMV
  GEOMOV
    OPNFL *
    BNDBOX
    SETFNC
    SETSTD
    ASTSTD
    ASTFNC
    SETFNC
  GETAGR
  CHRNUM
  GETITM *
  ADDCAL
    GETITM *
    GETGRU *
    GETAGR
    HUACAL
      HUGCOP
        HUGCO1
      HUSORT
        HUSOR1
      HUSSTA
        HUSSTI1
      HUGSOR
        HUGS01
      GETCOP *
      INTCAL
        INT4X4
      GETXT *
SETPER
ATFROM *
PERDST
INQLAF
INQPER
SETWND
SETWND
INQDST
INQLAF
SETPRT
SETBGC
SETCLP
SETPRT
REDLIT
COMGLB
COPNUM
COPNUM
FRMONE
REDONE
RPLCOP
COPNUM *
HUGSOR *
RPLCOP1
MOV4X4
REDGLB *
COMGLB
MODGLB
GTUSCL
INT4X4
MUL4X4
MOV4X4
GTUROX *
GTUROY *
GTUROZ *
ANICOM
MODFRM
GTUTRN
GTUROZ *
GTUROZ *
GTUROY *
GTUROX *
GTUSCL *
GTUTRN
MOV4X4
RPLGLB
SETPGBL
SETBGC
ATFROM *
SETWND
PERDST *
SETPER
SETCLP
SETPRT
SETPRT
ANILIT
MOV4X4
RPLCOP *
SPLNGL
    INQFRM
    SPLINE
    MODGLB *
COMGLB
CTRLGL
    GLBCNM
MODFRC
MODGLB *
RPLGLB *
MODFRC
DOSPLN
    INQFRM
    SPLINE
    MODFRM *
ANICOM
MODFRM *
RPLCOP *
FOURVW *
DISALL *
CAMERA
MOV4X4
SPLNGL *
CTRLGL *
MODFRC
MODGLB *
COMGLB
RPLGLB *
DOSPLN *
MODFRM *
DOSPLN *
MODFRM *
ANICOM
RPLCOP *
FOURVW *
DISALL *
CAMERA
MOV4X4
GETXT *
WRTCHK
    OPFNIL *
GETAGR
INQAGL
INQTXT
INQPER
GETWND
INQPRP
INQBGC
GETCLP
GETDEF
INQBOX
INQFNC
ANQFNC
ANQREF

Appendix A    LINK MAP    A.14
INQREF
INQFOC
ANFILI
INQFRM
INQSUB
INQ RAT
INQCON
INQ TEN
INQ SPL
INTENG
INCONG
INSP LG
INRATG
IOPNAN
ANIDRV
INQFRM
GETXT *
BEGANI
ANFILI
CLRANI *
CNUMOP
ANFILS
OPNANI
GETCOP *
ANFILI
SETFRM
WRTGLB
INQGLB
INQLAF
INQPER
GETWND
INQPRT
INQB GC
GETCLP
INQFOG
WR TLT I T
ANFILS
INQFRM
INQSUB
GETXT *
GETNUM
SETSUB
COPNUM *
GETCOP *
INQ RAT
INQ TEN
INQCON
INQ SPL
GETNUM
SET RAT
SET TEN
SET CON
SET S PL
INRATG
STRAIG
INTENG
INSPLG
INCONG
STRATG
STTENG
STCONG
STSPLG
INRATG
STRATG
RUNANI *
SETRFM
ANIDRV *
GETXT *
ACTGRP *
DEFINE *
ADDCAL *
CHKNAM
GETXT *
GETCOP *
DELETE
GETCOP *
HUDITM
HUGSOR *
HUDCAL
HUSORT *
HUSSTA *
HUDGRP
HUGSOR *
HUDCAL *
PURGE
GETAGR
GETITM *
GETGRU *
GETCOP *
HUPITM
HUDITM *
HUDCAL
HUDITM *
HUDGRP
HUDITM *
CHKNAM *
MODIFY
GETCOP *
HUGSOR *
ANFILI
NEWANI
OPNANI *
EXTCOP
GETCOP *
HUGSOR *
EXTCP1
GETCOP *
GETAGR
TRAVIN *
WRTONE
MODTFM
SETREF
SETSTD
SETFNC
SETCNT
INQBGC
GENTXT
  INQTXT
  GETXT *
  GETCOM *
  GETNUM
  TXTINT
  SQUISH
  SETMOD
  DSPTXT *
  SAVTXT
INQDEV
RESET *
INQLAF
INQPRT
GETWND
GETCLP
INQLIT
INTSHA
  INTSH1
PERDST *
INQDST *
INQPERS
PNTHLP
OPNFILE *
GETTXT *
GETATT *
PNTMEN
  INQFRN
  INQCNT
PAUSE *
RMLEV
TREE
PGRUN *
NXTIDX
  NEXTWD
    GETXT *
    LCUC
RMLEV
ADLEV
FNDIDX
FNDCOM
FNDIDX
WRITCOM
In Chapter One, Example Problems, the fifth and sixth examples refer to this chapter, "An Introduction to Hierarchical Data Structures." We have included this section because reading through it will help you understand the hierarchical data structures used in RGDL.
AN INTRODUCTION TO HIERARCHICAL DATA STRUCTURES

If you read in a geometry file into RGD1 using READMV, the program will print a message similar to the following message:

A COPY OF 1 HAS BEEN ADDED

This line with a different number will be repeated for each part the applications program reads from the given geometry file. The message indicates that the hierarchical data structure is doing some default work for you.

You may choose to ignore the hierarchical data structure, but we strongly recommend you learn how to manipulate and use this powerful tool.

This appendix defines three terms you need to know and explains the hierarchical data structure, but does not give examples. You should see Chapter One, especially Examples Five and Six, for examples of how hierarchical data structures are used within RGD1.

Hierarchical Data Structure Terms

Item: An item is a collection of polygons that all behave in the same way. In other words, the polygons share the same attributes and are transformed together. An item cannot be deleted from the database and cannot carry attributes or transformations.

Instance: (or copy) An instance is a copy of an item or a group and can be deleted. It carries attributes as well as transformations. At display time, the instances show up on the screen.

Group: A group is a collection of instances. A group, like an item, cannot be deleted from the database, and it cannot carry attributes or transformations.

What Are Groups And Items?

Groups and items are part of a powerful hierarchical data structure that allows you to create and manipulate parts that may be related to one another.

A simple example of how parts can be created and manipulated is the creation of a car model. The wheels and the car body can be defined as separate items, while the wheels and car body together are a group.

Half of the car body can be modeled. This half can then be copied and mirrored to create an entire car body. A wheel can be created and replicated four times, then placed at the correct locations.
The body and wheels can then be manipulated together as an entire car. All four wheels can be rotated while the car is moving by simply rotating the instance containing the four wheels.

Upon initialization, RCDL creates a default group called ROOT (Capital letters are different from lower case letters. Thus, a group with the name 'ROOT' will be different than another group with the name 'root'). When a geometry file is read in, a copy of each of the parts are placed under the current active group (default ROOT).

Thus, if a three part geometry file were read in, the structure would look like Figure 1.

Because the numbers 1, 2, and 3 are not very descriptive of the geometry, we can change the names to improve the description. For example, we can rename items 1, 2, and 3 to part1, part2, and part3, and change the instance names to copy1, copy2, and copy3. The structure will then look like Figure 2.

Figure 1.

Appendix B  HIERARCHICAL DATA STRUCTURES  B.3
Because the numbers 1, 2, and 3 are not very descriptive of the geometry, we can change the names to improve the description. For example, we can rename items 1, 2, and 3 to part1, part2, and part3, and change the instance names to copy1, copy2, and copy3. The structure will then look like Figure 2.

Figure 2

As mentioned earlier, only instances can be deleted from the data structure. For example, we can delete copy1 and add another instance of part3. The resulting structure is shown in Figure 3.

Figure 3
As seen in Figure 3, item part1 has simply been unlinked from the data structure. It may be linked up at a later time under any group, or ignored.

Another group called 'NEW GROUP' can be created. Under this group, copies of other groups or items can be added.

The only limit is that the links can not be recursive. For example, a copy of 'ROOT' cannot be added under the group 'ROOT' because a circular list would be created. RGDL checks for recursive links and tells you about them.

A new structure might look like Figure 4.

The term definitions explain that only instances carry transformations and attributes. Transformations concatenate up the tree; thus a rotate of copy2 and a translate of ROOT COPY 1 would result in a scene that has two rotated copy2's, but only one translated copy2 (the rotate would occur before the translate).

In fact, such a scene would contain seven parts: two each of copy2, copy3, and copy4, and one part representing copy1. The one group of copy2, copy3, and copy4 would be translated.
Attributes such as color, shading type, and highlights are not concatenated. Instead they are inherited from "parent" to "child" for attributes not set for the child.

For example, if the color of copy2 was set to red, and the color of ROOT COPY 1 was set to green, the color of copy2 will remain red. If the color of copy3 was not set, it would be green under ROOT COPY 1 because copy3 inherited this color from its "parent".

However, copy3 under ROOT COPY 2 will not inherit color on the way up the tree, but will remain with its default color. An instance that has no attribute after traversing the tree from bottom to top will be assigned a default attribute.

To better understand hierarchical data structures, study the examples shown in Chapter One, especially Examples Five and Six.
Appendix C

SOFTWARE Installation

The magnetic tape supplied with this document is in a PRIME Magsav format for easy installation on other PRIME systems. The magnetic tape contains the following files:

- HIDDEN.F77: RGDL hidden surface routines.
- ANIMATE.F77: RGDL animation routines.
- GRUPTIT.F77: RGDL groups and items outlines.
- JONESD.F77: RGDL hidden line routines.
- MAIN.F77: RGDL common use routines.
- MOVLIB.F77: RGDL input/output library routines.

RGDL device driver routines
The C routines are for UNIX installations. Only one driver should be linked with an application.

- AED.F77
- AED.C
- RAS110.F77
- RAS120.F77
- RASOUT.C
- T4010.F77
- T4109.F77
- T4111.F77
- T4115.F77
- T4129.F77

RGDL include files

- ANIM.INC
- CVER.INC
- FNCT.INC
- HIDN.INC
- MOVL.INC
- MSTR.INC
- USER.INC

Example problems

- RSPEX1.F77
- RSPEX2.F77
- RSPEX3.F77
- RSPEX4.F77
- RSPEX5.F77
- RSPEX6.F77

Example problem geometry file

- EXP9.GEO
INSTALLATION

RGDL software is for installation on a PRIME computer. Even though the code is generic FORTRAN, it contains include file statements that are system dependent. The device drivers contain code that dumps buffers; this code is also system dependent.

To install RGDL on different operating systems, the include file statements in the source code must be modified to be compatible with your system's requirements. The code to perform system dependent buffer dumping in the device driver should also be changed.

BUGS, PROBLEMS, and COMMENTS

We have done our best to make RGDL and its documentation accurate and clear. However, you may find things that need to be clarified or changed. If you find bugs or problems in the software or the documentation, please contact us. Any positive comments would also be appreciated.

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