Internal Report #12

PRØPLT: A GENERALIZED THREE-DIMENSIONAL PLOTTING PROGRAM FOR THE SYSTEM 360

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A FØRTRAN subprogram has been developed to project and plot three-dimensional data on the IBM 360/75 using any of the three standard projections used in drafting and graph theory: (1) isometric, (2) oblique and (3) perspective projections. The use of this routine is simple and parallels the use of SYSPLT:

```
CALL PRØPLT (X,Y,Z,IPEN)
```

where (X,Y,Z) are the three-dimensional cartesian coordinates of the point to be projected into the plane of the graph paper, to which point the pen is moved. IPEN determines whether the pen movement results in a line being drawn as follows:

```
IPEN =  2 pen down
     = 12 pen down
     =  3 pen up
     = 13 pen up
```

Provision is made, through the use of IPEN = 12 or IPEN = 13 and "LCEØFF", for the automatic positioning of the plot on the graph paper with any arbitrary offset, scale factors or angular orientation (see discussion of "LCEØFF" below). Provision is also made for the generalized rotation of the coordinate axes prior to projection.

The type of projection used is determined by a parameter in a CØMMØN block to be discussed below. The same CØMMØN block also provides for specification of the parameters pertinent to the projection being used. The use of different entry points allows the user to express the three dimensional data in any of four coordinate systems: cartesian, cylindrical, spherical and three-dimensional polar. Entry points also allow the explicit designation of a particular projection or a determination of the graph paper coordinates of the projected point with no pen movement.

Although all of these features are discussed below, the documentation provided with the program in the form of CØMMENT cards (see appendix for program listing) should provide enough information for the use the program.

PROJECTIONS

Isometric

Figure 1a shows the configuration of the axes in an isometric projection. Scales along all axes are actual lengths, so an apparent distortion is introduced (i.e. no foreshortening). The parameter "ANGISØ" is the angle (measured in radians) in the plane of the graph paper between a perpendicular to the Z-axis and either the X-axis or the Y-axis. Although standard isometric projections used in drafting specify ANGISØ = 0.5235988 (30 degrees), this parameter may be set to any desired value (see discussion of CØMMØN block "/PRØJEC/" below). The projected coordinates (X_{proj}, Y_{proj}) in the plane of the graph paper are related to the three-dimensional cartesian coordinates by the following relations:

$$X_{proj} = (X-Y)\cos(\theta) + X_{ORG}$$

$$Y_{proj} = (X+Y)\sin(\theta) + Z + Y_{ORG}$$

where θ = ANGISØ

and (X_{ORG}, Y_{ORG}) = the coordinates on the graph paper of the projected coordinate origin

Oblique

Figure 1b shows the configuration of the axes used for an oblique projection. Scales along all axes are, again, actual lengths, and an apparent distortion is produced not only from the lack of foreshortening but also from the fact that an object or curve is being "projected" into two planes simultaneously. The parameter "ANGØBL" is the angle (measured in radians) in the plane of the graph paper between the X-axis and the Y-axis. This parameter may be set to any value (see discussion of CØMMØN block "/PRØJEC/" below). The projected coordinates (X_{proj}, Y_{proj}) in the plane of the graph paper are related to the three-dimensional cartesian coordinates by the following relations:

$$X_{proj} = X + Y\cos(\theta) + X_{ORG}$$

$$Y_{proj} = Y\sin(\theta) + Z + Y_{ORG}$$

where θ = ANGØBL

(X_{ORG}, Y_{ORG}) = the coordinates on the graph paper of the projected coordinate origin

Perspective

Figure 1c shows the configuration of the axes after a perspective projection. Perspective projections are quite different from the other

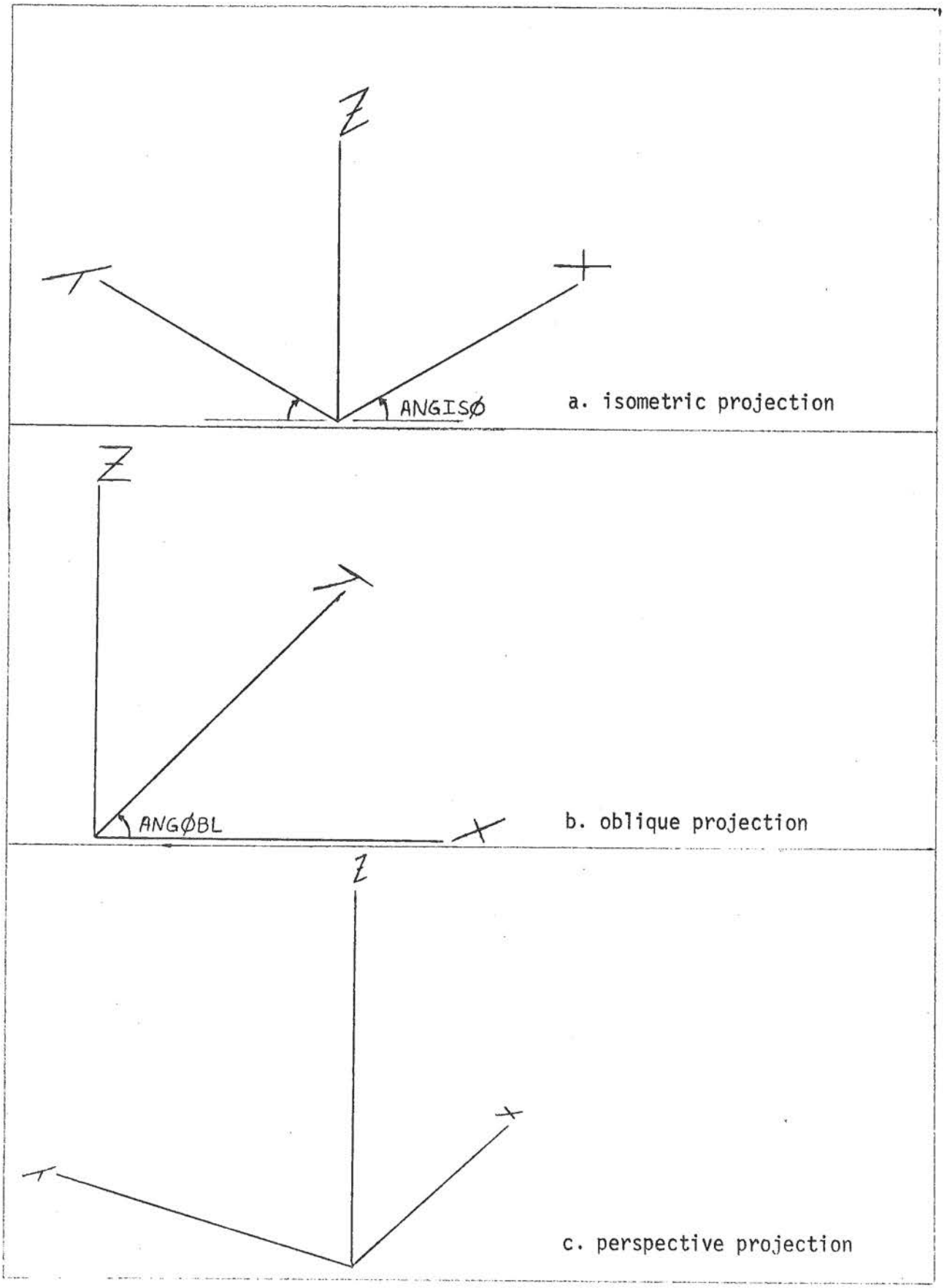


Figure 1. Projected Coordinate Axes

types of projections because perspective is an attempt to reproduce what the eye (or a camera) would actually see if the object or curve were produced in three dimensions and viewed normally. The form of the equations involved in the projection are much more complex than those above and will not be presented here (cf. appendix for program listing). The projection is indicated schematically in figure 2 to indicate the interrelationship of the various parameters. Variations in these parameters will give the effect of moving the object (or curve) closer, further away, higher, lower, back and forth, etc. The exact relationship between variations in the parameters and the apparent effective motions is not always obvious, and a good deal of experimentation may be necessary to obtain any particular configuration. The following parameters may be assigned any values (see discussion of CØMMØN block "/PRØJEC/" below): "PICANG", "DGLH", "EXTENT", "SUBTND", "DØH", and "DØC".

For a more detailed discussion of this projection, see J. H. Hills, Pictorial Drafting, McGraw-Hill Book Co., Inc., New York, 1930, pp. 75-106. A xerox copy is available through L. C. Evans.

ENTRY POINTS

LCEPLT (X,Y,IPEN)

Same as "SYSPLT(X,Y,IPEN)" except that rotation of the plot on the graph paper is allowed through the use of "LCEØFF(XØFF,XFACT,YØFF, YFACT,THETA)"

X = X-coordinate (in inches) of point to which pen is to be moved

Y = Y-coordinate (in inches) of point to which pen is to be moved

IPEN = status of pen during movement

= 2 pen down

= 12 pen down (see below)

= 3 pen up

= 13 pen up (see below)

= 12,13 new coordinates on graph paper are computed before moving pen according to

$$X_{new} = (XF_X + X_0)\cos(\theta) + (YF_Y + Y_0)\sin(\theta)$$

$$Y_{new} = (YF_Y + Y_0)\cos(\theta) - (XF_X + X_0)\sin(\theta)$$

where

F_X = XFACT

X_0 + XØFF

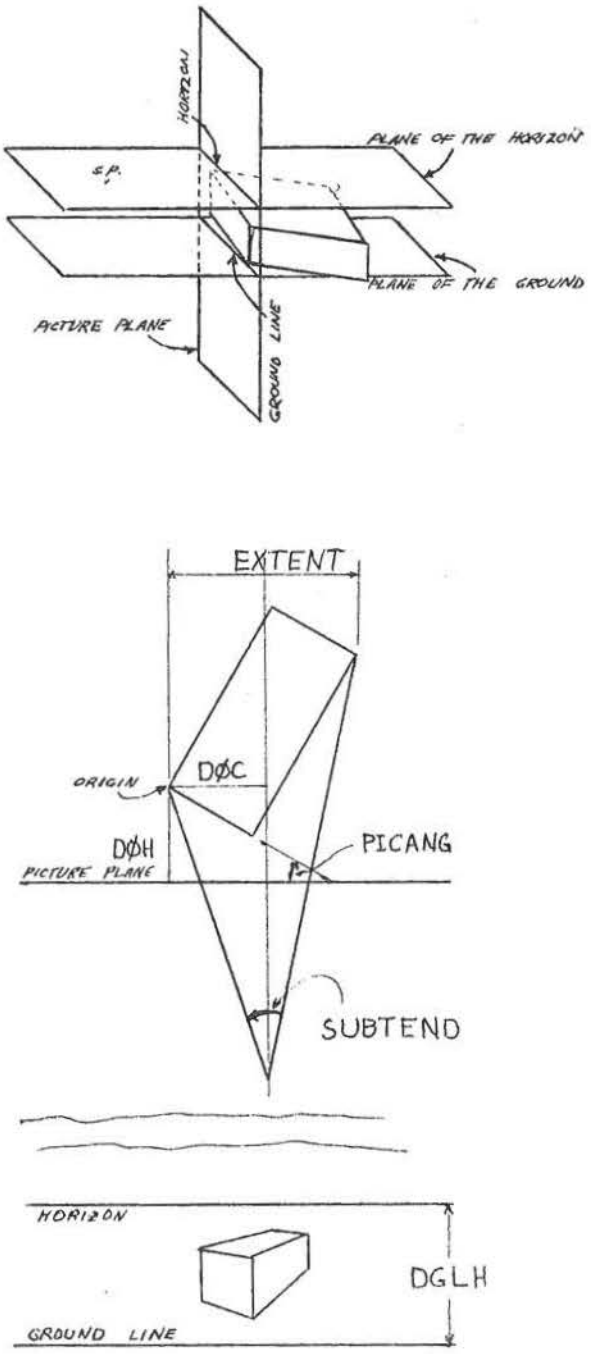


Figure 2. Schematic Representation of Perspective Projection Showing the Definition of the Pertinent Parameters

F_Y = YFACT

Y_0 = YØFF

θ = THETA

LCEØFF(XØFF,XFACT,YØFF,YFACT,THETA)

Sets parameters used whenever IPEN = 12 or 13 is used (see description of "IPEN" above).

PRØPLT(X,Y,Z,IPEN)

ISØPLT(X,Y,Z,IPEN)

ØBLPLT(X,Y,Z,IPEN)

PERPLT(X,Y,Z,IPEN)

TRANSL(X,Y,Z,XPRØJ,YPRØJ)

Routines using input coordinates in terms of three-dimensional cartesian coordinates (Figure 3a). A further explanation of each entry point is given below.

PRØPLC(R,THPØS,Z,IPEN)

ISØPLC(R,THPØS,Z,IPEN)

ØBLPLC(R,THPØS,Z,IPEN)

PERPLC(R,THPØS,Z,IPEN)

TRANSC(R,THPØS,Z,XPRØJ,YPRØJ)

Routines using input coordinates in terms of three dimensional cylindrical coordinates (Figure 3b). A further explanation of each entry point is given below.

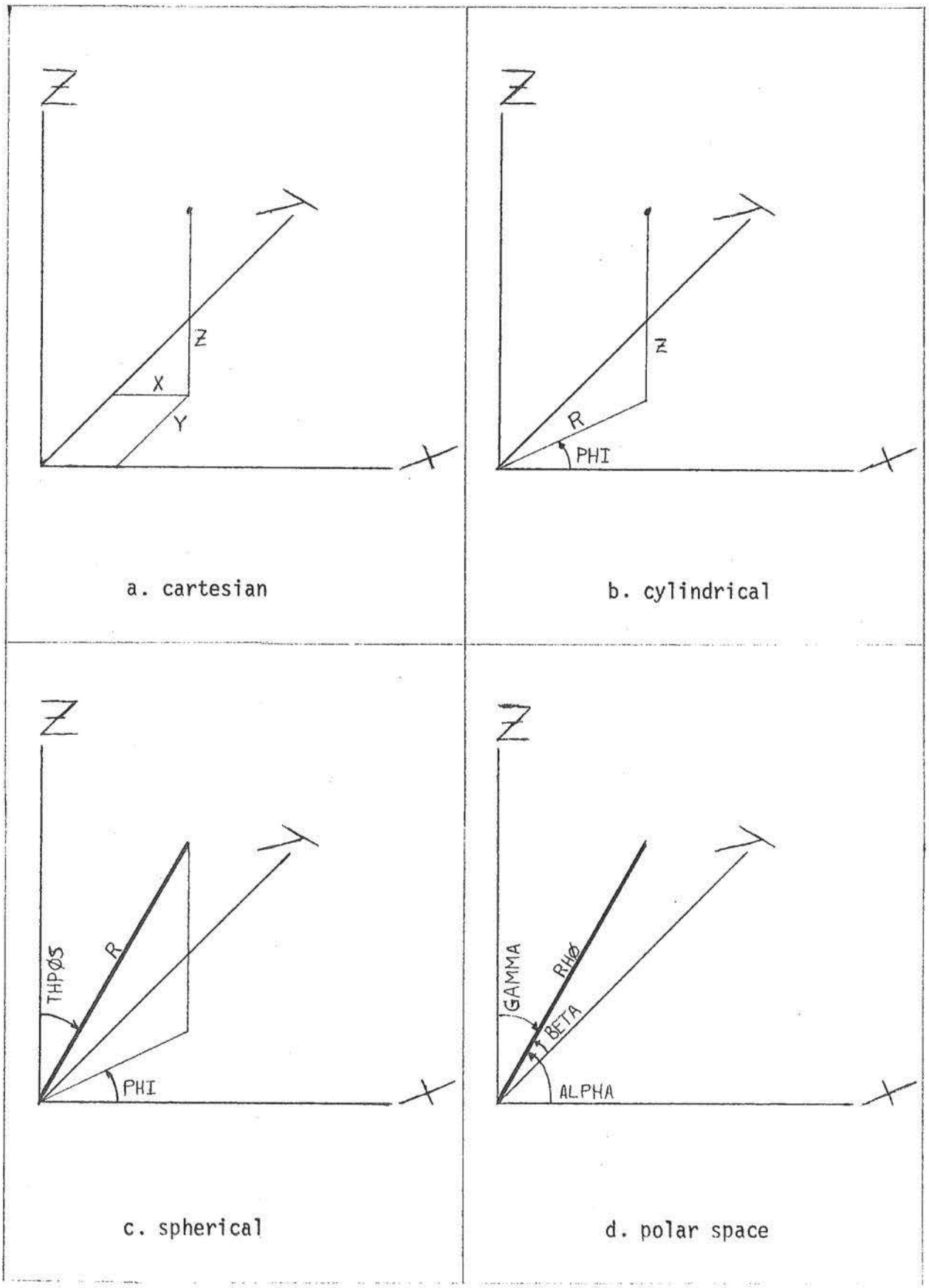
PRØPLS(R,THPØS,PHI,IPEN)

ISØPLS(R,THPØS,PHI,IPEN)

ØBLPLS(R,THPØS,PHI,IPEN)

PERPLS(R,THPØS,PHI,IPEN)

TRANSS(R,THPØS,PHI,XPRØJ,YPRØJ)



a. cartesian

b. cylindrical

c. spherical

d. polar space

Figure 3. Three Dimensional Coordinate Systems

Routines using input coordinates in terms of three dimensional spherical coordinates (Figure 3c). A further explanation of each entry point is given below.

PRØPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

ISØPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

ØBLPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

PERPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

TRANSP(RHØ,ALPHA,BETA,GAMMA,XPRØJ,YPRØJ)

Routines using input coordinates in terms of three dimensional polar space coordinates (Figure 3d). A further explanation of each entry point is given below.

PRØPLT(X,Y,Z,IPEN)

PRØPLC(R,THPØS,Z,IPEN)

PRØPLS(R,THPØS,PHI,IPEN)

PRØPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

Basic routines for plotting three-dimensional data in any one of the three types of projections. The desired projection is indicated by the value of "PTYPE" (see discussion of CØMMØN block "/PRØJEC/" below).

ISØPLT(X,Y,Z,IPEN)

ISØPLC(R,THPØS,Z,IPEN)

ISØPLS(R,THPØS,PHI,IPEN)

ISØPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

Entry points for plotting three-dimensional data using an isometric projection.

ØBLPLT(X,Y,Z,IPEN)

ØBLPLC(R,THPØS,Z,IPEN)

ØBLPLS(R,THPØS,PHI,IPEN)

ØBLPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

Entry points for plotting three-dimensional data using an oblique projection.

PERPLT(X,Y,Z,IPEN)

PERPLC(R,THPØS,Z,IPEN)

PERPLS(R,THPØS,PHI,IPEN)

PERPLP(RHØ,ALPHA,BETA,GAMMA,IPEN)

Entry points for plotting three-dimensional data using a perspective projection.

TRANSL(X,Y,Z,XPRØJ,YPRØJ)

TRANSC(R,THPØS,Z,XPRØJ,YPRØJ)

TRANSS(R,THPØS,PHI,XPRØJ,YPRØJ)

TRANSP(RHØ,ALPHA,BETA,GAMMA,XPRØJ,YPRØJ)

Entry points for determining the graph paper coordinates of the projection of three-dimensional data using any of the three basic projections. The pen is not moved. The type of projection desired is determined by the value of "PTYPE" (see discussion of CØMMØN block "/PRØJEC/" below).

REINIT

(No parameters) Reinitializes certain flags. This entry point must be called after any change in the parameters in CØMMØN block "/PRØJEC/".

PSTAND

(No parameters) Causes certain of the parameters in CØMMØN block "/PRØJEC/" to be set to the following standard values:

XØRG = (unchanged)
YØRG = (unchanged)
PHIX = 0.0
PHIY = 0.0
PHIZ = 0.0
PTYPE = (unchanged)
ANGISØ = 0.5235988 (30 degrees)
ANGØBL = 0.7853982 (45 degrees)
PICANG = 1.0471976 (60 degrees)
DGLH = 10.0
EXTENT = (unchanged)
SUBTND = 0.5235988 (30 degrees)
DØH = (unchanged)
DØC = (unchanged)

A call to "PSTAND" automatically results in a call to "REINIT."

PINVRT(XPRØJ,YPRØJ,X,Y,Z)

Inverts the desired projection for a given value of Z.

CØMMØN BLØCK

/PRØJEC/XØRG,YØRG,PHIX,PHIY,PHIZ,PTYPE,ANGISØ,ANGØBL,PICANG,
DGLH,EXTENT,SUBTND,DØH,DØC

XØRG,YØRG = coordinates in the plane of the graph paper of the projected origin

PHIX,PHIY,PHIZ - a generalized rotation of the coordinate system prior to projection is handled by defining "PHIX", "PHIY", and "PHIZ" so that the rotated system can be made to "coincide" with the unrotated system with respect to which the projection is made by performing the following three rotations (in this order): (1) -PHIZ around the Z-axis, (2) -PHIY around the Y-axis, and (3) -PHIX around the X-axis. All angles are measured in radians.

PTYPE - (integer) indicates which type of projection is to be used.

= 0 isometric projection

= 1 oblique projection

= 2 perspective projection

ANGISØ = the apparent angle in radians between the horizontal and the X-axis and the Y-axis in an isometric projection (ignored unless PTYPE = 0). (Figure 1a).

ANGØBL = the apparent angle in radians between the X-axis and the Y-axis in an oblique projection (ignored unless PTYPE = 1) measured in the plane of the graph paper. (Figure 1b)

The remaining parameters are related to perspective projections and are ignored unless PTYPE = 2 (Figures 1c and 2).

PICANG = angle in radians between X-axis and picture plane

DGLH = distance in inches between ground line and horizon on graph paper

EXTENT = the total horizontal extent (in inches) of the object

SUBTND = angle in radians in a horizontal plane subtended by the object (or curve, etc) at the station point

DØH = distance from origin of object to picture plane

DØC = distance from origin of object to center line (perpendicular to picture plane through station point).

STORAGE AND TIMING

Storage requirements are 8134 $(207A)_{16}$ bytes. One call to "PRØPLT" takes about 360 μs.

LE/jam

Distribution:

E. Aguilar
J. Brown
J. Fanselow
J. Lupton
S. Murray
J. Stevenson
E. Stone

APPENDIX

LISTING OF "LCEPLT"

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C     SUBROUTINE LCEPLT(XPOS,YPOS,IPEN)                                 LEPLT001
C                                                                       LEPLT002
C     LCEPLT IS ESSENTIALLY 'SYSPLT' EXCEPT THAT ROTATION OF THE        LEPLT003
C         COORDINATE AXES IS ALLOWED THROUGH THE USE OF 'LCEOFF'.       LEPLT004
C         ENTRY POINTS PROVIDE FOR THE PLOTTING OF POINTS GIVEN IN      LEPLT005
C         THREE DIMENSIONAL COORDINATES WITH A CHOICE OF PROJECTIONS.   LEPLT006
C                                                                       LEPLT007
C         XPOS,YPOS,IPEN - PARAMETERS AS IN 'SYSPLT'.                   LEPLT008
C                                                                       LEPLT009
C         ENTRY POINTS                                                  LEPLT010
C              LCEOFF(XOFF,XFACT,YOFF,YFACT,THETA) - ESSENTIALLY        LEPLT011
C                   'SYSOFF', EXCEPT THAT ROTATION OF AXES IS           LEPLT012
C                   ESTABLISHED.                                        LEPLT013
C                   XOFF,XFACT,YOFF,YFACT - PARAMETERS AS IN 'SYSOFF'   LEPLT014
C                   THETA  - ANGLE THROUGH WHICH COORDINATE AXES ARE    LEPLT015
C                            TO BE ROTATED (IN RADIANS).                LEPLT016
C              PROPLT(XPOS,YPOS,ZPOS,IPEN) -- BASIC ROUTINE FOR         LEPLT017
C                   PLOTTING THREE DIMENSIONAL CARTESIAN COORDINATE     LEPLT018
C                   POINTS WITH A GIVEN PROJECTION.  (THE TYPE OF       LEPLT019
C                   PROJECTION IS SPECIFIED BY THE VALUE OF 'PTYPE' IN  LEPLT020
C                   'COMMON' BLOCK '/PROJEC/' DISCUSSED BELOW.)         LEPLT021
C                   XPOS,YPOS,ZPOS - THREE DIMENSIONAL CARTESIAN COOR-  LEPLT022
C                        DINATES TO WHICH PEN IS TO BE MOVED.           LEPLT023
C                   IPEN - AS IN 'SYSPLT'                               LEPLT024
C                          =  2  PEN DOWN                               LEPLT025
C                          = 12  PEN DOWN USING 'XOFF', 'XFACT', 'YOFF',LEPLT026
C                                  'YFACT', AND 'THETA' (CF. 'LCEOFF').LEPLT027
C                          =  3  PEN UP                                 LEPLT028
C                          = 13  PEN UP USING 'XOFF', 'XFACT', 'YOFF',  LEPLT029
C                                  'YFACT', AND 'THETA' (CF. 'LCEOFF'). LEPLT030
C                          = 12,13 NEW X,Y-COORDINATES (ON GRAPH PAPER) LEPLT031
C                                  ARE COMPUTED BEFORE MOVING PEN,      LEPLT032
C                                  ACCORDING TO                         LEPLT033
C                                  XNEW=(X*XFACT+XOFF)*COS(THETA)       LEPLT034
C                                              +(Y*YFACT+YOFF)*SIN(THETA)LEPLT035
C                                  YNEW=(Y*YFACT+YOFF)*COS(THETA)       LEPLT036
C                                              -(X*XFACT+XOFF)*SIN(THETA)LEPLT037
C              ISOPLT(XPOS,YPOS,ZPOS,IPEN) -- ROUTINE FOR PLOTTING      LEPLT038
C                   THREE DIMENSIONAL CARTESIAN COORDINATES IN AN       LEPLT039
C                   'ISOMETRIC' PROJECTION.                             LEPLT040
C                   XPOS,YPOS,ZPOS,IPEN -- PARAMETERS AS IN 'PROPLT'.   LEPLT041
C              OBLPLT(XPOS,YPOS,ZPOS,IPEN) -- ROUTINE FOR PLOTTING      LEPLT042
C                   THREE DIMENSIONAL CARTESIAN COORDINATES IN AN       LEPLT043
C                   OBLIQUE PROJECTION.                                 LEPLT044
C                   XPOS,YPOS,ZPOS,IPEN -- PARAMETERS AS IN 'PROPLT'.   LEPLT045
C                   FOR THREE DIMENSIONAL CYLINDRICAL COORDINATES.      LEPLT046
C              PERPLT(XPOS,YPOS,ZPOS,IPEN) -- ROUTINE FOR PLOTTING      LEPLT047
C                   THREE DIMENSIONAL CARTESIAN COORDINATES IN A        LEPLT048
C                   PERSPECTIVE PROJECTION.                             LEPLT049
C                   XPOS,YPOS,ZPOS,IPEN -- PARAMETERS AS IN 'PROPLT'.   LEPLT050
C              TRANSL(XPOS,YPOS,ZPOS,XPROJ,YPROJ) -- GENERATES THE      LEPLT051
C                   PROJECTED COORDINATES (I.E., IN THE PLANE OF THE    LEPLT052
C                   GRAPH PAPER) OF A POINT GIVEN IN THREE DIMENSIONAL  LEPLT053
C                   CARTESIAN COORDINATES FOR THE PROJECTION SPECIFIED  LEPLT054
C                   BY 'PTYPE' IN 'COMMON' BLOCK '/PROJEC/'.  NO        LEPLT055
C                   PLOTTER MOVEMENT OCCURS.                            LEPLT056
C                   XPOS,YPOS,ZPOS -- PARAMETERS AS IN 'PROPLT'.        LEPLT057
C                   XPROJ,YPROJ -- COORDINATES OF (XPOS,YPOS,ZPOS)      LEPLT058
C                        AFTER PROJECTION.                              LEPLT059
C              PROPLC(RPOS,THPOS,ZPOS,IPEN) -- SAME AS 'PROPLT', BUT    LEPLT060
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C          FOR THREE DIMENSIONAL CYLINDRICAL COORDINATES.          LEPLT061
C          RPOS,THPOS,ZPOS - STANDARD THREE DIMENSIONAL            LEPLT062
C               CYLINDRICAL COORDINATES ('THPOS' IN RADIANS).      LEPLT063
C          IPEN - AS IN 'PROPLT'.                                  LEPLT064
C        ISOPLC(RPOS,THPOS,ZPOS,IPEN) -- SAME AS 'ISOPLT', BUT     LEPLT065
C          FOR THREE DIMENSIONAL CYLINDRICAL COORDINATES.          LEPLT066
C          RPOS,THPOS,ZPOS,IPEN - PARAMETERS AS IN 'PROPLC'.       LEPLT067
C        OBLPLC(RPOS,THPOS,ZPOS,IPEN) -- SAME AS 'OBLPLT', BUT     LEPLT068
C          FOR THREE DIMENSIONAL CYLINDRICAL COORDINATES.          LEPLT069
C          RPOS,THPOS,ZPOS,IPEN - PARAMETERS AS IN 'PROPLC'.       LEPLT070
C        PERPLC(RPOS,THPOS,ZPOS,IPEN) -- SAME AS 'PERPLT', BUT     LEPLT071
C          RPOS,THPOS,ZPOS,IPEN - PARAMETERS AS IN 'PROPLC'.       LEPLT072
C        TRANSC(RPOS,THPOS,ZPOS,XPROJ,YPROJ) -- SAME AS 'TRANSL',  LEPLT073
C          BUT FOR THREE DIMENSIONAL CYLINDRICAL COORDINATES.      LEPLT074
C          RPOS,THPOS,ZPOS - AS IN 'PROPLC'.                       LEPLT075
C          XPROJ,YPROJ - AS IN 'TRANSL'.                           LEPLT076
C        PROPLS(RPOS,THPOS,PHIPOS,IPEN) -- SAME AS 'PROPLT', BUT   LEPLT077
C          FOR THREE DIMENSIONAL SPHERICAL COORDINATES.            LEPLT078
C          RPOS    - RADIAL DISTANCE FROM ORIGIN TO POINT.         LEPLT079
C          THPOS   - ANGLE SUBTENDED BY ARC OF RADIUS 'RPOS'       LEPLT080
C                    FROM ZENITH TO POINT (IN RADIANS).            LEPLT081
C          PHIPOS - ANGLE IN HORIZONTAL PLANE THROUGH ORIGIN       LEPLT082
C                    BETWEEN POLAR AXIS (X-AXIS) AND PROJEC-       LEPLT083
C                    TION OF RADIAL LINE THROUGH POINT (IN         LEPLT084
C                    RADIANS).                                     LEPLT085
C          IPEN    - AS IN 'PROPLT'.                               LEPLT086
C        ISOPLS(RPOS,THPOS,PHIPOS,IPEN) -- SAME AS 'ISOPLT', BUT   LEPLT087
C          FOR THREE DIMENSIONAL SPHERICAL COORDINATES.            LEPLT088
C          RPOS,THPOS,PHIPOS,IPEN - PARAMETERS AS IN 'PROPLS'.     LEPLT089
C        OBLPLS(RPOS,THPOS,PHIPOS,IPEN) -- SAME AS 'OBLPLT', BUT   LEPLT090
C          FOR THREE DIMENSIONAL SPHERICAL COORDINATES.            LEPLT091
C          RPOS,THPOS,PHIPOS,IPEN - PARAMETERS AS IN 'PROPLS'.     LEPLT092
C        PERPLS(RPOS,THPOS,PHIPOS,IPEN) -- SAME AS 'PERPLT', BUT   LEPLT093
C          FOR THREE DIMENSIONAL SPHERICAL COORDINATES.            LEPLT094
C          RPOS,THPOS,PHIPOS,IPEN - PARAMETERS AS IN 'PROPLS'.     LEPLT095
C        TRANSS(RPOS,THPOS,PHIPOS,XPROJ,YPROJ) -- SAME AS          LEPLT096
C          'TRANSL', BUT FOR THREE DIMENSIONAL SPHERICAL           LEPLT097
C          COORDINATES.                                            LEPLT098
C          RPOS,THPOS,PHIPOS - AS IN 'PROPLS'.                     LEPLT099
C          XPROJ,YPROJ - AS IN 'TRANSL'.                           LEPLT100
C        PROPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN) -- SAME AS       LEPLT101
C          'PROPLT', BUT FOR THREE DIMENSIONAL POLAR SPACE         LEPLT102
C          COORDINATES.                                            LEPLT103
C          RHOPOS - RADIAL DISTANCE FROM ORIGIN TO POINT.          LEPLT104
C          ALFPOS - ANGLE BETWEEN RADIAL LINE THROUGH POINT        LEPLT105
C                    AND X-AXIS (IN RADIANS).                      LEPLT106
C          BETPOS - ANGLE BETWEEN RADIAL LINE THROUGH POINT        LEPLT107
C                    AND Y-AXIS (IN RADIANS).                      LEPLT108
C          GAMPOS - ANGLE BETWEEN RADIAL LINE THROUGH POINT        LEPLT109
C                    AND Z-AXIS (IN RADIANS).                      LEPLT110
C          IPEN    - AS IN 'PROPLT'                                LEPLT111
C        ISOPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN) -- SAME AS       LEPLT112
C          'ISOPLT', BUT FOR THREE DIMENSIONAL POLAR SPACE         LEPLT113
C          COORDINATES.                                            LEPLT114
C          RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN - AS IN 'PROPLP'.      LEPLT115
C        OBLPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN) -- SAME AS       LEPLT116
C          'OBLPLT', BUT FOR THREE DIMENSIONAL POLAR SPACE         LEPLT117
C          COORDINATES.                                            LEPLT118
C          RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN - AS IN 'PROPLP'.      LEPLT119
C        PERPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN) -- SAME AS       LEPLT120
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C                'PERPLT', BUT FOR THREE DIMENSIONAL POLAR SPACE      LEPLT121
C                COORDINATES.                                         LEPLT122
C                RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN - AS IN 'PROPLP'.   LEPLT123
C           TRANSP(RHOPOS,ALFPOS,BETPOS,GAMPOS,XPROJ,YPROJ) -- SAME   LEPLT124
C                AS 'TRANSL', BUT FOR THREE DIMENSIONAL POLAR SPACE   LEPLT125
C                COORDINATES.                                         LEPLT126
C                RHOPOS,ALFPOS,BETPOS,GAMPOS - AS IN 'PROPLP'.        LEPLT127
C                XPROJ,YPROJ - AS IN 'TRANSL'.                        LEPLT128
C           PSTAND -- CAUSES CERTAIN OF THE PARAMETERS IN 'COMMON'    LEPLT129
C                BLOCK '/PROJEC/' TO BE SET TO CERTAIN STANDARD       LEPLT130
C                VALUES AS FOLLOWS --                                 LEPLT131
C                     XORG   = (UNCHANGED)                            LEPLT132
C                     YORG   = (UNCHANGED)                            LEPLT133
C                     PHIX   = 0.0                                    LEPLT134
C                     PHIY   = 0.0                                    LEPLT135
C                     PHIZ   = 0.0                                    LEPLT136
C                     PTYPE  = (UNCHANGED)                            LEPLT137
C                     ANGISO = 0.5235988 (30 DEGREES)                 LEPLT138
C                     ANGOBL = 0.7853982 (45 DEGREES)                 LEPLT139
C                     PICANG = 1.0471976 (60 DEGREES)                 LEPLT140
C                     DGLH   = 10.0                                   LEPLT141
C                     EXTENT = (UNCHANGED)                            LEPLT142
C                     SUBTND = 0.5235988 (30 DEGREES)                 LEPLT143
C                     DOH    = (UNCHANGED)                            LEPLT144
C                     DOC    = (UNCHANGED)                            LEPLT145
C                AFTER THESE VALUES ARE SET, CONTROL IS AUTOMATICALLYLEPLT146
C                TRANSFERRED TO 'REINIT'.                             LEPLT147
C           REINIT -- CAUSES THE PARAMETERS DERIVED FROM THE          LEPLT148
C                PARAMETERS IN 'COMMON' BLOCK '/PROJEC/' TO BE        LEPLT149
C                REINITIALIZED.  THIS ENTRY POINT MUST BE CALLED      LEPLT150
C                WHENEVER THE RELEVANT PARAMETERS ARE CHANGED.        LEPLT151
C                                                                     LEPLT152
C      CCMMON BLOCK                                                   LEPLT153
C           /PROJEC/XORG,YORG,PHIX,PHIY,PHIZ,PTYPE,ANGISO,ANGOBL,     LEPLT154
C                PICANG,DGLH,EXTENT,SUBTND,DOH,DOC                    LEPLT155
C                XORG,YORG - COORDINATES (IN PLANE OF GRAPH PAPER)    LEPLT156
C                          OF PROJECTED ORIGIN                        LEPLT157
C                PHIX,PHIY,PHIZ - A GENERALIZED ROTATION OF THE       LEPLT158
C                          COORDINATE AXES PRIOR TO PROJECTION IS     LEPLT159
C                          HANDLED BY ASSUMING THAT THE ROTATED SYS-  LEPLT160
C                          TEM CAN BE MADE TO 'COINCIDE' WITH THE     LEPLT161
C                          UNROTATED SYSTEM BY PERFORMING THE FOL-    LEPLT162
C                          LOWING ROTATIONS IN THIS ORDER --          LEPLT163
C                          (1) -PHIZ AROUND THE Z-AXIS, (2) -PHIY     LEPLT164
C                          AROUND THE Y-AXIS, AND (3) -PHIX AROUND    LEPLT165
C                          THE X-AXIS.  ALL ANGLES ARE TO BE MEASUREDLEPLT166
C                          IN RADIANS.                                LEPLT167
C                PTYPE  - (INTEGER) INDICATES WHICH TYPE OF PRO-      LEPLT168
C                          JECTION IS TO BE USED.                     LEPLT169
C                          = 0  ISOMETRIC PROJECTION                  LEPLT170
C                          = 1  OBLIQUE PROJECTION                    LEPLT171
C                          = 2  PERSPECTIVE PROJECTION                LEPLT172
C                ANGISO - IN AN ISOMETRIC PROJECTION, THE APPARENT    LEPLT173
C                          ANGLE BETWEEN THE HORIZONTAL AND THE X-    LEPLT174
C                          AND Y-AXES.  (IGNORED UNLESS PTYPE=0)      LEPLT175
C                ANGOBL - IN AN OBLIQUE PROJECTION, THE APPARENT      LEPLT176
C                          ANGLE BETWEEN THE X-AXIS AND THE Y-AXIS.   LEPLT177
C                          (IGNORED UNLESS PTYPE=1)                   LEPLT178
C                THE REMAINING PARAMETERS ARE RELATED TO A PERSPEC-   LEPLT179
C                 TIVE PROJECTION AND ARE IGNORED UNLESS PTYPE=2.     LEPLT180
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C                    FOR A MORE DETAILED DISCUSSION OF THE EFFECTS      LEPLT181
C                    OF THESE PARAMETERS ON THE APPEARANCE OF THE PRO-  LEPLT182
C                    JECTION, PLEASE REFER TO EITHER THE WRITE-UP FOR   LEPLT183
C                    THIS PROGRAM OR J. H. HILLS, 'PICTORIAL DRAFTING', LEPLT184
C                    MCGRAW-HILL BOOK COMPANY, INC., NEW YORK, N. Y.,   LEPLT185
C                    1930, PAGES 63FF.                                  LEPLT186
C                  PICANG - ANGLE, IN RADIANS, BETWEEN X-AXIS AND       LEPLT187
C                           PICTURE PLANE.                            LEPLT188
C                  DGLH   - DISTANCE (ON GRAPH PAPER BETWEEN GROUND     LEPLT189
C                           LINE AND HORIZON                          LEPLT190
C                  EXTENT - THE TOTAL HORIZONTAL EXTENT OF THE OBJECT   LEPLT191
C                           PROJECTED ORTHOG NALLY INTO A PLANE       LEPLT192
C                           PARALELL WITH THE PICTURE PLANE.          LEPLT193
C                  SUBTND - ANGLE (IN RADIANS) IN HORIZONTAL PLANE      LEPLT194
C                           SUBTENDED BY OBJECT AT STATION POINT.     LEPLT195
C                  DOH    - DISTANCE FROM ORIGIN OF OBJECT TO PICTURE   LEPLT196
C                           PLANE.                                    LEPLT197
C                  DOC    - DISTANCE FROM ORIGIN OF OBJECT TO CENTER    LEPLT198
C                           LINE (PERPENDICULAR TO PICTURE PLANE      LEPLT199
C                           THROUGH STATION POINT)                    LEPLT200
C                                                                     LEPLT201
C                                                                     LEPLT202
      SUBROUTINE LCEPLT(XPOS,YPOS,IPEN)                               LEPLT203
      COMMON/ORIGIN/X00,Y00                                           LEPLT204
      COMMON/PROJEC/XORG,YORG,PHIX,PHIY,PHIZ,PTYPE,ANGISO,ANGOBL,PICANG,LEPLT205
     +    DGLH,EXTENT,SUBTND,DOH,DOC                                  LEPLT206
      INTEGER PTYPE                                                   LEPLT207
      DATA IENTI,IENTO,IENTP,IENTR/0,0,0,0/                           LEPLT208
      DATA XOF,XFAC,YOF,YFAC,THET,IENT/0.0,1.0,0.0,1.0,0.0,0/         LEPLT209
      IF(IENT.NE.0) GO TO 1                                           LEPLT210
      CALL SYSOFF(XOF,XFAC,YOF,YFAC)                                  LEPLT211
      THETA=THET                                                      LEPLT212
      CTHETA=COS(THETA)                                               LEPLT213
      STHETA=SIN(THETA)                                               LEPLT214
      IENT=1                                                          LEPLT215
    1 CALL SYSPLT(XPOS*CTHETA+YPOS*STHETA,YPOS*CTHETA-XPOS*STHETA,IPEN) LEPLT216
      RETURN                                                          LEPLT217
C                                                                     LEPLT218
C   ** LCEOFF **                                                      LEPLT219
C                                                                     LEPLT220
      ENTRY LCEOFF(XOFF,XFACT,YOFF,YFACT,THETA)                       LEPLT221
      IENT=1                                                          LEPLT222
      CALL SYSOFF(XOFF,XFACT,YOFF,YFACT)                              LEPLT223
      CTHETA=COS(THETA)                                               LEPLT224
      STHETA=SIN(THETA)                                               LEPLT225
      RETURN                                                          LEPLT226
C                                                                     LEPLT227
C   ** PROPLT **                                                      LEPLT228
C                                                                     LEPLT229
      ENTRY PROPLT(XPOS,YPOS,ZPOS,IPEN)                               LEPLT230
      IENTT=0                                                         LEPLT231
      XP=XPOS                                                         LEPLT232
      YP=YPOS                                                         LEPLT233
      ZP=ZPOS                                                         LEPLT234
  201 IF(IENT.NE.0) GO TO 202                                         LEPLT235
      THETA=THET                                                      LEPLT236
      CTHETA=COS(THETA)                                               LEPLT237
      STHETA=SIN(THETA)                                               LEPLT238
      IENT=1                                                          LEPLT239
      CALL SYSOFF(XOF,XFAC,YOF,YFAC)                                  LEPLT240
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  202 IF(PTYPE-1) 302,402,502                                          LEPLT241
C                                                                      LEPLT242
C   ** ISOPLT **                                                       LEPLT243
C                                                                      LEPLT244
      ENTRY ISOPLT(XPOS,YPOS,ZPOS,IPEN)                                LEPLT245
      IENTT=0                                                          LEPLT246
      XP=XPOS                                                          LEPLT247
      YP=YPOS                                                          LEPLT248
      ZP=ZPOS                                                          LEPLT249
  301 IF(IENT.NE.0) GO TO 302                                          LEPLT250
      CALL SYSOFF(XOF,XFAC,YOF,YFAC)                                   LEPLT251
      THETA=THET                                                       LEPLT252
      CTHETA=COS(THETA)                                                LEPLT253
      STHETA=SIN(THETA)                                                LEPLT254
      IENT=1                                                           LEPLT255
  302 IF(IENTI.NE.0) GO TO 303                                         LEPLT256
      CANGI=COS(ANGISO)                                                LEPLT257
      SANGI=SIN(ANGISO)                                                LEPLT258
      IENTI=1                                                          LEPLT259
  303 IF(IENTR.NE.0) GO TO 305                                         LEPLT260
      IENTR=1                                                          LEPLT261
  304 CX=COS(PHIX)                                                     LEPLT262
      SX=SIN(PHIX)                                                     LEPLT263
      CY=COS(PHIY)                                                     LEPLT264
      SY=SIN(PHIY)                                                     LEPLT265
      CZ=COS(PHIZ)                                                     LEPLT266
      SZ=SIN(PHIZ)                                                     LEPLT267
      CXX=CY*CZ                                                        LEPLT268
      CXY=SX*SY*CZ-CX*SZ                                               LEPLT269
      CXZ=CZ*CX*SY+SZ*SX                                               LEPLT270
      CYX=CY*SZ                                                        LEPLT271
      CYY=CX*CZ+SX*SY*SZ                                               LEPLT272
      CYZ=CX*SY*SZ-SX*CZ                                               LEPLT273
      CZX=-SY                                                          LEPLT274
      CZY=SX*CY                                                        LEPLT275
      CZZ=CX*CY                                                        LEPLT276
      GO TO (305,404,504),IENTR                                        LEPLT277
  305 XX=XP*CXX+YP*CXY+ZP*CXZ                                          LEPLT278
      YY=XP*CYX+YP*CYY+ZP*CYZ                                          LEPLT279
      ZZ=XP*CZX+YP*CZY+ZP*CZZ                                          LEPLT280
      XPROJ=(XX-YY)*CANGI+XORG                                         LEPLT281
      YPROJ=(XX+YY)*SANGI+ZZ+YORG                                      LEPLT282
  306 IF(IENTT.NE.0) RETURN                                            LEPLT283
      XP=XPROJ*CTHETA+YPROJ*STHETA                                     LEPLT284
      YP=YPROJ*CTHETA-XPROJ*STHETA                                     LEPLT285
      CALL SYSPLT(XP,YP,IPEN)                                          LEPLT286
      RETURN                                                           LEPLT287
C                                                                      LEPLT288
C   ** OBLPLT **                                                       LEPLT289
C                                                                      LEPLT290
      ENTRY OBLPLT(XPOS,YPOS,ZPOS,IPEN)                                LEPLT291
      IENTT=0                                                          LEPLT292
      XP=XPOS                                                          LEPLT293
      YP=YPOS                                                          LEPLT294
      ZP=ZPOS                                                          LEPLT295
  401 IF(IENT.NE.0) GO TO 402                                          LEPLT296
      CALL SYSOFF(XOF,XFAC,YOF,YFAC)                                   LEPLT297
      THETA=THET                                                       LEPLT298
      CTHETA=COS(THETA)                                                LEPLT299
      STHETA=SIN(THETA)                                                LEPLT300
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      IENT=1                                                          LEPLT301
  402 IF(IENTO.NE.0) GO TO 403                                        LEPLT302
      CANGO=COS(ANGOBL)                                               LEPLT303
      SANGO=SIN(ANGOBL)                                               LEPLT304
      IENTO=1                                                         LEPLT305
  403 IF(IENTR.NE.0) GO TO 404                                        LEPLT306
      IENTR=2                                                         LEPLT307
      GO TO 304                                                       LEPLT308
  404 XX=XP*CXX+YP*CXY+ZP*CXZ                                         LEPLT309
      YY=XP*CYX+YP*CYY+ZP*CYZ                                         LEPLT310
      ZZ=XP*CZX+YP*CZY+ZP*CZZ                                         LEPLT311
      XPROJ=XX+YY*CANGO+XORG                                          LEPLT312
      YPROJ=YY*SANGO+ZZ+YORG                                          LEPLT313
      GO TO 306                                                       LEPLT314
C                                                                     LEPLT315
C  ** PERPLT **                                                       LEPLT316
C                                                                     LEPLT317
      ENTRY PERPLT(XPOS,YPOS,ZPOS,IPEN)                               LEPLT318
      IENTT=0                                                         LEPLT319
      XP=XPOS                                                         LEPLT320
      YP=YPOS                                                         LEPLT321
      ZP=ZPOS                                                         LEPLT322
  501 IF(IENT.NE.0) GO TO 502                                         LEPLT323
      CALL SYSOFF(XOF,XFAC,YOF,YFAC)                                  LEPLT324
      THETA=THET                                                      LEPLT325
      CTHETA=COS(THETA)                                               LEPLT326
      STHETA=SIN(THETA)                                               LEPLT327
      IENT=1                                                          LEPLT328
  502 IF(IENTP.NE.0) GO TO 503                                        LEPLT329
      IENTP=1                                                         LEPLT330
      SPANG=SIN(PICANG)                                               LEPLT331
      CPANG=COS(PICANG)                                               LEPLT332
      TPANG=SPANG/CPANG                                               LEPLT333
      DSP=EXTENT/2/SIN(SUBTND/2)*COS(SUBTND/2)                        LEPLT334
      DPPSP=DSP-DOH                                                   LEPLT335
      XVP2=DPPSP/TPANG                                                LEPLT336
      XVP1=-DPPSP*TPANG                                               LEPLT337
      X01=-DOH/TPANG+DOC                                              LEPLT338
      X02=DOH*TPANG+DOC                                               LEPLT339
      X1=X01                                                          LEPLT340
      X2=X02                                                          LEPLT341
      X0=(X2*XVP2-X1*XVP1)/(XVP2-XVP1+X2-X1)                          LEPLT342
      Y0=DGLH*(X1-X2)/(X1+XVP1-X2-XVP2)                               LEPLT343
      DX0=XORG-X0                                                     LEPLT344
      DY0=YORG-Y0                                                     LEPLT345
  503 IF(IENTR.NE.0) GO TO 504                                        LEPLT346
      IENTR=3                                                         LEPLT347
      GO TO 304                                                       LEPLT348
  504 XX=XP*CXX+YP*CXY+ZP*CXZ                                         LEPLT349
      YY=XP*CYX+YP*CYY+ZP*CYZ                                         LEPLT350
      ZZ=XP*CZX+YP*CZY+ZP*CZZ                                         LEPLT351
      X1=X01-YY/SPANG                                                 LEPLT352
      X2=X02+XX/CPANG                                                 LEPLT353
      DX1=X1+XVP1                                                     LEPLT354
      DX2=X2+XVP2                                                     LEPLT355
      DDX=DX1-DX2                                                     LEPLT356
      XPROJ=(X1*XVP1-X2*XVP2)/DDX+DX0                                 LEPLT357
      YPROJ=ZZ-(DGLH-ZZ)*(X2-X1)/DDX+DY0                              LEPLT358
      GO TO 306                                                       LEPLT359
C                                                                     LEPLT360
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C   ** TRANSL **                                                    LEPLT361
C                                                                   LEPLT362
      ENTRY TRANSL(XPOS,YPOS,ZPOS,XPROJ,YPROJ)                      LEPLT363
      IENTT=1                                                       LEPLT364
      XP=XPOS                                                       LEPLT365
      YP=YPOS                                                       LEPLT366
      ZP=ZPOS                                                       LEPLT367
      GO TO 201                                                     LEPLT368
C                                                                   LEPLT369
C   ** PROPLC **                                                    LEPLT370
C                                                                   LEPLT371
      ENTRY PROPLC(RPOS,THPOS,ZPOS,IPEN)                            LEPLT372
      IENTT=0                                                       LEPLT373
      IGO=1                                                         LEPLT374
  701 XP=RPOS*COS(THPOS)                                            LEPLT375
      YP=RPOS*SIN(THPOS)                                            LEPLT376
      ZP=ZPOS                                                       LEPLT377
  702 GO TO (201,301,401,501),IGO                                   LEPLT378
C                                                                   LEPLT379
C   ** ISOPLC **                                                    LEPLT380
C                                                                   LEPLT381
      ENTRY ISOPLC(RPOS,THPOS,ZPOS,IPEN)                            LEPLT382
      IENTT=0                                                       LEPLT383
      IGO=2                                                         LEPLT384
      GO TO 701                                                     LEPLT385
C                                                                   LEPLT386
C   ** OBLPLC **                                                    LEPLT387
C                                                                   LEPLT388
      ENTRY OBLPLC(RPOS,THPOS,ZPOS,IPEN)                            LEPLT389
      IENTT=0                                                       LEPLT390
      IGO=3                                                         LEPLT391
      GO TO 701                                                     LEPLT392
C                                                                   LEPLT393
C   ** PERPLC **                                                    LEPLT394
C                                                                   LEPLT395
      ENTRY PERPLC(RPOS,THPOS,ZPOS,IPEN)                            LEPLT396
      IENTT=0                                                       LEPLT397
      IGO=4                                                         LEPLT398
      GO TO 701                                                     LEPLT399
C                                                                   LEPLT400
C   ** TRANSC **                                                    LEPLT401
C                                                                   LEPLT402
      ENTRY TRANSC(RPOS,THPOS,ZPOS,XPROJ,YPROJ)                     LEPLT403
      IENTT=1                                                       LEPLT404
      IGO=1                                                         LEPLT405
      GO TO 701                                                     LEPLT406
C                                                                   LEPLT407
C   ** PROPLS **                                                    LEPLT408
C                                                                   LEPLT409
      ENTRY PROPLS(RPOS,THPOS,PHIPOS,IPEN)                          LEPLT410
      IENTT=0                                                       LEPLT411
      IGO=1                                                         LEPLT412
 1201 STH=SIN(THPOS)                                                LEPLT413
      XP=RPOS*STH*COS(PHIPOS)                                       LEPLT414
      YP=RPOS*STH*SIN(PHIPOS)                                       LEPLT415
      ZP=RPOS*COS(THPOS)                                            LEPLT416
      GO TO 702                                                     LEPLT417
C                                                                   LEPLT418
C   ** ISOPLS **                                                    LEPLT419
C                                                                   LEPLT420
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      ENTRY ISOPLS(RPOS,THPOS,PHIPOS,IPEN)                              LEPLT421
      IENTT=0                                                           LEPLT422
      IGO=2                                                             LEPLT423
      GO TO 1201                                                        LEPLT424
C                                                                       LEPLT425
C   ** OBLPLS **                                                        LEPLT426
C                                                                       LEPLT427
      ENTRY OBLPLS(RPOS,THPOS,PHIPOS,IPEN)                              LEPLT428
      IENTT=0                                                           LEPLT429
      IGO=3                                                             LEPLT430
      GO TO 1201                                                        LEPLT431
C                                                                       LEPLT432
C   ** PERPLS **                                                        LEPLT433
C                                                                       LEPLT434
      ENTRY PERPLS(RPOS,THPOS,PHIPOS,IPEN)                              LEPLT435
      IGO=4                                                             LEPLT436
      IENTT=0                                                           LEPLT437
      GO TO 1201                                                        LEPLT438
C                                                                       LEPLT439
C   ** TRANSS **                                                        LEPLT440
C                                                                       LEPLT441
      ENTRY TRANSS(RPOS,THPOS,PHIPOS,XPROJ,YPROJ)                       LEPLT442
      IGO=1                                                             LEPLT443
      IENTT=1                                                           LEPLT444
      GO TO 1201                                                        LEPLT445
C                                                                       LEPLT446
C   ** PROPLP **                                                        LEPLT447
C                                                                       LEPLT448
      ENTRY PROPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN)                    LEPLT449
      IENTT=0                                                           LEPLT450
      IGO=1                                                             LEPLT451
 1701 XP=RHOPOS*COS(ALFPOS)                                             LEPLT452
      YP=RHOPOS*COS(BETPOS)                                             LEPLT453
      ZP=RHOPOS*COS(GAMPOS)                                             LEPLT454
      GO TO 702                                                         LEPLT455
C                                                                       LEPLT456
C   ** ISOPLP **                                                        LEPLT457
C                                                                       LEPLT458
      ENTRY ISOPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN)                    LEPLT459
      IENTT=0                                                           LEPLT460
      IGO=2                                                             LEPLT461
      GO TO 1701                                                        LEPLT462
C                                                                       LEPLT463
C   ** OBLPLP **                                                        LEPLT464
C                                                                       LEPLT465
      ENTRY OBLPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN)                    LEPLT466
      IENTT=0                                                           LEPLT467
      IGO=3                                                             LEPLT468
      GO TO 1701                                                        LEPLT469
C                                                                       LEPLT470
C   ** PERPLP **                                                        LEPLT471
C                                                                       LEPLT472
      ENTRY PERPLP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN)                    LEPLT473
      IENTT=0                                                           LEPLT474
      IGO=4                                                             LEPLT475
      GO TO 1701                                                        LEPLT476
C                                                                       LEPLT477
C   ** TRANSP **                                                        LEPLT478
C                                                                       LEPLT479
      ENTRY TRANSP(RHOPOS,ALFPOS,BETPOS,GAMPOS,IPEN)                    LEPLT480
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      IENTT=1                                                          LEPLT481
      IGO=1                                                            LEPLT482
      GO TO 1701                                                       LEPLT483
C                                                                      LEPLT484
C  ** PSTAND **                                                        LEPLT485
C                                                                      LEPLT486
      ENTRY PSTAND                                                     LEPLT487
      PHIX=0.0                                                         LEPLT488
      PHIY=0.0                                                         LEPLT489
      PHIZ=0.0                                                         LEPLT490
      ANGISO=0.5235988                                                 LEPLT491
      ANGOBL=0.7853982                                                 LEPLT492
      PICANG=1.0471976                                                 LEPLT493
      DGLH=10.0                                                        LEPLT494
      SUBTND=0.5235988                                                 LEPLT495
C                                                                      LEPLT496
C  ** REINIT **                                                        LEPLT497
C                                                                      LEPLT498
      ENTRY REINIT                                                     LEPLT499
      IENTI=0                                                          LEPLT500
      IENTO=0                                                          LEPLT501
      IENTP=0                                                          LEPLT502
      IENTR=0                                                          LEPLT503
      XOO=XORG                                                         LEPLT504
      YOO=YORG                                                         LEPLT505
      RETURN                                                           LEPLT506
C                                                                      LEPLT507
C  ** PINVRT **                                                        LEPLT508
C                                                                      LEPLT509
      ENTRY PINVRT(X,Y,XP,YP,ZP)                                       LEPLT510
      IF(PTYPE-1) 2401,2402,2403                                       LEPLT511
 2401 XMY=(X-XORG)/CANGI                                               LEPLT512
      XPY=(Y-ZP-YORG)/SANGI                                            LEPLT513
      XX=(XMY+XPY)/2                                                   LEPLT514
      YY=(XPY-XMY)/2                                                   LEPLT515
      GO TO 2404                                                       LEPLT516
 2402 YY=(Y -ZP-YORG)/SANGO                                            LEPLT517
      XX=X-XORG-YY*CANGO                                               LEPLT518
      GO TO 2404                                                       LEPLT519
 2403 DGLHZ=DGLH-ZP                                                    LEPLT520
      XX=CPANG*((Y-ZP-DY0)*(XVP1-X02)-DGLHZ*(X-DX0-X02))/(Y-DY0-DGLHZ) LEPLT521
      YY=SPANG*((Y-ZP-DY0)*(X01-XVP2)+DGLHZ*(X-DX0-X01))/(Y-DY0-DGLHZ) LEPLT522
 2404 XP=XX*CXX+YY*CYX                                                 LEPLT523
      YP=XX*CXY+YY*CYY                                                 LEPLT524
      RETURN                                                           LEPLT525
      END                                                              LEPLT526
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